
# Port Expansion Project EIS

## Appendix List

AECOM BMT WBM

# Appendix List

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# Port Expansion Project EIS

## Appendix Q1

## Port Expansion Operational Modal Split

AECOM BMT WBM

| | | | | | | | | | | | | | | 15 | t / truck | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Commodity** | **YEAR** | | | | | | | tonnage change (2010 to 2035) | additional 2035 tonnage over base | % by road | 2035 road tonnage | 2035 road trips (loaded) | Origin/destination % traffic split | | | Origin/destination loaded traffic split | | | |
| | | **2010** | **2015** | **2020** | **2025** | **2030** | **2035** | **2040** | | | | | | **North** | **Tsv** | **South** | **North** | **Tsv** | **South** | |
| **Import** | **Dry Bulk** | | | | | | | | | | | | | | | | | | | |
| | Cement | 500,000 | 525,000 | 600,000 | 700,000 | 700,000 | 700,000 | 745,500 | 200,000 | 200,000 | 60% | 120,000 | 8,000 | 10% | 80% | 10% | 800 | 6,400 | 800 | |
| | Fertilizer | 140,000 | 155,000 | 170,000 | 195,000 | 195,000 | 195,000 | 207,675 | | | | | | | | | | | | |
| | Nickel Ore | 4,100,000 | 5,000,000 | 6,200,000 | 8,000,000 | 8,000,000 | 8,000,000 | 8,520,000 | | | | | | | | | | | | |
| | Sulphur | 100,000 | 300,000 | 500,000 | 500,000 | 500,000 | 625,000 | 665,625 | | | | | | | | | | | | |
| | Mineral Concentrates | 230,000 | 250,000 | 275,000 | 300,000 | 300,000 | 300,000 | 319,500 | | | | | | | | | | | | |
| | **Wet Bulk** | | | | | | 0 | | | | | | | | | | | | | |
| | Ammonia | 0 | 100,000 | 200,000 | 200,000 | 200,000 | 200,000 | 213,000 | | | | | | | | | | | | |
| | Bitumen | 0 | 100,000 | 100,000 | 100,000 | 150,000 | 150,000 | 159,750 | 150,000 | 150,000 | 100% | 150,000 | 10,000 | 0% | 50% | 50% | 0 | 5,000 | 5,000 | |
| | Oil | 1,000,000 | 1,000,000 | 1,125,000 | 1,275,000 | 1,900,000 | 1,900,000 | 2,023,500 | 900,000 | 900,000 | 40% | 360,000 | 24,000 | 0% | 50% | 50% | 0 | 12,000 | 12,000 | |
| | Sulphuric Acid | 0 | 0 | 0 | 10,000 | 10,000 | 20,000 | 21,300 | | | | | | | | | | | | |
| | **Break Bulk / Non-Containerised / Containerised** | | | | | | 0 | | | | | | | | | | | | | |
| | Copper Anode | 100,000 | 90,000 | 90,000 | 90,000 | 90,000 | 90,000 | 95,850 | -10,000 | -10,000 | 100% | -10,000 | | 0% | 0% | 100% | 0 | 0 | 0 | |
| | General Cargo | 190,000 | 228,000 | 260,000 | 295,000 | 324,500 | 356,950 | 392,645 | 166,950 | 166,950 | 75% | 125,213 | 8,348 | 5% | 75% | 20% | 417 | 6,261 | 1,670 | |
| | Motor Vehicles | 23,000 | 28,000 | 30,000 | 32,000 | 38,000 | 38,000 | 40,470 | 15,000 | 15,000 | 100% | 15,000 | 1,000 | 5% | 80% | 15% | 50 | 800 | 150 | |
| | Nickel Oxide Cake | 0 | 78,000 | 78,000 | 78,000 | 78,000 | 78,000 | 83,070 | 78,000 | 78,000 | 100% | 78,000 | 5,200 | 100% | 0% | 0% | 5,200 | 0 | 0 | |
| | **Total - Import** | **6,383,000** | **7,854,000** | **9,628,000** | **11,775,000** | **12,485,500** | **12,652,950** | **13,487,885** | | | | | | | | | | | | |
| **Export** | **Dry Bulk** | | | | | | | | | | | | | | | | | | | |
| | Fertilizer | 800,000 | 1,400,000 | 2,000,000 | 2,600,000 | 3,000,000 | 3,000,000 | 3,195,000 | | | | | | | | | | | | |
| | Geothite | 150,000 | 150,000 | 150,000 | 150,000 | 150,000 | 150,000 | 159,750 | | | | | | | | | | | | |
| | Magnetite | 263,000 | 2,200,000 | 3,500,000 | 5,500,000 | 11,200,000 | 11,500,000 | 12,247,500 | | | | | | | | | | | | |
| | Mineral Concentrates | 1,350,000 | 2,085,500 | 2,726,000 | 2,956,000 | 3,956,000 | 3,956,000 | 4,213,140 | | | | | | | | | | | | |
| | Sand/Gravel/Coke | 8,000 | 8,000 | 8,000 | 13,000 | 15,000 | 15,000 | 15,975 | 7,000 | 7,000 | 50% | 3,500 | 233 | 5% | 75% | 20% | 12 | 175 | 47 | |
| | Sugar | 875,000 | 1,200,000 | 1,200,000 | 1,200,000 | 1,200,000 | 1,200,000 | 1,278,000 | | | | | | | | | | | | |
| | Zinc Ferrite | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 | 106,500 | | | | | | | | | | | | |
| | Coal | n/a | 5,000,000 | 8,000,000 | 8,000,000 | 8,000,000 | 8,000,000 | 8,000,000 | | | | | | | | | | | | |
| | New Dry Bulk | 0 | 0 | 0 | 0 | 0 | 1,600,000 | 1,704,000 | 1,600,000 | 1,600,000 | 5% | 80,000 | 5,333 | 50% | 0% | 50% | 2,667 | 0 | 2,667 | |
| | **Wet Bulk** | | | | | | 0 | | | | | | | | | | | | | |
| | Contaminated Oil | 3,000 | 2,000 | 2,000 | 7,000 | 7,000 | 7,000 | 7,455 | 4,000 | 4,000 | 100% | 4,000 | 267 | 0% | 60% | 40% | 0 | 160 | 107 | |
| | Molasses | 178,000 | 200,000 | 200,000 | 200,000 | 200,000 | 200,000 | 213,000 | 22,000 | 22,000 | 60% | 13,200 | 880 | 20% | 0% | 80% | 176 | 0 | 704 | |
| | Sulphuric Acid | 10,000 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | |
| | New Bulk Liquid | n/a | 0 | n/a | n/a | 500,000 | 2,500,000 | 2,662,500 | | | | | | | | | | | | |
| | **Break Bulk / Non-Containerised / Containerised** | | | | | | 0 | | | | | | | | | | | | | |
| | Cattle | 30,000 | 50,000 | 55,000 | 70,000 | 70,000 | 70,000 | 74,550 | 40,000 | 40,000 | 100% | 40,000 | 2,667 | 20% | 0% | 80% | 533 | 0 | 2,133 | |
| | General Cargo | 150,000 | 155,000 | 169,781 | 189,720 | 208,692 | 229,561 | 252,517 | 79,561 | 79,561 | 75% | 59,671 | 3,978 | 5% | 75% | 20% | 199 | 2,984 | 796 | |
| | Meat and By Products | 16,000 | 15,000 | 15,000 | 20,000 | 20,000 | 20,000 | 21,300 | 4,000 | 4,000 | 100% | 4,000 | 267 | 20% | 60% | 20% | 53 | 160 | 53 | |
| | Mineral Concentrates Containers | 63,000 | 85,500 | 98,000 | 98,000 | 98,000 | 98,000 | 104,370 | 35,000 | 35,000 | 100% | 35,000 | 2,333 | 0% | 0% | 100% | 0 | 0 | 2,333 | |
| | Refined Copper | 200,000 | 200,000 | 200,000 | 200,000 | 200,000 | 200,000 | 213,000 | 0 | 0 | 100% | 0 | 0 | 0% | 0% | 100% | 0 | 0 | 0 | |
| | Refined Lead | 150,000 | 150,000 | 150,000 | 150,000 | 150,000 | 150,000 | 159,750 | | | | | | | | | | | | |
| | Refined Nickel | 10,500 | 10,000 | 10,000 | 25,000 | 25,000 | 25,000 | 26,625 | 14,500 | 14,500 | 100% | 14,500 | 967 | 100% | 0% | 0% | 967 | 0 | 0 | |
| | Refined Zinc | 180,000 | 160,000 | 160,000 | 160,000 | 160,000 | 160,000 | 170,400 | -20,000 | -20,000 | 100% | -20,000 | | 0% | 0% | 100% | 0 | 0 | 0 | |
| | Timber | 130,000 | 0 | 0 | 0 | 0 | 0 | 0 | -130,000 | -130,000 | 100% | -130,000 | | 20% | 0% | 80% | 0 | 0 | 0 | |
| | **Total - Export** | **4,666,500** | **13,171,000** | **18,743,781** | **21,638,720** | **29,259,692** | **33,180,561** | **34,825,332** | | | | | | | | | | | | **Total** |
| | **TOTAL - IMPORT & EXPORT** | **11,049,500** | **21,025,000** | **28,371,781** | **33,413,720** | **41,745,192** | **45,833,511** | **48,313,217** | **3,156,011** | | | **942,083** | **73,472** | | | | **11,074** | **33,939** | **28,459** | **73,472** |

**Total Trips Loaded**

| | North | Tsv | South | Total |
|---|---|---|---|---|
| **Ave. Daily Trips (loaded)** | **32** | **97** | **81** | **210** |
| **Ave. Hourly Trips (loaded)** | **3** | **8** | **7** | **17** |

Operations conducted over 350 days p.a.
trucking hours per day 12 hrs

| | North | Tsv | South |
|---|---|---|---|
| **Direction Distribution** | **15.1%** | **46.2%** | **38.7%** |


# Port Expansion Project EIS

## Appendix Q2

## Port Expansion Construction and Operational Traffic Spreadsheet

AECOM BMT WBM

# Road Traffic Estimates for Construction

## Stage A

### Preliminary Construction Schedule

**Dredging**

| Dredge Area | Dredge Methodology | Duration | |
|---|---|---|---|
| Harbour basin & reclamation area | Small TSHD | 23.8 | 93 |
| Harbour basin & reclamation area | Large BHD/GRAB + hopper barges | 23.8 | |
| Harbour basin & reclamation area | Medium Small CSD | 45.3 | |
| Platypus Channel deepening | Medium TSHD | 7.0 | 13 |
| Sea Channel deepening | Medium TSHD | 5.9 | |
| Widen Platypus Channel (ch1,850-2,750) | Large BHD/GRAB + hopper barges | 14.2 | 14 |

| | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| week | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |

**Breakwater & perimeter revetments** 90

**Internal bunds** 35

**Wharves B14 & B15** Pile driving Concrete Construction

**Terminal construction (above wharf facilities)**

### Traffic Estimates - heavy vehicles

**Assumptions** Traffic distributed evenly over 24/7 (or 12/6 for terminal construction)

**Average hourly traffic (Trucks/hour)**

| | | tonnes | truck load | total no. cycles | no.wks | trucks per wk | ave. trucks per hr | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rock for bunds, revetments and breakwaters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bund and core rockfill (selected rockfill < 300mm) | 24/7 | 5,070,510 | 30 | 169,017 | 90 | 1,878 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | | | | | | | | | | | | | | | | |
| Filter layers ($W_{50}$ 300 & 600mm) | 24/7 | 295,078 | 30 | 9,836 | 90 | 109 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | | | | | | | | | | | | | | | | | | | | | | |
| Primary armour - NE b/wtr & NE revetment ($W_{50}$ 7t) | 24/7 | 281,960 | 30 | 9,399 | 90 | 104 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | | | | | | | | | | | | | | | | |
| Primary armour - b/wtr lee & eastern revet. ($W_{50}$ 3t) | 24/7 | 0 | 30 | 0 | 90 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Fill material for reclamation** | 24/7 | 410,938 | 30 | 13,698 | 35 | 391 | 2.3 | | | | | | | | | | | | | | | | | | | | | | | | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | | | | | | | | | | |
| **Pavement base and sub base material** | 24/7 | 26,600 | 30 | 887 | 15 | 59 | 0.4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.4 | 0.4 | 0.4 | | | | | | | | | | |
| **Concrete and materials (wharves)** | 24/7 | 58,622 | 15 | 3,908 | 35 | 112 | 0.7 | | | | | | | | | | | | | | | | | | | | | | | | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | | | | | | | | | | |
| **Terminal construction (2 above wharf facilities)** | 12/6 | 40,000 | 15 | 2,667 | 45 | 59 | 0.8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | | | |
| | | | | 209,411 | | | **Total** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **12.5** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **3.0** | **3.0** | **3.0** | **3.0** | **3.3** | **4.2** | **4.2** | **0.8** | **0.8** | **0.8** | **0.8** | **0.8** | **0.8** | **0.8** | **0.0** | **0.0** | **0.0** |

### Traffic Estimates - passenger vehicles

In addition to the travel to work vehicles assume that there will be general hourly traffic of passenger vehicles

**Peak hourly traffic (cars/hour)**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2** | **2** | **2** | **2** | **2** | **2** | **2** | **2** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **4** | **4** | **4** | **4** | **5** | **5** | **5** | **5** | **5** | **5** | **12** | **12** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | | | |

### Traffic Estimates - passenger vehicles for workers

**Daily worker numbers - assumed vehicle trips occur at peak hours**

| Construction Activity | Peak number of workers | Duration (months) | FTE (workers / month) | No. Daily 12hr shifts | | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Infrastructure Construction (on site)** | | **36** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Contractor's head office and site office | 5 | 36 | 5.0 | 1 | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | |
| Dredge crew incl surveyor, barges and work boats | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Grab dredge | 8 | 4.5 | 1.0 | 2 | | 8 | 8 | 8 | 8 | 8 | | | | | | | | | | | | | | | | 8 | | | | | | | | | | | | | | | | | | | |
| CSD | 10 | 7.5 | 2.1 | 2 | | | | | | | | | | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | |
| TSHD | 10 | 9 | 2.5 | n/a | stay on vessel | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bund and breakwater construction | 10 | 18 | 5.0 | 2 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | | | | | | |
| reclamation fill placement | 5 | 7.5 | 1.0 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | |
| capping layer placement and ground treatment | 5 | 9 | 1.3 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | |
| materials transport operators | 45 | 36 | 45.0 | n/a | part of truck ops | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Piling crew | 5 | 12 | 1.7 | 1 | | | | | | | | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | |
| berth construction | 10 | 12 | 3.3 | 2 | | | | | | | | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | |
| road and rail access | 20 | 6 | 3.3 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | | | | | | | | | | |
| services and utilities construction | 20 | 6 | 3.3 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Port and Marine Operations** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| head office and vessel control | 3 | 36 | 3.0 | 2 | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | |
| Tug crew and pilots, pilot boat crew, linesmen | 10 | 36 | 10.0 | 2 | | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | |
| security staff | 3 | 36 | 3.0 | 2 | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | |
| maintenance and repair crew | 5 | 36 | 5.0 | 2 | | | | | | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Above Wharf Facilities Construction (on site)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Storage sheds, conveyors, shiploaders/unloaders, material receival facilities, administration and amenities buildings, tank farms, pipelines (per berth) | 150 | 18 | 75.0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | | | |
| | | **Total FTE** | **170.5** | | **Total** | **39** | **39** | **39** | **39** | **39** | **21** | **26** | **26** | **31** | **31** | **31** | **31** | **31** | **31** | **31** | **31** | **41** | **41** | **41** | **41** | **59** | **51** | **51** | **96** | **96** | **96** | **96** | **96** | **246** | **246** | **150** | **150** | **150** | **150** | **150** | **150** | **150** | | | |
| | | **Duration** | **36.0** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| car share - avg 2 / veh | 20 | 20 | 20 | 20 | 20 | 11 | 13 | 13 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 21 | 21 | 21 | 21 | 30 | 26 | 26 | 48 | 48 | 48 | 48 | 48 | 123 | 123 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 |

**Construction Related Hourly Vehicles**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 0 | 0 | 0 |
| total cars CW | 20 | 20 | 20 | 20 | 20 | 11 | 13 | 13 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 21 | 21 | 21 | 21 | 30 | 26 | 26 | 48 | 48 | 48 | 48 | 48 | 123 | 123 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 |
| total trucks C | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.3 | 4.2 | 4.2 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.0 | 0.0 | 0.0 |

**Operation Related Hourly Vehicles - workers only (goods seperate)**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars O | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Stage B

### Preliminary Construction Schedule

**Dredging**

| Dredge Area | Dredge Methodology | Duration | |
|---|---|---|---|
| Harbour basin & reclamation area | Small TSHD | 3.3 | 42.1 |
| Harbour basin & reclamation area | Large BHD/GRAB + hopper barges | 1.7 | |
| Harbour basin & reclamation area | Medium Small CSD | 37.1 | |

| | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| week | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
| **Breakwater & perimeter revetments** 90 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Internal bunds** 35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Wharf B16** | | | | | | Pile driving | | | | | | | Concrete Construction | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Terminal construction (above wharf facilities)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

### Traffic Estimates - heavy vehicles

**Assumptions**

Traffic distributed evenly over 24/7 (or 12/6 for terminal construction)

| | | tonnes | truck load | total no. cycles | no.wks | trucks per wk | ave. trucks per hr |
|---|---|---|---|---|---|---|---|
| **Rock for bunds, revetments and breakwaters** | | | | | | | |
| Bund and core rockfill (selected rockfill < 300mm) | 24/7 | 0 | 30 | | | | |
| Filter layers ($W_{50}$ 300 & 600mm) | 12/6 | 11,263 | 30 | 375 | 15 | 25 | 0.3 |
| Primary armour - NE b/wtr & NE revetment ($W_{50}$ 7t) | 24/7 | 0 | 30 | | | | |
| Primary armour - b/wtr lee & eastern revet. ($W_{50}$ 3t) | 24/7 | 0 | 30 | | | | |
| **Fill material for reclamation** | 24/7 | 93,616 | 30 | 3,121 | 15 | 208 | 1.2 |
| **Pavement base and sub base material** | 24/7 | 9,690 | 30 | 323 | 10 | 32 | 0.2 |
| **Concrete and materials (wharves)** | 24/7 | 29,311 | 15 | 1,954 | 35 | 56 | 0.3 |
| **Terminal construction (2 above wharf facilities)** | 12/6 | 20,000 | 15 | 1,333 | 35 | 38 | 0.5 |
| | | | | 7,106 | | | |

**Average hourly traffic (Trucks/hour)**

| | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Filter layers | 0.3 | 0.3 | 0.3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fill material for reclamation | | | | | | | | | | 1.2 | 1.2 | 1.2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pavement base and sub base material | | | | | | | | | | | | | 0.2 | 0.2 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Concrete and materials (wharves) | | | | | | | | | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | | | | | | | | | | | | | | | | | | | |
| Terminal construction (2 above wharf facilities) | | | | | | | | | | | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | | | | | | | | | | | | | | | | | | | | | |
| **Total** | **0.3** | **0.3** | **0.3** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **1.2** | **1.2** | **1.2** | **1.1** | **1.1** | **0.9** | **0.9** | **0.9** | **0.9** | **0.9** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

### Traffic Estimates - passenger vehicles

In addition to the travel to work vehicles assume that there will be general hourly traffic of passenger vehicles

**Peak hourly traffic (cars/hour)**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 3 | | | | | | | | | | | | | | | | | | | | |

### Traffic Estimates - passenger vehicles for workers

| Construction Activity | Peak number of workers | Duration (months) | FTE (workers / month) | No. Daily 12hr shifts | |
|---|---|---|---|---|---|
| **Infrastructure Construction (on site)** | | 18 | | | |
| Contractor's head office and site office | 5 | 18 | 54.2 | 1 | |
| Dredge crew incl surveyor, barges and work boats | | | | | |
| Grab dredge | 0 | 0 | 0.0 | 2 | |
| CSD | 10 | 4.5 | 27.1 | 2 | |
| TSHD | 0 | 0 | 0.0 | n/a | stay on vessel |
| Bund and breakwater construction | 0 | 0 | 0.0 | 2 | |
| reclamation fill placement | 5 | 6 | 18.1 | 2 | |
| capping layer placement and ground treatment | 5 | 6 | 18.1 | 2 | |
| materials transport operators | 10 | 18 | 108.4 | n/a | part of truck ops |
| Piling crew | 5 | 7 | 21.1 | 1 | |
| berth construction | 10 | 8 | 48.2 | 2 | |
| road and rail access | 20 | 6 | 72.3 | 1 | |
| services and utilities construction | 10 | 6 | 36.1 | 1 | |
| **Port and Marine Operations** | | | | | |
| head office and vessel control | 2 | 18 | 21.7 | 2 | |
| Tug crew and pilots, pilot boat crew, linesmen | 7 | 18 | 75.9 | 2 | |
| security staff | 3 | 18 | 32.5 | 2 | |
| maintenance and repair crew | 3 | 18 | 32.5 | 2 | |
| **Above Wharf Facilities Construction (on site)** | | | | | |
| Storage sheds, conveyors, shiploaders/unloaders, material receival facilities, administration and amenities buildings, tank farms, pipelines (per berth) | 75 | 18 | 813.3 | 1 | |
| | | **Total FTE** | **1,379.6** | | |
| | | **Duration** | **18** | | |

**Daily worker numbers**

| | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contractor's head office and site office | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | | |
| CSD | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| reclamation fill placement | | | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| capping layer placement and ground treatment | | | | | | | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Piling crew | | | | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| berth construction | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | | | | | |
| road and rail access | | | | | | | | | | | | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | | | | | | | | | | | | | | | | | | | | | |
| services and utilities construction | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | | | | | |
| head office and vessel control | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tug crew and pilots, pilot boat crew, linesmen | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| security staff | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| maintenance and repair crew | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Storage sheds, conveyors, shiploaders/unloaders, ... (per berth) | | | | | | | | | | | | | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | | | | | | | | | | | | | | | | | | | | |
| **Total** | **23** | **30** | **30** | **30** | **35** | **40** | **45** | **45** | **45** | **45** | **35** | **25** | **120** | **120** | **120** | **120** | **120** | **120** | **120** | **80** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| car share - avg 2 / veh | 12 | 15 | 15 | 15 | 18 | 20 | 23 | 23 | 23 | 23 | 18 | 13 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Construction Related Hourly Vehicles**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total cars CW | 12 | 15 | 15 | 15 | 18 | 20 | 23 | 23 | 23 | 23 | 18 | 13 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total trucks C | 0.3 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Operation Related Hourly Vehicles - workers only (goods seperate)**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars O | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |

# Road Traffic Estimates for Construction

## Stage C

### Preliminary Construction Schedule

**Dredging**

| Dredge Area | Dredge Methodology | Duration | |
|---|---|---|---|
| Harbour basin & reclamation area | Small TSHD | 3.1 | 60 |
| Harbour basin & reclamation area | Large BHD/GRAB + hopper barges | 1.5 | |
| Harbour basin & reclamation area | Medium Small CSD | 55.7 | |
| Platypus Channel deepening | Medium TSHD | 6.7 | 12 |
| Sea Channel deepening | Medium TSHD | 4.8 | |

| | | |
|---|---|---|
| **Breakwater & perimeter revetments** | 90 | |
| **Internal bunds** | 35 | |
| **Wharf B16** | | Pile driving; Concrete Construction |
| **Terminal construction (above wharf facilities)** | | |

Weeks: Year 1 (5–50), Year 2 (55–100), Year 3 (105–150), Year 4 (155–200)

### Traffic Estimates - heavy vehicles

**Assumptions**

Traffic distributed evenly over 24/7 (or 12/6 for terminal construction)

**Average hourly traffic (Trucks/hour)**

| | | tonnes | truck load | total no. cycles | no.wks | trucks per wk | ave. trucks per hr | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
| **Rock for bunds, revetments and breakwaters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bund and core rockfill (selected rockfill < 300mm) | 24/7 | 0 | 30 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Filter layers ($W_{50}$ 300 & 600mm) | 12/6 | 11,263 | 30 | 375 | 15 | 25 | 0.3 | 0.3 | 0.3 | 0.3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Primary armour - NE b/wtr & NE revetment ($W_{50}$ 7t) | 24/7 | 0 | 30 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Primary armour - b/wtr lee & eastern revet. ($W_{50}$ 3t) | 24/7 | 0 | 30 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Fill material for reclamation** | 24/7 | 234,079 | 30 | 7,803 | 30 | 260 | 1.5 | | | | | | | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | | | | | | | | | | | | | | | | | | | | | | |
| **Pavement base and sub base material** | 24/7 | 29,450 | 30 | 982 | 20 | 49 | 0.3 | | | | | | | | | | | | | 0.3 | 0.3 | 0.3 | 0.3 | | | | | | | | | | | | | | | | | | | | | | | | |
| **Concrete and materials (wharves)** | 24/7 | 29,311 | 15 | 1,954 | 35 | 56 | 0.3 | | | | | | | | | | | | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | | | | | | | | | | | | | | | | |
| **Terminal construction (2 above wharf facilities)** | 12/6 | 20,000 | 15 | 1,333 | 40 | 33 | 0.5 | | | | | | | | | | | | | | | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | | | | | | | | | | | | | | | | |
| | | | | 12,447 | | | Total | 0.3 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 1.5 | 1.8 | 1.8 | 1.8 | 2.2 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.5 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

### Traffic Estimates - passenger vehicles

In addition to the travel to work vehicles assume that there will be general hourly traffic of passenger vehicles

**Peak hourly traffic (cars/hour)**

| 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | | | | | | | | | | | | | | | | |

### Traffic Estimates - passenger vehicles for workers

**Daily worker numbers - assumed vehicle trips occur at peak hours**

| Construction Activity | Peak number of workers | Duration (months) | FTE (workers / month) | No. Daily 12hr shifts | | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
| **Infrastructure Construction (on site)** | | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Contractor's head office and site office | 5 | 18 | 5.0 | 1 | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | |
| Dredge crew incl surveyor, barges and work boats | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Grab dredge | 0 | 0 | 0.0 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CSD | 10 | 4.5 | 2.5 | 2 | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TSHD | 10 | 9 | 5.0 | n/a | stay on vessel | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bund and breakwater construction | 0 | 0 | 0.0 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| reclamation fill placement | 5 | 6 | 1.7 | 2 | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| capping layer placement and ground treatment | 5 | 6 | 1.7 | 2 | | | | | | | | | | | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| materials transport operators | 10 | 18 | 10.0 | n/a | part of truck ops | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Piling crew | 5 | 7 | 1.9 | 1 | | | | | | | | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| berth construction | 10 | 8 | 4.4 | 2 | | | | | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | | |
| road and rail access | 20 | 6 | 6.7 | 1 | | | | | | | | | | | | | | | | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | | | | | | | | | | | | | | | | | | |
| services and utilities construction | 10 | 6 | 3.3 | 1 | | | | | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | | |
| **Port and Marine Operations** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| head office and vessel control | 3 | 18 | 3.0 | 2 | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tug crew and pilots, pilot boat crew, linesmen | 10 | 18 | 10.0 | 2 | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| security staff | 3 | 18 | 3.0 | 2 | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| maintenance and repair crew | 5 | 18 | 5.0 | 2 | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Above Wharf Facilities Construction (on site)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Storage sheds, conveyors, shiploaders/unloaders, material receival facilities, administration and amenities buildings, tank farms, pipelines (per berth) | 75 | 18 | 75.0 | 1 | | | | | | | | | | | | | | | | | | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | | | | | | | | | | | | | | | | |
| | | Total FTE | 138 | | Total | 16 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 46 | 51 | 51 | 51 | 51 | 51 | 10 | 45 | 120 | 120 | 120 | 120 | 120 | 120 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Duration | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | car share - avg 2 / veh | | 8 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 23 | 26 | 26 | 26 | 26 | 26 | 5 | 23 | 60 | 60 | 60 | 60 | 60 | 60 | 38 | 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Construction Related Hourly Vehicles**

| | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total cars CW | 8 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 23 | 26 | 26 | 26 | 26 | 26 | 5 | 23 | 60 | 60 | 60 | 60 | 60 | 60 | 38 | 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total trucks C | 0.3 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 1.5 | 1.8 | 1.8 | 1.8 | 2.2 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.5 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Operation Related Hourly Vehicles - workers only (goods seperate)**

| | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars O | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |

# Road Traffic Estimates for Construction

## Stage D

**Preliminary Construction Schedule**

| | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| week | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Activity | Status | | Schedule |
|---|---|---|---|
| Breakwater & perimeter revetments | not required | 0 | |
| Internal bunds | not required | 0 | |
| Wharves B18 & B19 | | | Pile driving (weeks 5–75); Concrete Construction (weeks 80–115) |
| Terminal construction (above wharf facilities) | | | |

### Traffic Estimates - heavy vehicles

**Assumptions** — Traffic distributed evenly over 24/7 (or 12/6 for terminal construction)

| | | tonnes | truck load | total no. cycles | no.wks | trucks per wk | ave. trucks per hr |
|---|---|---|---|---|---|---|---|
| **Rock for bunds, revetments and breakwaters** | | | | | | | |
| Bund and core rockfill (selected rockfill < 300mm) | 24/7 | 0 | 30 | 0 | 90 | 0 | 0.0 |
| Filter layers ($W_{50}$ 300 & 600mm) | 24/7 | 0 | 30 | 0 | 90 | 0 | 0.0 |
| Primary armour - NE b/wtr & NE revetment ($W_{50}$ 7t) | 24/7 | 0 | 30 | 0 | 90 | 0 | 0.0 |
| Primary armour - b/wtr lee & eastern revet. ($W_{50}$ 3t) | 24/7 | 0 | 30 | 0 | 90 | 0 | |
| **Fill material for reclamation** | 24/7 | 100,000 | 30 | 3,333 | 30 | 111 | 0.7 |
| **Pavement base and sub base material** | 24/7 | 30,000 | 20 | 1,500 | 20 | 75 | 0.4 |
| **Concrete and materials (wharves)** | 24/7 | 58,622 | 15 | 3,908 | 35 | 112 | 0.7 |
| **Terminal construction (2 above wharf facilities)** | 12/6 | 40,000 | 15 | 2,667 | 55 | 48 | 0.7 |
| | | | | 11,408 | | | |

**Average hourly traffic (Trucks/hour)**

| | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fill material for reclamation | | | | | | | | | | | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | | | | | | | | | | | | | | | | | | | | | | | | |
| Pavement base and sub base material | | | | | | | | | | | | | | | | | 0.4 | 0.4 | 0.4 | 0.4 | | | | | | | | | | | | | | | | | | | | |
| Concrete and materials (wharves) | | | | | | | | | | | | | | | | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | | | | | | | | | | | | | | | | | | |
| Terminal construction (2 above wharf facilities) | | | | | | | | | | | | | | | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | | | | | | | | | | | | | | | |
| **Total** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.7 | 0.7 | 0.7 | 1.3 | 2.0 | 1.8 | 1.8 | 1.8 | 1.8 | 1.3 | 1.3 | 0.7 | 0.7 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

### Traffic Estimates - passenger vehicles

In addition to the travel to work vehicles assume that there will be general hourly traffic of passenger vehicles

**Peak hourly traffic (cars/hour)**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | | | | | | | | | | | | | | | |

### Traffic Estimates - passenger vehicles for workers

| Construction Activity | Peak number of workers | Duration (months) | FTE (workers / month) | No. Daily 12hr shifts | |
|---|---|---|---|---|---|
| **Infrastructure Construction (on site)** | | 15 | | | |
| Contractor's head office and site office | 5 | 15 | 5.0 | 1 | |
| Dredge crew incl surveyor, barges and work boats | | | | | |
| Grab dredge | 0 | 0 | 0.0 | n/a | |
| CSD | 0 | 0 | 0.0 | n/a | |
| TSHD | 0 | 0 | 0.0 | n/a | stay on vessel |
| Bund and breakwater construction | 10 | 4 | 2.7 | 2 | |
| reclamation fill placement | 0 | 0 | 0.0 | n/a | |
| capping layer placement and ground treatment | 5 | 6 | 2.0 | 2 | |
| materials transport operators | 10 | 15 | 10.0 | n/a | part of truck ops |
| Piling crew | 5 | 12 | 4.0 | 1 | |
| berth construction | 10 | 12 | 8.0 | 2 | |
| road and rail access | 10 | 4.5 | 3.0 | 1 | |
| services and utilities construction | 15 | 6 | 6.0 | 1 | |
| **Port and Marine Operations** | | | | | |
| head office and vessel control | 1 | 15 | 1.0 | 2 | |
| Tug crew and pilots, pilot boat crew, linesmen | 2 | 15 | 2.0 | 2 | |
| security staff | 3 | 15 | 3.0 | 2 | |
| maintenance and repair crew | 1 | 15 | 1.0 | 2 | |
| **Above Wharf Facilities Construction (on site)** | | | | | |
| Storage sheds, conveyors, shiploaders/unloaders, material receival facilities, administration and amenities buildings, tank farms, pipelines (per berth) | 150 | | 0.0 | 1 | |
| | | **Total FTE** | **47.7** | | |
| | | **Duration** | **15.0** | | |

**Daily worker numbers - assumed vehicle trips occur at peak hours**

| | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contractor's head office and site office | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | |
| Bund and breakwater construction | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| capping layer placement and ground treatment | | | | | | | | | | | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | |
| Piling crew | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| berth construction | | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | |
| road and rail access | | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | |
| services and utilities construction | | | | | | | | | | | | | | | | | 15 | 15 | 15 | 15 | | | | | | | | | | | | | | | | | | | | |
| head office and vessel control | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | |
| Tug crew and pilots, pilot boat crew, linesmen | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | | | | | | | | | | | | | |
| security staff | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | | | |
| maintenance and repair crew | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | |
| Storage sheds, conveyors, shiploaders/unloaders, ... (per berth) | | | | | | | | | | | | | | | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | | | | | | | | | | | | | | |
| **Total** | 27 | 27 | 27 | 27 | 27 | 27 | 17 | 17 | 17 | 17 | 22 | 22 | 22 | 42 | 192 | 187 | 197 | 197 | 197 | 197 | 182 | 182 | 182 | 182 | 182 | 150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| car share - avg 2 / veh | 14 | 14 | 14 | 14 | 14 | 14 | 8.5 | 8.5 | 8.5 | 8.5 | 11 | 11 | 11 | 21 | 96 | 94 | 99 | 99 | 99 | 99 | 91 | 91 | 91 | 91 | 91 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Construction Related Hourly Vehicles**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total cars CW | 14 | 14 | 14 | 14 | 14 | 14 | 9 | 9 | 9 | 9 | 11 | 11 | 11 | 21 | 96 | 94 | 99 | 99 | 99 | 99 | 91 | 91 | 91 | 91 | 91 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total trucks C | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.7 | 0.7 | 0.7 | 1.3 | 2.0 | 1.8 | 1.8 | 1.8 | 1.8 | 1.3 | 1.3 | 0.7 | 0.7 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Operation Related Hourly Vehicles - workers only (goods seperate)**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars O | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |

# Road Traffic Estimates for Construction

## Post Stage D

**Preliminary Construction Schedule**

| | | | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | week | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | |
| Breakwater & perimeter revetments | not required | 0 | | | | | | | | | | | | | | | | | | | | |
| Internal bunds | not required | 0 | | | | | | | | | | | | | | | | | | | | |
| Wharves B18 & B19 | | | Pile driving | | | | | | | | | | | | | | | Concrete Construction | | | | |
| Terminal construction (above wharf facilities) | | | | | | | | | | | | | | | | | | | | | | |

| | | | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | week | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | |
| No Dredging | | | | | | | | | | | | | | | | | | | | | | |
| Breakwater & perimeter revetments | not required | 0 | | | | | | | | | | | | | | | | | | | | |
| Internal bunds | not required | 0 | | | | | | | | | | | | | | | | | | | | |
| Wharves B18 & B19 | | | | | | | | | | | | | | | | | | | | | | |
| Terminal construction (above wharf facilities) | | | | | | | | | | | | | | | | | | | | | | |

### Traffic Estimates - heavy vehicles

**Assumptions**

Traffic distributed evenly over 24/7 (or 12/6 for terminal construction)

| | | tonnes | truck load | total no. cycles | no.wks | trucks per wk | ave. trucks per hr |
|---|---|---|---|---|---|---|---|
| **Rock for bunds, revetments and breakwaters** | | | | | | | |
| Bund and core rockfill (selected rockfill < 300mm) | 24/7 | 0 | 30 | 0 | 90 | 0 | 0.0 |
| Filter layers ($W_{50}$ 300 & 600mm) | 24/7 | 0 | 30 | 0 | 90 | 0 | 0.0 |
| Primary armour - NE b/wtr & NE revetment ($W_{50}$ 7t) | 24/7 | 0 | 30 | 0 | 90 | 0 | 0.0 |
| Primary armour - b/wtr lee & eastern revet. ($W_{50}$ 3t) | 24/7 | 0 | 30 | 0 | 90 | 0 | |
| **Fill material for reclamation** | 24/7 | 100,000 | 30 | 3,333 | 30 | 111 | 0.7 |
| **Pavement base and sub base material** | 24/7 | 30,000 | 20 | 1,500 | 20 | 75 | 0.4 |
| **Concrete and materials (wharves)** | 24/7 | 58,622 | 15 | 3,908 | 35 | 112 | 0.7 |
| **Terminal construction (2 above wharf facilities)** | 12/6 | 40,000 | 15 | 2,667 | 55 | 48 | 0.7 |
| | | | | **11,408** | | | **Total** |

**Average hourly traffic (Trucks/hour)**

| | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| week | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| Bund and core rockfill (selected rockfill < 300mm) | | | | | | | | | | | | | | | | | | | | |
| Filter layers ($W_{50}$ 300 & 600mm) | | | | | | | | | | | | | | | | | | | | |
| Primary armour - NE b/wtr & NE revetment ($W_{50}$ 7t) | | | | | | | | | | | | | | | | | | | | |
| Primary armour - b/wtr lee & eastern revet. ($W_{50}$ 3t) | | | | | | | | | | | | | | | | | | | | |
| Fill material for reclamation | | | | | | | | | | | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | | | | |
| Pavement base and sub base material | | | | | | | | | | | | | | | | | 0.4 | 0.4 | 0.4 | 0.4 |
| Concrete and materials (wharves) | | | | | | | | | | | | | | | | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Terminal construction (2 above wharf facilities) | | | | | | | | | | | | | | | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| **Total** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| week | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
| Bund and core rockfill (selected rockfill < 300mm) | | | | | | | | | | | | | | | | | | | | |
| Filter layers ($W_{50}$ 300 & 600mm) | | | | | | | | | | | | | | | | | | | | |
| Primary armour - NE b/wtr & NE revetment ($W_{50}$ 7t) | | | | | | | | | | | | | | | | | | | | |
| Primary armour - b/wtr lee & eastern revet. ($W_{50}$ 3t) | | | | | | | | | | | | | | | | | | | | |
| Fill material for reclamation | | | | | | | | | | | | | | | | | | | | |
| Pavement base and sub base material | | | | | | | | | | | | | | | | | | | | |
| Concrete and materials (wharves) | 0.7 | 0.7 | | | | | | | | | | | | | | | | | | |
| Terminal construction (2 above wharf facilities) | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | | | | | | | | | | | | | | | |
| **Total** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

### Traffic Estimates - passenger vehicles

In addition to the travel to work vehicles assume that there will be general hourly traffic of passenger vehicles

**Peak hourly traffic (cars/hour)**

| week | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |

| week | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0** | **0** | **0** | **0** | **0** | | | | | | | | | | | | | | | |

### Traffic Estimates - passenger vehicles for workers

| Construction Activity | Peak number of workers | Duration (months) | FTE (workers / month) | No. Daily 12hr shifts | |
|---|---|---|---|---|---|
| **Infrastructure Construction (on site)** | | **15** | | | |
| Contractor's head office and site office | 5 | 15 | 5.0 | 1 | |
| Dredge crew incl surveyor, barges and work boats | | | | | |
| Grab dredge | 0 | 0 | 0.0 | n/a | |
| CSD | 0 | 0 | 0.0 | n/a | |
| TSHD | 0 | 0 | 0.0 | n/a | stay on vessel |
| Bund and breakwater construction | 10 | 4 | 2.7 | 2 | |
| reclamation fill placement | 0 | 0 | 0.0 | n/a | |
| capping layer placement and ground treatment | 5 | 6 | 2.0 | 2 | |
| materials transport operators | 10 | 15 | 10.0 | n/a | part of truck ops |
| Piling crew | 5 | 12 | 4.0 | 1 | |
| berth construction | 10 | 12 | 8.0 | 2 | |
| road and rail access | 10 | 4.5 | 3.0 | 1 | |
| services and utilities construction | 15 | 6 | 6.0 | 1 | |
| | | | | | |
| **Port and Marine Operations** | | | | | |
| head office and vessel control | 1 | 15 | 1.0 | 2 | |
| Tug crew and pilots, pilot boat crew, linesmen | 2 | 15 | 2.0 | 2 | |
| security staff | 3 | 15 | 3.0 | 2 | |
| maintenance and repair crew | 1 | 15 | 1.0 | 2 | |
| | | | | | |
| **Above Wharf Facilities Construction (on site)** | | | | | |
| Storage sheds, conveyors, shiploaders/unloaders, material receival facilities, administration and amenities buildings, tank farms, pipelines (per berth) | 150 | | 0.0 | 1 | |
| | | **Total FTE** | **47.7** | | |
| | | **Duration** | **15.0** | | |

**Daily worker numbers - assumed vehicle trips occur at peak hours**

| | Year 1 | | | | | | | | | | Year 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| week | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| Contractor's head office and site office | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Bund and breakwater construction | 10 | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | |
| capping layer placement and ground treatment | | | | | | | | | | | 5 | 5 | 5 | 5 | 5 | 5 | | | | |
| Piling crew | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | |
| berth construction | | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| road and rail access | | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| services and utilities construction | | | | | | | | | | | | | | | | | 15 | 15 | 15 | 15 |
| head office and vessel control | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Tug crew and pilots, pilot boat crew, linesmen | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| security staff | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| maintenance and repair crew | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Storage sheds, conveyors, shiploaders/unloaders, ... (per berth) | | | | | | | | | | | | | | | 150 | 150 | 150 | 150 | 150 | 150 |
| **Total** | **27** | **27** | **27** | **27** | **27** | **27** | **17** | **17** | **17** | **17** | **22** | **22** | **22** | **42** | **192** | **187** | **197** | **197** | **197** | **197** |
| car share - avg 2 / veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Year 3 | | | | | | | | | | Year 4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| week | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
| Contractor's head office and site office | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | |
| Bund and breakwater construction | | | | | | | | | | | | | | | | | | | | |
| capping layer placement and ground treatment | | | | | | | | | | | | | | | | | | | | |
| Piling crew | | | | | | | | | | | | | | | | | | | | |
| berth construction | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | |
| road and rail access | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | |
| services and utilities construction | | | | | | | | | | | | | | | | | | | | |
| head office and vessel control | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | |
| Tug crew and pilots, pilot boat crew, linesmen | 2 | 2 | 2 | 2 | 2 | | | | | | | | | | | | | | | |
| security staff | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | | | |
| maintenance and repair crew | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | |
| Storage sheds, conveyors, shiploaders/unloaders, ... (per berth) | 150 | 150 | 150 | 150 | 150 | 150 | | | | | | | | | | | | | | |
| **Total** | **182** | **182** | **182** | **182** | **182** | **150** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | | | |
| car share - avg 2 / veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Construction Related Hourly Vehicles**

| week | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total cars CW | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total trucks C | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| week | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total cars CW | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total trucks C | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Operation Related Hourly Vehicles - workers only (goods seperate)**

| week | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars O | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |

| week | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total cars O | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |

| | Stage A | | | Stage B | | | Stage C | | | Stage D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Summary description of works** | Works to establish outer harbour basin for berths B14 & B15 and dredge basin to -12.0m; bunds for entire outer harbour footprint; breakwaters and revetments; reclamation and ground treatment; construct wharves B14 & B15 and associated services, roads and cargo transfer facilities; construct first rail loop; first stage of channel deepening & widening of channel approaches. | | | Works to extend outer harbour basin to berth B16; reclamation and ground treatment; construct wharf B16 and associated services, roads and cargo transfer facilities; construct second rail loop. | | | Works to complete outer harbour basin to berth B17, B18 & B19 and dredge basin to -12.9m; complete reclamation and ground treatment; construct wharf B17 and associated services, roads and cargo transfer facilities; construct third rail loop; second stage of channel deepening. | | | Works to construct wharves B18 and B19 and associated services, roads and cargo transfer facilities. | | |
| **Construction Activity** | **Peak number of workers** | **Duration (months)** | **FTE (workers / month)** | **Peak number of workers** | **Duration (months)** | **FTE (workers / month)** | **Peak number of workers** | **Duration (months)** | **FTE (workers / month)** | **Peak number of workers** | **Duration (months)** | **FTE (workers / month)** |
| **Infrastructure Construction (on site)** | | **36** | | | **18** | | | **18** | | | **15** | |
| Contractor's head office and site office | 5 | 36 | 5.0 | 5 | 18 | 5.0 | 5 | 18 | 5.0 | 5 | 15 | 5.0 |
| Dredge crew incl surveyor, barges and work boats | | | | | | | | | | | | |
| Grab dredge | 8 | 4.5 | 1.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 |
| CSD | 10 | 7.5 | 2.1 | 10 | 4.5 | 2.5 | 10 | 4.5 | 2.5 | 0 | 0 | 0.0 |
| TSHD | 10 | 9 | 2.5 | 0 | 0 | 0.0 | 10 | 9 | 5.0 | 0 | 0 | 0.0 |
| Bund and breakwater construction | 10 | 18 | 5.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 10 | 4 | 2.7 |
| reclamation fill placement | 5 | 7.5 | 1.0 | 5 | 6 | 1.7 | 5 | 6 | 1.7 | 0 | 0 | 0.0 |
| capping layer placement and ground treatment | 5 | 9 | 1.3 | 5 | 6 | 1.7 | 5 | 6 | 1.7 | 5 | 6 | 2.0 |
| materials transport operators | 45 | 36 | 45.0 | 10 | 18 | 10.0 | 10 | 18 | 10.0 | 10 | 15 | 10.0 |
| Piling crew | 5 | 12 | 1.7 | 5 | 7 | 1.9 | 5 | 7 | 1.9 | 5 | 12 | 4.0 |
| berth construction | 10 | 12 | 3.3 | 10 | 8 | 4.4 | 10 | 8 | 4.4 | 10 | 12 | 8.0 |
| road and rail access | 20 | 6 | 3.3 | 20 | 6 | 6.7 | 20 | 6 | 6.7 | 10 | 4.5 | 3.0 |
| services and utilities construction | 20 | 6 | 3.3 | 10 | 6 | 3.3 | 10 | 6 | 3.3 | 15 | 6 | 6.0 |
| | | | | | | | | | | | | |
| **Port and Marine Operations** | | | | | | | | | | | | |
| head office and vessel control | 3 | 36 | 3.0 | 2 | 18 | 2.0 | 3 | 18 | 3.0 | 1 | 15 | 1.0 |
| Tug crew and pilots, pilot boat crew, linesmen | 10 | 36 | 10.0 | 7 | 18 | 7.0 | 10 | 18 | 10.0 | 2 | 15 | 2.0 |
| security staff | 3 | 36 | 3.0 | 3 | 18 | 3.0 | 3 | 18 | 3.0 | 3 | 15 | 3.0 |
| maintenance and repair crew | 5 | 36 | 5.0 | 3 | 18 | 3.0 | 5 | 18 | 5.0 | 1 | 15 | 1.0 |
| | | | | | | | | | | | | |
| **Above Wharf Facilities Construction (on site)** | | | | | | | | | | | | |
| Storage sheds, conveyors, shiploaders/unloaders, material receival facilities, administration and amenities buildings, tank farms, pipelines (per berth) | 150 | 18 | 75.0 | 75 | 18 | 75.0 | 75 | 18 | 75.0 | 150 | | 0.0 |
| | | **Total FTE** | **170.5** | | **Total FTE** | **127.2** | | **Total FTE** | **138.2** | | **Total FTE** | **47.7** |
| | | **Duration** | **36.0** | | **Duration** | **18** | | **Duration** | **18** | | **Duration** | **15** |

**Above Wharf Facilities Operation**

| | Stage A | Stage B | Stage C | Stage D |
|---|---|---|---|---|
| Management and administration, equipment operators, general labour, shunters (per berth) | 60 | 30 | 30 | 60 |
| **Cumulative total** | **60** | **90** | **120** | **180** |

= workers live on dredge craft

**Plus:**
Offsite construction support - precast concrete fabrication; structural steel fabrication; equipment fabrication and supply; materials and equipment transport; quarry operations; materials supply, etc.

Employment at mines and other import/export industries which could not be established without the port expansion being in place.

Indirect employment flow-ons from all of the above (residential accommodation, goods and services, etc).

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | add to Stg B traffic | | add to Stg C traffic | | add to Stg D traffic | | add to post Stg D traffic | |
| Car Share - avg 2 / veh | 0 | workers | 60 | workers | 90 | workers | 120 | workers | 180 workers |
| | **0** | **cars** | **30** | **cars** | **45** | **cars** | **60** | **cars** | **90 cars** |
| | **Stage A** | | **Stage B** | | **Stage C** | | **Stage D** | | |

Revision: A
Print Date: 29/08/2011


# Port Expansion Project EIS

## Appendix Q3

## Additional Port Expansion Traffic Spreadsheet

AECOM BMT WBM

| 2014, veh/hr | | | Background + Marine Precinct Traffic | | | Development Traffic Only (2014 AM Peak Hour, Veh/hr) | | | % Background Traffic (2014 AM Peak Hour, Veh/hr) | | | Background + Marine Precinct Traffic | | | Development Traffic Only (2014 PM Peak Hour, Veh/hr) | | | % Background Traffic (2014 PM Peak Hour, Veh/hr) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV |
| Intersection 1: Benwell Rd / Secondary Access | North | Left | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 1 | 1 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 13 | 12 | 1 | 16 | 12 | 4 | 125% | 97% | 781% | 19 | 18 | 1 | 139 | 135 | 4 | 728% | 735% | 554% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | East | Left | 12 | 10 | 2 | 0 | 0 | 0 | 0% | 0% | 0% | 57 | 52 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 1 | 1 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 19 | 18 | 1 | 139 | 135 | 4 | 745% | 743% | 810% | 13 | 13 | 1 | 16 | 12 | 4 | 121% | 95% | 555% |
| | | Right | 60 | 55 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 15 | 12 | 3 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Intersection 2: Benwell Rd / Archer St | North | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 31 | 29 | 2 | 16 | 12 | 4 | 53% | 42% | 209% | 73 | 62 | 10 | 139 | 135 | 4 | 191% | 216% | 40% |
| | | Right | 3 | 3 | 1 | 0 | 0 | 0 | 0% | 0% | 0% | 12 | 11 | 1 | 0 | 0 | 0 | 2% | 2% | 3% |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | South | Left | 53 | 45 | 8 | 0 | 0 | 0 | 0% | 0% | 0% | 60 | 48 | 12 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 76 | 70 | 5 | 139 | 135 | 4 | 184% | 192% | 81% | 34 | 30 | 4 | 16 | 12 | 4 | 48% | 41% | 95% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | 12 | 10 | 2 | 0 | 0 | 0 | 2% | 2% | 1% | 3 | 3 | 0 | 0 | 0 | 0 | 6% | 5% | 11% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 56 | 44 | 11 | 0 | 0 | 0 | 0% | 0% | 0% | 55 | 45 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 3: Benwell Rd / Boundary Rd / Primary Access | North | Left | 27 | 25 | 2 | 0 | 0 | 0 | 0% | 0% | 0% | 6 | 5 | 1 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 28 | 23 | 5 | 5 | 1 | 4 | 19% | 5% | 81% | 77 | 68 | 9 | 18 | 14 | 4 | 23% | 20% | 48% |
| | | Right | 23 | 20 | 4 | 11 | 11 | 0 | 46% | 55% | 0% | 37 | 31 | 6 | 122 | 122 | 0 | 330% | 389% | 0% |
| | East | Left | 87 | 72 | 15 | 0 | 0 | 0 | 0% | 0% | 0% | 406 | 371 | 35 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 23 | 19 | 4 | 0 | 0 | 0 | 0% | 0% | 0% | 108 | 99 | 9 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 6 | 5 | 1 | 0 | 0 | 0 | 0% | 0% | 0% | 27 | 25 | 2 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 1056 | 1011 | 45 | 0 | 0 | 0 | 0% | 0% | 0% | 635 | 573 | 62 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 83 | 75 | 8 | 18 | 14 | 4 | 21% | 18% | 54% | 36 | 28 | 8 | 5 | 1 | 4 | 15% | 4% | 56% |
| | | Right | 427 | 392 | 35 | 0 | 0 | 0 | 0% | 0% | 0% | 108 | 89 | 20 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 37 | 33 | 4 | 122 | 122 | 0 | 332% | 374% | 0% | 26 | 20 | 6 | 11 | 11 | 0 | 42% | 54% | 0% |
| | | Through | 114 | 105 | 9 | 0 | 0 | 0 | 0% | 0% | 0% | 29 | 24 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 455 | 412 | 44 | 0 | 0 | 0 | 0% | 0% | 0% | 1253 | 1195 | 58 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 4: Boundary Rd / Saunders St | North | Left | 98 | 95 | 3 | 0 | 0 | 0 | 0% | 0% | 0% | 140 | 136 | 4 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 645 | 606 | 39 | 0 | 0 | 0 | 0% | 0% | 0% | 1581 | 1527 | 54 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 221 | 199 | 22 | 0 | 0 | 0 | 0% | 0% | 0% | 501 | 469 | 32 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | 96 | 88 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 135 | 126 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 209 | 192 | 16 | 11 | 11 | 0 | 5% | 6% | 0% | 348 | 321 | 27 | 122 | 122 | 0 | 35% | 38% | 0% |
| | | Right | 111 | 108 | 3 | 0 | 0 | 0 | 0% | 0% | 0% | 116 | 112 | 4 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 196 | 189 | 6 | 0 | 0 | 0 | 0% | 0% | 0% | 150 | 141 | 9 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 1023 | 993 | 30 | 0 | 0 | 0 | 0% | 0% | 0% | 665 | 620 | 45 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 57 | 54 | 3 | 0 | 0 | 0 | 0% | 0% | 0% | 45 | 41 | 4 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 527 | 497 | 29 | 0 | 0 | 0 | 0% | 0% | 0% | 346 | 305 | 41 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 341 | 317 | 24 | 122 | 122 | 0 | 36% | 38% | 0% | 296 | 268 | 28 | 11 | 11 | 0 | 4% | 4% | 0% |
| | | Right | 85 | 79 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 309 | 298 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 5: Abbott St / Bruce Hwy | North | Left | 95 | 88 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 211 | 198 | 14 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 236 | 217 | 19 | 0 | 0 | 0 | 0% | 0% | 0% | 532 | 507 | 25 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 1282 | 1172 | 110 | 0 | 0 | 0 | 0% | 0% | 0% | 1485 | 1330 | 155 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 136 | 128 | 8 | 0 | 0 | 0 | 0% | 0% | 0% | 142 | 130 | 12 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | 420 | 401 | 19 | 0 | 0 | 0 | 0% | 0% | 0% | 292 | 264 | 27 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 841 | 746 | 95 | 0 | 0 | 0 | 0% | 0% | 0% | 1233 | 1099 | 134 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Intersection 6: Stuart Dr / Bruce Hwy | North | Left | 293 | 259 | 34 | 0 | 0 | 0 | 0% | 0% | 0% | 548 | 502 | 46 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 275 | 258 | 17 | 0 | 0 | 0 | 0% | 0% | 0% | 441 | 417 | 23 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 96 | 89 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 116 | 106 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | 80 | 75 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 189 | 7 | 182 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 870 | 783 | 87 | 0 | 0 | 0 | 0% | 0% | 0% | 1346 | 121 | 1225 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 596 | 558 | 38 | 0 | 0 | 0 | 0% | 0% | 0% | 474 | 53 | 421 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 289 | 276 | 13 | 0 | 0 | 0 | 0% | 0% | 0% | 360 | 341 | 20 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 307 | 296 | 10 | 0 | 0 | 0 | 0% | 0% | 0% | 264 | 249 | 15 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 145 | 140 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 111 | 105 | 7 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 107 | 100 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 84 | 74 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 799 | 726 | 73 | 0 | 0 | 0 | 0% | 0% | 0% | 823 | 717 | 107 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 563 | 537 | 27 | 0 | 0 | 0 | 0% | 0% | 0% | 544 | 505 | 39 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 7: Stuart Bypass / Bruce Hwy | North | Left | 395 | 355 | 39 | 0 | 0 | 0 | 0% | 0% | 0% | 1051 | 999 | 52 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 38 | 34 | 4 | 5 | 1 | 4 | 14% | 4% | 98% | 101 | 95 | 6 | 18 | 14 | 4 | 18% | 14% | 70% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 1338 | 1228 | 110 | 0 | 0 | 0 | 0% | 0% | 0% | 1510 | 1357 | 153 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 878 | 839 | 39 | 0 | 0 | 0 | 0% | 0% | 0% | 546 | 490 | 56 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 3 | 2 | 1 | 0 | 0 | 0 | 15% | 0% | 68% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 69 | 64 | 4 | 18 | 14 | 4 | 26% | 21% | 103% | 50 | 44 | 6 | 5 | 1 | 4 | 11% | 3% | 73% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 846 | 846 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 1307 | 1307 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 0 | 0 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |

| 2035, veh/hr | | | Traffic (2035 AM Peak Hour, Veh/hr) | | | Development Traffic Only (2035 AM Peak Hour, Veh/hr) | | | % Background Traffic (2035 AM Peak Hour, Veh/hr) | | | Traffic (2035 PM Peak Hour, Veh/hr) | | | Development Traffic Only (2035 PM Peak Hour, Veh/hr) | | | % Background Traffic (2035 PM Peak Hour, Veh/hr) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV |
| Intersection 1: Benwell Rd / Secondary Access | North | Left | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 1 | 1 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 13 | 12 | 1 | 31 | 12 | 19 | 241% | 97% | 3613% | 19 | 18 | 1 | 190 | 171 | 19 | 993% | 929% | 2560% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | East | Left | 12 | 10 | 2 | 0 | 0 | 0 | 0% | 0% | 0% | 57 | 52 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 1 | 1 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 19 | 18 | 1 | 190 | 171 | 19 | 1016% | 938% | 3746% | 13 | 13 | 1 | 31 | 12 | 19 | 233% | 95% | 2567% |
| | | Right | 60 | 55 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 15 | 12 | 3 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Intersection 2: Benwell Rd / Archer St | North | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 38 | 35 | 3 | 31 | 12 | 19 | 83% | 34% | 751% | 80 | 68 | 12 | 190 | 171 | 19 | 238% | 250% | 164% |
| | | Right | 2 | 2 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 12 | 11 | 1 | 0 | 0 | 0 | 2% | 2% | 3% |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | South | Left | 53 | 45 | 8 | 0 | 0 | 0 | 0% | 0% | 0% | 60 | 48 | 12 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 83 | 77 | 6 | 190 | 171 | 19 | 230% | 222% | 338% | 42 | 36 | 6 | 31 | 12 | 19 | 75% | 33% | 331% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | 12 | 10 | 2 | 0 | 0 | 0 | 2% | 2% | 1% | 3 | 3 | 0 | 0 | 0 | 0 | 6% | 5% | 11% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 56 | 44 | 11 | 0 | 0 | 0 | 0% | 0% | 0% | 58 | 48 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 3: Benwell Rd / Boundary Rd / Primary Access | North | Left | 27 | 25 | 2 | 0 | 0 | 0 | 0% | 0% | 0% | 6 | 5 | 1 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 28 | 23 | 5 | 10 | 1 | 9 | 35% | 5% | 167% | 77 | 68 | 9 | 26 | 17 | 9 | 33% | 25% | 99% |
| | | Right | 23 | 20 | 4 | 21 | 11 | 11 | 92% | 55% | 276% | 37 | 31 | 6 | 164 | 153 | 11 | 446% | 492% | 190% |
| | East | Left | 87 | 72 | 15 | 0 | 0 | 0 | 0% | 0% | 0% | 406 | 371 | 35 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 23 | 19 | 4 | 0 | 0 | 0 | 0% | 0% | 0% | 108 | 99 | 9 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 6 | 5 | 1 | 0 | 0 | 0 | 0% | 0% | 0% | 27 | 25 | 2 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 1056 | 1011 | 45 | 0 | 0 | 0 | 0% | 0% | 0% | 635 | 573 | 62 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 82 | 74 | 8 | 26 | 17 | 9 | 31% | 23% | 113% | 36 | 28 | 8 | 10 | 1 | 9 | 28% | 4% | 115% |
| | | Right | 427 | 392 | 35 | 0 | 0 | 0 | 0% | 0% | 0% | 108 | 89 | 20 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 37 | 33 | 4 | 164 | 153 | 11 | 448% | 472% | 258% | 26 | 20 | 6 | 21 | 11 | 11 | 83% | 54% | 192% |
| | | Through | 114 | 105 | 9 | 0 | 0 | 0 | 0% | 0% | 0% | 29 | 24 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 455 | 412 | 44 | 0 | 0 | 0 | 0% | 0% | 0% | 1253 | 1195 | 58 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 4: Boundary Rd / Saunders St | North | Left | 99 | 96 | 3 | 0 | 0 | 0 | 0% | 0% | 0% | 140 | 136 | 4 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 645 | 606 | 39 | 0 | 0 | 0 | 0% | 0% | 0% | 1581 | 1527 | 54 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 221 | 199 | 22 | 0 | 0 | 0 | 0% | 0% | 0% | 501 | 469 | 32 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | 97 | 89 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 136 | 127 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 212 | 195 | 17 | 21 | 11 | 11 | 10% | 6% | 63% | 361 | 333 | 28 | 164 | 153 | 11 | 45% | 46% | 38% |
| | | Right | 111 | 108 | 3 | 0 | 0 | 0 | 0% | 0% | 0% | 116 | 112 | 4 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 196 | 189 | 6 | 0 | 0 | 0 | 0% | 0% | 0% | 150 | 141 | 9 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 1023 | 993 | 30 | 0 | 0 | 0 | 0% | 0% | 0% | 665 | 620 | 45 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 59 | 56 | 4 | 0 | 0 | 0 | 0% | 0% | 0% | 45 | 41 | 4 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 527 | 497 | 29 | 0 | 0 | 0 | 0% | 0% | 0% | 346 | 305 | 41 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 359 | 333 | 26 | 164 | 153 | 11 | 46% | 46% | 41% | 301 | 272 | 29 | 21 | 11 | 11 | 7% | 4% | 37% |
| | | Right | 85 | 79 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 309 | 298 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 5: Abbott St / Bruce Hwy | North | Left | 95 | 88 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 211 | 198 | 14 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 236 | 217 | 19 | 0 | 0 | 0 | 0% | 0% | 0% | 532 | 507 | 25 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 1282 | 1172 | 110 | 0 | 0 | 0 | 0% | 0% | 0% | 1485 | 1330 | 155 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 136 | 128 | 8 | 0 | 0 | 0 | 0% | 0% | 0% | 142 | 130 | 12 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | 420 | 401 | 19 | 0 | 0 | 0 | 0% | 0% | 0% | 292 | 264 | 27 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 841 | 746 | 95 | 0 | 0 | 0 | 0% | 0% | 0% | 1233 | 1099 | 134 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Intersection 6: Stuart Dr / Bruce Hwy | North | Left | 293 | 259 | 34 | 0 | 0 | 0 | 0% | 0% | 0% | 548 | 502 | 46 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 275 | 258 | 17 | 0 | 0 | 0 | 0% | 0% | 0% | 441 | 417 | 23 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 96 | 89 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 116 | 106 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | 80 | 75 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 189 | 7 | 182 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 870 | 783 | 87 | 0 | 0 | 0 | 0% | 0% | 0% | 1346 | 121 | 1225 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 596 | 558 | 38 | 0 | 0 | 0 | 0% | 0% | 0% | 474 | 53 | 421 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 289 | 276 | 13 | 0 | 0 | 0 | 0% | 0% | 0% | 360 | 341 | 20 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 307 | 296 | 10 | 0 | 0 | 0 | 0% | 0% | 0% | 264 | 249 | 15 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 145 | 140 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 111 | 105 | 7 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 107 | 100 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 84 | 74 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 799 | 726 | 73 | 0 | 0 | 0 | 0% | 0% | 0% | 823 | 717 | 107 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 563 | 537 | 27 | 0 | 0 | 0 | 0% | 0% | 0% | 544 | 505 | 39 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 7: Stuart Bypass / Bruce Hwy | North | Left | 437 | 393 | 43 | 0 | 0 | 0 | 0% | 0% | 0% | 1182 | 1124 | 57 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 42 | 38 | 5 | 10 | 1 | 9 | 23% | 3% | 185% | 113 | 106 | 7 | 26 | 17 | 9 | 23% | 16% | 131% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 1468 | 1348 | 120 | 0 | 0 | 0 | 0% | 0% | 0% | 1629 | 1463 | 166 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 964 | 922 | 42 | 0 | 0 | 0 | 0% | 0% | 0% | 589 | 528 | 61 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 3 | 2 | 1 | 0 | 0 | 0 | 14% | 0% | 67% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 72 | 68 | 4 | 26 | 17 | 9 | 36% | 25% | 204% | 52 | 46 | 6 | 10 | 1 | 9 | 19% | 3% | 145% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 846 | 846 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 1307 | 1307 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 0 | 0 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |

| 2036, veh/hr | | | Traffic (2035 AM Peak Hour, Veh/hr) | | | Development Traffic Only (2036 AM Peak Hour, Veh/hr) | | | % Background Traffic (2036 AM Peak Hour, Veh/hr) | | | Traffic (2035 PM Peak Hour, Veh/hr) | | | Development Traffic Only (2036 PM Peak Hour, Veh/hr) | | | % Background Traffic (2036 PM Peak Hour, Veh/hr) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV |
| Intersection 1: Benwell Rd / Secondary Access | North | Left | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 1 | 1 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 13 | 12 | 1 | 20 | 0 | 20 | 157% | 0% | 3809% | 19 | 18 | 1 | 110 | 90 | 20 | 577% | 490% | 2698% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | East | Left | 12 | 10 | 2 | 0 | 0 | 0 | 0% | 0% | 0% | 57 | 52 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 1 | 1 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 19 | 18 | 1 | 110 | 90 | 20 | 590% | 495% | 3963% | 13 | 13 | 1 | 20 | 0 | 20 | 152% | 0% | 2705% |
| | | Right | 60 | 55 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 15 | 12 | 3 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Intersection 2: Benwell Rd / Archer St | North | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 38 | 35 | 3 | 20 | 0 | 20 | 54% | 0% | 792% | 80 | 68 | 12 | 110 | 90 | 20 | 138% | 132% | 173% |
| | | Right | 2 | 2 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 12 | 11 | 1 | 0 | 0 | 0 | 2% | 2% | 3% |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | South | Left | 54 | 46 | 8 | 0 | 0 | 0 | 0% | 0% | 0% | 60 | 48 | 12 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 83 | 77 | 6 | 110 | 90 | 20 | 133% | 117% | 356% | 42 | 36 | 6 | 20 | 0 | 20 | 48% | 0% | 348% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | 12 | 10 | 2 | 0 | 0 | 0 | 2% | 2% | 1% | 3 | 3 | 0 | 0 | 0 | 0 | 6% | 5% | 11% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 56 | 45 | 11 | 0 | 0 | 0 | 0% | 0% | 0% | 59 | 49 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 3: Benwell Rd / Boundary Rd / Primary Access | North | Left | 27 | 25 | 2 | 0 | 0 | 0 | 0% | 0% | 0% | 6 | 5 | 1 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 28 | 23 | 5 | 8 | 0 | 8 | 28% | 0% | 152% | 78 | 69 | 9 | 17 | 9 | 8 | 22% | 13% | 91% |
| | | Right | 24 | 20 | 4 | 12 | 0 | 12 | 52% | 0% | 316% | 37 | 32 | 6 | 93 | 81 | 12 | 251% | 256% | 218% |
| | East | Left | 87 | 72 | 15 | 0 | 0 | 0 | 0% | 0% | 0% | 406 | 371 | 35 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 23 | 19 | 4 | 0 | 0 | 0 | 0% | 0% | 0% | 108 | 99 | 9 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 6 | 5 | 1 | 0 | 0 | 0 | 0% | 0% | 0% | 27 | 25 | 2 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 1095 | 1048 | 47 | 0 | 0 | 0 | 0% | 0% | 0% | 651 | 587 | 64 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 83 | 75 | 8 | 17 | 9 | 8 | 20% | 12% | 103% | 36 | 29 | 8 | 8 | 0 | 8 | 22% | 0% | 104% |
| | | Right | 427 | 392 | 35 | 0 | 0 | 0 | 0% | 0% | 0% | 108 | 89 | 20 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 37 | 33 | 4 | 93 | 81 | 12 | 250% | 244% | 295% | 26 | 21 | 6 | 12 | 0 | 12 | 47% | 0% | 219% |
| | | Through | 114 | 105 | 9 | 0 | 0 | 0 | 0% | 0% | 0% | 29 | 24 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 466 | 422 | 45 | 0 | 0 | 0 | 0% | 0% | 0% | 1290 | 1231 | 59 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 4: Boundary Rd / Saunders St | North | Left | 100 | 97 | 3 | 0 | 0 | 0 | 0% | 0% | 0% | 141 | 137 | 4 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 653 | 614 | 40 | 0 | 0 | 0 | 0% | 0% | 0% | 1599 | 1544 | 55 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 223 | 201 | 22 | 0 | 0 | 0 | 0% | 0% | 0% | 507 | 474 | 33 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | 98 | 91 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 139 | 129 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 215 | 198 | 17 | 12 | 0 | 12 | 6% | 0% | 73% | 366 | 337 | 28 | 93 | 81 | 12 | 26% | 24% | 44% |
| | | Right | 113 | 110 | 3 | 0 | 0 | 0 | 0% | 0% | 0% | 118 | 114 | 4 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 197 | 190 | 6 | 0 | 0 | 0 | 0% | 0% | 0% | 152 | 143 | 9 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 1027 | 996 | 30 | 0 | 0 | 0 | 0% | 0% | 0% | 673 | 628 | 45 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 59 | 56 | 4 | 0 | 0 | 0 | 0% | 0% | 0% | 46 | 41 | 4 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 533 | 503 | 30 | 0 | 0 | 0 | 0% | 0% | 0% | 350 | 309 | 41 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 362 | 336 | 26 | 93 | 81 | 12 | 26% | 24% | 47% | 304 | 275 | 29 | 12 | 0 | 12 | 4% | 0% | 42% |
| | | Right | 86 | 80 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 312 | 302 | 11 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 5: Abbott St / Bruce Hwy | North | Left | 96 | 89 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 213 | 199 | 14 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 238 | 219 | 19 | 0 | 0 | 0 | 0% | 0% | 0% | 536 | 510 | 26 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 1300 | 1189 | 111 | 0 | 0 | 0 | 0% | 0% | 0% | 1509 | 1352 | 158 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 138 | 130 | 8 | 0 | 0 | 0 | 0% | 0% | 0% | 144 | 132 | 12 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | 427 | 407 | 19 | 0 | 0 | 0 | 0% | 0% | 0% | 298 | 270 | 28 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 854 | 758 | 96 | 0 | 0 | 0 | 0% | 0% | 0% | 1259 | 1122 | 136 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Intersection 6: Stuart Dr / Bruce Hwy | North | Left | 296 | 262 | 34 | 0 | 0 | 0 | 0% | 0% | 0% | 556 | 510 | 47 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 278 | 261 | 17 | 0 | 0 | 0 | 0% | 0% | 0% | 448 | 424 | 24 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 98 | 90 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 118 | 108 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | 82 | 77 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 191 | 7 | 185 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 886 | 798 | 89 | 0 | 0 | 0 | 0% | 0% | 0% | 1363 | 123 | 1241 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 607 | 568 | 39 | 0 | 0 | 0 | 0% | 0% | 0% | 480 | 54 | 427 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 289 | 276 | 13 | 0 | 0 | 0 | 0% | 0% | 0% | 364 | 344 | 20 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 307 | 297 | 10 | 0 | 0 | 0 | 0% | 0% | 0% | 266 | 251 | 15 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 146 | 141 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 112 | 106 | 7 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 108 | 101 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 85 | 75 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 808 | 734 | 74 | 0 | 0 | 0 | 0% | 0% | 0% | 833 | 725 | 108 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 569 | 542 | 27 | 0 | 0 | 0 | 0% | 0% | 0% | 550 | 511 | 39 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 7: Stuart Bypass / Bruce Hwy | North | Left | 448 | 404 | 44 | 0 | 0 | 0 | 0% | 0% | 0% | 1217 | 1158 | 59 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 43 | 38 | 5 | 8 | 0 | 8 | 18% | 0% | 166% | 116 | 110 | 7 | 17 | 9 | 8 | 15% | 8% | 117% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 1503 | 1380 | 122 | 0 | 0 | 0 | 0% | 0% | 0% | 1661 | 1491 | 170 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 987 | 944 | 43 | 0 | 0 | 0 | 0% | 0% | 0% | 600 | 538 | 62 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 3 | 2 | 1 | 0 | 0 | 0 | 14% | 0% | 67% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 73 | 69 | 4 | 17 | 9 | 8 | 23% | 13% | 186% | 53 | 47 | 6 | 8 | 0 | 8 | 15% | 0% | 132% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 863 | 863 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 1337 | 1337 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 0 | 0 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |

| 2046, veh/hr | | | Traffic (2035 AM Peak Hour, Veh/hr) | | | Development Traffic Only (2046 AM Peak Hour, Veh/hr) | | | % Background Traffic (2046 AM Peak Hour, Veh/hr) | | | Traffic (2035 PM Peak Hour, Veh/hr) | | | Development Traffic Only (2046 PM Peak Hour, Veh/hr) | | | % Background Traffic (2046 PM Peak Hour, Veh/hr) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV | TOTAL | PV | CV |
| Intersection 1: Benwell Rd / Secondary Access | North | Left | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 1 | 1 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 13 | 12 | 1 | 20 | 0 | 20 | 157% | 0% | 3785% | 19 | 18 | 1 | 110 | 90 | 20 | 578% | 491% | 2684% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | East | Left | 12 | 10 | 2 | 0 | 0 | 0 | 0% | 0% | 0% | 57 | 52 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 1 | 1 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 19 | 18 | 0 | 110 | 90 | 20 | 591% | 495% | 4091% | 13 | 13 | 1 | 20 | 0 | 20 | 151% | 0% | 2688% |
| | | Right | 60 | 55 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 15 | 12 | 3 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Intersection 2: Benwell Rd / Archer St | North | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 38 | 35 | 3 | 20 | 0 | 20 | 54% | 0% | 791% | 80 | 68 | 12 | 110 | 90 | 20 | 138% | 132% | 173% |
| | | Right | 2 | 2 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 12 | 11 | 1 | 0 | 0 | 0 | 2% | 2% | 3% |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | South | Left | 61 | 52 | 9 | 0 | 0 | 0 | 0% | 0% | 0% | 64 | 51 | 14 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 86 | 80 | 6 | 110 | 90 | 20 | 129% | 112% | 351% | 44 | 38 | 6 | 20 | 0 | 20 | 46% | 0% | 342% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | 12 | 10 | 2 | 0 | 0 | 0 | 2% | 2% | 1% | 3 | 3 | 0 | 0 | 0 | 0 | 6% | 5% | 11% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 62 | 49 | 13 | 0 | 0 | 0 | 0% | 0% | 0% | 70 | 59 | 12 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 3: Benwell Rd / Boundary Rd / Primary Access | North | Left | 27 | 25 | 2 | 0 | 0 | 0 | 0% | 0% | 0% | 6 | 5 | 1 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 31 | 25 | 6 | 8 | 0 | 8 | 26% | 0% | 137% | 83 | 74 | 9 | 17 | 9 | 8 | 20% | 12% | 84% |
| | | Right | 27 | 22 | 5 | 12 | 0 | 12 | 46% | 0% | 275% | 42 | 36 | 6 | 93 | 81 | 12 | 222% | 227% | 193% |
| | East | Left | 87 | 72 | 15 | 0 | 0 | 0 | 0% | 0% | 0% | 406 | 371 | 35 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 23 | 19 | 4 | 0 | 0 | 0 | 0% | 0% | 0% | 108 | 99 | 9 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 6 | 5 | 1 | 0 | 0 | 0 | 0% | 0% | 0% | 27 | 25 | 2 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 1572 | 1506 | 65 | 0 | 0 | 0 | 0% | 0% | 0% | 840 | 760 | 80 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 100 | 91 | 9 | 17 | 9 | 8 | 17% | 10% | 84% | 44 | 34 | 9 | 8 | 0 | 8 | 18% | 0% | 87% |
| | | Right | 427 | 392 | 35 | 0 | 0 | 0 | 0% | 0% | 0% | 108 | 89 | 20 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 46 | 41 | 5 | 93 | 81 | 12 | 202% | 197% | 242% | 34 | 27 | 7 | 12 | 0 | 12 | 36% | 0% | 178% |
| | | Through | 114 | 105 | 9 | 0 | 0 | 0 | 0% | 0% | 0% | 29 | 24 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 588 | 534 | 55 | 0 | 0 | 0 | 0% | 0% | 0% | 1719 | 1645 | 73 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 4: Boundary Rd / Saunders St | North | Left | 113 | 109 | 4 | 0 | 0 | 0 | 0% | 0% | 0% | 158 | 154 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 743 | 697 | 46 | 0 | 0 | 0 | 0% | 0% | 0% | 1795 | 1731 | 64 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 254 | 229 | 26 | 0 | 0 | 0 | 0% | 0% | 0% | 570 | 531 | 38 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | 114 | 105 | 9 | 0 | 0 | 0 | 0% | 0% | 0% | 164 | 153 | 11 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 247 | 228 | 19 | 12 | 0 | 12 | 5% | 0% | 64% | 419 | 387 | 31 | 93 | 81 | 12 | 22% | 21% | 40% |
| | | Right | 131 | 128 | 3 | 0 | 0 | 0 | 0% | 0% | 0% | 141 | 136 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 203 | 196 | 7 | 0 | 0 | 0 | 0% | 0% | 0% | 172 | 161 | 10 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 1061 | 1030 | 31 | 0 | 0 | 0 | 0% | 0% | 0% | 761 | 709 | 52 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 61 | 57 | 4 | 0 | 0 | 0 | 0% | 0% | 0% | 52 | 47 | 5 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 601 | 567 | 35 | 0 | 0 | 0 | 0% | 0% | 0% | 394 | 346 | 47 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 396 | 367 | 29 | 93 | 81 | 12 | 24% | 22% | 43% | 338 | 305 | 33 | 12 | 0 | 12 | 4% | 0% | 38% |
| | | Right | 97 | 91 | 6 | 0 | 0 | 0 | 0% | 0% | 0% | 350 | 338 | 12 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 5: Abbott St / Bruce Hwy | North | Left | 107 | 99 | 8 | 0 | 0 | 0 | 0% | 0% | 0% | 228 | 214 | 14 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | 266 | 244 | 21 | 0 | 0 | 0 | 0% | 0% | 0% | 575 | 548 | 27 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 1496 | 1366 | 130 | 0 | 0 | 0 | 0% | 0% | 0% | 1775 | 1586 | 190 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 159 | 149 | 10 | 0 | 0 | 0 | 0% | 0% | 0% | 170 | 155 | 14 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | 497 | 474 | 23 | 0 | 0 | 0 | 0% | 0% | 0% | 365 | 331 | 34 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 996 | 881 | 116 | 0 | 0 | 0 | 0% | 0% | 0% | 1542 | 1378 | 164 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Intersection 6: Stuart Dr / Bruce Hwy | North | Left | 336 | 296 | 40 | 0 | 0 | 0 | 0% | 0% | 0% | 652 | 597 | 55 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 315 | 295 | 20 | 0 | 0 | 0 | 0% | 0% | 0% | 525 | 497 | 28 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 111 | 102 | 8 | 0 | 0 | 0 | 0% | 0% | 0% | 138 | 126 | 12 | 0 | 0 | 0 | 0% | 0% | 0% |
| | East | Left | 98 | 92 | 6 | 0 | 0 | 0 | 0% | 0% | 0% | 217 | 8 | 209 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 1065 | 959 | 106 | 0 | 0 | 0 | 0% | 0% | 0% | 1550 | 145 | 1405 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 730 | 683 | 46 | 0 | 0 | 0 | 0% | 0% | 0% | 546 | 63 | 483 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 296 | 282 | 14 | 0 | 0 | 0 | 0% | 0% | 0% | 398 | 376 | 22 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 314 | 303 | 11 | 0 | 0 | 0 | 0% | 0% | 0% | 291 | 275 | 17 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 149 | 144 | 5 | 0 | 0 | 0 | 0% | 0% | 0% | 123 | 115 | 8 | 0 | 0 | 0 | 0% | 0% | 0% |
| | West | Left | 121 | 113 | 8 | 0 | 0 | 0 | 0% | 0% | 0% | 96 | 84 | 12 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 903 | 817 | 86 | 0 | 0 | 0 | 0% | 0% | 0% | 939 | 814 | 126 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 635 | 604 | 31 | 0 | 0 | 0 | 0% | 0% | 0% | 619 | 574 | 45 | 0 | 0 | 0 | 0% | 0% | 0% |
| Intersection 7: Stuart Bypass / Bruce Hwy | North | Left | 577 | 521 | 56 | 0 | 0 | 0 | 0% | 0% | 0% | 1631 | 1556 | 75 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 56 | 50 | 6 | 8 | 0 | 8 | 14% | 0% | 131% | 156 | 147 | 9 | 17 | 9 | 8 | 11% | 6% | 92% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | East | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 1895 | 1745 | 151 | 0 | 0 | 0 | 0% | 0% | 0% | 2009 | 1801 | 208 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 1246 | 1193 | 53 | 0 | 0 | 0 | 0% | 0% | 0% | 726 | 650 | 76 | 0 | 0 | 0 | 0% | 0% | 0% |
| | South | Left | 3 | 2 | 1 | 0 | 0 | 0 | 13% | 0% | 64% | 3 | 3 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Through | 83 | 78 | 5 | 17 | 9 | 8 | 20% | 12% | 166% | 59 | 53 | 7 | 8 | 0 | 8 | 13% | 0% | 118% |
| | | Right | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | West | Left | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | | Through | 1055 | 1055 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 1669 | 1669 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |
| | | Right | 0 | 0 | 0 | 0 | 0 | 0 | 0% | 0% | 0% | 4 | 4 | 0 | 0 | 0 | 0 | 0% | 0% | 0% |


# Port Expansion Project EIS

## Appendix Q4

## Intersection 1: Benwell Road / Secondary Access SIDRA Summaries

AECOM BMT WBM

# MOVEMENT SUMMARY

**Site: 2014 AM peak WOD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2014 Without Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 36 | 17.6 | 0.063 | 8.7 | LOS A | 0.0 | 0.0 | 0.00 | 0.92 | 49.0 |
| 2 | T | 78 | 6.8 | 0.063 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 114 | 10.2 | 0.063 | 2.7 | LOS A | 0.0 | 0.0 | 0.00 | 0.29 | 56.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 33 | 6.5 | 0.021 | 0.5 | LOS A | 0.2 | 1.2 | 0.26 | 0.00 | 55.0 |
| 9 | R | 4 | 25.0 | 0.021 | 9.6 | LOS A | 0.2 | 1.2 | 0.26 | 0.93 | 48.9 |
| Approach | | 37 | 8.6 | 0.021 | 1.5 | LOS A | 0.2 | 1.2 | 0.26 | 0.11 | 54.2 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.019 | 12.1 | LOS B | 0.1 | 0.5 | 0.21 | 0.88 | 46.3 |
| 12 | R | 47 | 20.0 | 0.053 | 12.4 | LOS B | 0.2 | 2.0 | 0.26 | 0.88 | 46.1 |
| Approach | | 60 | 19.3 | 0.053 | 12.3 | LOS B | 0.2 | 2.0 | 0.25 | 0.88 | 46.2 |
| All Vehicles | | 211 | 12.5 | 0.063 | 5.3 | NA | 0.2 | 2.0 | 0.12 | 0.42 | 52.5 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.



SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2014 AM peak WD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2014 With Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 36 | 17.6 | 0.140 | 8.7 | LOS A | 0.0 | 0.0 | 0.00 | 1.03 | 49.0 |
| 2 | T | 224 | 4.2 | 0.140 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 260 | 6.1 | 0.140 | 1.2 | LOS A | 0.0 | 0.0 | 0.00 | 0.14 | 58.2 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 49 | 12.8 | 0.031 | 1.2 | LOS A | 0.3 | 2.1 | 0.41 | 0.00 | 52.6 |
| 9 | R | 4 | 25.0 | 0.031 | 10.3 | LOS B | 0.3 | 2.1 | 0.41 | 0.91 | 49.1 |
| Approach | | 54 | 13.7 | 0.031 | 1.9 | LOS B | 0.3 | 2.1 | 0.41 | 0.07 | 52.3 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.020 | 13.0 | LOS B | 0.1 | 0.5 | 0.35 | 0.86 | 45.6 |
| 12 | R | 47 | 20.0 | 0.066 | 13.6 | LOS B | 0.3 | 2.4 | 0.41 | 0.89 | 45.2 |
| Approach | | 60 | 19.3 | 0.066 | 13.5 | LOS B | 0.3 | 2.4 | 0.40 | 0.89 | 45.3 |
| All Vehicles | | 374 | 9.3 | 0.140 | 3.3 | NA | 0.3 | 2.4 | 0.12 | 0.25 | 54.8 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.



SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2014 PM peak WOD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2014 Without Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 51 | 18.8 | 0.050 | 8.7 | LOS A | 0.0 | 0.0 | 0.00 | 0.79 | 49.0 |
| 2 | T | 35 | 12.1 | 0.050 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 85 | 16.0 | 0.050 | 5.2 | LOS A | 0.0 | 0.0 | 0.00 | 0.47 | 52.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 76 | 13.9 | 0.050 | 0.3 | LOS A | 0.3 | 2.5 | 0.20 | 0.00 | 56.0 |
| 9 | R | 13 | 8.3 | 0.050 | 8.9 | LOS A | 0.3 | 2.5 | 0.20 | 0.92 | 48.9 |
| Approach | | 88 | 13.1 | 0.050 | 1.5 | LOS A | 0.3 | 2.5 | 0.20 | 0.13 | 54.8 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 10.9 | LOS B | 0.0 | 0.1 | 0.15 | 0.89 | 46.4 |
| 12 | R | 37 | 22.9 | 0.044 | 12.7 | LOS B | 0.2 | 1.7 | 0.29 | 0.87 | 46.0 |
| Approach | | 40 | 21.1 | 0.044 | 12.6 | LOS B | 0.2 | 1.7 | 0.28 | 0.88 | 46.0 |
| All Vehicles | | 214 | 15.8 | 0.050 | 5.0 | NA | 0.3 | 2.5 | 0.14 | 0.41 | 52.2 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.



SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2014 PM peak WD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2014 With Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 51 | 18.8 | 0.061 | 8.7 | LOS A | 0.0 | 0.0 | 0.00 | 0.84 | 49.0 |
| 2 | T | 53 | 18.0 | 0.061 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 103 | 18.4 | 0.061 | 4.3 | LOS A | 0.0 | 0.0 | 0.00 | 0.41 | 54.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 223 | 7.1 | 0.128 | 0.4 | LOS A | 0.9 | 6.9 | 0.25 | 0.00 | 55.3 |
| 9 | R | 13 | 8.3 | 0.128 | 9.0 | LOS A | 0.9 | 6.9 | 0.25 | 0.95 | 49.0 |
| Approach | | 236 | 7.1 | 0.128 | 0.9 | LOS A | 0.9 | 6.9 | 0.25 | 0.05 | 54.9 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.0 | LOS B | 0.0 | 0.1 | 0.18 | 0.88 | 46.4 |
| 12 | R | 37 | 22.9 | 0.055 | 14.1 | LOS B | 0.2 | 2.1 | 0.43 | 0.90 | 44.9 |
| Approach | | 40 | 21.1 | 0.055 | 13.9 | LOS B | 0.2 | 2.1 | 0.41 | 0.89 | 45.0 |
| All Vehicles | | 379 | 11.7 | 0.128 | 3.2 | NA | 0.9 | 6.9 | 0.20 | 0.24 | 53.4 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

# MOVEMENT SUMMARY

**Site: 2035 AM peak WOD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2035 Without Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 56 | 15.1 | 0.080 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.88 | 49.0 |
| 2 | T | 87 | 7.2 | 0.080 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 143 | 10.3 | 0.080 | 3.4 | LOS A | 0.0 | 0.0 | 0.00 | 0.34 | 55.2 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 40 | 7.9 | 0.023 | 0.4 | LOS A | 0.1 | 1.1 | 0.26 | 0.00 | 55.2 |
| 9 | R | 2 | 0.0 | 0.023 | 8.7 | LOS A | 0.1 | 1.1 | 0.26 | 0.93 | 49.0 |
| Approach | | 42 | 7.5 | 0.023 | 0.8 | LOS A | 0.1 | 1.1 | 0.26 | 0.05 | 54.8 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.019 | 12.2 | LOS B | 0.1 | 0.5 | 0.23 | 0.87 | 46.2 |
| 12 | R | 58 | 20.0 | 0.067 | 12.6 | LOS B | 0.3 | 2.5 | 0.29 | 0.88 | 46.0 |
| Approach | | 71 | 19.4 | 0.067 | 12.5 | LOS B | 0.3 | 2.5 | 0.28 | 0.88 | 46.0 |
| All Vehicles | | 256 | 12.3 | 0.080 | 5.5 | NA | 0.3 | 2.5 | 0.12 | 0.44 | 52.3 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).

Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Friday, 19 August 2011 3:29:09 PM
SIDRA INTERSECTION 5.0.5.1510

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2035 WOD\2 Benwell Road - Archer Street - Priority.sip
8000907, AECOM, ENTERPRISE

SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2035 AM peak WD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2035 With Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 56 | 15.1 | 0.189 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 1.01 | 49.0 |
| 2 | T | 286 | 9.2 | 0.189 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 342 | 10.2 | 0.189 | 1.4 | LOS A | 0.0 | 0.0 | 0.00 | 0.16 | 57.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 73 | 31.9 | 0.047 | 1.3 | LOS A | 0.3 | 2.8 | 0.41 | 0.00 | 52.8 |
| 9 | R | 2 | 0.0 | 0.047 | 9.6 | LOS A | 0.3 | 2.8 | 0.41 | 0.93 | 49.2 |
| Approach | | 75 | 31.0 | 0.047 | 1.5 | LOS A | 0.3 | 2.8 | 0.41 | 0.03 | 52.7 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.021 | 13.7 | LOS B | 0.1 | 0.6 | 0.42 | 0.87 | 45.1 |
| 12 | R | 58 | 20.0 | 0.095 | 14.9 | LOS B | 0.4 | 3.5 | 0.49 | 0.94 | 44.2 |
| Approach | | 71 | 19.4 | 0.095 | 14.7 | LOS B | 0.4 | 3.5 | 0.48 | 0.92 | 44.3 |
| All Vehicles | | 487 | 14.7 | 0.189 | 3.3 | NA | 0.4 | 3.5 | 0.13 | 0.25 | 54.6 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

# MOVEMENT SUMMARY

**Site: 2035 PM peak WOD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2035 Without Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 63 | 20.0 | 0.064 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.80 | 49.0 |
| 2 | T | 44 | 14.3 | 0.064 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 107 | 17.6 | 0.064 | 5.2 | LOS A | 0.0 | 0.0 | 0.00 | 0.47 | 53.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 84 | 15.0 | 0.055 | 0.4 | LOS A | 0.4 | 2.8 | 0.23 | 0.00 | 55.4 |
| 9 | R | 13 | 8.3 | 0.055 | 8.9 | LOS A | 0.4 | 2.8 | 0.23 | 0.91 | 48.9 |
| Approach | | 97 | 14.1 | 0.055 | 1.5 | LOS A | 0.4 | 2.8 | 0.23 | 0.12 | 54.5 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.0 | LOS B | 0.0 | 0.1 | 0.18 | 0.88 | 46.4 |
| 12 | R | 61 | 17.2 | 0.071 | 12.6 | LOS B | 0.3 | 2.6 | 0.32 | 0.88 | 45.9 |
| Approach | | 64 | 16.4 | 0.071 | 12.5 | LOS B | 0.3 | 2.6 | 0.31 | 0.88 | 45.9 |
| All Vehicles | | 268 | 16.1 | 0.071 | 5.6 | NA | 0.4 | 2.8 | 0.16 | 0.44 | 51.6 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

# MOVEMENT SUMMARY

**Site: 2035 PM peak WD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2035 With Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 63 | 20.0 | 0.087 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.85 | 49.0 |
| 2 | T | 77 | 34.2 | 0.087 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 140 | 27.8 | 0.087 | 4.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.38 | 54.5 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 284 | 11.5 | 0.165 | 0.7 | LOS A | 1.3 | 9.7 | 0.32 | 0.00 | 54.1 |
| 9 | R | 13 | 8.3 | 0.166 | 9.2 | LOS A | 1.3 | 9.7 | 0.32 | 0.94 | 49.1 |
| Approach | | 297 | 11.3 | 0.165 | 1.0 | LOS A | 1.3 | 9.7 | 0.32 | 0.04 | 53.9 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.2 | LOS B | 0.0 | 0.1 | 0.23 | 0.86 | 46.3 |
| 12 | R | 61 | 17.2 | 0.100 | 14.9 | LOS B | 0.5 | 3.6 | 0.50 | 0.94 | 44.1 |
| Approach | | 64 | 16.4 | 0.100 | 14.7 | LOS B | 0.5 | 3.6 | 0.49 | 0.94 | 44.2 |
| All Vehicles | | 501 | 16.6 | 0.165 | 3.6 | NA | 1.3 | 9.7 | 0.25 | 0.25 | 52.6 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).

Approach LOS values are based on the worst delay for any vehicle movement.

# MOVEMENT SUMMARY

**Site: 2036 AM peak WOD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2036 (Opening Year) Without Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 57 | 14.8 | 0.081 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.88 | 49.0 |
| 2 | T | 87 | 7.2 | 0.081 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 144 | 10.2 | 0.081 | 3.4 | LOS A | 0.0 | 0.0 | 0.00 | 0.35 | 55.1 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 40 | 7.9 | 0.023 | 0.4 | LOS A | 0.1 | 1.1 | 0.26 | 0.00 | 55.2 |
| 9 | R | 2 | 0.0 | 0.023 | 8.7 | LOS A | 0.1 | 1.1 | 0.26 | 0.93 | 49.0 |
| Approach | | 42 | 7.5 | 0.023 | 0.9 | LOS A | 0.1 | 1.1 | 0.26 | 0.05 | 54.8 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.019 | 12.2 | LOS B | 0.1 | 0.5 | 0.24 | 0.87 | 46.2 |
| 12 | R | 59 | 19.6 | 0.068 | 12.5 | LOS B | 0.3 | 2.6 | 0.29 | 0.88 | 46.0 |
| Approach | | 72 | 19.1 | 0.068 | 12.5 | LOS B | 0.3 | 2.6 | 0.28 | 0.88 | 46.0 |
| All Vehicles | | 258 | 12.2 | 0.081 | 5.5 | NA | 0.3 | 2.6 | 0.12 | 0.44 | 52.2 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

# MOVEMENT SUMMARY

**Site: 2036 AM peak WD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2036 (Opening Year) With Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 57 | 14.8 | 0.147 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.97 | 49.0 |
| 2 | T | 203 | 13.5 | 0.147 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 260 | 13.8 | 0.147 | 1.9 | LOS A | 0.0 | 0.0 | 0.00 | 0.21 | 57.2 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 61 | 39.7 | 0.041 | 0.9 | LOS A | 0.3 | 2.3 | 0.35 | 0.00 | 53.7 |
| 9 | R | 2 | 0.0 | 0.041 | 9.2 | LOS A | 0.3 | 2.3 | 0.35 | 0.93 | 49.1 |
| Approach | | 63 | 38.3 | 0.041 | 1.2 | LOS A | 0.3 | 2.3 | 0.35 | 0.03 | 53.5 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.021 | 13.1 | LOS B | 0.1 | 0.6 | 0.36 | 0.86 | 45.6 |
| 12 | R | 59 | 19.6 | 0.085 | 14.0 | LOS B | 0.4 | 3.2 | 0.44 | 0.91 | 44.9 |
| Approach | | 72 | 19.1 | 0.085 | 13.8 | LOS B | 0.4 | 3.2 | 0.42 | 0.90 | 45.0 |
| All Vehicles | | 395 | 18.7 | 0.147 | 3.9 | NA | 0.4 | 3.2 | 0.13 | 0.31 | 54.0 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).

Approach LOS values are based on the worst delay for any vehicle movement.

# MOVEMENT SUMMARY

**Site: 2036 PM peak WOD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2036 (Opening Year) Without Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 63 | 20.0 | 0.064 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.80 | 49.0 |
| 2 | T | 44 | 14.3 | 0.064 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 107 | 17.6 | 0.064 | 5.2 | LOS A | 0.0 | 0.0 | 0.00 | 0.47 | 53.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 84 | 15.0 | 0.055 | 0.4 | LOS A | 0.4 | 2.8 | 0.23 | 0.00 | 55.4 |
| 9 | R | 13 | 8.3 | 0.055 | 8.9 | LOS A | 0.4 | 2.8 | 0.23 | 0.91 | 48.9 |
| Approach | | 97 | 14.1 | 0.055 | 1.5 | LOS A | 0.4 | 2.8 | 0.23 | 0.12 | 54.5 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.0 | LOS B | 0.0 | 0.1 | 0.18 | 0.88 | 46.4 |
| 12 | R | 62 | 16.9 | 0.072 | 12.5 | LOS B | 0.3 | 2.7 | 0.32 | 0.88 | 45.9 |
| Approach | | 65 | 16.1 | 0.072 | 12.5 | LOS B | 0.3 | 2.7 | 0.31 | 0.88 | 45.9 |
| All Vehicles | | 269 | 16.0 | 0.072 | 5.6 | NA | 0.4 | 2.8 | 0.16 | 0.44 | 51.6 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).

Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Wednesday, 5 October 2011 9:54:07 AM
SIDRA INTERSECTION 5.0.5.1510

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2036 WOD\2 Benwell Road - Archer Street - Priority.sip
8000907, AECOM, ENTERPRISE

# MOVEMENT SUMMARY

**Site: 2036 PM peak WD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2036 (Opening Year) With Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 63 | 20.0 | 0.081 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.84 | 49.0 |
| 2 | T | 65 | 41.9 | 0.081 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 128 | 31.1 | 0.081 | 4.3 | LOS A | 0.0 | 0.0 | 0.00 | 0.41 | 54.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 200 | 16.8 | 0.122 | 0.6 | LOS A | 0.9 | 6.9 | 0.30 | 0.00 | 54.5 |
| 9 | R | 13 | 8.3 | 0.123 | 9.1 | LOS A | 0.9 | 6.9 | 0.30 | 0.94 | 49.0 |
| Approach | | 213 | 16.3 | 0.122 | 1.1 | LOS A | 0.9 | 6.9 | 0.30 | 0.06 | 54.1 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.2 | LOS B | 0.0 | 0.1 | 0.22 | 0.86 | 46.3 |
| 12 | R | 62 | 16.9 | 0.090 | 13.9 | LOS B | 0.4 | 3.3 | 0.45 | 0.91 | 44.8 |
| Approach | | 65 | 16.1 | 0.090 | 13.8 | LOS B | 0.4 | 3.3 | 0.44 | 0.91 | 44.9 |
| All Vehicles | | 406 | 21.0 | 0.122 | 4.2 | NA | 0.9 | 6.9 | 0.22 | 0.31 | 52.4 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Friday, 19 August 2011 3:39:29 PM
SIDRA INTERSECTION 5.0.5.1510

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2036 WD\2 Benwell Road - Archer Street - Priority.sip
8000907, AECOM, ENTERPRISE

# MOVEMENT SUMMARY

**Site: 2046 AM peak WOD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2046 (Opening Year + 10 years) Without Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 64 | 14.8 | 0.087 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.87 | 49.0 |
| 2 | T | 91 | 7.0 | 0.087 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 155 | 10.2 | 0.087 | 3.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.36 | 54.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 40 | 7.9 | 0.023 | 0.5 | LOS A | 0.2 | 1.1 | 0.27 | 0.00 | 55.0 |
| 9 | R | 2 | 0.0 | 0.023 | 8.8 | LOS A | 0.2 | 1.1 | 0.27 | 0.92 | 49.0 |
| Approach | | 42 | 7.5 | 0.023 | 0.9 | LOS A | 0.2 | 1.1 | 0.27 | 0.05 | 54.7 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.019 | 12.2 | LOS B | 0.1 | 0.5 | 0.24 | 0.87 | 46.2 |
| 12 | R | 65 | 21.0 | 0.077 | 12.7 | LOS B | 0.4 | 3.0 | 0.31 | 0.88 | 45.9 |
| Approach | | 78 | 20.3 | 0.077 | 12.6 | LOS B | 0.4 | 3.0 | 0.30 | 0.88 | 46.0 |
| All Vehicles | | 275 | 12.6 | 0.087 | 5.7 | NA | 0.4 | 3.0 | 0.12 | 0.46 | 52.0 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).

Approach LOS values are based on the worst delay for any vehicle movement.





SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2046 AM peak WD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2046 (Opening Year + 10 years) With Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 64 | 14.8 | 0.153 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.96 | 49.0 |
| 2 | T | 206 | 13.3 | 0.153 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 271 | 13.6 | 0.153 | 2.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.23 | 57.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 61 | 39.7 | 0.041 | 1.0 | LOS A | 0.3 | 2.4 | 0.36 | 0.00 | 53.5 |
| 9 | R | 2 | 0.0 | 0.041 | 9.3 | LOS A | 0.3 | 2.4 | 0.36 | 0.93 | 49.1 |
| Approach | | 63 | 38.3 | 0.041 | 1.2 | LOS A | 0.3 | 2.4 | 0.36 | 0.03 | 53.4 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.021 | 13.1 | LOS B | 0.1 | 0.6 | 0.37 | 0.86 | 45.5 |
| 12 | R | 65 | 21.0 | 0.097 | 14.2 | LOS B | 0.4 | 3.7 | 0.45 | 0.91 | 44.8 |
| Approach | | 78 | 20.3 | 0.097 | 14.0 | LOS B | 0.4 | 3.7 | 0.43 | 0.91 | 44.9 |
| All Vehicles | | 412 | 18.7 | 0.153 | 4.2 | NA | 0.4 | 3.7 | 0.14 | 0.33 | 53.7 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.



SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2046 PM peak WOD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2046 (Opening Year + 10 years) Without Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 68 | 21.5 | 0.068 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.79 | 49.0 |
| 2 | T | 46 | 13.6 | 0.068 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 115 | 18.3 | 0.068 | 5.2 | LOS A | 0.0 | 0.0 | 0.00 | 0.47 | 52.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 84 | 15.0 | 0.056 | 0.4 | LOS A | 0.4 | 2.8 | 0.24 | 0.00 | 55.2 |
| 9 | R | 13 | 8.3 | 0.056 | 9.0 | LOS A | 0.4 | 2.8 | 0.24 | 0.91 | 48.9 |
| Approach | | 97 | 14.1 | 0.056 | 1.5 | LOS A | 0.4 | 2.8 | 0.24 | 0.12 | 54.3 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.0 | LOS B | 0.0 | 0.1 | 0.18 | 0.88 | 46.4 |
| 12 | R | 75 | 16.9 | 0.087 | 12.6 | LOS B | 0.4 | 3.3 | 0.33 | 0.88 | 45.9 |
| Approach | | 78 | 16.2 | 0.087 | 12.5 | LOS B | 0.4 | 3.3 | 0.32 | 0.88 | 45.9 |
| All Vehicles | | 289 | 16.4 | 0.087 | 6.0 | NA | 0.4 | 3.3 | 0.17 | 0.46 | 51.3 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.





SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2046 PM peak WD (Marine Precinct EIS Layout)**

Benwell Road / Archer Street
2046 (Opening Year + 10 years) With Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 68 | 21.5 | 0.086 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.83 | 49.0 |
| 2 | T | 67 | 40.6 | 0.086 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 136 | 31.0 | 0.086 | 4.4 | LOS A | 0.0 | 0.0 | 0.00 | 0.42 | 53.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 200 | 16.8 | 0.122 | 0.6 | LOS A | 0.9 | 6.9 | 0.30 | 0.00 | 54.3 |
| 9 | R | 13 | 8.3 | 0.123 | 9.2 | LOS A | 0.9 | 6.9 | 0.30 | 0.94 | 49.0 |
| Approach | | 213 | 16.3 | 0.122 | 1.1 | LOS A | 0.9 | 6.9 | 0.30 | 0.06 | 54.0 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.2 | LOS B | 0.0 | 0.1 | 0.23 | 0.86 | 46.3 |
| 12 | R | 75 | 16.9 | 0.109 | 14.0 | LOS B | 0.5 | 4.0 | 0.46 | 0.92 | 44.7 |
| Approach | | 78 | 16.2 | 0.109 | 13.9 | LOS B | 0.5 | 4.0 | 0.45 | 0.92 | 44.8 |
| All Vehicles | | 426 | 21.0 | 0.122 | 4.5 | NA | 0.9 | 6.9 | 0.23 | 0.33 | 52.0 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Friday, 19 August 2011 3:42:23 PM
SIDRA INTERSECTION 5.0.5.1510

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2046 WD\2 Benwell Road - Archer Street - Priority.sip
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# Port Expansion Project EIS

**Appendix Q5**

**Intersection 2: Benwell Road / Archer Street SIDRA Summaries**

AECOM BMT WBM

# MOVEMENT SUMMARY

**Site: 2014 AM peak WOD (GHD Layout)**

Benwell Road / Archer Street
2014 Without Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 36 | 17.6 | 0.063 | 8.7 | LOS A | 0.0 | 0.0 | 0.00 | 0.92 | 49.0 |
| 2 | T | 78 | 6.8 | 0.063 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 114 | 10.2 | 0.063 | 2.7 | LOS A | 0.0 | 0.0 | 0.00 | 0.29 | 56.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 33 | 6.5 | 0.021 | 0.5 | LOS A | 0.2 | 1.2 | 0.26 | 0.00 | 55.0 |
| 9 | R | 4 | 25.0 | 0.021 | 9.6 | LOS A | 0.2 | 1.2 | 0.26 | 0.93 | 48.9 |
| Approach | | 37 | 8.6 | 0.021 | 1.5 | LOS A | 0.2 | 1.2 | 0.26 | 0.11 | 54.2 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.019 | 12.1 | LOS B | 0.1 | 0.5 | 0.21 | 0.88 | 46.3 |
| 12 | R | 47 | 20.0 | 0.053 | 12.4 | LOS B | 0.2 | 2.0 | 0.26 | 0.88 | 46.1 |
| Approach | | 60 | 19.3 | 0.053 | 12.3 | LOS B | 0.2 | 2.0 | 0.25 | 0.88 | 46.2 |
| All Vehicles | | 211 | 12.5 | 0.063 | 5.3 | NA | 0.2 | 2.0 | 0.12 | 0.42 | 52.5 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Friday, 4 November 2011 9:34:40 AM
SIDRA INTERSECTION 5.0.1.1427

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2014 WOD\2 Benwell Road - Archer Street - Priority.sip
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# MOVEMENT SUMMARY

**Site: 2014 AM peak WD (GHD Layout)**

Benwell Road / Archer Street
2014 With Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 36 | 17.6 | 0.140 | 8.7 | LOS A | 0.0 | 0.0 | 0.00 | 1.03 | 49.0 |
| 2 | T | 224 | 4.2 | 0.140 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 260 | 6.1 | 0.140 | 1.2 | LOS A | 0.0 | 0.0 | 0.00 | 0.14 | 58.2 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 49 | 12.8 | 0.031 | 1.2 | LOS A | 0.3 | 2.1 | 0.41 | 0.00 | 52.6 |
| 9 | R | 4 | 25.0 | 0.031 | 10.3 | LOS B | 0.3 | 2.1 | 0.41 | 0.91 | 49.1 |
| Approach | | 54 | 13.7 | 0.031 | 1.9 | LOS B | 0.3 | 2.1 | 0.41 | 0.07 | 52.3 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.020 | 13.0 | LOS B | 0.1 | 0.5 | 0.35 | 0.86 | 45.6 |
| 12 | R | 47 | 20.0 | 0.066 | 13.6 | LOS B | 0.3 | 2.4 | 0.41 | 0.89 | 45.2 |
| Approach | | 60 | 19.3 | 0.066 | 13.5 | LOS B | 0.3 | 2.4 | 0.40 | 0.89 | 45.3 |
| All Vehicles | | 374 | 9.3 | 0.140 | 3.3 | NA | 0.3 | 2.4 | 0.12 | 0.25 | 54.8 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.



SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2014 PM peak WOD (GHD Layout)**

Benwell Road / Archer Street
2014 Without Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 51 | 18.8 | 0.050 | 8.7 | LOS A | 0.0 | 0.0 | 0.00 | 0.79 | 49.0 |
| 2 | T | 35 | 12.1 | 0.050 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 85 | 16.0 | 0.050 | 5.2 | LOS A | 0.0 | 0.0 | 0.00 | 0.47 | 52.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 76 | 13.9 | 0.050 | 0.3 | LOS A | 0.3 | 2.5 | 0.20 | 0.00 | 56.0 |
| 9 | R | 13 | 8.3 | 0.050 | 8.9 | LOS A | 0.3 | 2.5 | 0.20 | 0.92 | 48.9 |
| Approach | | 88 | 13.1 | 0.050 | 1.5 | LOS A | 0.3 | 2.5 | 0.20 | 0.13 | 54.8 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 10.9 | LOS B | 0.0 | 0.1 | 0.15 | 0.89 | 46.4 |
| 12 | R | 37 | 22.9 | 0.044 | 12.7 | LOS B | 0.2 | 1.7 | 0.29 | 0.87 | 46.0 |
| Approach | | 40 | 21.1 | 0.044 | 12.6 | LOS B | 0.2 | 1.7 | 0.28 | 0.88 | 46.0 |
| All Vehicles | | 214 | 15.8 | 0.050 | 5.0 | NA | 0.3 | 2.5 | 0.14 | 0.41 | 52.2 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Friday, 4 November 2011 9:34:40 AM
SIDRA INTERSECTION 5.0.1.1427
Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2014 WOD\2 Benwell Road - Archer Street - Priority.sip
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SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2014 PM peak WD (GHD Layout)**

Benwell Road / Archer Street
2014 With Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 51 | 18.8 | 0.061 | 8.7 | LOS A | 0.0 | 0.0 | 0.00 | 0.84 | 49.0 |
| 2 | T | 53 | 18.0 | 0.061 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 103 | 18.4 | 0.061 | 4.3 | LOS A | 0.0 | 0.0 | 0.00 | 0.41 | 54.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 223 | 7.1 | 0.128 | 0.4 | LOS A | 0.9 | 6.9 | 0.25 | 0.00 | 55.3 |
| 9 | R | 13 | 8.3 | 0.128 | 9.0 | LOS A | 0.9 | 6.9 | 0.25 | 0.95 | 49.0 |
| Approach | | 236 | 7.1 | 0.128 | 0.9 | LOS A | 0.9 | 6.9 | 0.25 | 0.05 | 54.9 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.0 | LOS B | 0.0 | 0.1 | 0.18 | 0.88 | 46.4 |
| 12 | R | 37 | 22.9 | 0.055 | 14.1 | LOS B | 0.2 | 2.1 | 0.43 | 0.90 | 44.9 |
| Approach | | 40 | 21.1 | 0.055 | 13.9 | LOS B | 0.2 | 2.1 | 0.41 | 0.89 | 45.0 |
| All Vehicles | | 379 | 11.7 | 0.128 | 3.2 | NA | 0.9 | 6.9 | 0.20 | 0.24 | 53.4 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.




SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2035 AM peak WOD (GHD Layout)**

Benwell Road / Archer Street
2035 Without Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 56 | 15.1 | 0.080 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.88 | 49.0 |
| 2 | T | 87 | 7.2 | 0.080 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 143 | 10.3 | 0.080 | 3.4 | LOS A | 0.0 | 0.0 | 0.00 | 0.34 | 55.2 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 40 | 7.9 | 0.023 | 0.4 | LOS A | 0.1 | 1.1 | 0.26 | 0.00 | 55.2 |
| 9 | R | 2 | 0.0 | 0.023 | 8.7 | LOS A | 0.1 | 1.1 | 0.26 | 0.93 | 49.0 |
| Approach | | 42 | 7.5 | 0.023 | 0.8 | LOS A | 0.1 | 1.1 | 0.26 | 0.05 | 54.8 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.019 | 12.2 | LOS B | 0.1 | 0.5 | 0.23 | 0.87 | 46.2 |
| 12 | R | 58 | 20.0 | 0.067 | 12.6 | LOS B | 0.3 | 2.5 | 0.29 | 0.88 | 46.0 |
| Approach | | 71 | 19.4 | 0.067 | 12.5 | LOS B | 0.3 | 2.5 | 0.28 | 0.88 | 46.0 |
| All Vehicles | | 256 | 12.3 | 0.080 | 5.5 | NA | 0.3 | 2.5 | 0.12 | 0.44 | 52.3 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Friday, 19 August 2011 3:29:09 PM
SIDRA INTERSECTION 5.0.1.1427

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2035 (without development)\2 Benwell Road - Archer Street - Priority.sip
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SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2035 AM peak WD (GHD Layout)**

Benwell Road / Archer Street
2035 With Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 56 | 15.1 | 0.189 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 1.01 | 49.0 |
| 2 | T | 286 | 9.2 | 0.189 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 342 | 10.2 | 0.189 | 1.4 | LOS A | 0.0 | 0.0 | 0.00 | 0.16 | 57.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 73 | 31.9 | 0.047 | 1.3 | LOS A | 0.3 | 2.8 | 0.41 | 0.00 | 52.8 |
| 9 | R | 2 | 0.0 | 0.047 | 9.6 | LOS A | 0.3 | 2.8 | 0.41 | 0.93 | 49.2 |
| Approach | | 75 | 31.0 | 0.047 | 1.5 | LOS A | 0.3 | 2.8 | 0.41 | 0.03 | 52.7 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.021 | 13.7 | LOS B | 0.1 | 0.6 | 0.42 | 0.87 | 45.1 |
| 12 | R | 58 | 20.0 | 0.095 | 14.9 | LOS B | 0.4 | 3.5 | 0.49 | 0.94 | 44.2 |
| Approach | | 71 | 19.4 | 0.095 | 14.7 | LOS B | 0.4 | 3.5 | 0.48 | 0.92 | 44.3 |
| All Vehicles | | 487 | 14.7 | 0.189 | 3.3 | NA | 0.4 | 3.5 | 0.13 | 0.25 | 54.6 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.



SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2035 PM peak WOD (GHD Layout)**

Benwell Road / Archer Street
2035 Without Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 63 | 20.0 | 0.064 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.80 | 49.0 |
| 2 | T | 44 | 14.3 | 0.064 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 107 | 17.6 | 0.064 | 5.2 | LOS A | 0.0 | 0.0 | 0.00 | 0.47 | 53.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 84 | 15.0 | 0.055 | 0.4 | LOS A | 0.4 | 2.8 | 0.23 | 0.00 | 55.4 |
| 9 | R | 13 | 8.3 | 0.055 | 8.9 | LOS A | 0.4 | 2.8 | 0.23 | 0.91 | 48.9 |
| Approach | | 97 | 14.1 | 0.055 | 1.5 | LOS A | 0.4 | 2.8 | 0.23 | 0.12 | 54.5 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.0 | LOS B | 0.0 | 0.1 | 0.18 | 0.88 | 46.4 |
| 12 | R | 61 | 17.2 | 0.071 | 12.6 | LOS B | 0.3 | 2.6 | 0.32 | 0.88 | 45.9 |
| Approach | | 64 | 16.4 | 0.071 | 12.5 | LOS B | 0.3 | 2.6 | 0.31 | 0.88 | 45.9 |
| All Vehicles | | 268 | 16.1 | 0.071 | 5.6 | NA | 0.4 | 2.8 | 0.16 | 0.44 | 51.6 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Friday, 19 August 2011 3:32:44 PM
SIDRA INTERSECTION 5.0.1.1427

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2035 (without development)\2 Benwell Road - Archer Street - Priority.sip
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SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2035 PM peak WD (GHD Layout)**

Benwell Road / Archer Street
2035 With Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 63 | 20.0 | 0.087 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.85 | 49.0 |
| 2 | T | 77 | 34.2 | 0.087 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 140 | 27.8 | 0.087 | 4.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.38 | 54.5 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 284 | 11.5 | 0.165 | 0.7 | LOS A | 1.3 | 9.7 | 0.32 | 0.00 | 54.1 |
| 9 | R | 13 | 8.3 | 0.166 | 9.2 | LOS A | 1.3 | 9.7 | 0.32 | 0.94 | 49.1 |
| Approach | | 297 | 11.3 | 0.165 | 1.0 | LOS A | 1.3 | 9.7 | 0.32 | 0.04 | 53.9 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.2 | LOS B | 0.0 | 0.1 | 0.23 | 0.86 | 46.3 |
| 12 | R | 61 | 17.2 | 0.100 | 14.9 | LOS B | 0.5 | 3.6 | 0.50 | 0.94 | 44.1 |
| Approach | | 64 | 16.4 | 0.100 | 14.7 | LOS B | 0.5 | 3.6 | 0.49 | 0.94 | 44.2 |
| All Vehicles | | 501 | 16.6 | 0.165 | 3.6 | NA | 1.3 | 9.7 | 0.25 | 0.25 | 52.6 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

# MOVEMENT SUMMARY

**Site: 2036 AM peak WOD (GHD Layout)**

Benwell Road / Archer Street
2036 (Opening Year) Without Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 57 | 14.8 | 0.081 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.88 | 49.0 |
| 2 | T | 87 | 7.2 | 0.081 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 144 | 10.2 | 0.081 | 3.4 | LOS A | 0.0 | 0.0 | 0.00 | 0.35 | 55.1 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 40 | 7.9 | 0.023 | 0.4 | LOS A | 0.1 | 1.1 | 0.26 | 0.00 | 55.2 |
| 9 | R | 2 | 0.0 | 0.023 | 8.7 | LOS A | 0.1 | 1.1 | 0.26 | 0.93 | 49.0 |
| Approach | | 42 | 7.5 | 0.023 | 0.9 | LOS A | 0.1 | 1.1 | 0.26 | 0.05 | 54.8 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.019 | 12.2 | LOS B | 0.1 | 0.5 | 0.24 | 0.87 | 46.2 |
| 12 | R | 59 | 19.6 | 0.068 | 12.5 | LOS B | 0.3 | 2.6 | 0.29 | 0.88 | 46.0 |
| Approach | | 72 | 19.1 | 0.068 | 12.5 | LOS B | 0.3 | 2.6 | 0.28 | 0.88 | 46.0 |
| All Vehicles | | 258 | 12.2 | 0.081 | 5.5 | NA | 0.3 | 2.6 | 0.12 | 0.44 | 52.2 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Wednesday, 5 October 2011 9:54:05 AM
SIDRA INTERSECTION 5.0.1.1427

Project: \\AUBNE1FP001\Jobs\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2036 WOD\2 Benwell Road - Archer Street - Priority.sip
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# MOVEMENT SUMMARY

**Site: 2036 AM peak WD (GHD Layout)**

Benwell Road / Archer Street
2036 (Opening Year) With Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 57 | 14.8 | 0.147 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.97 | 49.0 |
| 2 | T | 203 | 13.5 | 0.147 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 260 | 13.8 | 0.147 | 1.9 | LOS A | 0.0 | 0.0 | 0.00 | 0.21 | 57.2 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 61 | 39.7 | 0.041 | 0.9 | LOS A | 0.3 | 2.3 | 0.35 | 0.00 | 53.7 |
| 9 | R | 2 | 0.0 | 0.041 | 9.2 | LOS A | 0.3 | 2.3 | 0.35 | 0.93 | 49.1 |
| Approach | | 63 | 38.3 | 0.041 | 1.2 | LOS A | 0.3 | 2.3 | 0.35 | 0.03 | 53.5 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.021 | 13.1 | LOS B | 0.1 | 0.6 | 0.36 | 0.86 | 45.6 |
| 12 | R | 59 | 19.6 | 0.085 | 14.0 | LOS B | 0.4 | 3.2 | 0.44 | 0.91 | 44.9 |
| Approach | | 72 | 19.1 | 0.085 | 13.8 | LOS B | 0.4 | 3.2 | 0.42 | 0.90 | 45.0 |
| All Vehicles | | 395 | 18.7 | 0.147 | 3.9 | NA | 0.4 | 3.2 | 0.13 | 0.31 | 54.0 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

# MOVEMENT SUMMARY

**Site: 2036 PM peak WOD (GHD Layout)**

Benwell Road / Archer Street
2036 (Opening Year) Without Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 63 | 20.0 | 0.064 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.80 | 49.0 |
| 2 | T | 44 | 14.3 | 0.064 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 107 | 17.6 | 0.064 | 5.2 | LOS A | 0.0 | 0.0 | 0.00 | 0.47 | 53.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 84 | 15.0 | 0.055 | 0.4 | LOS A | 0.4 | 2.8 | 0.23 | 0.00 | 55.4 |
| 9 | R | 13 | 8.3 | 0.055 | 8.9 | LOS A | 0.4 | 2.8 | 0.23 | 0.91 | 48.9 |
| Approach | | 97 | 14.1 | 0.055 | 1.5 | LOS A | 0.4 | 2.8 | 0.23 | 0.12 | 54.5 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.0 | LOS B | 0.0 | 0.1 | 0.18 | 0.88 | 46.4 |
| 12 | R | 62 | 16.9 | 0.072 | 12.5 | LOS B | 0.3 | 2.7 | 0.32 | 0.88 | 45.9 |
| Approach | | 65 | 16.1 | 0.072 | 12.5 | LOS B | 0.3 | 2.7 | 0.31 | 0.88 | 45.9 |
| All Vehicles | | 269 | 16.0 | 0.072 | 5.6 | NA | 0.4 | 2.8 | 0.16 | 0.44 | 51.6 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

# MOVEMENT SUMMARY

**Site: 2036 PM peak WD (GHD Layout)**

Benwell Road / Archer Street
2036 (Opening Year) With Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 63 | 20.0 | 0.081 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.84 | 49.0 |
| 2 | T | 65 | 41.9 | 0.081 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 128 | 31.1 | 0.081 | 4.3 | LOS A | 0.0 | 0.0 | 0.00 | 0.41 | 54.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 200 | 16.8 | 0.122 | 0.6 | LOS A | 0.9 | 6.9 | 0.30 | 0.00 | 54.5 |
| 9 | R | 13 | 8.3 | 0.123 | 9.1 | LOS A | 0.9 | 6.9 | 0.30 | 0.94 | 49.0 |
| Approach | | 213 | 16.3 | 0.122 | 1.1 | LOS A | 0.9 | 6.9 | 0.30 | 0.06 | 54.1 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.2 | LOS B | 0.0 | 0.1 | 0.22 | 0.86 | 46.3 |
| 12 | R | 62 | 16.9 | 0.090 | 13.9 | LOS B | 0.4 | 3.3 | 0.45 | 0.91 | 44.8 |
| Approach | | 65 | 16.1 | 0.090 | 13.8 | LOS B | 0.4 | 3.3 | 0.44 | 0.91 | 44.9 |
| All Vehicles | | 406 | 21.0 | 0.122 | 4.2 | NA | 0.9 | 6.9 | 0.22 | 0.31 | 52.4 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Friday, 19 August 2011 3:39:29 PM
SIDRA INTERSECTION 5.0.1.1427

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2036 (post stage d ops)\2 Benwell Road - Archer Street - Priority.sip
8000907, AECOM, ENTERPRISE

SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2046 AM peak WOD (GHD Layout)**

Benwell Road / Archer Street
2046 (Opening Year + 10 years) Without Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 64 | 14.8 | 0.087 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.87 | 49.0 |
| 2 | T | 91 | 7.0 | 0.087 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 155 | 10.2 | 0.087 | 3.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.36 | 54.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 40 | 7.9 | 0.023 | 0.5 | LOS A | 0.2 | 1.1 | 0.27 | 0.00 | 55.0 |
| 9 | R | 2 | 0.0 | 0.023 | 8.8 | LOS A | 0.2 | 1.1 | 0.27 | 0.92 | 49.0 |
| Approach | | 42 | 7.5 | 0.023 | 0.9 | LOS A | 0.2 | 1.1 | 0.27 | 0.05 | 54.7 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.019 | 12.2 | LOS B | 0.1 | 0.5 | 0.24 | 0.87 | 46.2 |
| 12 | R | 65 | 21.0 | 0.077 | 12.7 | LOS B | 0.4 | 3.0 | 0.31 | 0.88 | 45.9 |
| Approach | | 78 | 20.3 | 0.077 | 12.6 | LOS B | 0.4 | 3.0 | 0.30 | 0.88 | 46.0 |
| All Vehicles | | 275 | 12.6 | 0.087 | 5.7 | NA | 0.4 | 3.0 | 0.12 | 0.46 | 52.0 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Wednesday, 5 October 2011 10:23:34 AM
SIDRA INTERSECTION 5.0.1.1427

Project: \\AUBNE1FP001\Jobs\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2046 WOD\2 Benwell Road - Archer Street - Priority.sip
8000907, AECOM, ENTERPRISE

# MOVEMENT SUMMARY

**Site: 2046 AM peak WD (GHD Layout)**

Benwell Road / Archer Street
2046 (Opening Year + 10 years) With Development
AM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 64 | 14.8 | 0.153 | 8.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.96 | 49.0 |
| 2 | T | 206 | 13.3 | 0.153 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 271 | 13.6 | 0.153 | 2.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.23 | 57.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 61 | 39.7 | 0.041 | 1.0 | LOS A | 0.3 | 2.4 | 0.36 | 0.00 | 53.5 |
| 9 | R | 2 | 0.0 | 0.041 | 9.3 | LOS A | 0.3 | 2.4 | 0.36 | 0.93 | 49.1 |
| Approach | | 63 | 38.3 | 0.041 | 1.2 | LOS A | 0.3 | 2.4 | 0.36 | 0.03 | 53.4 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 13 | 16.7 | 0.021 | 13.1 | LOS B | 0.1 | 0.6 | 0.37 | 0.86 | 45.5 |
| 12 | R | 65 | 21.0 | 0.097 | 14.2 | LOS B | 0.4 | 3.7 | 0.45 | 0.91 | 44.8 |
| Approach | | 78 | 20.3 | 0.097 | 14.0 | LOS B | 0.4 | 3.7 | 0.43 | 0.91 | 44.9 |
| All Vehicles | | 412 | 18.7 | 0.153 | 4.2 | NA | 0.4 | 3.7 | 0.14 | 0.33 | 53.7 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.





SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2046 PM peak WOD (GHD Layout)**

Benwell Road / Archer Street
2046 (Opening Year + 10 years) Without Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 68 | 21.5 | 0.068 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.79 | 49.0 |
| 2 | T | 46 | 13.6 | 0.068 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 115 | 18.3 | 0.068 | 5.2 | LOS A | 0.0 | 0.0 | 0.00 | 0.47 | 52.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 84 | 15.0 | 0.056 | 0.4 | LOS A | 0.4 | 2.8 | 0.24 | 0.00 | 55.2 |
| 9 | R | 13 | 8.3 | 0.056 | 9.0 | LOS A | 0.4 | 2.8 | 0.24 | 0.91 | 48.9 |
| Approach | | 97 | 14.1 | 0.056 | 1.5 | LOS A | 0.4 | 2.8 | 0.24 | 0.12 | 54.3 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.0 | LOS B | 0.0 | 0.1 | 0.18 | 0.88 | 46.4 |
| 12 | R | 75 | 16.9 | 0.087 | 12.6 | LOS B | 0.4 | 3.3 | 0.33 | 0.88 | 45.9 |
| Approach | | 78 | 16.2 | 0.087 | 12.5 | LOS B | 0.4 | 3.3 | 0.32 | 0.88 | 45.9 |
| All Vehicles | | 289 | 16.4 | 0.087 | 6.0 | NA | 0.4 | 3.3 | 0.17 | 0.46 | 51.3 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).

Approach LOS values are based on the worst delay for any vehicle movement.

# MOVEMENT SUMMARY

**Site: 2046 PM peak WD (GHD Layout)**

Benwell Road / Archer Street
2046 (Opening Year + 10 years) With Development
PM peak
Stop (Two-Way)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Benwell Road (South) | | | | | | | | | | | |
| 1 | L | 68 | 21.5 | 0.086 | 8.8 | LOS A | 0.0 | 0.0 | 0.00 | 0.83 | 49.0 |
| 2 | T | 67 | 40.6 | 0.086 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 60.0 |
| Approach | | 136 | 31.0 | 0.086 | 4.4 | LOS A | 0.0 | 0.0 | 0.00 | 0.42 | 53.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 200 | 16.8 | 0.122 | 0.6 | LOS A | 0.9 | 6.9 | 0.30 | 0.00 | 54.3 |
| 9 | R | 13 | 8.3 | 0.123 | 9.2 | LOS A | 0.9 | 6.9 | 0.30 | 0.94 | 49.0 |
| Approach | | 213 | 16.3 | 0.122 | 1.1 | LOS A | 0.9 | 6.9 | 0.30 | 0.06 | 54.0 |
| West: Archer Street (West) | | | | | | | | | | | |
| 10 | L | 3 | 0.0 | 0.004 | 11.2 | LOS B | 0.0 | 0.1 | 0.23 | 0.86 | 46.3 |
| 12 | R | 75 | 16.9 | 0.109 | 14.0 | LOS B | 0.5 | 4.0 | 0.46 | 0.92 | 44.7 |
| Approach | | 78 | 16.2 | 0.109 | 13.9 | LOS B | 0.5 | 4.0 | 0.45 | 0.92 | 44.8 |
| All Vehicles | | 426 | 21.0 | 0.122 | 4.5 | NA | 0.9 | 6.9 | 0.23 | 0.33 | 52.0 |

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on the worst delay for any vehicle movement.

Processed: Friday, 19 August 2011 3:42:23 PM
SIDRA INTERSECTION 5.0.1.1427

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2046 (post stage d ops)\2 Benwell Road - Archer Street - Priority.sip
8000907, AECOM, ENTERPRISE

SIDRA INTERSECTION


# Port Expansion Project EIS

## Appendix Q6

## Intersection 3: Boundary Street / Benwell Road / Southern Access / Townsville Port Access Road SIDRA Summaries

AECOM BMT WBM

# MOVEMENT SUMMARY

**Site: 2014 AM peak WOD**

Boundary Street / Benwell Road
2014 Without Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (User-Given Cycle Time)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 513 | 10.0 | 0.653 | 17.3 | LOS B | 14.1 | 107.0 | 0.85 | 0.75 | 38.5 |
| Approach | | 513 | 10.0 | 0.653 | 17.3 | LOS B | 14.1 | 107.0 | 0.85 | 0.75 | 38.5 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 109 | 17.6 | 0.104 | 6.4 | LOS A | 1.6 | 12.7 | 0.45 | 0.36 | 49.2 |
| 9 | R | 24 | 17.4 | 0.171 | 43.1 | LOS D | 0.8 | 6.6 | 0.96 | 0.71 | 27.6 |
| Approach | | 134 | 17.6 | 0.171 | 13.0 | LOS B | 1.6 | 12.7 | 0.54 | 0.43 | 43.1 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 157 | 11.4 | 0.091 | 7.8 | X | X | X | X | 0.60 | 49.8 |
| Approach | | 157 | 11.4 | 0.091 | 7.8 | NA | 0.0 | 0.0 | 0.00 | 0.60 | 49.8 |
| All Vehicles | | 803 | 11.5 | 0.653 | 14.7 | LOS B | 14.1 | 107.0 | 0.63 | 0.67 | 41.1 |

X: Not applicable for Continuous movement.

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P5 | Across N approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P7 | Across W approach | 53 | 13.8 | LOS B | 0.1 | 0.1 | 0.63 | 0.63 |
| All Pedestrians | | 106 | 21.5 | LOS C | | | 0.77 | 0.77 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.



SIDRA INTERSECTION

# PHASING SUMMARY

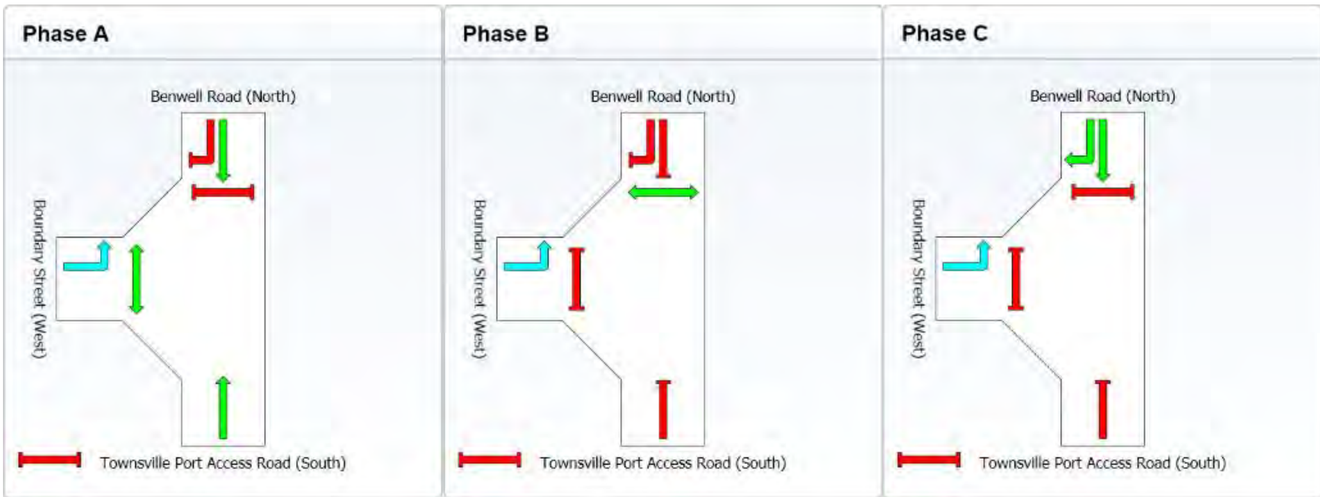
Site: 2014 AM peak WOD

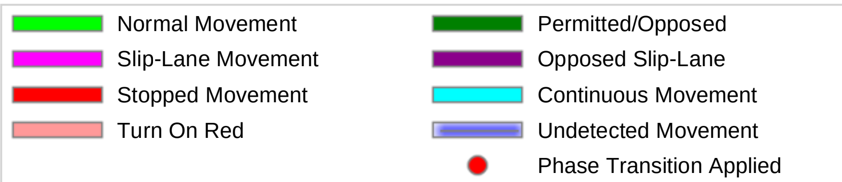
Boundary Street / Benwell Road
2014 Without Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (User-Given Cycle Time)

**Phase times determined by the program**
**Sequence: Three Phase**
**Input Sequence: A, B, C**
**Output Sequence: A, B, C**

**Phase Timing Results**

| Phase | A | B | C |
|---|---|---|---|
| Green Time (sec) | 30 | 16 | 6 |
| Yellow Time (sec) | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 |
| Phase Time (sec) | 36 | 22 | 12 |
| Phase Split | 51 % | 31 % | 17 % |




Processed: Tuesday, 14 August 2012 11:48:03 AM
SIDRA INTERSECTION 5.1.11.2079

Project: J:\MMPL\60161996\4. Tech Work Area\4.3 Engineering\Traffic and Infrastructure\SIDRA\2014 WOD\3 Boundary Street - Benwell Road - Signals.sip
8000907, AECOM, ENTERPRISE

# MOVEMENT SUMMARY

**Site: 2014 AM peak WD**

Boundary Street / Benwell Road
2014 With Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Practical Cycle Time)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 531 | 13.0 | 0.688 | 17.7 | LOS B | 14.9 | 115.9 | 0.87 | 0.77 | 38.2 |
| Approach | | 531 | 13.0 | 0.688 | 17.7 | LOS B | 14.9 | 115.9 | 0.87 | 0.77 | 38.2 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 117 | 33.3 | 0.122 | 6.5 | LOS A | 1.7 | 15.4 | 0.46 | 0.37 | 49.1 |
| 9 | R | 36 | 11.8 | 0.244 | 43.3 | LOS D | 1.2 | 9.5 | 0.97 | 0.73 | 27.5 |
| Approach | | 153 | 28.3 | 0.244 | 15.1 | LOS B | 1.7 | 15.4 | 0.58 | 0.45 | 41.5 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 285 | 2.5 | 0.156 | 7.6 | X | X | X | X | 0.60 | 49.8 |
| Approach | | 285 | 2.5 | 0.156 | 7.6 | NA | 0.0 | 0.0 | 0.00 | 0.60 | 49.8 |
| All Vehicles | | 968 | 12.3 | 0.688 | 14.3 | LOS B | 14.9 | 115.9 | 0.57 | 0.67 | 41.6 |

X: Not applicable for Continuous movement.

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P5 | Across N approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P7 | Across W approach | 53 | 13.8 | LOS B | 0.1 | 0.1 | 0.63 | 0.63 |
| All Pedestrians | | 106 | 21.5 | LOS C | | | 0.77 | 0.77 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

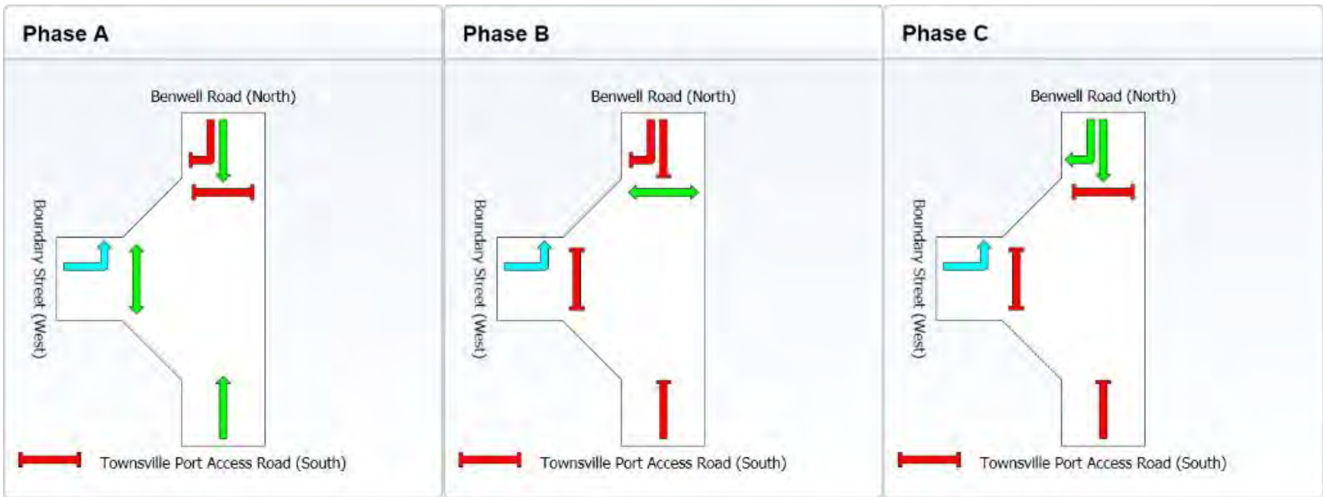


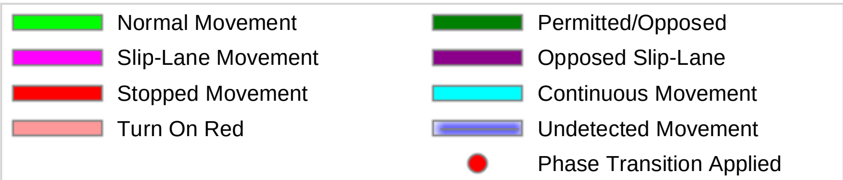
Boundary Street / Benwell Road
2014 With Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Practical Cycle Time)

**Phase times determined by the program**
**Sequence: Three Phase**
**Input Sequence: A, B, C**
**Output Sequence: A, B, C**

**Phase Timing Results**

| Phase | A | B | C |
|---|---|---|---|
| Green Time (sec) | 30 | 16 | 6 |
| Yellow Time (sec) | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 |
| Phase Time (sec) | 36 | 22 | 12 |
| Phase Split | 51 % | 31 % | 17 % |



# MOVEMENT SUMMARY

**Site: 2014 PM peak WOD**

Boundary Street / Benwell Road
2014 Without Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 60 seconds (Practical Cycle Time)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 139 | 21.7 | 0.244 | 16.0 | LOS B | 3.0 | 25.1 | 0.76 | 0.62 | 39.6 |
| Approach | | 139 | 21.7 | 0.244 | 16.0 | LOS B | 3.0 | 25.1 | 0.76 | 0.62 | 39.6 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 487 | 10.5 | 0.501 | 9.7 | LOS A | 9.2 | 70.0 | 0.68 | 0.60 | 45.0 |
| 9 | R | 39 | 16.2 | 0.234 | 37.7 | LOS D | 1.1 | 9.1 | 0.96 | 0.73 | 29.6 |
| Approach | | 526 | 10.9 | 0.501 | 11.8 | LOS B | 9.2 | 70.0 | 0.70 | 0.61 | 43.4 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 56 | 20.8 | 0.035 | 8.0 | X | X | X | X | 0.59 | 49.8 |
| Approach | | 56 | 20.8 | 0.035 | 8.0 | NA | 0.0 | 0.0 | 0.00 | 0.59 | 49.8 |
| All Vehicles | | 721 | 13.8 | 0.501 | 12.3 | LOS B | 9.2 | 70.0 | 0.66 | 0.61 | 43.0 |

X: Not applicable for Continuous movement.

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P5 | Across N approach | 53 | 24.3 | LOS C | 0.1 | 0.1 | 0.90 | 0.90 |
| P7 | Across W approach | 53 | 16.1 | LOS B | 0.1 | 0.1 | 0.73 | 0.73 |
| All Pedestrians | | 106 | 20.2 | LOS C | | | 0.82 | 0.82 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

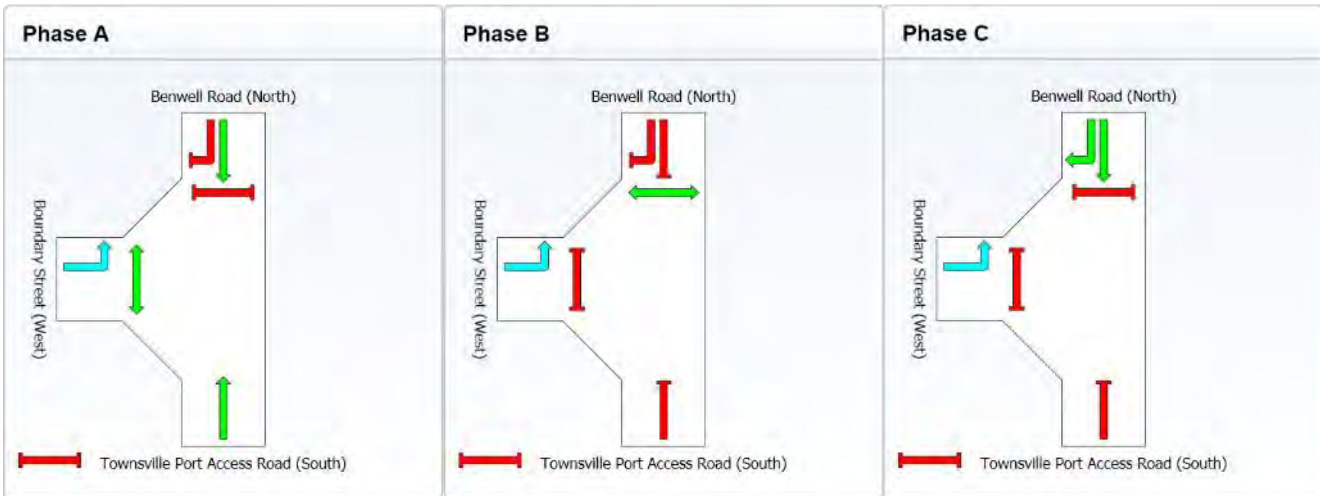


Boundary Street / Benwell Road
2014 Without Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 60 seconds (Practical Cycle Time)

**Phase times determined by the program**
**Sequence: Three Phase**
**Input Sequence: A, B, C**
**Output Sequence: A, B, C**

**Phase Timing Results**

| Phase | A | B | C |
|---|---|---|---|
| Green Time (sec) | 20 | 16 | 6 |
| Yellow Time (sec) | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 |
| Phase Time (sec) | 26 | 22 | 12 |
| Phase Split | 43 % | 37 % | 20 % |




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

Processed: Tuesday, 14 August 2012 9:56:33 AM
SIDRA INTERSECTION 5.1.11.2079

Project: J:\MMPL\60161996\4. Tech Work Area\4.3 Engineering\Traffic and Infrastructure\SIDRA\2014 WOD\3 Boundary Street - Benwell Road - Signals.sip
8000907, AECOM, ENTERPRISE

# MOVEMENT SUMMARY

**Site: 2014 PM peak WD**

Boundary Street / Benwell Road
2014 With Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 60 seconds (Practical Cycle Time)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 144 | 32.1 | 0.413 | 22.8 | LOS C | 3.8 | 34.0 | 0.90 | 0.73 | 35.0 |
| Approach | | 144 | 32.1 | 0.413 | 22.8 | LOS C | 3.8 | 34.0 | 0.90 | 0.73 | 35.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 8 | T | 505 | 13.5 | 0.529 | 9.9 | LOS A | 9.7 | 75.9 | 0.70 | 0.61 | 44.8 |
| 9 | R | 166 | 3.8 | 0.425 | 31.1 | LOS C | 4.4 | 31.7 | 0.91 | 0.80 | 32.3 |
| Approach | | 672 | 11.1 | 0.529 | 15.2 | LOS B | 9.7 | 75.9 | 0.75 | 0.66 | 40.9 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 67 | 14.3 | 0.040 | 7.9 | X | X | X | X | 0.60 | 49.8 |
| Approach | | 67 | 14.3 | 0.040 | 7.9 | NA | 0.0 | 0.0 | 0.00 | 0.60 | 49.8 |
| All Vehicles | | 883 | 14.8 | 0.529 | 15.9 | LOS B | 9.7 | 75.9 | 0.72 | 0.67 | 40.3 |

X: Not applicable for Continuous movement.

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P5 | Across N approach | 53 | 24.3 | LOS C | 0.1 | 0.1 | 0.90 | 0.90 |
| P7 | Across W approach | 53 | 21.7 | LOS C | 0.1 | 0.1 | 0.85 | 0.85 |
| All Pedestrians | | 106 | 23.0 | LOS C | | | 0.88 | 0.88 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.



SIDRA INTERSECTION

## PHASING SUMMARY

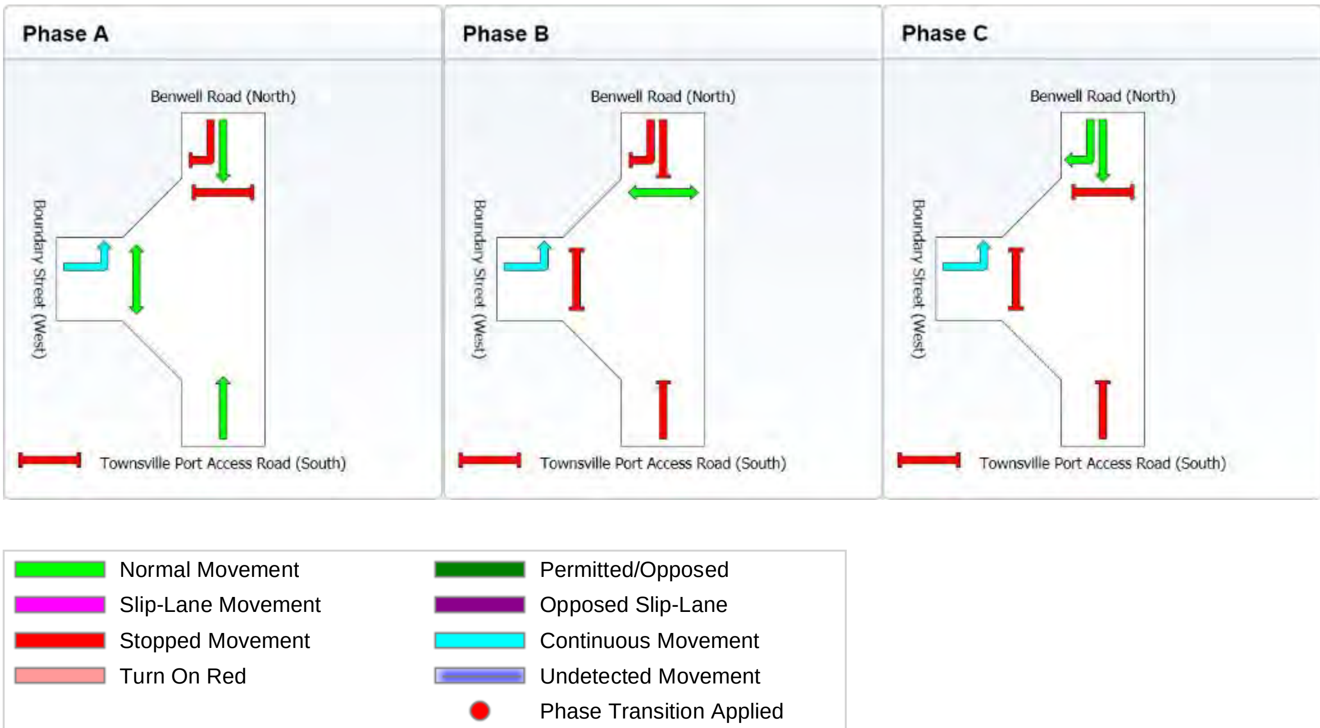
**Site: 2014 PM peak WD**

Boundary Street / Benwell Road
2014 With Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 60 seconds (Practical Cycle Time)

**Phase times determined by the program**
**Sequence: Three Phase**
**Input Sequence: A, B, C**
**Output Sequence: A, B, C**

**Phase Timing Results**

| Phase | A | B | C |
|---|---|---|---|
| Green Time (sec) | 13 | 16 | 13 |
| Yellow Time (sec) | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 22 | 19 |
| Phase Split | 32 % | 37 % | 32 % |



# MOVEMENT SUMMARY

**Site: 2035 AM peak WOD (Optimised Signals)**

Boundary Street / Benwell Road
2035 Without Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 86 | 9.8 | 0.181 | 42.9 | LOS D | 1.9 | 14.6 | 0.93 | 0.69 | 26.4 |
| 3 | R | 449 | 8.2 | 0.674 | 36.2 | LOS D | 18.4 | 137.6 | 0.89 | 0.85 | 30.1 |
| Approach | | 536 | 8.4 | 0.674 | 37.3 | LOS D | 18.4 | 137.6 | 0.90 | 0.83 | 29.5 |
| East: Southern Acces (East) | | | | | | | | | | | |
| 4 | L | 88 | 14.3 | 0.088 | 8.3 | LOS A | 0.3 | 2.3 | 0.13 | 0.62 | 49.0 |
| 5 | T | 24 | 17.4 | 0.073 | 36.1 | LOS D | 1.0 | 7.9 | 0.85 | 0.62 | 28.9 |
| 6 | R | 6 | 16.7 | 0.063 | 58.9 | LOS E | 0.3 | 2.5 | 0.97 | 0.66 | 23.0 |
| Approach | | 119 | 15.0 | 0.088 | 16.6 | LOS B | 1.0 | 7.9 | 0.32 | 0.62 | 40.9 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 28 | 7.4 | 0.070 | 13.5 | LOS B | 0.4 | 3.3 | 0.40 | 0.66 | 44.0 |
| 8 | T | 29 | 17.9 | 0.065 | 41.9 | LOS D | 0.6 | 5.2 | 0.91 | 0.64 | 26.8 |
| 9 | R | 25 | 16.7 | 0.040 | 29.3 | LOS C | 0.8 | 6.1 | 0.65 | 0.71 | 33.4 |
| Approach | | 83 | 13.9 | 0.070 | 28.4 | LOS C | 0.8 | 6.1 | 0.66 | 0.67 | 33.3 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 39 | 10.8 | 0.035 | 8.3 | LOS A | 0.2 | 1.2 | 0.15 | 0.62 | 49.0 |
| 11 | T | 120 | 7.9 | 0.341 | 38.5 | LOS D | 5.2 | 38.6 | 0.91 | 0.73 | 28.0 |
| Approach | | 159 | 8.6 | 0.341 | 31.1 | LOS C | 5.2 | 38.6 | 0.72 | 0.70 | 31.3 |
| All Vehicles | | 897 | 9.9 | 0.674 | 32.6 | LOS C | 18.4 | 137.6 | 0.77 | 0.76 | 31.3 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P5 | Across N approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 43.2 | LOS E | 0.1 | 0.1 | 0.93 | 0.93 |
| All Pedestrians | | 159 | 43.9 | LOS E | | | 0.94 | 0.94 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

**Site: 2035 AM peak WOD (Optimised Signals)**

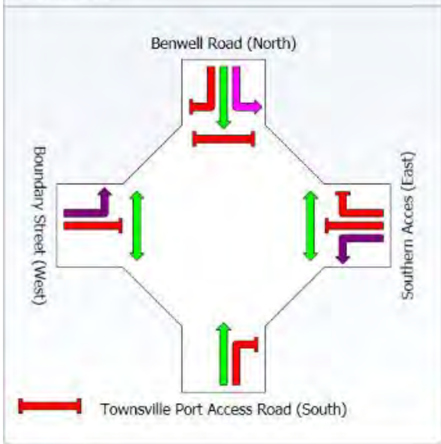
Boundary Street / Benwell Road
2035 Without Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

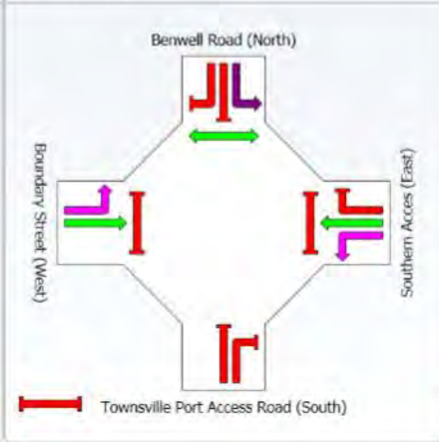
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 38 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 44 |
| Phase Split | 19 % | 25 % | 12 % | 44 % |

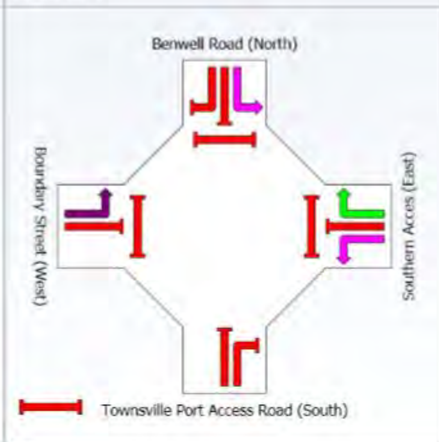
**Phase A**



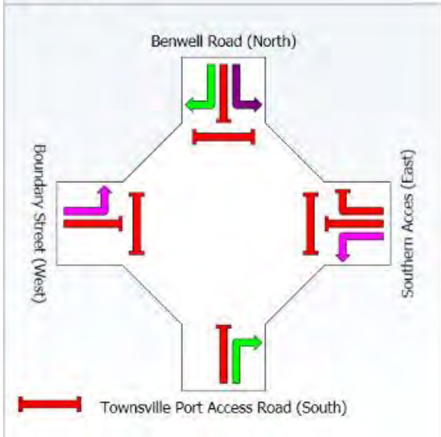

**Phase B**




**Phase C**




**Phase D**




- Normal Movement
- Slip-Lane Movement
- Stopped Movement
- Turn On Red
- Permitted/Opposed
- Opposed Slip-Lane
- Continuous Movement
- Undetected Movement
- Phase Transition Applied

Processed: Monday, 13 August 2012 3:00:58 PM
SIDRA INTERSECTION 5.1.11.2079

Project: J:\MMPL\60161996\4. Tech Work Area\4.3 Engineering\Traffic and Infrastructure\SIDRA\2035 WOD\3 Boundary Street - Benwell Road - Signals.sip
8000907, AECOM, ENTERPRISE

# MOVEMENT SUMMARY

**Site: 2035 AM peak WD (Optimised Signals)**

Boundary Street / Benwell Road
2035 With Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 95 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 113 | 15.0 | 0.232 | 40.6 | LOS D | 2.4 | 19.0 | 0.93 | 0.71 | 27.2 |
| 3 | R | 449 | 8.2 | 0.738 | 38.9 | LOS D | 18.9 | 141.5 | 0.94 | 0.88 | 29.1 |
| Approach | | 562 | 9.6 | 0.738 | 39.2 | LOS D | 18.9 | 141.5 | 0.94 | 0.84 | 28.7 |
| East: Southern Access (East) | | | | | | | | | | | |
| 4 | L | 92 | 17.2 | 0.097 | 8.4 | LOS A | 0.3 | 2.8 | 0.15 | 0.62 | 48.9 |
| 5 | T | 24 | 17.4 | 0.069 | 33.5 | LOS C | 0.9 | 7.4 | 0.84 | 0.61 | 30.0 |
| 6 | R | 6 | 16.7 | 0.060 | 56.1 | LOS E | 0.3 | 2.3 | 0.96 | 0.66 | 23.7 |
| Approach | | 122 | 17.2 | 0.097 | 15.9 | LOS B | 0.9 | 7.4 | 0.33 | 0.62 | 41.5 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 28 | 7.4 | 0.069 | 13.8 | LOS B | 0.4 | 3.3 | 0.42 | 0.66 | 43.7 |
| 8 | T | 40 | 36.8 | 0.093 | 39.7 | LOS D | 0.8 | 7.7 | 0.90 | 0.65 | 27.5 |
| 9 | R | 47 | 33.3 | 0.091 | 31.5 | LOS C | 1.5 | 13.3 | 0.70 | 0.74 | 32.6 |
| Approach | | 116 | 28.2 | 0.093 | 30.0 | LOS C | 1.5 | 13.3 | 0.70 | 0.69 | 32.6 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 212 | 7.5 | 0.186 | 8.4 | LOS A | 0.9 | 6.9 | 0.18 | 0.64 | 48.8 |
| 11 | T | 120 | 7.9 | 0.323 | 35.7 | LOS D | 4.9 | 36.2 | 0.90 | 0.72 | 29.0 |
| Approach | | 332 | 7.6 | 0.323 | 18.2 | LOS B | 4.9 | 36.2 | 0.44 | 0.67 | 39.2 |
| All Vehicles | | 1132 | 11.7 | 0.738 | 29.6 | LOS C | 18.9 | 141.5 | 0.70 | 0.75 | 32.8 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 41.7 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P5 | Across N approach | 53 | 41.7 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 40.8 | LOS E | 0.1 | 0.1 | 0.93 | 0.93 |
| All Pedestrians | | 159 | 41.4 | LOS E | | | 0.93 | 0.93 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

**Site: 2035 AM peak WD (Optimised Signals)**

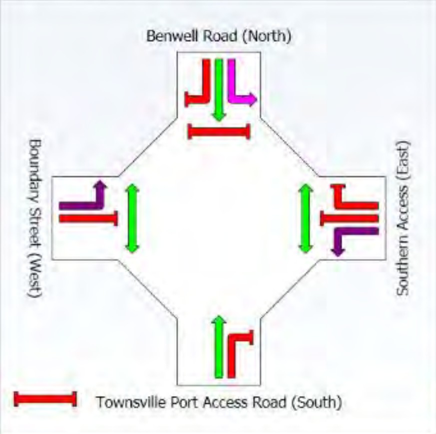
Boundary Street / Benwell Road
2035 With Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 95 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

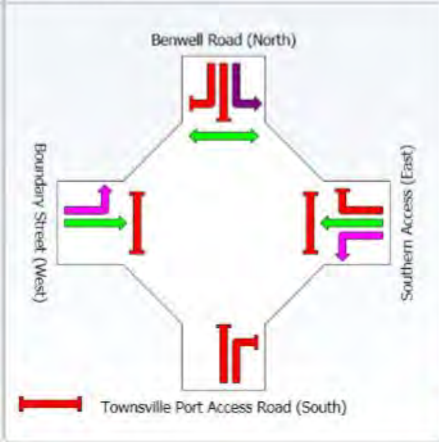
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 33 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 39 |
| Phase Split | 20 % | 26 % | 13 % | 41 % |

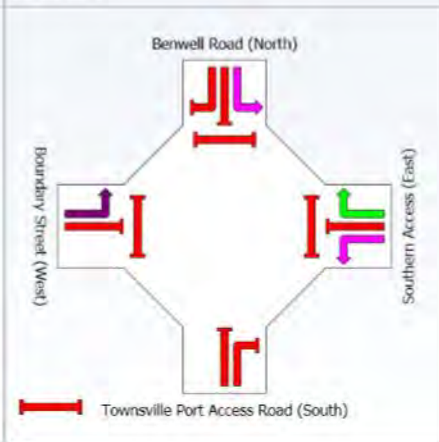
**Phase A**



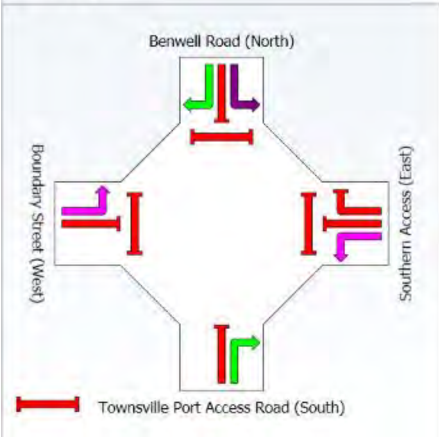

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2035 PM peak WOD (Optimised Signals)**

Boundary Street / Benwell Road
2035 Without Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 38 | 22.2 | 0.060 | 25.9 | LOS C | 0.5 | 4.6 | 0.85 | 0.61 | 33.4 |
| 3 | R | 115 | 18.3 | 0.611 | 43.3 | LOS D | 4.1 | 33.0 | 1.00 | 0.82 | 27.6 |
| Approach | | 153 | 19.3 | 0.611 | 39.0 | LOS D | 4.1 | 33.0 | 0.96 | 0.77 | 28.8 |
| East: Southern Acces (East) | | | | | | | | | | | |
| 4 | L | 427 | 8.6 | 0.429 | 8.6 | LOS A | 2.1 | 15.6 | 0.26 | 0.66 | 48.4 |
| 5 | T | 114 | 8.3 | 0.226 | 21.7 | LOS C | 3.1 | 23.0 | 0.82 | 0.65 | 35.8 |
| 6 | R | 28 | 7.4 | 0.188 | 42.5 | LOS D | 1.0 | 7.2 | 0.96 | 0.72 | 27.7 |
| Approach | | 569 | 8.5 | 0.429 | 12.9 | LOS B | 3.1 | 23.0 | 0.41 | 0.66 | 43.7 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 6 | 16.7 | 0.008 | 8.9 | LOS A | 0.0 | 0.2 | 0.24 | 0.61 | 48.5 |
| 8 | T | 81 | 11.7 | 0.120 | 26.3 | LOS C | 1.2 | 9.1 | 0.87 | 0.64 | 33.2 |
| 9 | R | 39 | 16.2 | 0.205 | 40.7 | LOS D | 1.3 | 10.2 | 0.94 | 0.73 | 28.5 |
| Approach | | 126 | 13.3 | 0.205 | 29.9 | LOS C | 1.3 | 10.2 | 0.86 | 0.67 | 32.1 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 27 | 23.1 | 0.026 | 8.7 | LOS A | 0.1 | 0.8 | 0.20 | 0.62 | 48.7 |
| 11 | T | 31 | 17.2 | 0.064 | 20.6 | LOS C | 0.8 | 6.3 | 0.77 | 0.57 | 36.6 |
| Approach | | 58 | 20.0 | 0.064 | 14.9 | LOS B | 0.8 | 6.3 | 0.50 | 0.59 | 41.5 |
| All Vehicles | | 906 | 11.7 | 0.611 | 19.8 | LOS B | 4.1 | 33.0 | 0.57 | 0.68 | 38.3 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P5 | Across N approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P7 | Across W approach | 53 | 28.4 | LOS C | 0.1 | 0.1 | 0.90 | 0.90 |
| All Pedestrians | | 159 | 29.0 | LOS C | | | 0.91 | 0.91 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

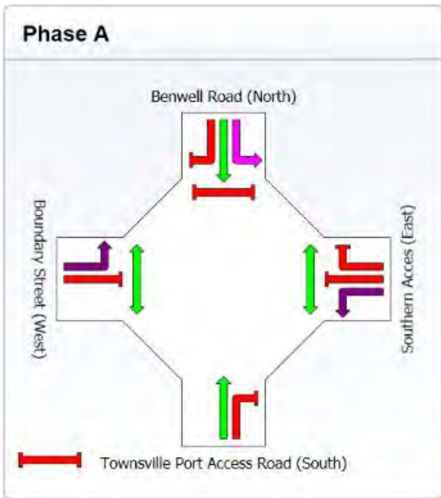
**Site: 2035 PM peak WOD (Optimised Signals)**

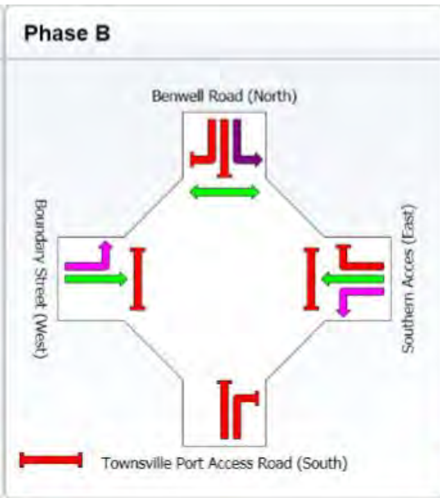
Boundary Street / Benwell Road
2035 Without Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

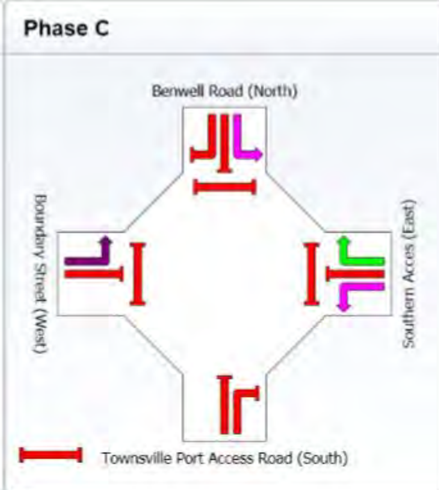
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

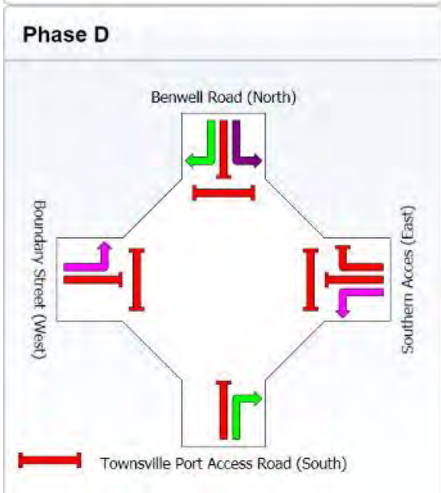
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 8 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 14 |
| Phase Split | 27 % | 36 % | 17 % | 20 % |




- Normal Movement
- Slip-Lane Movement
- Stopped Movement
- Turn On Red
- Permitted/Opposed
- Opposed Slip-Lane
- Continuous Movement
- Undetected Movement
- Phase Transition Applied

# MOVEMENT SUMMARY

**Site: 2035 PM peak WD (Optimised Signals)**

Boundary Street / Benwell Road
2035 With Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 75 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 47 | 35.6 | 0.086 | 28.9 | LOS C | 0.8 | 6.9 | 0.87 | 0.63 | 31.9 |
| 3 | R | 115 | 18.3 | 0.403 | 39.6 | LOS D | 3.9 | 31.6 | 0.93 | 0.79 | 28.9 |
| Approach | | 162 | 23.4 | 0.403 | 36.5 | LOS D | 3.9 | 31.6 | 0.91 | 0.74 | 29.7 |
| East: Southern Access (East) | | | | | | | | | | | |
| 4 | L | 427 | 8.6 | 0.446 | 8.6 | LOS A | 2.1 | 16.0 | 0.25 | 0.66 | 48.4 |
| 5 | T | 114 | 8.3 | 0.243 | 24.4 | LOS C | 3.4 | 25.3 | 0.84 | 0.67 | 34.2 |
| 6 | R | 28 | 7.4 | 0.201 | 45.4 | LOS D | 1.0 | 7.8 | 0.97 | 0.72 | 26.8 |
| Approach | | 569 | 8.5 | 0.446 | 13.6 | LOS B | 3.4 | 25.3 | 0.40 | 0.66 | 43.2 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 6 | 16.7 | 0.008 | 8.9 | LOS A | 0.0 | 0.2 | 0.22 | 0.61 | 48.6 |
| 8 | T | 108 | 16.5 | 0.178 | 29.4 | LOS C | 1.7 | 14.0 | 0.89 | 0.67 | 31.7 |
| 9 | R | 212 | 8.0 | 0.695 | 42.4 | LOS D | 7.8 | 58.7 | 0.99 | 0.86 | 27.8 |
| Approach | | 326 | 11.0 | 0.695 | 37.4 | LOS D | 7.8 | 58.7 | 0.94 | 0.80 | 29.2 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 49 | 34.0 | 0.051 | 8.9 | LOS A | 0.2 | 1.6 | 0.19 | 0.62 | 48.8 |
| 11 | T | 31 | 17.2 | 0.069 | 23.1 | LOS C | 0.9 | 6.9 | 0.79 | 0.58 | 35.0 |
| Approach | | 80 | 27.6 | 0.069 | 14.3 | LOS B | 0.9 | 6.9 | 0.42 | 0.61 | 42.5 |
| All Vehicles | | 1138 | 12.7 | 0.695 | 23.7 | LOS C | 7.8 | 58.7 | 0.63 | 0.71 | 35.9 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 31.7 | LOS D | 0.1 | 0.1 | 0.92 | 0.92 |
| P5 | Across N approach | 53 | 31.7 | LOS D | 0.1 | 0.1 | 0.92 | 0.92 |
| P7 | Across W approach | 53 | 30.8 | LOS D | 0.1 | 0.1 | 0.91 | 0.91 |
| All Pedestrians | | 159 | 31.4 | LOS D | | | 0.92 | 0.92 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

**Site: 2035 PM peak WD (Optimised Signals)**

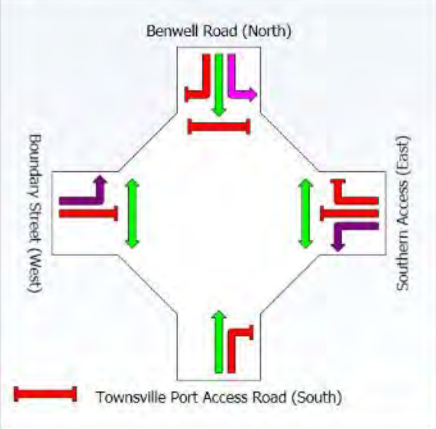
Boundary Street / Benwell Road
2035 With Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 75 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

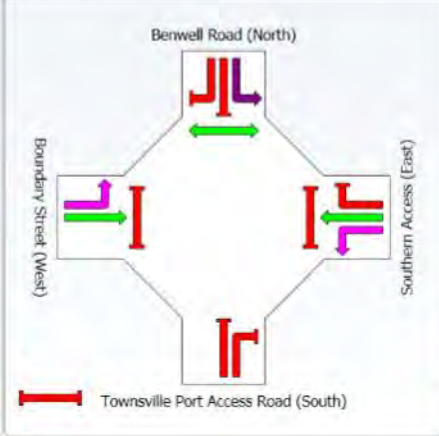
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 13 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 19 |
| Phase Split | 25 % | 33 % | 16 % | 25 % |

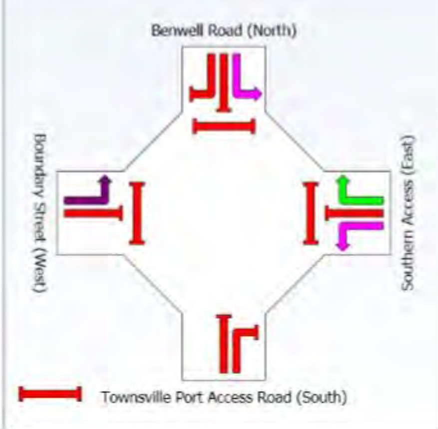
**Phase A**



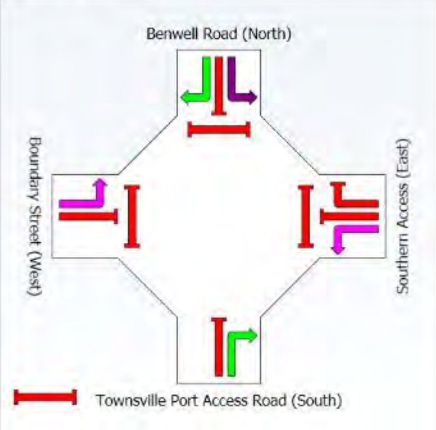

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2036 AM peak WOD (Optimised Signals)**

Boundary Street / Benwell Road
2036 (Opening Year) Without Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 87 | 9.6 | 0.183 | 42.9 | LOS D | 2.0 | 14.8 | 0.93 | 0.69 | 26.4 |
| 3 | R | 449 | 8.2 | 0.674 | 36.2 | LOS D | 18.4 | 137.6 | 0.89 | 0.85 | 30.1 |
| Approach | | 537 | 8.4 | 0.674 | 37.3 | LOS D | 18.4 | 137.6 | 0.90 | 0.83 | 29.5 |
| East: Southern Access (East) | | | | | | | | | | | |
| 4 | L | 92 | 17.2 | 0.094 | 8.3 | LOS A | 0.3 | 2.4 | 0.13 | 0.62 | 49.0 |
| 5 | T | 24 | 17.4 | 0.073 | 36.1 | LOS D | 1.0 | 7.9 | 0.85 | 0.62 | 28.9 |
| 6 | R | 6 | 16.7 | 0.063 | 58.9 | LOS E | 0.3 | 2.5 | 0.97 | 0.66 | 23.0 |
| Approach | | 122 | 17.2 | 0.094 | 16.4 | LOS B | 1.0 | 7.9 | 0.32 | 0.62 | 41.1 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 28 | 7.4 | 0.070 | 13.5 | LOS B | 0.4 | 3.3 | 0.40 | 0.66 | 44.0 |
| 8 | T | 29 | 17.9 | 0.065 | 41.9 | LOS D | 0.6 | 5.2 | 0.91 | 0.64 | 26.8 |
| 9 | R | 25 | 16.7 | 0.040 | 29.3 | LOS C | 0.8 | 6.1 | 0.65 | 0.71 | 33.4 |
| Approach | | 83 | 13.9 | 0.070 | 28.4 | LOS C | 0.8 | 6.1 | 0.66 | 0.67 | 33.3 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 39 | 10.8 | 0.035 | 8.3 | LOS A | 0.2 | 1.2 | 0.15 | 0.62 | 49.0 |
| 11 | T | 120 | 7.9 | 0.341 | 38.5 | LOS D | 5.2 | 38.6 | 0.91 | 0.73 | 28.0 |
| Approach | | 159 | 8.6 | 0.341 | 31.1 | LOS C | 5.2 | 38.6 | 0.72 | 0.70 | 31.3 |
| All Vehicles | | 901 | 10.2 | 0.674 | 32.6 | LOS C | 18.4 | 137.6 | 0.77 | 0.76 | 31.3 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P5 | Across N approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 43.2 | LOS E | 0.1 | 0.1 | 0.93 | 0.93 |
| All Pedestrians | | 159 | 43.9 | LOS E | | | 0.94 | 0.94 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

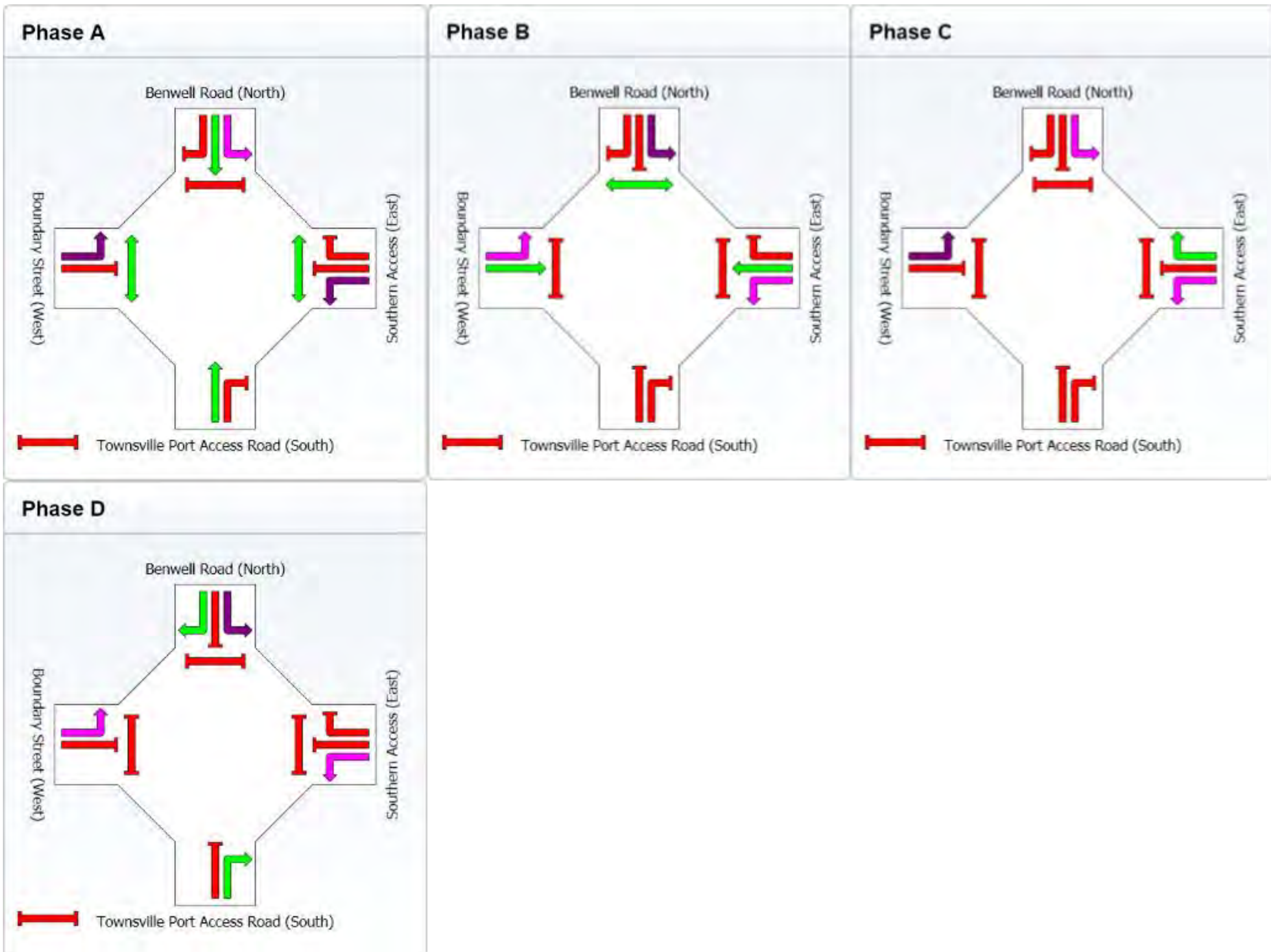
**Site: 2036 AM peak WOD (Optimised Signals)**

Boundary Street / Benwell Road
2036 (Opening Year) Without Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 38 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 44 |
| Phase Split | 19 % | 25 % | 12 % | 44 % |




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2036 AM peak WD (Optimised Signals)**

Boundary Street / Benwell Road
2036 (Opening Year) With Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 105 | 16.0 | 0.229 | 43.4 | LOS D | 2.4 | 18.9 | 0.93 | 0.71 | 26.3 |
| 3 | R | 449 | 8.2 | 0.674 | 36.2 | LOS D | 18.4 | 137.6 | 0.89 | 0.85 | 30.1 |
| Approach | | 555 | 9.7 | 0.674 | 37.6 | LOS D | 18.4 | 137.6 | 0.90 | 0.83 | 29.3 |
| East: Southern Access (East) | | | | | | | | | | | |
| 4 | L | 92 | 17.2 | 0.097 | 8.4 | LOS A | 0.3 | 2.8 | 0.14 | 0.62 | 49.0 |
| 5 | T | 24 | 17.4 | 0.073 | 36.1 | LOS D | 1.0 | 7.9 | 0.85 | 0.62 | 28.9 |
| 6 | R | 6 | 16.7 | 0.063 | 58.9 | LOS E | 0.3 | 2.5 | 0.97 | 0.66 | 23.0 |
| Approach | | 122 | 17.2 | 0.097 | 16.5 | LOS B | 1.0 | 7.9 | 0.33 | 0.62 | 41.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 28 | 7.4 | 0.070 | 13.5 | LOS B | 0.4 | 3.3 | 0.40 | 0.66 | 44.0 |
| 8 | T | 38 | 36.1 | 0.092 | 42.4 | LOS D | 0.8 | 7.7 | 0.91 | 0.65 | 26.6 |
| 9 | R | 38 | 44.4 | 0.071 | 30.5 | LOS C | 1.2 | 11.3 | 0.67 | 0.73 | 33.2 |
| Approach | | 104 | 31.3 | 0.092 | 30.2 | LOS C | 1.2 | 11.3 | 0.68 | 0.68 | 32.5 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 138 | 13.0 | 0.126 | 8.4 | LOS A | 0.6 | 4.5 | 0.16 | 0.63 | 48.9 |
| 11 | T | 120 | 7.9 | 0.341 | 38.5 | LOS D | 5.2 | 38.6 | 0.91 | 0.73 | 28.0 |
| Approach | | 258 | 10.6 | 0.341 | 22.4 | LOS C | 5.2 | 38.6 | 0.51 | 0.68 | 36.3 |
| All Vehicles | | 1039 | 13.0 | 0.674 | 30.6 | LOS C | 18.4 | 137.6 | 0.71 | 0.75 | 32.3 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P5 | Across N approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 43.2 | LOS E | 0.1 | 0.1 | 0.93 | 0.93 |
| All Pedestrians | | 159 | 43.9 | LOS E | | | 0.94 | 0.94 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

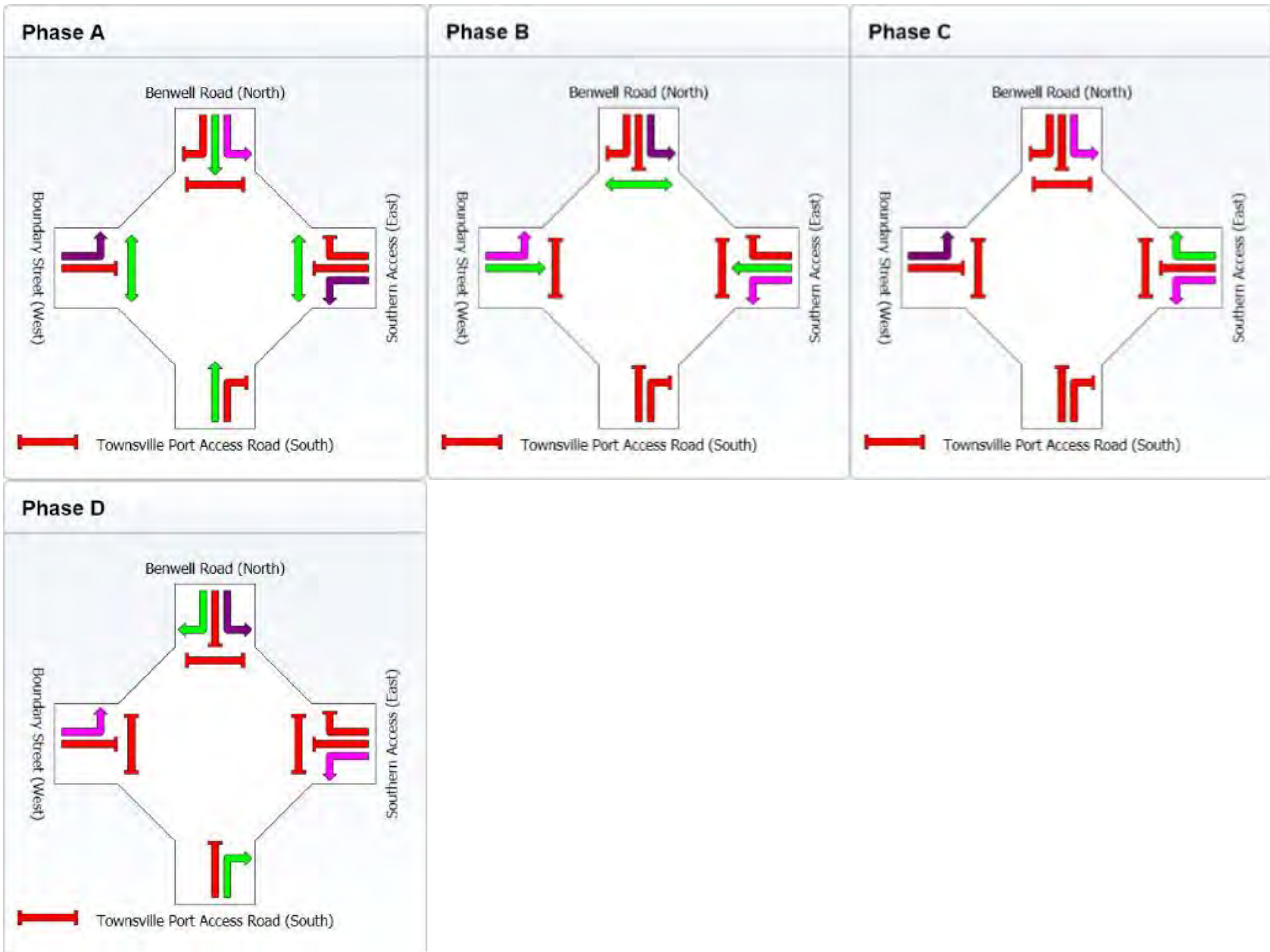
**Site: 2036 AM peak WD (Optimised Signals)**

Boundary Street / Benwell Road
2036 (Opening Year) With Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time  Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 38 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 44 |
| Phase Split | 19 % | 25 % | 12 % | 44 % |




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2036 PM peak WOD (Optimised Signals)**

Boundary Street / Benwell Road
2036 (Opening Year) Without Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Access Road (South) | | | | | | | | | | | |
| 2 | T | 39 | 21.6 | 0.061 | 25.9 | LOS C | 0.6 | 4.7 | 0.85 | 0.61 | 33.4 |
| 3 | R | 115 | 18.3 | 0.611 | 43.3 | LOS D | 4.1 | 33.0 | 1.00 | 0.82 | 27.6 |
| Approach | | 154 | 19.2 | 0.611 | 38.9 | LOS D | 4.1 | 33.0 | 0.96 | 0.77 | 28.8 |
| East: Southern Access (East) | | | | | | | | | | | |
| 4 | L | 427 | 8.6 | 0.430 | 8.6 | LOS A | 2.1 | 15.6 | 0.26 | 0.66 | 48.4 |
| 5 | T | 114 | 8.3 | 0.226 | 21.7 | LOS C | 3.1 | 23.0 | 0.82 | 0.65 | 35.8 |
| 6 | R | 28 | 7.4 | 0.188 | 42.5 | LOS D | 1.0 | 7.2 | 0.96 | 0.72 | 27.7 |
| Approach | | 569 | 8.5 | 0.430 | 12.9 | LOS B | 3.1 | 23.0 | 0.41 | 0.66 | 43.7 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 6 | 16.7 | 0.008 | 8.9 | LOS A | 0.0 | 0.2 | 0.24 | 0.61 | 48.5 |
| 8 | T | 82 | 11.5 | 0.122 | 26.3 | LOS C | 1.2 | 9.2 | 0.87 | 0.64 | 33.2 |
| 9 | R | 40 | 15.8 | 0.210 | 40.7 | LOS D | 1.3 | 10.5 | 0.94 | 0.73 | 28.5 |
| Approach | | 128 | 13.1 | 0.210 | 29.9 | LOS C | 1.3 | 10.5 | 0.86 | 0.67 | 32.0 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 28 | 22.2 | 0.027 | 8.7 | LOS A | 0.1 | 0.8 | 0.20 | 0.62 | 48.7 |
| 11 | T | 31 | 17.2 | 0.064 | 20.6 | LOS C | 0.8 | 6.3 | 0.77 | 0.57 | 36.6 |
| Approach | | 59 | 19.6 | 0.064 | 14.8 | LOS B | 0.8 | 6.3 | 0.49 | 0.59 | 41.6 |
| All Vehicles | | 911 | 11.7 | 0.611 | 19.8 | LOS B | 4.1 | 33.0 | 0.57 | 0.68 | 38.3 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P5 | Across N approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P7 | Across W approach | 53 | 28.4 | LOS C | 0.1 | 0.1 | 0.90 | 0.90 |
| All Pedestrians | | 159 | 29.0 | LOS C | | | 0.91 | 0.91 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

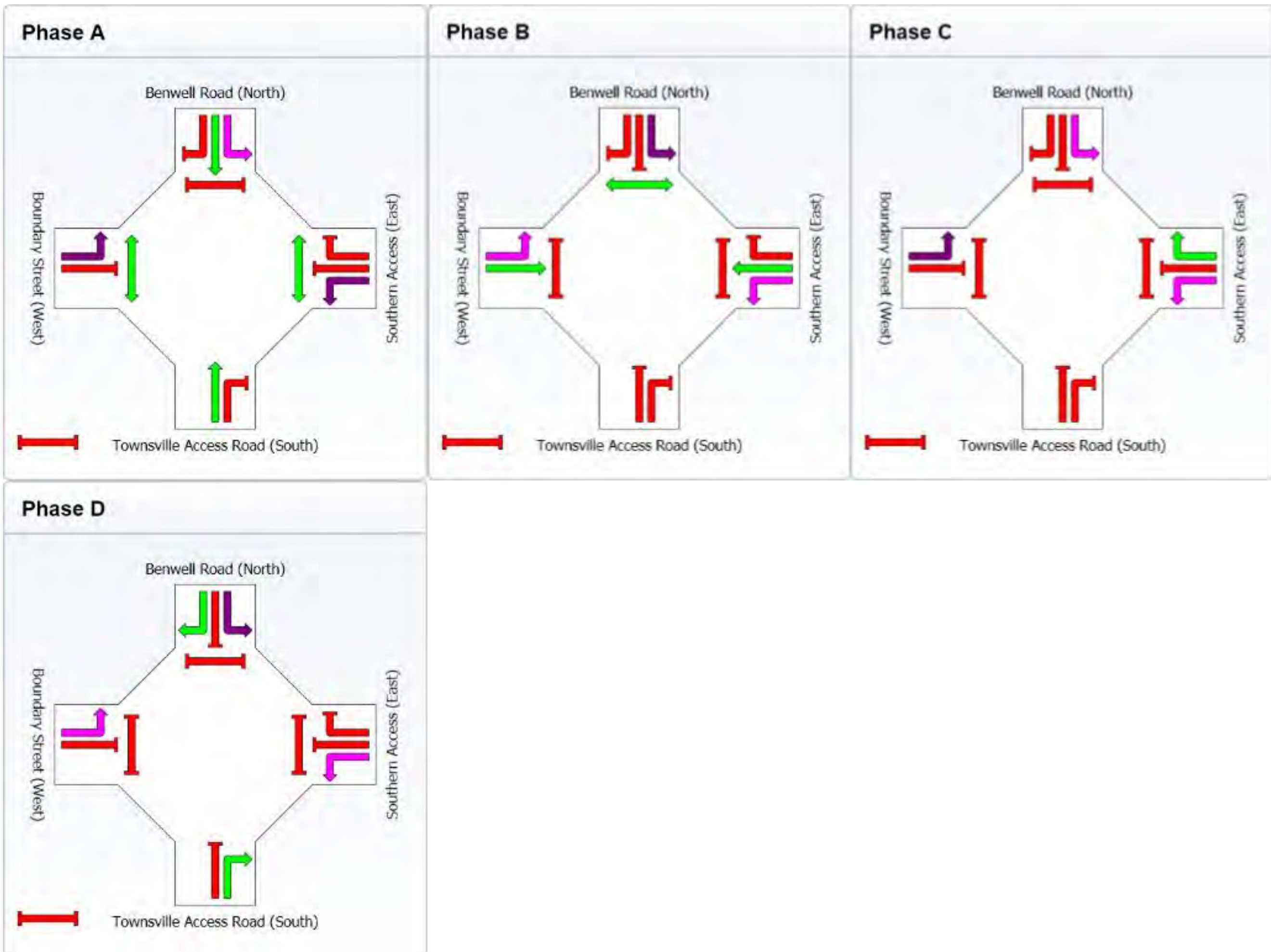
**Site: 2036 PM peak WOD (Optimised Signals)**

Boundary Street / Benwell Road
2036 (Opening Year) Without Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 8 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 14 |
| Phase Split | 27 % | 36 % | 17 % | 20 % |




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2036 PM peak WD (Optimised Signals)**

Boundary Street / Benwell Road
2036 (Opening Year) With Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 47 | 35.6 | 0.081 | 26.1 | LOS C | 0.7 | 6.3 | 0.86 | 0.62 | 33.3 |
| 3 | R | 115 | 18.3 | 0.611 | 43.3 | LOS D | 4.1 | 33.0 | 1.00 | 0.82 | 27.6 |
| Approach | | 162 | 23.4 | 0.611 | 38.3 | LOS D | 4.1 | 33.0 | 0.96 | 0.76 | 29.0 |
| East: Southern Access (East) | | | | | | | | | | | |
| 4 | L | 427 | 8.6 | 0.440 | 8.7 | LOS A | 2.1 | 15.9 | 0.27 | 0.67 | 48.3 |
| 5 | T | 114 | 8.3 | 0.226 | 21.7 | LOS C | 3.1 | 23.0 | 0.82 | 0.65 | 35.8 |
| 6 | R | 28 | 7.4 | 0.188 | 42.5 | LOS D | 1.0 | 7.2 | 0.96 | 0.72 | 27.7 |
| Approach | | 569 | 8.5 | 0.440 | 12.9 | LOS B | 3.1 | 23.0 | 0.41 | 0.66 | 43.7 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 6 | 16.7 | 0.008 | 8.9 | LOS A | 0.0 | 0.2 | 0.24 | 0.61 | 48.5 |
| 8 | T | 101 | 18.8 | 0.157 | 26.6 | LOS C | 1.5 | 12.1 | 0.87 | 0.66 | 33.0 |
| 9 | R | 138 | 13.7 | 0.713 | 44.7 | LOS D | 5.1 | 39.6 | 1.00 | 0.88 | 27.0 |
| Approach | | 245 | 15.9 | 0.713 | 36.3 | LOS D | 5.1 | 39.6 | 0.93 | 0.78 | 29.6 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 41 | 46.2 | 0.046 | 9.1 | LOS A | 0.1 | 1.4 | 0.20 | 0.62 | 48.7 |
| 11 | T | 31 | 17.2 | 0.064 | 20.6 | LOS C | 0.8 | 6.3 | 0.77 | 0.57 | 36.6 |
| Approach | | 72 | 33.8 | 0.064 | 14.0 | LOS B | 0.8 | 6.3 | 0.44 | 0.60 | 42.7 |
| All Vehicles | | 1048 | 14.3 | 0.713 | 22.4 | LOS C | 5.1 | 39.6 | 0.62 | 0.70 | 36.7 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P5 | Across N approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P7 | Across W approach | 53 | 28.4 | LOS C | 0.1 | 0.1 | 0.90 | 0.90 |
| All Pedestrians | | 159 | 29.0 | LOS C | | | 0.91 | 0.91 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

Processed: Monday, 13 August 2012 3:24:44 PM
SIDRA INTERSECTION 5.1.11.2079

Project: J:\MMPL\60161996\4. Tech Work Area\4.3 Engineering\Traffic and Infrastructure\SIDRA\2036 WD\3 Boundary Street - Benwell Road - Signals.sip
8000907, AECOM, ENTERPRISE

# PHASING SUMMARY

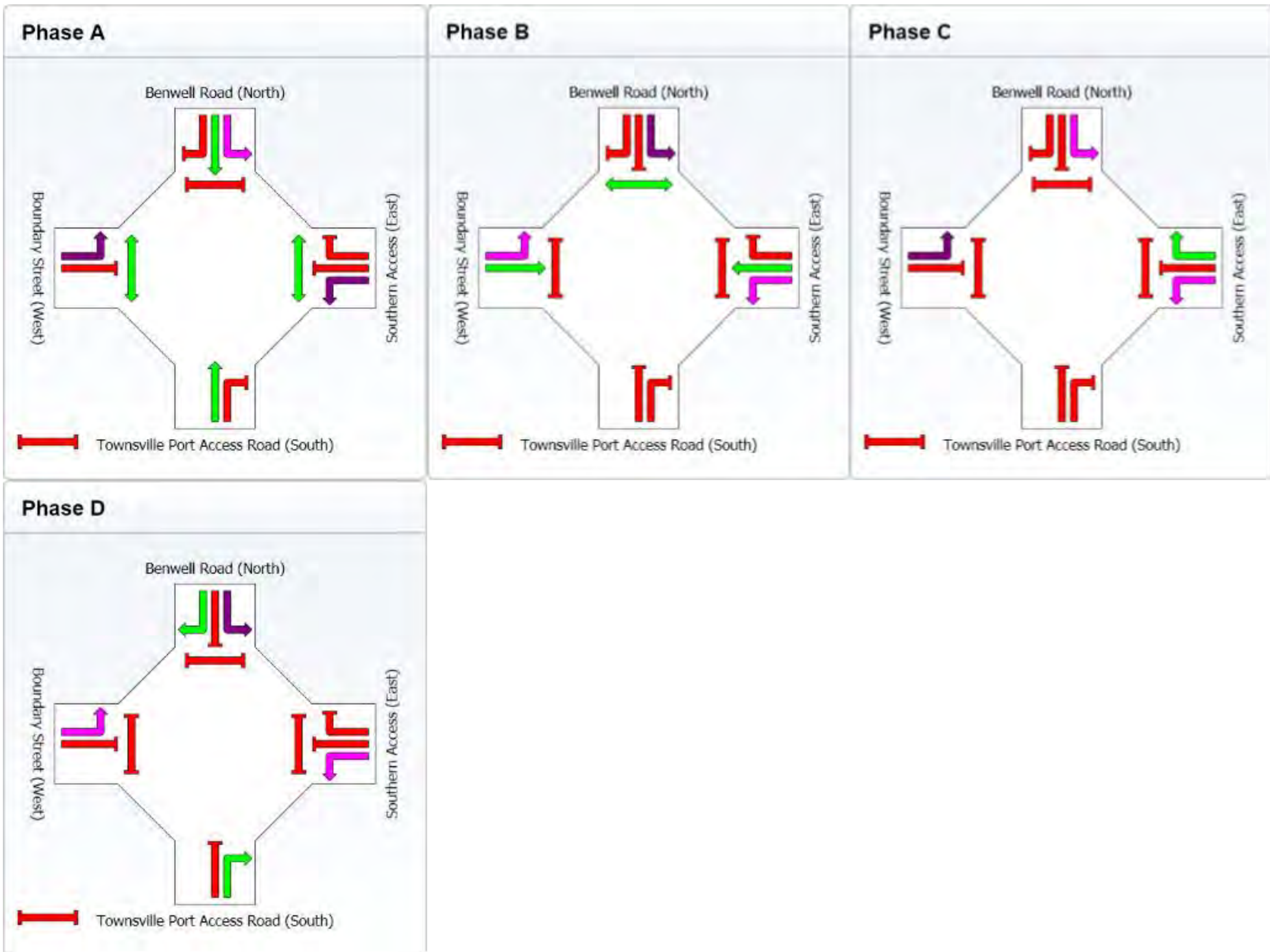
**Site: 2036 PM peak WD (Optimised Signals)**

Boundary Street / Benwell Road
2036 (Opening Year) With Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 8 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 14 |
| Phase Split | 27 % | 36 % | 17 % | 20 % |




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2046 AM peak WOD (Optimised Signals)**

Boundary Street / Benwell Road
2046 (Opening Year + 10 years) Without Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 105 | 9.0 | 0.220 | 43.2 | LOS D | 2.4 | 17.9 | 0.93 | 0.70 | 26.3 |
| 3 | R | 449 | 8.2 | 0.674 | 36.2 | LOS D | 18.4 | 137.6 | 0.89 | 0.85 | 30.1 |
| Approach | | 555 | 8.3 | 0.674 | 37.5 | LOS D | 18.4 | 137.6 | 0.90 | 0.83 | 29.3 |
| East: Southern Access (East) | | | | | | | | | | | |
| 4 | L | 92 | 17.2 | 0.095 | 8.3 | LOS A | 0.3 | 2.4 | 0.13 | 0.62 | 49.0 |
| 5 | T | 24 | 17.4 | 0.073 | 36.1 | LOS D | 1.0 | 7.9 | 0.85 | 0.62 | 28.9 |
| 6 | R | 6 | 16.7 | 0.063 | 58.9 | LOS E | 0.3 | 2.5 | 0.97 | 0.66 | 23.0 |
| Approach | | 122 | 17.2 | 0.095 | 16.4 | LOS B | 1.0 | 7.9 | 0.32 | 0.62 | 41.1 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 28 | 7.4 | 0.070 | 13.5 | LOS B | 0.4 | 3.3 | 0.40 | 0.66 | 44.0 |
| 8 | T | 33 | 19.4 | 0.072 | 42.0 | LOS D | 0.7 | 5.8 | 0.91 | 0.64 | 26.7 |
| 9 | R | 28 | 18.5 | 0.046 | 29.4 | LOS C | 0.9 | 7.0 | 0.66 | 0.72 | 33.4 |
| Approach | | 89 | 15.3 | 0.072 | 29.0 | LOS C | 0.9 | 7.0 | 0.67 | 0.67 | 33.0 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 48 | 10.9 | 0.043 | 8.3 | LOS A | 0.2 | 1.5 | 0.15 | 0.62 | 49.0 |
| 11 | T | 120 | 7.9 | 0.341 | 38.5 | LOS D | 5.2 | 38.6 | 0.91 | 0.73 | 28.0 |
| Approach | | 168 | 8.8 | 0.341 | 29.8 | LOS C | 5.2 | 38.6 | 0.69 | 0.70 | 31.9 |
| All Vehicles | | 935 | 10.2 | 0.674 | 32.6 | LOS C | 18.4 | 137.6 | 0.76 | 0.76 | 31.3 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P5 | Across N approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 43.2 | LOS E | 0.1 | 0.1 | 0.93 | 0.93 |
| All Pedestrians | | 159 | 43.9 | LOS E | | | 0.94 | 0.94 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

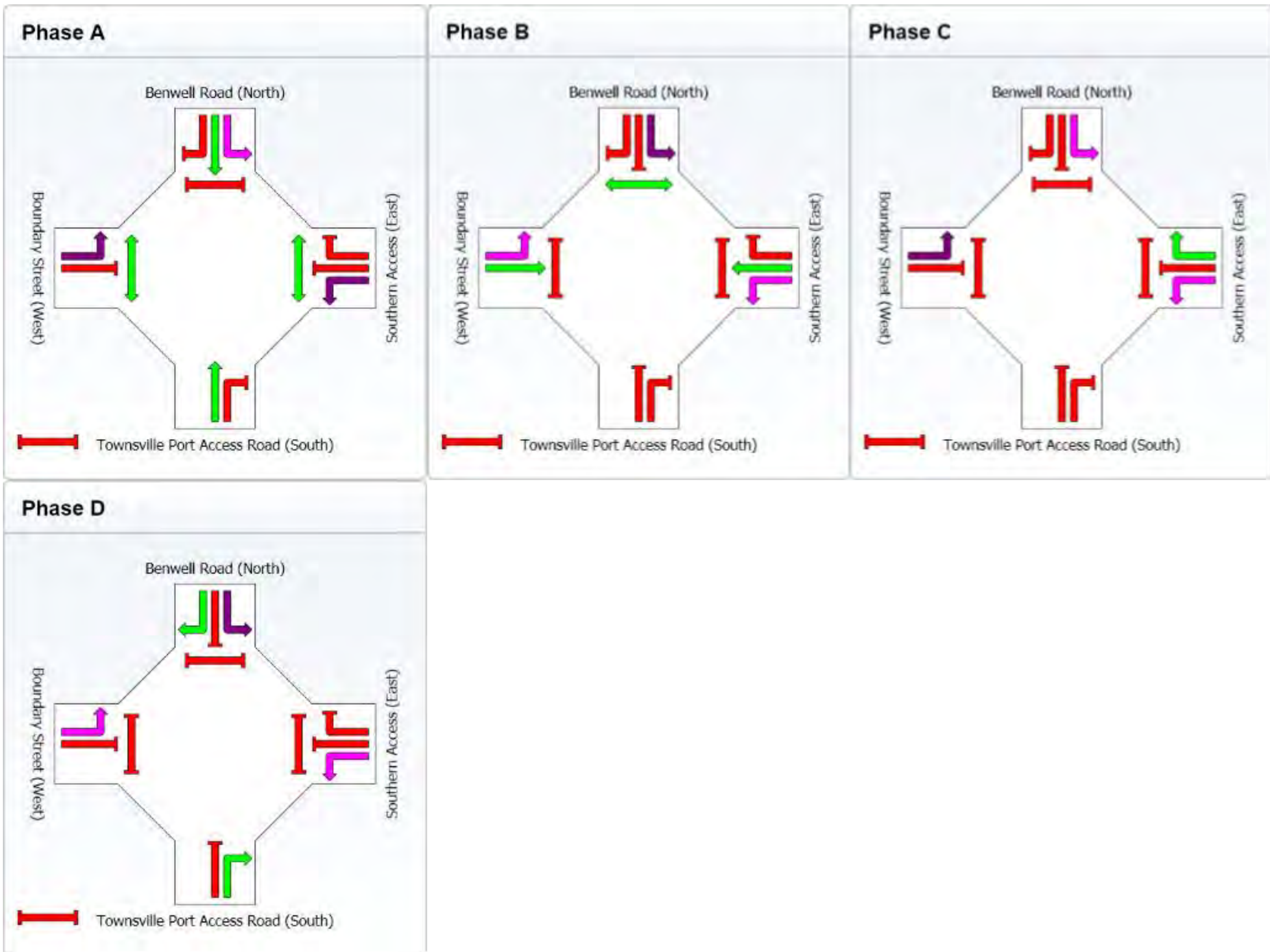
**Site: 2046 AM peak WOD (Optimised Signals)**

Boundary Street / Benwell Road
2046 (Opening Year + 10 years) Without Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 38 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 44 |
| Phase Split | 19 % | 25 % | 12 % | 44 % |




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2046 AM peak WD (Optimised Signals)**

Boundary Street / Benwell Road
2046 (Opening Year + 10 years) With Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 123 | 14.5 | 0.266 | 43.6 | LOS D | 2.8 | 22.0 | 0.94 | 0.72 | 26.2 |
| 3 | R | 449 | 8.2 | 0.674 | 36.2 | LOS D | 18.4 | 137.6 | 0.89 | 0.85 | 30.1 |
| Approach | | 573 | 9.6 | 0.674 | 37.8 | LOS D | 18.4 | 137.6 | 0.90 | 0.83 | 29.2 |
| East: Southern Access (East) | | | | | | | | | | | |
| 4 | L | 92 | 17.2 | 0.097 | 8.4 | LOS A | 0.3 | 2.8 | 0.14 | 0.62 | 49.0 |
| 5 | T | 24 | 17.4 | 0.073 | 36.1 | LOS D | 1.0 | 7.9 | 0.85 | 0.62 | 28.9 |
| 6 | R | 6 | 16.7 | 0.063 | 58.9 | LOS E | 0.3 | 2.5 | 0.97 | 0.66 | 23.0 |
| Approach | | 122 | 17.2 | 0.097 | 16.5 | LOS B | 1.0 | 7.9 | 0.33 | 0.62 | 41.0 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 28 | 7.4 | 0.070 | 13.5 | LOS B | 0.4 | 3.3 | 0.40 | 0.66 | 44.0 |
| 8 | T | 41 | 35.9 | 0.100 | 42.5 | LOS D | 0.9 | 8.3 | 0.91 | 0.66 | 26.6 |
| 9 | R | 41 | 43.6 | 0.076 | 30.6 | LOS C | 1.3 | 12.3 | 0.67 | 0.73 | 33.2 |
| Approach | | 111 | 31.4 | 0.100 | 30.6 | LOS C | 1.3 | 12.3 | 0.69 | 0.68 | 32.3 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 147 | 12.9 | 0.139 | 8.5 | LOS A | 0.7 | 5.4 | 0.17 | 0.63 | 48.8 |
| 11 | T | 120 | 7.9 | 0.341 | 38.5 | LOS D | 5.2 | 38.6 | 0.91 | 0.73 | 28.0 |
| Approach | | 267 | 10.6 | 0.341 | 22.0 | LOS C | 5.2 | 38.6 | 0.50 | 0.68 | 36.6 |
| All Vehicles | | 1073 | 13.0 | 0.674 | 30.7 | LOS C | 18.4 | 137.6 | 0.72 | 0.75 | 32.2 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P5 | Across N approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 43.2 | LOS E | 0.1 | 0.1 | 0.93 | 0.93 |
| All Pedestrians | | 159 | 43.9 | LOS E | | | 0.94 | 0.94 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

# PHASING SUMMARY

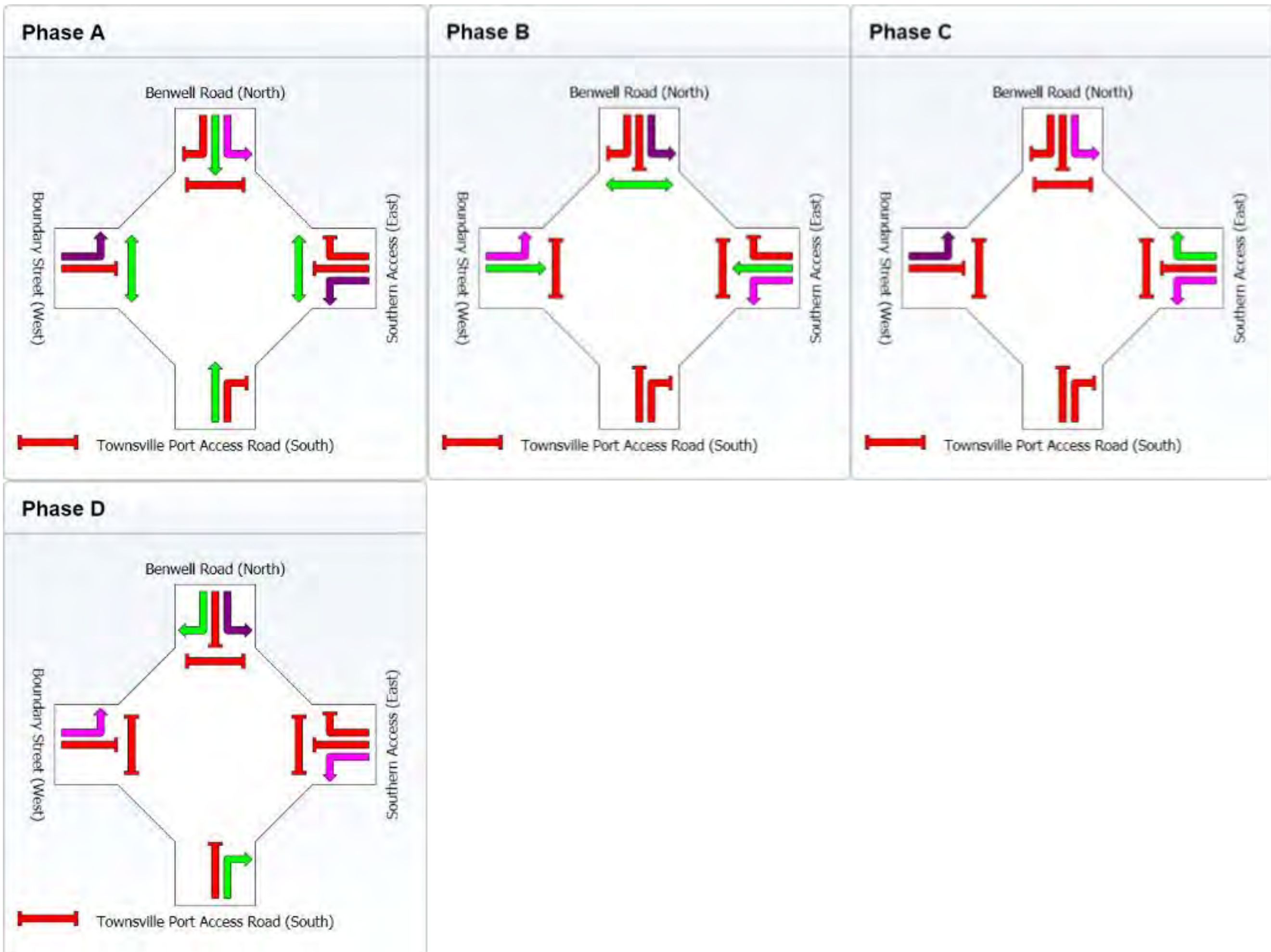
**Site: 2046 AM peak WD (Optimised Signals)**

Boundary Street / Benwell Road
2046 (Opening Year + 10 years) With Development
AM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 38 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 44 |
| Phase Split | 19 % | 25 % | 12 % | 44 % |




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2046 PM peak WOD (Optimised Signals)**

Boundary Street / Benwell Road
2046 (Opening Year + 10 years) Without Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 45 | 20.9 | 0.071 | 26.0 | LOS C | 0.7 | 5.4 | 0.85 | 0.62 | 33.4 |
| 3 | R | 115 | 18.3 | 0.611 | 43.3 | LOS D | 4.1 | 33.0 | 1.00 | 0.82 | 27.6 |
| Approach | | 160 | 19.1 | 0.611 | 38.4 | LOS D | 4.1 | 33.0 | 0.96 | 0.76 | 29.0 |
| East: Southern Access (East) | | | | | | | | | | | |
| 4 | L | 427 | 8.6 | 0.432 | 8.6 | LOS A | 2.1 | 15.7 | 0.26 | 0.66 | 48.3 |
| 5 | T | 114 | 8.3 | 0.226 | 21.7 | LOS C | 3.1 | 23.0 | 0.82 | 0.65 | 35.8 |
| 6 | R | 28 | 7.4 | 0.188 | 42.5 | LOS D | 1.0 | 7.2 | 0.96 | 0.72 | 27.7 |
| Approach | | 569 | 8.5 | 0.432 | 12.9 | LOS B | 3.1 | 23.0 | 0.41 | 0.66 | 43.7 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 6 | 16.7 | 0.008 | 8.9 | LOS A | 0.0 | 0.2 | 0.24 | 0.61 | 48.5 |
| 8 | T | 87 | 10.8 | 0.129 | 26.3 | LOS C | 1.3 | 9.8 | 0.87 | 0.65 | 33.2 |
| 9 | R | 44 | 14.3 | 0.230 | 40.8 | LOS D | 1.5 | 11.5 | 0.94 | 0.74 | 28.4 |
| Approach | | 138 | 12.2 | 0.230 | 30.2 | LOS C | 1.5 | 11.5 | 0.86 | 0.68 | 31.9 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 36 | 20.6 | 0.034 | 8.6 | LOS A | 0.1 | 1.0 | 0.20 | 0.62 | 48.7 |
| 11 | T | 31 | 17.2 | 0.064 | 20.6 | LOS C | 0.8 | 6.3 | 0.77 | 0.57 | 36.6 |
| Approach | | 66 | 19.0 | 0.064 | 14.1 | LOS B | 0.8 | 6.3 | 0.46 | 0.60 | 42.3 |
| All Vehicles | | 934 | 11.6 | 0.611 | 19.9 | LOS B | 4.1 | 33.0 | 0.57 | 0.68 | 38.3 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P5 | Across N approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P7 | Across W approach | 53 | 28.4 | LOS C | 0.1 | 0.1 | 0.90 | 0.90 |
| All Pedestrians | | 159 | 29.0 | LOS C | | | 0.91 | 0.91 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

## PHASING SUMMARY

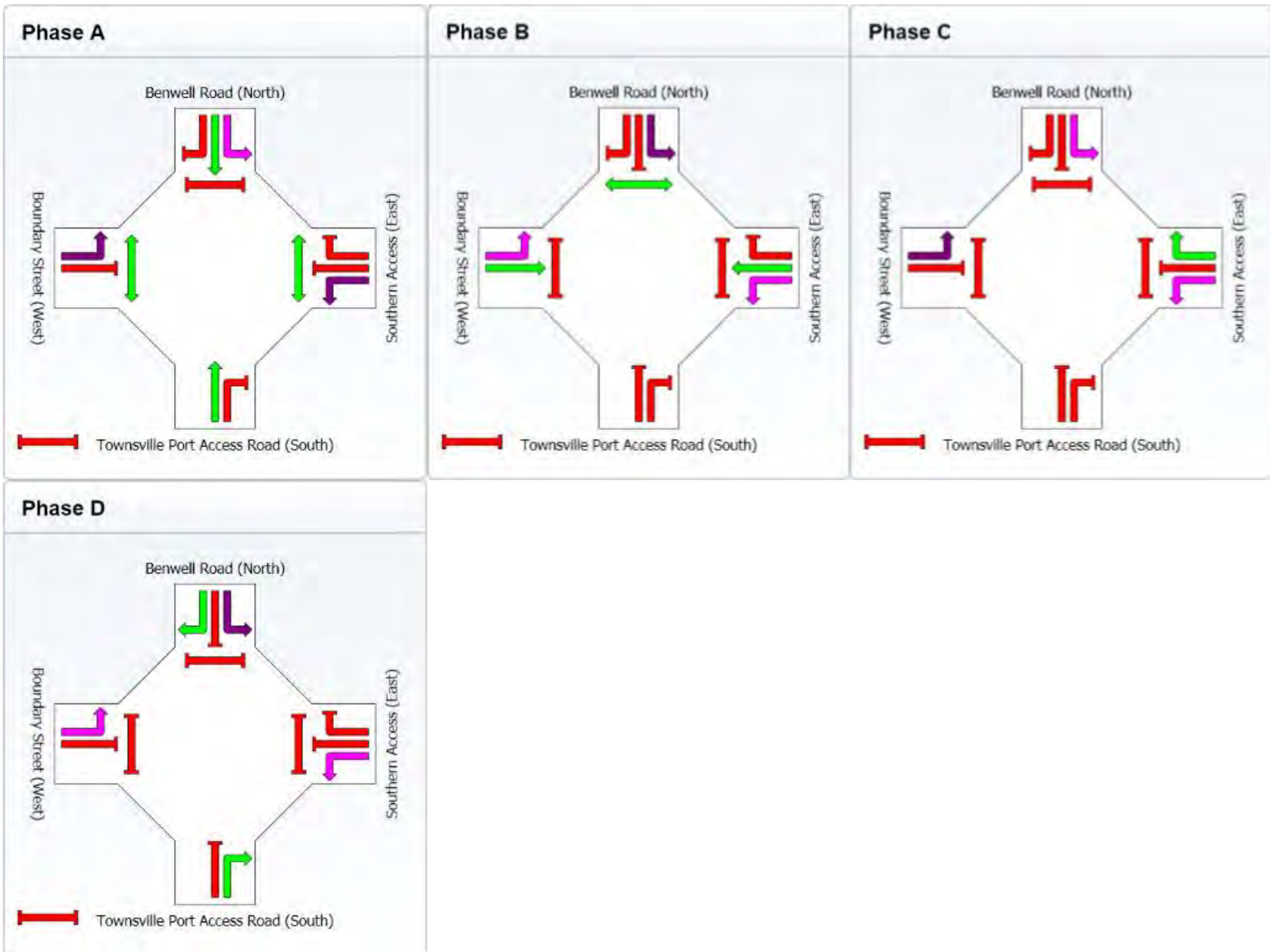
**Site: 2046 PM peak WOD (Optimised Signals)**

Boundary Street / Benwell Road
2046 (Opening Year + 10 years) Without Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 8 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 14 |
| Phase Split | 27 % | 36 % | 17 % | 20 % |




Normal Movement
Slip-Lane Movement
Stopped Movement
Turn On Red
Permitted/Opposed
Opposed Slip-Lane
Continuous Movement
Undetected Movement
Phase Transition Applied

# MOVEMENT SUMMARY

**Site: 2046 PM peak WD (Optimised Signals)**

Boundary Street / Benwell Road
2046 (Opening Year + 10 years) With Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Townsville Port Access Road (South) | | | | | | | | | | | |
| 2 | T | 54 | 33.3 | 0.090 | 26.2 | LOS C | 0.8 | 7.0 | 0.86 | 0.63 | 33.3 |
| 3 | R | 115 | 18.3 | 0.611 | 43.3 | LOS D | 4.1 | 33.0 | 1.00 | 0.82 | 27.6 |
| Approach | | 168 | 23.1 | 0.611 | 37.8 | LOS D | 4.1 | 33.0 | 0.95 | 0.76 | 29.2 |
| East: Southern Access (East) | | | | | | | | | | | |
| 4 | L | 427 | 8.6 | 0.442 | 8.7 | LOS A | 2.1 | 15.9 | 0.27 | 0.67 | 48.3 |
| 5 | T | 114 | 8.3 | 0.226 | 21.7 | LOS C | 3.1 | 23.0 | 0.82 | 0.65 | 35.8 |
| 6 | R | 28 | 7.4 | 0.188 | 42.5 | LOS D | 1.0 | 7.2 | 0.96 | 0.72 | 27.7 |
| Approach | | 569 | 8.5 | 0.442 | 12.9 | LOS B | 3.1 | 23.0 | 0.41 | 0.66 | 43.7 |
| North: Benwell Road (North) | | | | | | | | | | | |
| 7 | L | 6 | 16.7 | 0.008 | 8.9 | LOS A | 0.0 | 0.2 | 0.24 | 0.61 | 48.5 |
| 8 | T | 105 | 17.0 | 0.161 | 26.6 | LOS C | 1.6 | 12.5 | 0.87 | 0.66 | 33.0 |
| 9 | R | 143 | 14.0 | 0.742 | 45.3 | LOS D | 5.3 | 41.7 | 1.00 | 0.90 | 26.8 |
| Approach | | 255 | 15.3 | 0.742 | 36.7 | LOS D | 5.3 | 41.7 | 0.93 | 0.79 | 29.4 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 48 | 41.3 | 0.053 | 9.0 | LOS A | 0.2 | 1.6 | 0.20 | 0.62 | 48.7 |
| 11 | T | 31 | 17.2 | 0.064 | 20.6 | LOS C | 0.8 | 6.3 | 0.77 | 0.57 | 36.6 |
| Approach | | 79 | 32.0 | 0.064 | 13.5 | LOS B | 0.8 | 6.3 | 0.42 | 0.60 | 43.2 |
| All Vehicles | | 1072 | 14.1 | 0.742 | 22.5 | LOS C | 5.3 | 41.7 | 0.62 | 0.71 | 36.6 |

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P3 | Across E approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P5 | Across N approach | 53 | 29.3 | LOS C | 0.1 | 0.1 | 0.91 | 0.91 |
| P7 | Across W approach | 53 | 28.4 | LOS C | 0.1 | 0.1 | 0.90 | 0.90 |
| All Pedestrians | | 159 | 29.0 | LOS C | | | 0.91 | 0.91 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.



SIDRA INTERSECTION

# PHASING SUMMARY

**Site: 2046 PM peak WD (Optimised Signals)**

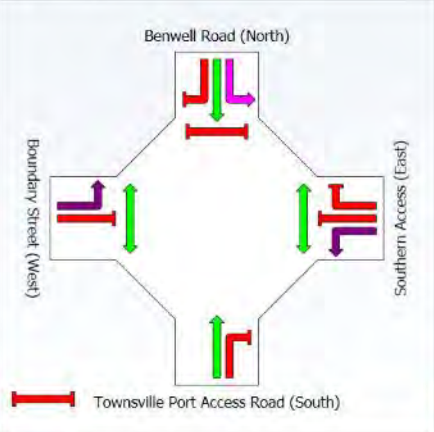
Boundary Street / Benwell Road
2046 (Opening Year + 10 years) With Development
PM peak
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

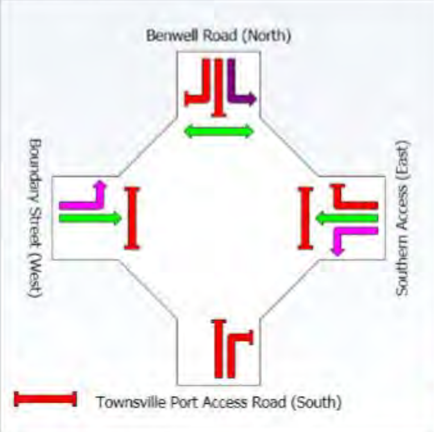
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 13 | 19 | 6 | 8 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 19 | 25 | 12 | 14 |
| Phase Split | 27 % | 36 % | 17 % | 20 % |

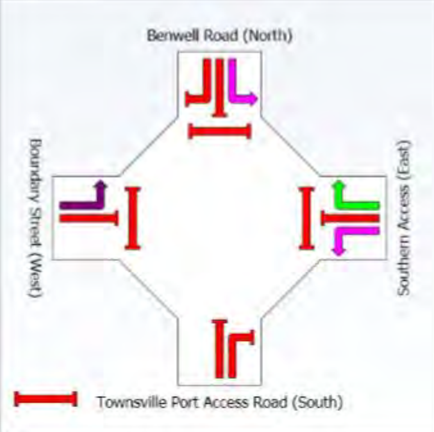
**Phase A**



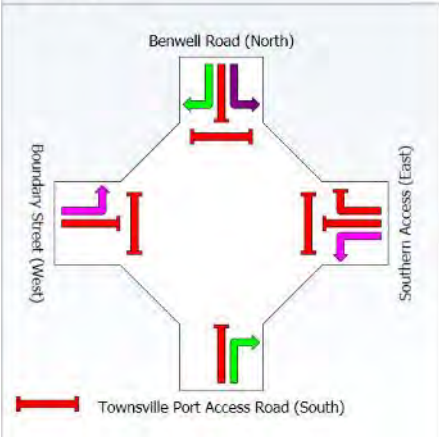

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |


# Port Expansion Project EIS

## Appendix Q7

## Intersection 4: Boundary Street / Saunders Street SIDRA Summaries

AECOM BMT WBM

# MOVEMENT SUMMARY

**Site: 2014 AM peak WOD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2014 Without Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 85 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 206 | 3.6 | 0.559 | 26.2 | LOS C | 7.3 | 52.8 | 0.70 | 0.78 | 34.9 |
| 2 | T | 815 | 2.8 | 0.786 | 34.6 | LOS C | 18.1 | 130.1 | 0.99 | 0.93 | 29.3 |
| 3 | R | 43 | 7.3 | 0.208 | 46.3 | LOS D | 2.5 | 18.7 | 0.94 | 0.74 | 26.5 |
| Approach | | 1064 | 3.2 | 0.786 | 33.5 | LOS C | 18.1 | 130.1 | 0.93 | 0.89 | 30.1 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 83 | 7.6 | 0.131 | 10.7 | LOS B | 1.3 | 9.9 | 0.34 | 0.66 | 46.6 |
| 5 | T | 176 | 7.8 | 0.183 | 26.7 | LOS C | 4.1 | 30.3 | 0.82 | 0.64 | 33.1 |
| 6 | R | 65 | 1.6 | 0.504 | 52.4 | LOS D | 4.0 | 28.4 | 1.00 | 0.75 | 24.6 |
| Approach | | 324 | 6.5 | 0.504 | 27.7 | LOS C | 4.1 | 30.3 | 0.73 | 0.67 | 33.3 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 59 | 3.6 | 0.539 | 37.3 | LOS D | 11.4 | 83.9 | 0.91 | 0.85 | 30.9 |
| 8 | T | 486 | 6.1 | 0.539 | 29.0 | LOS C | 11.5 | 84.8 | 0.91 | 0.76 | 31.6 |
| 9 | R | 159 | 9.9 | 0.779 | 52.8 | LOS D | 8.9 | 67.3 | 1.00 | 0.92 | 24.6 |
| Approach | | 704 | 6.7 | 0.779 | 35.1 | LOS D | 11.5 | 84.8 | 0.93 | 0.81 | 29.6 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 443 | 5.0 | 0.581 | 13.5 | LOS B | 9.3 | 67.7 | 0.53 | 0.74 | 43.8 |
| 11 | T | 300 | 7.0 | 0.438 | 28.2 | LOS C | 9.2 | 68.0 | 0.86 | 0.71 | 32.3 |
| 12 | R | 86 | 6.1 | 0.687 | 54.3 | LOS D | 5.3 | 39.0 | 1.00 | 0.83 | 24.1 |
| Approach | | 829 | 5.8 | 0.687 | 23.1 | LOS C | 9.3 | 68.0 | 0.70 | 0.74 | 36.1 |
| All Vehicles | | 2922 | 5.2 | 0.786 | 30.3 | LOS C | 18.1 | 130.1 | 0.84 | 0.80 | 31.8 |

Level of Service (Aver. Int. Delay): LOS C. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS D. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 36.7 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 |
| P3 | Across E approach | 53 | 33.1 | LOS D | 0.1 | 0.1 | 0.88 | 0.88 |
| P5 | Across N approach | 53 | 34.0 | LOS D | 0.1 | 0.1 | 0.89 | 0.89 |
| P7 | Across W approach | 53 | 33.1 | LOS D | 0.1 | 0.1 | 0.88 | 0.88 |
| All Pedestrians | | 212 | 34.2 | | | | 0.90 | 0.90 |

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS D. LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2014 AM peak WOD (Amended Layout & Optimised Signals)**

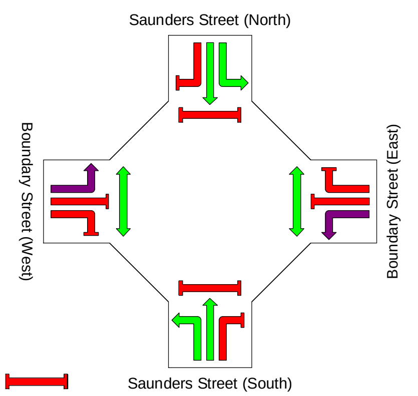
Boundary Street / Saunders Street
2014 Without Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 85 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

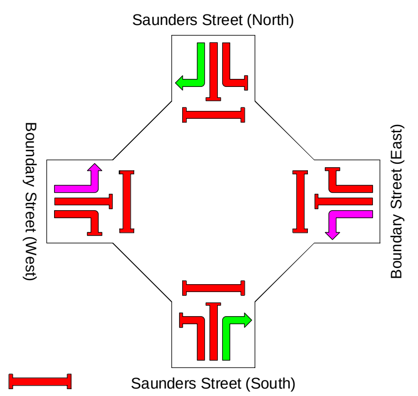
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 23 | 10 | 22 | 6 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 29 | 16 | 28 | 12 |
| Phase Split | 34 % | 19 % | 33 % | 14 % |

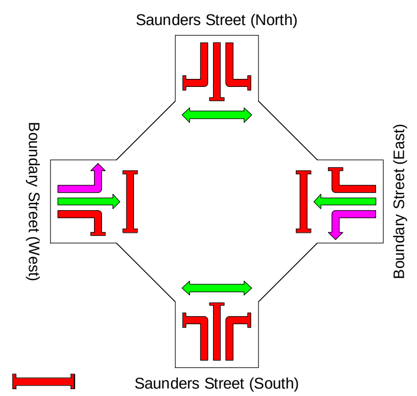
**Phase A**



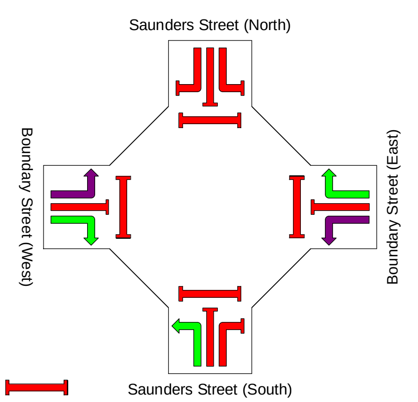

**Phase B**




**Phase C**




**Phase D**




Normal Movement
Slip-Lane Movement
Stopped Movement
Turn On Red
Permitted/Opposed
Opposed Slip-Lane
Continuous Movement
Undetected Movement
Phase Transition Applied

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# MOVEMENT SUMMARY

**Site: 2014 AM peak WD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2014 With Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 85 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 206 | 3.6 | 0.559 | 26.2 | LOS C | 7.3 | 52.8 | 0.70 | 0.78 | 34.9 |
| 2 | T | 815 | 2.8 | 0.786 | 34.6 | LOS C | 18.1 | 130.1 | 0.99 | 0.93 | 29.3 |
| 3 | R | 43 | 7.3 | 0.208 | 46.3 | LOS D | 2.5 | 18.7 | 0.94 | 0.74 | 26.5 |
| Approach | | 1064 | 3.2 | 0.786 | 33.5 | LOS C | 18.1 | 130.1 | 0.93 | 0.89 | 30.1 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 83 | 7.6 | 0.131 | 10.7 | LOS B | 1.3 | 9.9 | 0.34 | 0.66 | 46.6 |
| 5 | T | 187 | 7.3 | 0.194 | 26.7 | LOS C | 4.3 | 32.1 | 0.82 | 0.65 | 33.1 |
| 6 | R | 65 | 1.6 | 0.504 | 52.4 | LOS D | 4.0 | 28.4 | 1.00 | 0.75 | 24.6 |
| Approach | | 336 | 6.3 | 0.504 | 27.8 | LOS C | 4.3 | 32.1 | 0.74 | 0.67 | 33.3 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 59 | 3.6 | 0.539 | 37.3 | LOS D | 11.4 | 83.9 | 0.91 | 0.85 | 30.9 |
| 8 | T | 486 | 6.1 | 0.539 | 29.0 | LOS C | 11.5 | 84.8 | 0.91 | 0.76 | 31.6 |
| 9 | R | 159 | 9.9 | 0.779 | 52.8 | LOS D | 8.9 | 67.3 | 1.00 | 0.92 | 24.6 |
| Approach | | 704 | 6.7 | 0.779 | 35.1 | LOS D | 11.5 | 84.8 | 0.93 | 0.81 | 29.6 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 443 | 5.0 | 0.581 | 13.5 | LOS B | 9.3 | 67.7 | 0.53 | 0.74 | 43.8 |
| 11 | T | 428 | 4.9 | 0.617 | 29.5 | LOS C | 12.8 | 93.5 | 0.91 | 0.76 | 31.6 |
| 12 | R | 86 | 6.1 | 0.687 | 54.3 | LOS D | 5.3 | 39.0 | 1.00 | 0.83 | 24.1 |
| Approach | | 958 | 5.1 | 0.687 | 24.4 | LOS C | 12.8 | 93.5 | 0.74 | 0.76 | 35.2 |
| All Vehicles | | 3062 | 4.9 | 0.786 | 30.4 | LOS C | 18.1 | 130.1 | 0.85 | 0.81 | 31.8 |

Level of Service (Aver. Int. Delay): LOS C. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS D. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 36.7 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 |
| P3 | Across E approach | 53 | 33.1 | LOS D | 0.1 | 0.1 | 0.88 | 0.88 |
| P5 | Across N approach | 53 | 34.0 | LOS D | 0.1 | 0.1 | 0.89 | 0.89 |
| P7 | Across W approach | 53 | 33.1 | LOS D | 0.1 | 0.1 | 0.88 | 0.88 |
| All Pedestrians | | 212 | 34.2 | | | | 0.90 | 0.90 |

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS D. LOS Method for individual pedestrian movements: Delay (HCM).

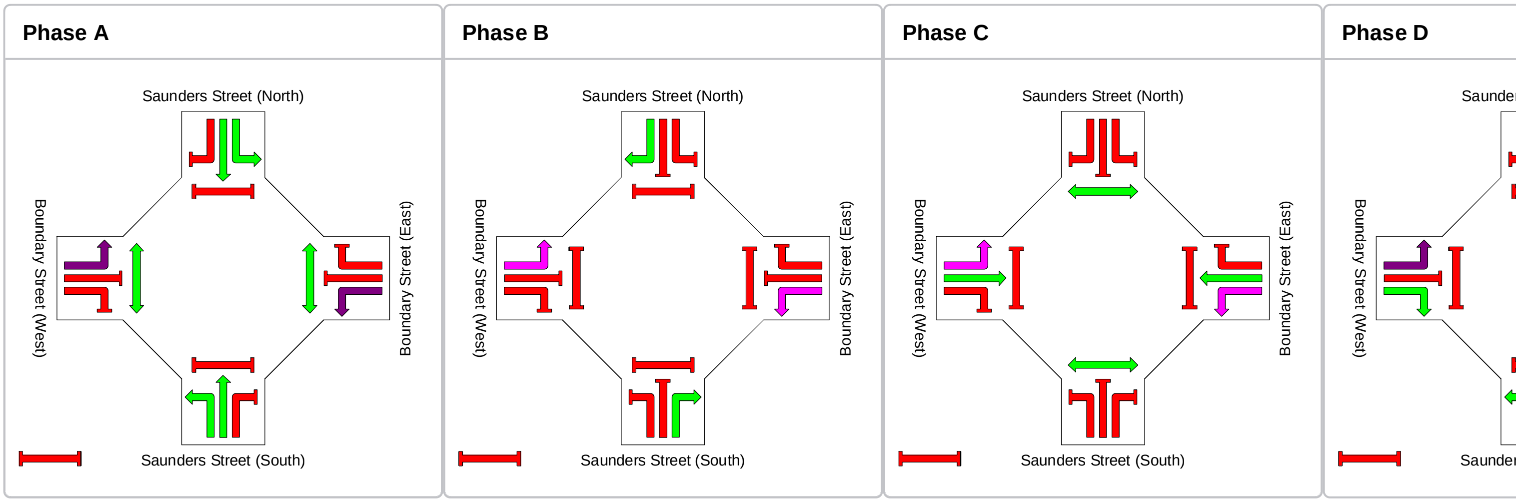
# PHASING SUMMARY

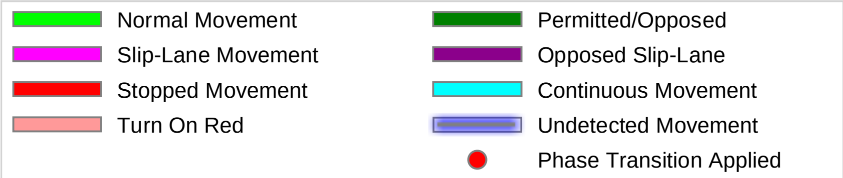
Boundary Street / Saunders Street
2014 With Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 85 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 23 | 10 | 22 | 6 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 29 | 16 | 28 | 12 |
| Phase Split | 34 % | 19 % | 33 % | 14 % |

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SIDRA INTERSECTION 5.0.1.1427

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8000907, AECOM, ENTERPRISE

# MOVEMENT SUMMARY

**Site: 2014 PM peak WOD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2014 Without Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 135 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 160 | 6.6 | 0.519 | 24.8 | LOS C | 6.8 | 50.3 | 0.54 | 0.75 | 35.7 |
| 2 | T | 491 | 6.7 | 0.341 | 31.2 | LOS C | 12.9 | 95.1 | 0.75 | 0.64 | 31.1 |
| 3 | R | 34 | 9.4 | 0.119 | 60.4 | LOS E | 2.8 | 21.2 | 0.89 | 0.73 | 22.7 |
| Approach | | 684 | 6.8 | 0.519 | 31.2 | LOS C | 12.9 | 95.1 | 0.71 | 0.67 | 31.4 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 120 | 7.9 | 0.421 | 25.5 | LOS C | 5.5 | 41.1 | 0.59 | 0.72 | 35.5 |
| 5 | T | 271 | 8.2 | 0.448 | 55.7 | LOS E | 9.9 | 73.9 | 0.95 | 0.77 | 22.9 |
| 6 | R | 61 | 3.4 | 0.303 | 69.1 | LOS E | 5.2 | 37.4 | 0.96 | 0.76 | 20.7 |
| Approach | | 452 | 7.5 | 0.448 | 49.5 | LOS D | 9.9 | 73.9 | 0.86 | 0.75 | 24.9 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 82 | 2.6 | 1.045 | 134.4 | LOS F | 82.3 | 592.0 | 1.00 | 1.40 | 13.0 |
| 8 | T | 1440 | 3.4 | 1.047 | 126.3 | LOS F | 82.3 | 592.0 | 1.00 | 1.38 | 13.1 |
| 9 | R | 161 | 6.3 | 1.000[3] | 65.1 | LOS E | 11.6 | 85.6 | 0.97 | 0.80 | 21.6 |
| Approach | | 1683 | 3.9 | 1.047 | 120.8 | LOS F | 82.3 | 592.0 | 1.00 | 1.33 | 13.6 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 281 | 10.9 | 0.389 | 10.4 | LOS B | 5.2 | 39.7 | 0.28 | 0.67 | 46.9 |
| 11 | T | 336 | 9.4 | 0.792 | 60.6 | LOS E | 17.1 | 127.6 | 0.98 | 0.86 | 21.5 |
| 12 | R | 169 | 3.4 | 1.000[3] | 73.6 | LOS E | 12.9 | 92.9 | 1.00 | 0.81 | 19.9 |
| Approach | | 786 | 8.0 | 1.000 | 45.4 | LOS D | 17.1 | 127.6 | 0.73 | 0.78 | 26.2 |
| All Vehicles | | 3605 | 5.8 | 1.047 | 78.4 | LOS E | 82.3 | 592.0 | 0.87 | 1.01 | 18.6 |

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 61.6 | LOS F | 0.2 | 0.2 | 0.96 | 0.96 |
| P3 | Across E approach | 53 | 34.1 | LOS D | 0.1 | 0.1 | 0.71 | 0.71 |
| P5 | Across N approach | 53 | 58.8 | LOS E | 0.2 | 0.2 | 0.93 | 0.93 |
| P7 | Across W approach | 53 | 34.1 | LOS D | 0.1 | 0.1 | 0.71 | 0.71 |
| All Pedestrians | | 212 | 47.2 | | | | 0.83 | 0.83 |

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2014 PM peak WOD (Amended Layout & Optimised Signals)**

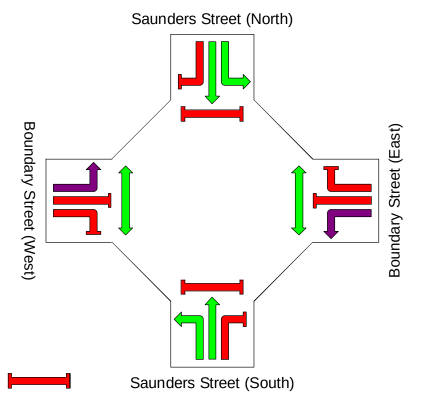
Boundary Street / Saunders Street
2014 Without Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 135 seconds (Optimum Cycle Time - Minimum Delay)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

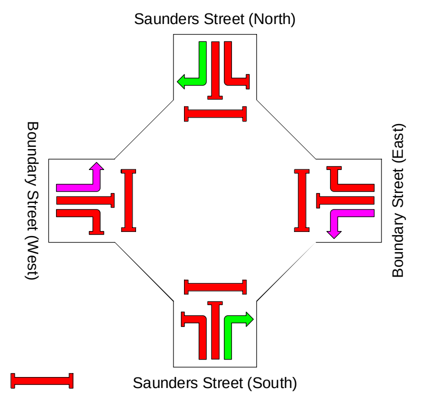
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 52 | 22 | 22 | 15 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 58 | 28 | 28 | 21 |
| Phase Split | 43 % | 21 % | 21 % | 16 % |

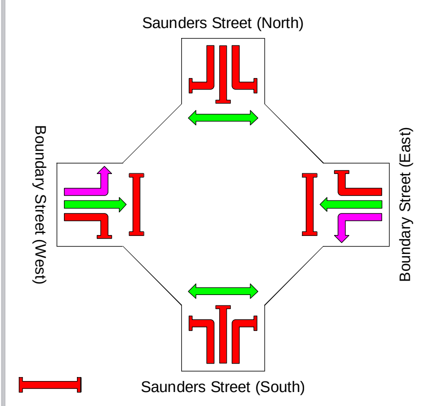
**Phase A**



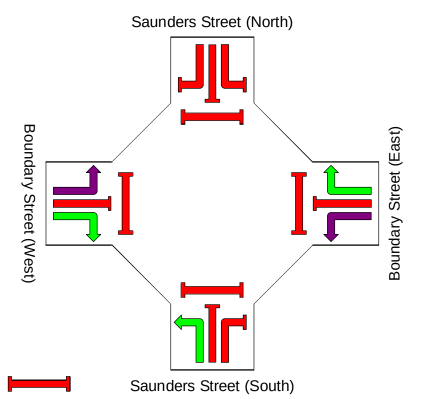

**Phase B**




**Phase C**




**Phase D**




Normal Movement
Slip-Lane Movement
Stopped Movement
Turn On Red
Permitted/Opposed
Opposed Slip-Lane
Continuous Movement
Undetected Movement
Phase Transition Applied

# MOVEMENT SUMMARY

**Site: 2014 PM peak WD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2014 With Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 135 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 160 | 6.6 | 0.519 | 24.8 | LOS C | 6.8 | 50.3 | 0.54 | 0.75 | 35.7 |
| 2 | T | 491 | 6.7 | 0.341 | 31.2 | LOS C | 12.9 | 95.1 | 0.75 | 0.64 | 31.1 |
| 3 | R | 34 | 9.4 | 0.119 | 60.4 | LOS E | 2.8 | 21.2 | 0.89 | 0.73 | 22.7 |
| Approach | | 684 | 6.8 | 0.519 | 31.2 | LOS C | 12.9 | 95.1 | 0.71 | 0.67 | 31.4 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 120 | 7.9 | 0.421 | 25.5 | LOS C | 5.5 | 41.1 | 0.59 | 0.72 | 35.5 |
| 5 | T | 399 | 5.5 | 0.650 | 57.9 | LOS E | 14.0 | 102.6 | 0.99 | 0.82 | 22.3 |
| 6 | R | 61 | 3.4 | 0.303 | 69.1 | LOS E | 5.2 | 37.4 | 0.96 | 0.76 | 20.7 |
| Approach | | 580 | 5.8 | 0.650 | 52.4 | LOS D | 14.0 | 102.6 | 0.90 | 0.79 | 24.0 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 82 | 2.6 | 1.045 | 134.4 | LOS F | 82.3 | 592.0 | 1.00 | 1.40 | 13.0 |
| 8 | T | 1440 | 3.4 | 1.047 | 126.3 | LOS F | 82.3 | 592.0 | 1.00 | 1.38 | 13.1 |
| 9 | R | 161 | 6.3 | 1.000 [3] | 65.1 | LOS E | 11.6 | 85.6 | 0.97 | 0.80 | 21.6 |
| Approach | | 1683 | 3.9 | 1.047 | 120.8 | LOS F | 82.3 | 592.0 | 1.00 | 1.33 | 13.6 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 281 | 10.9 | 0.389 | 10.4 | LOS B | 5.2 | 39.7 | 0.28 | 0.67 | 46.9 |
| 11 | T | 347 | 9.0 | 0.818 | 61.7 | LOS E | 17.9 | 133.2 | 0.98 | 0.88 | 21.3 |
| 12 | R | 169 | 3.4 | 1.000 [3] | 73.6 | LOS E | 12.9 | 92.9 | 1.00 | 0.81 | 19.9 |
| Approach | | 798 | 7.9 | 1.000 | 46.2 | LOS D | 17.9 | 133.2 | 0.74 | 0.79 | 25.9 |
| All Vehicles | | 3745 | 5.6 | 1.047 | 77.9 | LOS E | 82.3 | 592.0 | 0.87 | 1.01 | 18.7 |

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 61.6 | LOS F | 0.2 | 0.2 | 0.96 | 0.96 |
| P3 | Across E approach | 53 | 34.1 | LOS D | 0.1 | 0.1 | 0.71 | 0.71 |
| P5 | Across N approach | 53 | 58.8 | LOS E | 0.2 | 0.2 | 0.93 | 0.93 |
| P7 | Across W approach | 53 | 34.1 | LOS D | 0.1 | 0.1 | 0.71 | 0.71 |
| All Pedestrians | | 212 | 47.2 | | | | 0.83 | 0.83 |

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual pedestrian movements: Delay (HCM).

# MOVEMENT SUMMARY

**Site: 2014 PM peak WD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2014 With Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 135 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 160 | 6.6 | 0.519 | 24.8 | LOS C | 6.8 | 50.3 | 0.54 | 0.75 | 35.7 |
| 2 | T | 491 | 6.7 | 0.341 | 31.2 | LOS C | 12.9 | 95.1 | 0.75 | 0.64 | 31.1 |
| 3 | R | 34 | 9.4 | 0.119 | 60.4 | LOS E | 2.8 | 21.2 | 0.89 | 0.73 | 22.7 |
| Approach | | 684 | 6.8 | 0.519 | 31.2 | LOS C | 12.9 | 95.1 | 0.71 | 0.67 | 31.4 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 120 | 7.9 | 0.421 | 25.5 | LOS C | 5.5 | 41.1 | 0.59 | 0.72 | 35.5 |
| 5 | T | 399 | 5.5 | 0.650 | 57.9 | LOS E | 14.0 | 102.6 | 0.99 | 0.82 | 22.3 |
| 6 | R | 61 | 3.4 | 0.303 | 69.1 | LOS E | 5.2 | 37.4 | 0.96 | 0.76 | 20.7 |
| Approach | | 580 | 5.8 | 0.650 | 52.4 | LOS D | 14.0 | 102.6 | 0.90 | 0.79 | 24.0 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 82 | 2.6 | 1.045 | 134.4 | LOS F | 82.3 | 592.0 | 1.00 | 1.40 | 13.0 |
| 8 | T | 1440 | 3.4 | 1.047 | 126.3 | LOS F | 82.3 | 592.0 | 1.00 | 1.38 | 13.1 |
| 9 | R | 161 | 6.3 | 1.000[3] | 65.1 | LOS E | 11.6 | 85.6 | 0.97 | 0.80 | 21.6 |
| Approach | | 1683 | 3.9 | 1.047 | 120.8 | LOS F | 82.3 | 592.0 | 1.00 | 1.33 | 13.6 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 281 | 10.9 | 0.389 | 10.4 | LOS B | 5.2 | 39.7 | 0.28 | 0.67 | 46.9 |
| 11 | T | 347 | 9.0 | 0.818 | 61.7 | LOS E | 17.9 | 133.2 | 0.98 | 0.88 | 21.3 |
| 12 | R | 169 | 3.4 | 1.000[3] | 73.6 | LOS E | 12.9 | 92.9 | 1.00 | 0.81 | 19.9 |
| Approach | | 798 | 7.9 | 1.000 | 46.2 | LOS D | 17.9 | 133.2 | 0.74 | 0.79 | 25.9 |
| All Vehicles | | 3745 | 5.6 | 1.047 | 77.9 | LOS E | 82.3 | 592.0 | 0.87 | 1.01 | 18.7 |

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 61.6 | LOS F | 0.2 | 0.2 | 0.96 | 0.96 |
| P3 | Across E approach | 53 | 34.1 | LOS D | 0.1 | 0.1 | 0.71 | 0.71 |
| P5 | Across N approach | 53 | 58.8 | LOS E | 0.2 | 0.2 | 0.93 | 0.93 |
| P7 | Across W approach | 53 | 34.1 | LOS D | 0.1 | 0.1 | 0.71 | 0.71 |
| All Pedestrians | | 212 | 47.2 | | | | 0.83 | 0.83 |

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual pedestrian movements: Delay (HCM).

# MOVEMENT SUMMARY

**Site: 2035 AM peak WOD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2035 Without Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 90 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 205 | 3.1 | 0.571 | 26.5 | LOS C | 7.5 | 53.9 | 0.69 | 0.78 | 34.7 |
| 2 | T | 1077 | 2.9 | 0.974 | 68.5 | LOS E | 34.8 | 250.0 | 1.00 | 1.30 | 20.1 |
| 3 | R | 63 | 6.7 | 0.267 | 47.3 | LOS D | 3.7 | 27.4 | 0.94 | 0.76 | 26.2 |
| Approach | | 1345 | 3.1 | 0.974 | 61.1 | LOS E | 34.8 | 250.0 | 0.95 | 1.19 | 21.8 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 101 | 7.3 | 0.189 | 12.6 | LOS B | 2.2 | 16.0 | 0.41 | 0.68 | 44.7 |
| 5 | T | 223 | 8.0 | 0.246 | 29.8 | LOS C | 5.4 | 40.6 | 0.84 | 0.67 | 31.6 |
| 6 | R | 117 | 2.7 | 0.962 | 76.2 | LOS E | 8.5 | 60.5 | 1.00 | 1.11 | 19.4 |
| Approach | | 441 | 6.4 | 0.962 | 38.1 | LOS D | 8.5 | 60.5 | 0.79 | 0.79 | 28.8 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 104 | 3.0 | 0.727 | 40.8 | LOS D | 17.3 | 126.3 | 0.96 | 0.90 | 29.4 |
| 8 | T | 680 | 6.0 | 0.727 | 32.6 | LOS C | 17.4 | 128.0 | 0.96 | 0.86 | 30.0 |
| 9 | R | 231 | 10.0 | 1.000 [3] | 52.5 | LOS D | 12.3 | 93.6 | 1.00 | 0.83 | 24.7 |
| Approach | | 1016 | 6.6 | 1.000 | 37.9 | LOS D | 17.4 | 128.0 | 0.97 | 0.85 | 28.5 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 554 | 5.5 | 0.880 | 27.4 | LOS C | 18.9 | 138.3 | 0.74 | 0.87 | 34.5 |
| 11 | T | 378 | 7.2 | 0.584 | 32.0 | LOS C | 12.1 | 90.1 | 0.91 | 0.75 | 30.5 |
| 12 | R | 88 | 6.0 | 0.745 | 58.2 | LOS E | 5.7 | 42.3 | 1.00 | 0.86 | 23.2 |
| Approach | | 1020 | 6.2 | 0.880 | 31.7 | LOS C | 18.9 | 138.3 | 0.82 | 0.82 | 31.6 |
| All Vehicles | | 3822 | 5.3 | 1.000 | 44.5 | LOS D | 34.8 | 250.0 | 0.90 | 0.96 | 26.4 |

Level of Service (Aver. Int. Delay): LOS D.  Based on average delay for all vehicle movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E.  LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3  x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 39.2 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 |
| P3 | Across E approach | 53 | 32.9 | LOS D | 0.1 | 0.1 | 0.86 | 0.86 |
| P5 | Across N approach | 53 | 36.5 | LOS D | 0.1 | 0.1 | 0.90 | 0.90 |
| P7 | Across W approach | 53 | 32.9 | LOS D | 0.1 | 0.1 | 0.86 | 0.86 |
| All Pedestrians | | 212 | 35.4 | | | | 0.89 | 0.89 |

Level of Service (Aver. Int. Delay): LOS D.  Based on average delay for all pedestrian movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS D.  LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2035 AM peak WOD (Amended Layout & Optimised Signals)**

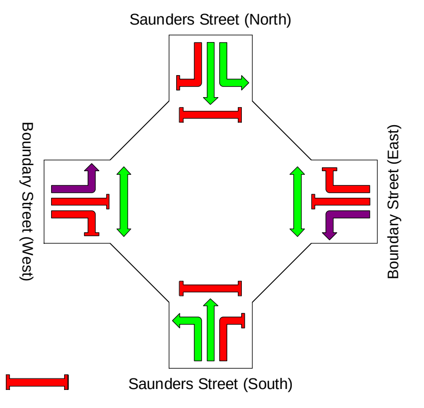
Boundary Street / Saunders Street
2035 Without Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 90 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

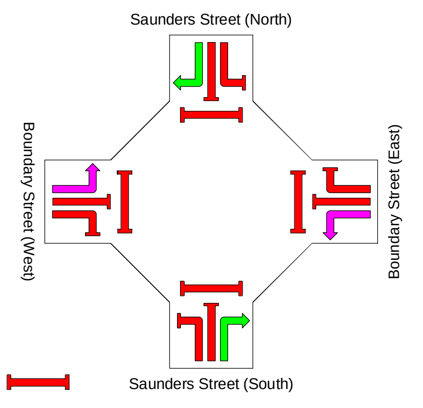
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 26 | 12 | 22 | 6 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 32 | 18 | 28 | 12 |
| Phase Split | 36 % | 20 % | 31 % | 13 % |

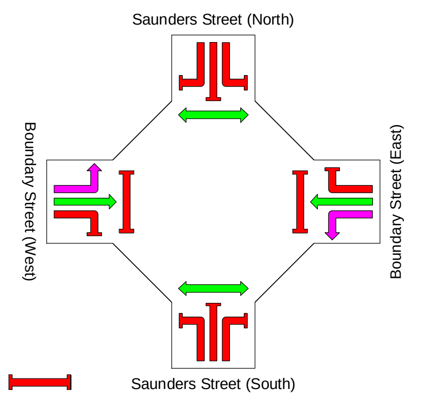
**Phase A**



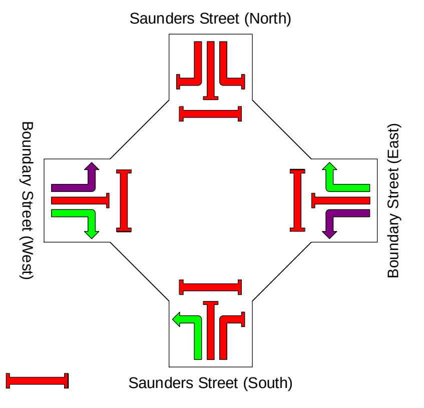

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2035 AM peak WD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2035 With Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 90 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 205 | 3.1 | 0.571 | 26.5 | LOS C | 7.5 | 53.9 | 0.69 | 0.78 | 34.7 |
| 2 | T | 1077 | 2.9 | 0.974 | 68.5 | LOS E | 34.8 | 250.0 | 1.00 | 1.30 | 20.1 |
| 3 | R | 63 | 6.7 | 0.267 | 47.3 | LOS D | 3.7 | 27.4 | 0.94 | 0.76 | 26.2 |
| Approach | | 1345 | 3.1 | 0.974 | 61.1 | LOS E | 34.8 | 250.0 | 0.95 | 1.19 | 21.8 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 101 | 7.3 | 0.189 | 12.6 | LOS B | 2.2 | 16.0 | 0.41 | 0.68 | 44.7 |
| 5 | T | 246 | 12.0 | 0.278 | 30.1 | LOS C | 6.0 | 46.0 | 0.85 | 0.69 | 31.4 |
| 6 | R | 117 | 2.7 | 0.962 | 76.2 | LOS E | 8.5 | 60.5 | 1.00 | 1.11 | 19.4 |
| Approach | | 464 | 8.6 | 0.962 | 37.9 | LOS D | 8.5 | 60.5 | 0.79 | 0.79 | 28.8 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 104 | 3.0 | 0.727 | 40.8 | LOS D | 17.3 | 126.3 | 0.96 | 0.90 | 29.4 |
| 8 | T | 680 | 6.0 | 0.727 | 32.6 | LOS C | 17.4 | 128.0 | 0.96 | 0.86 | 30.0 |
| 9 | R | 231 | 10.0 | 1.000[3] | 52.5 | LOS D | 12.3 | 93.6 | 1.00 | 0.83 | 24.7 |
| Approach | | 1016 | 6.6 | 1.000 | 37.9 | LOS D | 17.4 | 128.0 | 0.97 | 0.85 | 28.5 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 554 | 5.5 | 0.880 | 27.4 | LOS C | 18.9 | 138.3 | 0.74 | 0.87 | 34.5 |
| 11 | T | 552 | 7.1 | 0.852 | 39.4 | LOS D | 19.7 | 146.6 | 0.96 | 0.92 | 27.6 |
| 12 | R | 88 | 6.0 | 0.745 | 58.2 | LOS E | 5.7 | 42.3 | 1.00 | 0.86 | 23.2 |
| Approach | | 1194 | 6.3 | 0.880 | 35.2 | LOS D | 19.7 | 146.6 | 0.86 | 0.89 | 30.0 |
| All Vehicles | | 4019 | 5.6 | 1.000 | 44.9 | LOS D | 34.8 | 250.0 | 0.91 | 0.97 | 26.2 |

Level of Service (Aver. Int. Delay): LOS D.  Based on average delay for all vehicle movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E.  LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3  x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 39.2 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 |
| P3 | Across E approach | 53 | 32.9 | LOS D | 0.1 | 0.1 | 0.86 | 0.86 |
| P5 | Across N approach | 53 | 36.5 | LOS D | 0.1 | 0.1 | 0.90 | 0.90 |
| P7 | Across W approach | 53 | 32.9 | LOS D | 0.1 | 0.1 | 0.86 | 0.86 |
| All Pedestrians | | 212 | 35.4 | | | | 0.89 | 0.89 |

Level of Service (Aver. Int. Delay): LOS D.  Based on average delay for all pedestrian movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS D.  LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY



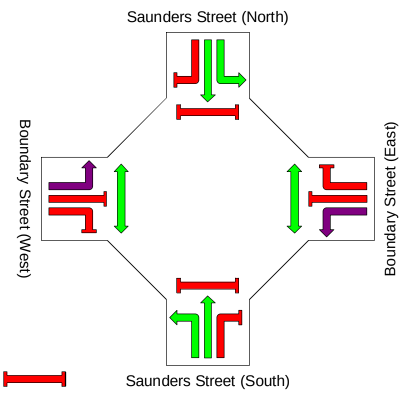
Boundary Street / Saunders Street
2035 With Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 90 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

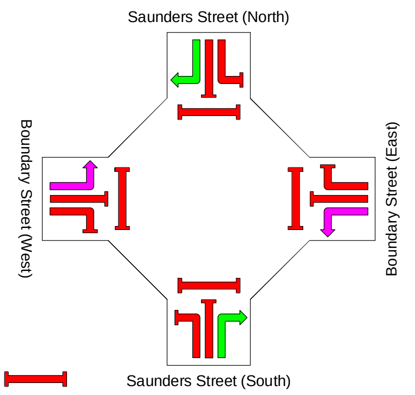
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 26 | 12 | 22 | 6 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 32 | 18 | 28 | 12 |
| Phase Split | 36 % | 20 % | 31 % | 13 % |

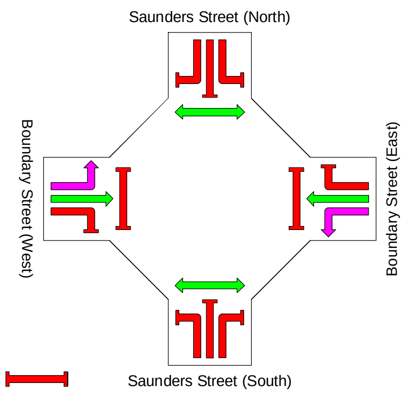
**Phase A**



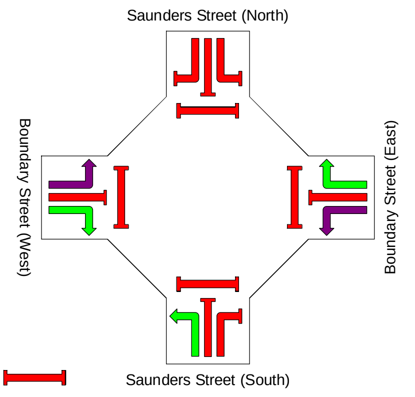

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

Processed: Tuesday, 23 August 2011 11:02:28 AM
SIDRA INTERSECTION 5.0.1.1427

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2035 (with

development_construction + stage d ops)\4 Boundary Street - Saunders Street - Signals (2017-27).sip
8000907, AECOM, ENTERPRISE

# MOVEMENT SUMMARY

**Site: 2035 PM peak WOD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2035 Without Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 158 | 6.0 | 0.440 | 19.1 | LOS B | 5.8 | 42.4 | 0.42 | 0.73 | 39.4 |
| 2 | T | 700 | 6.8 | 0.348 | 20.1 | LOS C | 15.2 | 112.3 | 0.61 | 0.53 | 37.2 |
| 3 | R | 47 | 8.9 | 0.328 | 78.1 | LOS E | 4.6 | 34.4 | 0.98 | 0.75 | 19.1 |
| Approach | | 905 | 6.7 | 0.440 | 22.9 | LOS C | 15.2 | 112.3 | 0.60 | 0.58 | 35.8 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 144 | 7.3 | 0.644 | 37.1 | LOS D | 8.4 | 62.4 | 0.72 | 0.77 | 30.0 |
| 5 | T | 381 | 7.8 | 0.677 | 64.0 | LOS E | 14.5 | 108.1 | 1.00 | 0.83 | 21.0 |
| 6 | R | 121 | 3.4 | 1.073 | 170.6 | LOS F | 15.0 | 108.0 | 1.00 | 1.20 | 10.5 |
| Approach | | 646 | 6.8 | 1.073 | 77.9 | LOS E | 15.0 | 108.1 | 0.94 | 0.89 | 18.8 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 147 | 2.9 | 1.087 | 156.3 | LOS F | 137.4 | 989.4 | 1.00 | 1.47 | 11.5 |
| 8 | T | 2045 | 3.4 | 1.085 | 148.3 | LOS F | 137.4 | 989.4 | 1.00 | 1.44 | 11.5 |
| 9 | R | 147 | 6.4 | 1.000[3] | 83.1 | LOS F | 12.5 | 92.2 | 1.00 | 0.80 | 18.3 |
| Approach | | 2339 | 4.1 | 1.085 | 144.7 | LOS F | 137.4 | 989.4 | 1.00 | 1.40 | 11.8 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 364 | 11.8 | 0.689 | 13.3 | LOS B | 10.2 | 78.8 | 0.41 | 0.72 | 44.2 |
| 11 | T | 527 | 9.6 | 1.065 | 118.9 | LOS F | 33.8 | 246.6 | 1.00 | 1.15 | 13.6 |
| 12 | R | 115 | 3.2 | 1.017 | 132.3 | LOS F | 12.8 | 92.0 | 1.00 | 1.13 | 13.0 |
| Approach | | 1005 | 8.4 | 1.065 | 82.2 | LOS F | 33.8 | 246.6 | 0.79 | 0.99 | 18.1 |
| All Vehicles | | 4896 | 5.8 | 1.085 | 100.5 | LOS F | 137.4 | 989.4 | 0.87 | 1.10 | 15.6 |

Level of Service (Aver. Int. Delay): LOS F. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 66.6 | LOS F | 0.2 | 0.2 | 0.96 | 0.96 |
| P3 | Across E approach | 53 | 22.1 | LOS C | 0.1 | 0.1 | 0.55 | 0.55 |
| P5 | Across N approach | 53 | 63.8 | LOS F | 0.2 | 0.2 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 22.1 | LOS C | 0.1 | 0.1 | 0.55 | 0.55 |
| All Pedestrians | | 212 | 43.6 | | | | 0.75 | 0.75 |

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual pedestrian movements: Delay (HCM).



SIDRA INTERSECTION

# PHASING SUMMARY

**Site: 2035 PM peak WOD (Amended Layout & Optimised Signals)**

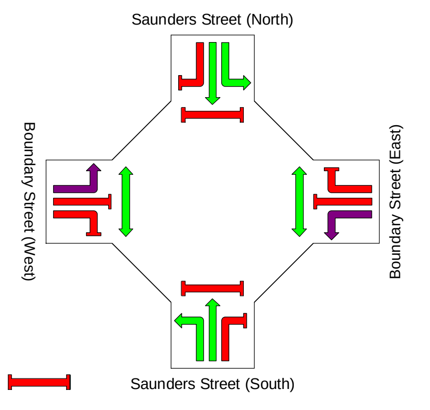
Boundary Street / Saunders Street
2035 Without Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

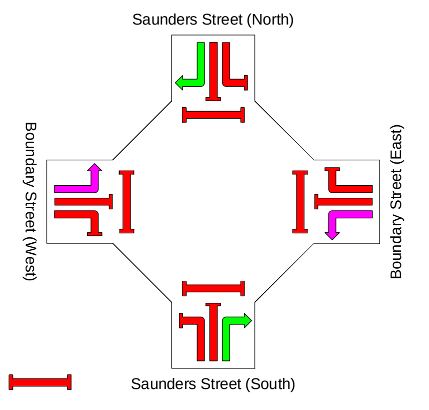
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 78 | 12 | 22 | 9 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 84 | 18 | 28 | 15 |
| Phase Split | 58 % | 12 % | 19 % | 10 % |

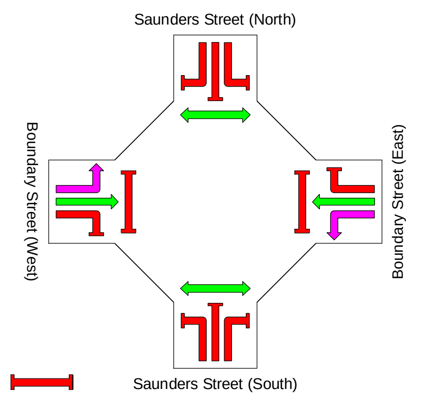
**Phase A**



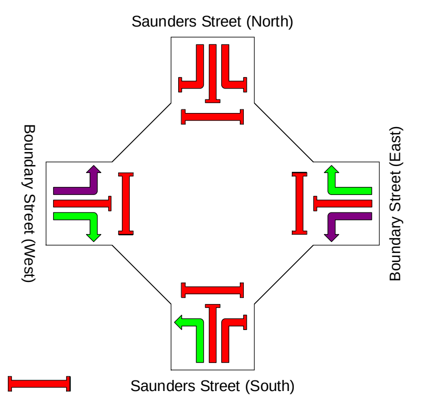

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2035 PM peak WD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2035 With Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

## Movement Performance - Vehicles

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 158 | 6.0 | 0.440 | 19.1 | LOS B | 5.8 | 42.4 | 0.42 | 0.73 | 39.4 |
| 2 | T | 700 | 6.8 | 0.348 | 20.1 | LOS C | 15.2 | 112.3 | 0.61 | 0.53 | 37.2 |
| 3 | R | 47 | 8.9 | 0.328 | 78.1 | LOS E | 4.6 | 34.4 | 0.98 | 0.75 | 19.1 |
| Approach | | 905 | 6.7 | 0.440 | 22.9 | LOS C | 15.2 | 112.3 | 0.60 | 0.58 | 35.8 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 144 | 7.3 | 0.644 | 37.1 | LOS D | 8.4 | 62.4 | 0.72 | 0.77 | 30.0 |
| 5 | T | 554 | 7.4 | 0.982 | 91.8 | LOS F | 26.2 | 195.4 | 1.00 | 1.07 | 16.6 |
| 6 | R | 121 | 3.4 | 1.073 | 170.6 | LOS F | 15.0 | 108.0 | 1.00 | 1.20 | 10.5 |
| Approach | | 819 | 6.8 | 1.073 | 93.8 | LOS F | 26.2 | 195.4 | 0.95 | 1.04 | 16.5 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 147 | 2.9 | 1.087 | 156.3 | LOS F | 137.4 | 989.4 | 1.00 | 1.47 | 11.5 |
| 8 | T | 2045 | 3.4 | 1.085 | 148.3 | LOS F | 137.4 | 989.4 | 1.00 | 1.44 | 11.5 |
| 9 | R | 147 | 6.4 | 1.000[3] | 83.1 | LOS F | 12.5 | 92.2 | 1.00 | 0.80 | 18.3 |
| Approach | | 2339 | 4.1 | 1.085 | 144.7 | LOS F | 137.4 | 989.4 | 1.00 | 1.40 | 11.8 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 364 | 11.8 | 0.689 | 13.3 | LOS B | 10.2 | 78.8 | 0.41 | 0.72 | 44.2 |
| 11 | T | 550 | 12.4 | 1.065 | 124.3 | LOS F | 33.6 | 246.6 | 1.00 | 1.21 | 13.2 |
| 12 | R | 115 | 3.2 | 1.017 | 132.3 | LOS F | 12.8 | 92.0 | 1.00 | 1.13 | 13.0 |
| Approach | | 1028 | 9.3 | 1.065 | 85.9 | LOS F | 33.6 | 246.6 | 0.79 | 1.03 | 17.5 |
| All Vehicles | | 5092 | 6.0 | 1.085 | 103.0 | LOS F | 137.4 | 989.4 | 0.88 | 1.12 | 15.4 |

Level of Service (Aver. Int. Delay): LOS F.  Based on average delay for all vehicle movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F.  LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3  x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

## Movement Performance - Pedestrians

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 66.6 | LOS F | 0.2 | 0.2 | 0.96 | 0.96 |
| P3 | Across E approach | 53 | 22.1 | LOS C | 0.1 | 0.1 | 0.55 | 0.55 |
| P5 | Across N approach | 53 | 63.8 | LOS F | 0.2 | 0.2 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 22.1 | LOS C | 0.1 | 0.1 | 0.55 | 0.55 |
| All Pedestrians | | 212 | 43.6 | | | | 0.75 | 0.75 |

Level of Service (Aver. Int. Delay): LOS E.  Based on average delay for all pedestrian movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F.  LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2035 PM peak WD (Amended Layout & Optimised Signals)**

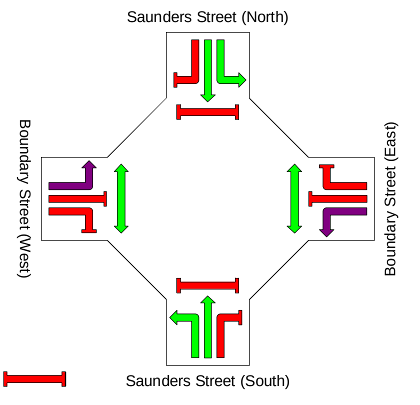
Boundary Street / Saunders Street
2035 With Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

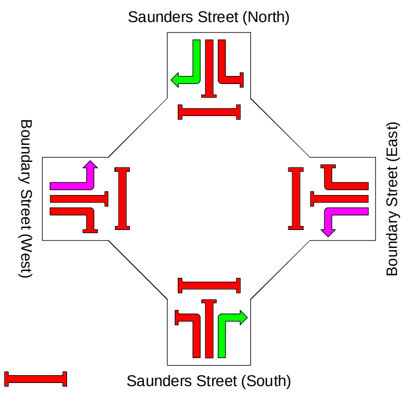
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 78 | 12 | 22 | 9 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 84 | 18 | 28 | 15 |
| Phase Split | 58 % | 12 % | 19 % | 10 % |

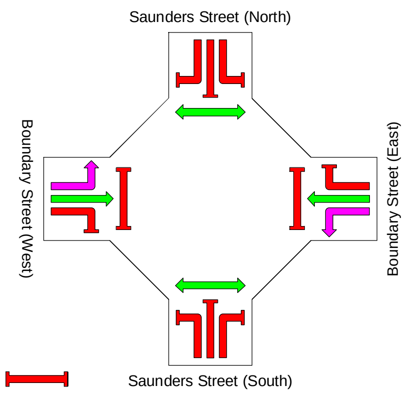
**Phase A**



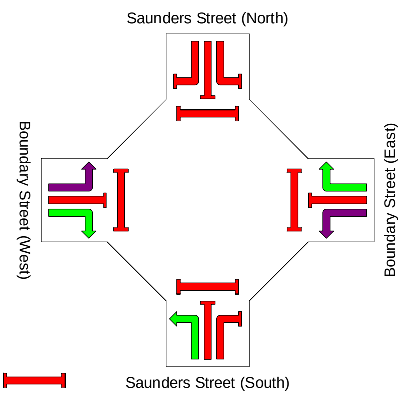

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2036 AM peak WOD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2036 (Opening Year) Without Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time Cycle Time = 90 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 206 | 3.1 | 0.573 | 26.5 | LOS C | 7.5 | 54.2 | 0.69 | 0.78 | 34.7 |
| 2 | T | 1080 | 2.9 | 0.977 | 69.7 | LOS E | 35.3 | 253.0 | 1.00 | 1.31 | 19.9 |
| 3 | R | 63 | 6.7 | 0.267 | 47.3 | LOS D | 3.7 | 27.4 | 0.94 | 0.76 | 26.2 |
| Approach | | 1349 | 3.1 | 0.977 | 62.1 | LOS E | 35.3 | 253.0 | 0.95 | 1.20 | 21.6 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 103 | 7.1 | 0.193 | 12.6 | LOS B | 2.2 | 16.3 | 0.41 | 0.68 | 44.7 |
| 5 | T | 226 | 7.9 | 0.250 | 29.8 | LOS C | 5.5 | 41.1 | 0.85 | 0.68 | 31.5 |
| 6 | R | 119 | 2.7 | 0.979 | 81.8 | LOS F | 8.9 | 63.6 | 1.00 | 1.14 | 18.5 |
| Approach | | 448 | 6.3 | 0.979 | 39.6 | LOS D | 8.9 | 63.6 | 0.79 | 0.80 | 28.2 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 105 | 3.0 | 0.739 | 41.3 | LOS D | 17.7 | 129.3 | 0.96 | 0.90 | 29.2 |
| 8 | T | 692 | 6.1 | 0.739 | 33.0 | LOS C | 17.8 | 131.0 | 0.96 | 0.87 | 29.8 |
| 9 | R | 231 | 9.9 | 1.000[3] | 52.5 | LOS D | 12.3 | 93.6 | 1.00 | 0.83 | 24.7 |
| Approach | | 1028 | 6.7 | 1.000 | 38.2 | LOS D | 17.8 | 131.0 | 0.97 | 0.86 | 28.4 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 561 | 5.6 | 0.897 | 26.9 | LOS C | 18.9 | 138.3 | 0.75 | 0.86 | 34.8 |
| 11 | T | 381 | 7.2 | 0.589 | 32.0 | LOS C | 12.2 | 90.8 | 0.91 | 0.75 | 30.5 |
| 12 | R | 89 | 5.9 | 0.753 | 58.4 | LOS E | 5.8 | 42.8 | 1.00 | 0.87 | 23.1 |
| Approach | | 1032 | 6.2 | 0.897 | 31.5 | LOS C | 18.9 | 138.3 | 0.83 | 0.82 | 31.8 |
| All Vehicles | | 3858 | 5.3 | 1.000 | 44.9 | LOS D | 35.3 | 253.0 | 0.90 | 0.96 | 26.2 |

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 39.2 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 |
| P3 | Across E approach | 53 | 32.9 | LOS D | 0.1 | 0.1 | 0.86 | 0.86 |
| P5 | Across N approach | 53 | 36.5 | LOS D | 0.1 | 0.1 | 0.90 | 0.90 |
| P7 | Across W approach | 53 | 32.9 | LOS D | 0.1 | 0.1 | 0.86 | 0.86 |
| All Pedestrians | | 212 | 35.4 | | | | 0.89 | 0.89 |

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS D. LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2036 AM peak WOD (Amended Layout & Optimised Signals)**

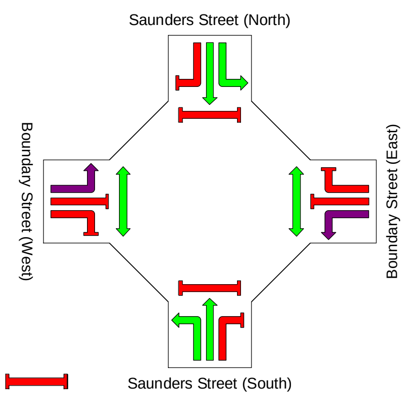
Boundary Street / Saunders Street
2036 (Opening Year) Without Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 90 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

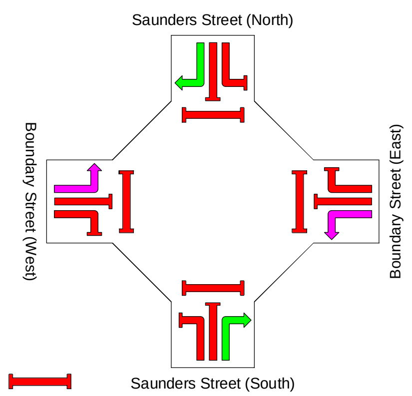
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 26 | 12 | 22 | 6 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 32 | 18 | 28 | 12 |
| Phase Split | 36 % | 20 % | 31 % | 13 % |

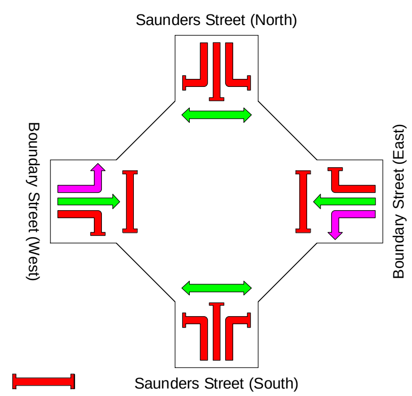
**Phase A**



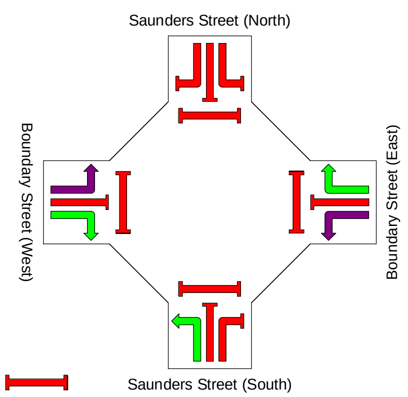

**Phase B**




**Phase C**




**Phase D**




Normal Movement
Slip-Lane Movement
Stopped Movement
Turn On Red
Permitted/Opposed
Opposed Slip-Lane
Continuous Movement
Undetected Movement
Phase Transition Applied

# MOVEMENT SUMMARY

**Site: 2036 AM peak WD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2036 (Opening Year) With Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 90 seconds

## Movement Performance - Vehicles

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 206 | 3.1 | 0.573 | 26.5 | LOS C | 7.5 | 54.2 | 0.69 | 0.78 | 34.7 |
| 2 | T | 1080 | 2.9 | 0.977 | 69.7 | LOS E | 35.3 | 253.0 | 1.00 | 1.31 | 19.9 |
| 3 | R | 63 | 6.7 | 0.267 | 47.3 | LOS D | 3.7 | 27.4 | 0.94 | 0.76 | 26.2 |
| Approach | | 1349 | 3.1 | 0.977 | 62.1 | LOS E | 35.3 | 253.0 | 0.95 | 1.20 | 21.6 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 103 | 7.1 | 0.193 | 12.6 | LOS B | 2.2 | 16.3 | 0.41 | 0.68 | 44.7 |
| 5 | T | 240 | 13.2 | 0.273 | 30.1 | LOS C | 5.8 | 45.3 | 0.85 | 0.68 | 31.4 |
| 6 | R | 119 | 2.7 | 0.979 | 81.8 | LOS F | 8.9 | 63.6 | 1.00 | 1.14 | 18.5 |
| Approach | | 462 | 9.1 | 0.979 | 39.5 | LOS D | 8.9 | 63.6 | 0.79 | 0.80 | 28.2 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 105 | 3.0 | 0.739 | 41.3 | LOS D | 17.7 | 129.3 | 0.96 | 0.90 | 29.2 |
| 8 | T | 692 | 6.1 | 0.739 | 33.0 | LOS C | 17.8 | 131.0 | 0.96 | 0.87 | 29.8 |
| 9 | R | 231 | 9.9 | 1.000 [3] | 52.5 | LOS D | 12.3 | 93.6 | 1.00 | 0.83 | 24.7 |
| Approach | | 1028 | 6.7 | 1.000 | 38.2 | LOS D | 17.8 | 131.0 | 0.97 | 0.86 | 28.4 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 561 | 5.6 | 0.897 | 26.9 | LOS C | 18.9 | 138.3 | 0.75 | 0.86 | 34.8 |
| 11 | T | 480 | 8.6 | 0.748 | 34.7 | LOS C | 15.9 | 119.5 | 0.95 | 0.84 | 29.3 |
| 12 | R | 89 | 5.9 | 0.753 | 58.4 | LOS E | 5.8 | 42.8 | 1.00 | 0.87 | 23.1 |
| Approach | | 1131 | 6.9 | 0.897 | 32.7 | LOS C | 18.9 | 138.3 | 0.85 | 0.85 | 31.1 |
| All Vehicles | | 3971 | 5.8 | 1.000 | 44.9 | LOS D | 35.3 | 253.0 | 0.91 | 0.97 | 26.2 |

Level of Service (Aver. Int. Delay): LOS D.  Based on average delay for all vehicle movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F.  LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3  x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

## Movement Performance - Pedestrians

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 39.2 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 |
| P3 | Across E approach | 53 | 32.9 | LOS D | 0.1 | 0.1 | 0.86 | 0.86 |
| P5 | Across N approach | 53 | 36.5 | LOS D | 0.1 | 0.1 | 0.90 | 0.90 |
| P7 | Across W approach | 53 | 32.9 | LOS D | 0.1 | 0.1 | 0.86 | 0.86 |
| All Pedestrians | | 212 | 35.4 | | | | 0.89 | 0.89 |

Level of Service (Aver. Int. Delay): LOS D.  Based on average delay for all pedestrian movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS D.  LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2036 AM peak WD (Amended Layout & Optimised Signals)**

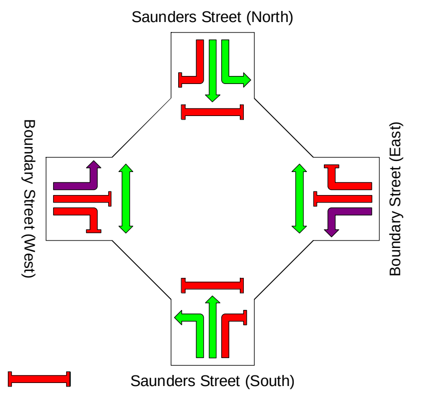
Boundary Street / Saunders Street
2036 (Opening Year) With Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 90 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

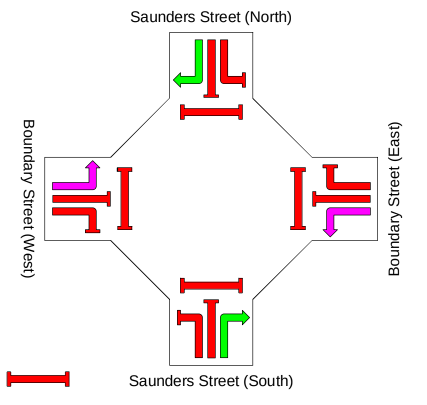
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 26 | 12 | 22 | 6 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 32 | 18 | 28 | 12 |
| Phase Split | 36 % | 20 % | 31 % | 13 % |

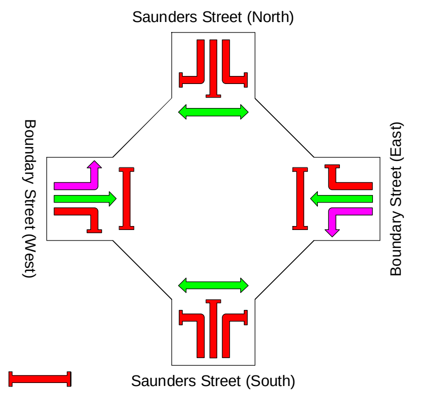
**Phase A**



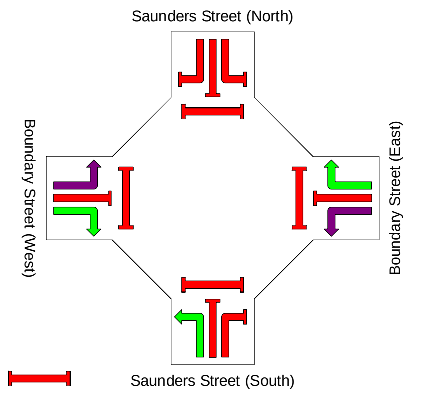

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |




SIDRA INTERSECTION

# MOVEMENT SUMMARY

**Site: 2036 PM peak WOD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2036 (Opening Year) Without Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time Cycle Time = 145 seconds

## Movement Performance - Vehicles

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 160 | 5.9 | 0.445 | 19.1 | LOS B | 5.8 | 42.9 | 0.42 | 0.73 | 39.4 |
| 2 | T | 708 | 6.7 | 0.352 | 20.1 | LOS C | 15.3 | 113.6 | 0.61 | 0.54 | 37.2 |
| 3 | R | 47 | 8.9 | 0.328 | 78.1 | LOS E | 4.6 | 34.4 | 0.98 | 0.75 | 19.1 |
| Approach | | 916 | 6.7 | 0.446 | 22.9 | LOS C | 15.3 | 113.6 | 0.60 | 0.58 | 35.8 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 146 | 7.2 | 0.654 | 37.5 | LOS D | 8.5 | 63.5 | 0.72 | 0.77 | 29.8 |
| 5 | T | 387 | 7.7 | 0.688 | 64.3 | LOS E | 14.7 | 109.9 | 1.00 | 0.84 | 20.9 |
| 6 | R | 121 | 3.4 | 1.075 | 170.4 | LOS F | 15.0 | 108.0 | 1.00 | 1.20 | 10.6 |
| Approach | | 655 | 6.8 | 1.075 | 77.9 | LOS E | 15.0 | 109.9 | 0.94 | 0.89 | 18.8 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 148 | 2.8 | 1.099 | 167.4 | LOS F | 143.5 | 1033.6 | 1.00 | 1.51 | 10.9 |
| 8 | T | 2070 | 3.4 | 1.098 | 159.4 | LOS F | 143.5 | 1033.6 | 1.00 | 1.49 | 10.9 |
| 9 | R | 147 | 6.5 | 1.000[3] | 83.1 | LOS F | 12.5 | 92.3 | 1.00 | 0.80 | 18.3 |
| Approach | | 2365 | 4.1 | 1.099 | 155.2 | LOS F | 143.5 | 1033.6 | 1.00 | 1.45 | 11.2 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 368 | 11.7 | 0.699 | 13.4 | LOS B | 10.4 | 80.1 | 0.42 | 0.72 | 44.2 |
| 11 | T | 535 | 9.5 | 1.066 | 119.6 | LOS F | 33.7 | 246.6 | 1.00 | 1.16 | 13.5 |
| 12 | R | 114 | 3.5 | 1.016 | 132.2 | LOS F | 12.8 | 92.0 | 1.00 | 1.13 | 13.0 |
| Approach | | 1018 | 8.4 | 1.066 | 82.6 | LOS F | 33.7 | 246.6 | 0.79 | 1.00 | 18.0 |
| All Vehicles | | 4954 | 5.8 | 1.099 | 105.6 | LOS F | 143.5 | 1033.6 | 0.87 | 1.12 | 15.1 |

Level of Service (Aver. Int. Delay): LOS F. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

## Movement Performance - Pedestrians

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 66.6 | LOS F | 0.2 | 0.2 | 0.96 | 0.96 |
| P3 | Across E approach | 53 | 22.1 | LOS C | 0.1 | 0.1 | 0.55 | 0.55 |
| P5 | Across N approach | 53 | 63.8 | LOS F | 0.2 | 0.2 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 22.1 | LOS C | 0.1 | 0.1 | 0.55 | 0.55 |
| All Pedestrians | | 212 | 43.6 | | | | 0.75 | 0.75 |

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F. LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2036 PM peak WOD (Amended Layout & Optimised Signals)**

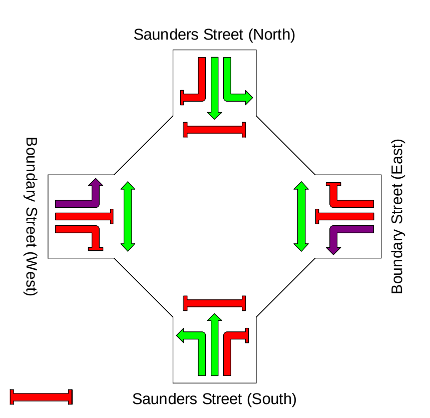
Boundary Street / Saunders Street
2036 (Opening Year) Without Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

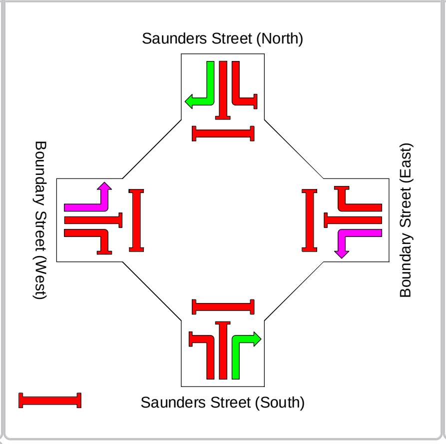
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 78 | 12 | 22 | 9 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 84 | 18 | 28 | 15 |
| Phase Split | 58 % | 12 % | 19 % | 10 % |

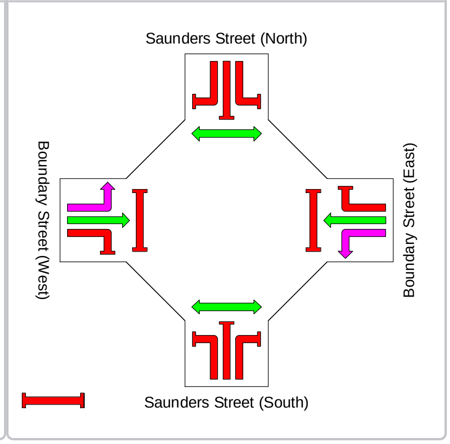
**Phase A**



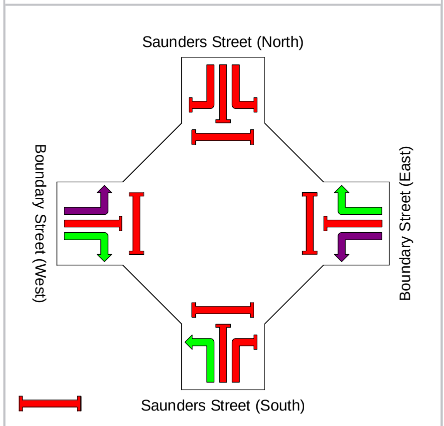

**Phase B**




**Phase C**




**Phase D**




- Normal Movement
- Slip-Lane Movement
- Stopped Movement
- Turn On Red
- Permitted/Opposed
- Opposed Slip-Lane
- Continuous Movement
- Undetected Movement
- Phase Transition Applied

# MOVEMENT SUMMARY

**Site: 2036 PM peak WD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2036 (Opening Year) With Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 160 | 5.9 | 0.445 | 19.1 | LOS B | 5.8 | 42.9 | 0.42 | 0.73 | 39.4 |
| 2 | T | 708 | 6.7 | 0.352 | 20.1 | LOS C | 15.3 | 113.6 | 0.61 | 0.54 | 37.2 |
| 3 | R | 47 | 8.9 | 0.328 | 78.1 | LOS E | 4.6 | 34.4 | 0.98 | 0.75 | 19.1 |
| Approach | | 916 | 6.7 | 0.446 | 22.9 | LOS C | 15.3 | 113.6 | 0.60 | 0.58 | 35.8 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 146 | 7.2 | 0.654 | 37.5 | LOS D | 8.5 | 63.5 | 0.72 | 0.77 | 29.8 |
| 5 | T | 486 | 8.9 | 0.870 | 75.0 | LOS E | 19.7 | 148.7 | 1.00 | 0.99 | 19.0 |
| 6 | R | 121 | 3.4 | 1.075 | 170.4 | LOS F | 15.0 | 108.0 | 1.00 | 1.20 | 10.6 |
| Approach | | 754 | 7.7 | 1.075 | 83.0 | LOS F | 19.7 | 148.7 | 0.95 | 0.98 | 18.0 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 148 | 2.8 | 1.099 | 167.4 | LOS F | 143.5 | 1033.6 | 1.00 | 1.51 | 10.9 |
| 8 | T | 2070 | 3.4 | 1.098 | 159.4 | LOS F | 143.5 | 1033.6 | 1.00 | 1.49 | 10.9 |
| 9 | R | 147 | 6.5 | 1.000 [3] | 83.1 | LOS F | 12.5 | 92.3 | 1.00 | 0.80 | 18.3 |
| Approach | | 2365 | 4.1 | 1.099 | 155.2 | LOS F | 143.5 | 1033.6 | 1.00 | 1.45 | 11.2 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 368 | 11.7 | 0.699 | 13.4 | LOS B | 10.4 | 80.1 | 0.42 | 0.72 | 44.2 |
| 11 | T | 549 | 13.2 | 1.065 | 125.0 | LOS F | 33.5 | 246.7 | 1.00 | 1.21 | 13.1 |
| 12 | R | 114 | 3.5 | 1.016 | 132.2 | LOS F | 12.8 | 92.0 | 1.00 | 1.13 | 13.0 |
| Approach | | 1032 | 9.6 | 1.065 | 85.9 | LOS F | 33.5 | 246.7 | 0.79 | 1.03 | 17.5 |
| All Vehicles | | 5066 | 6.2 | 1.099 | 106.4 | LOS F | 143.5 | 1033.6 | 0.88 | 1.13 | 15.0 |

Level of Service (Aver. Int. Delay): LOS F.  Based on average delay for all vehicle movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F.  LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3  x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 66.6 | LOS F | 0.2 | 0.2 | 0.96 | 0.96 |
| P3 | Across E approach | 53 | 22.1 | LOS C | 0.1 | 0.1 | 0.55 | 0.55 |
| P5 | Across N approach | 53 | 63.8 | LOS F | 0.2 | 0.2 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 22.1 | LOS C | 0.1 | 0.1 | 0.55 | 0.55 |
| All Pedestrians | | 212 | 43.6 | | | | 0.75 | 0.75 |

Level of Service (Aver. Int. Delay): LOS E.  Based on average delay for all pedestrian movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F.  LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2036 PM peak WD (Amended Layout & Optimised Signals)**

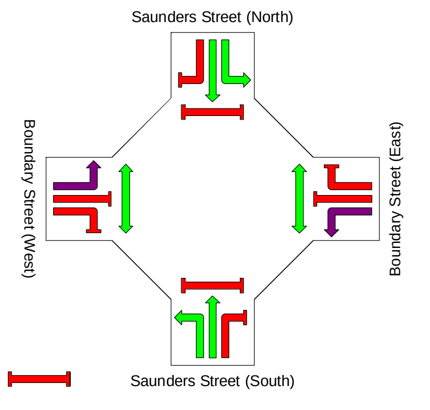
Boundary Street / Saunders Street
2036 (Opening Year) With Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

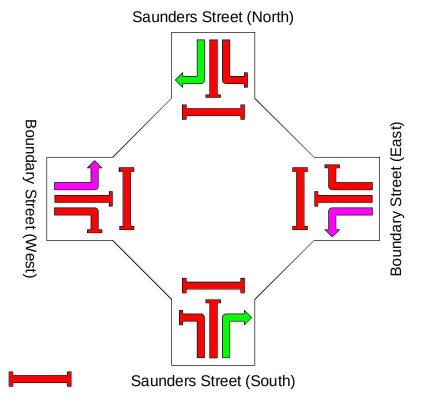
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 78 | 12 | 22 | 9 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 84 | 18 | 28 | 15 |
| Phase Split | 58 % | 12 % | 19 % | 10 % |

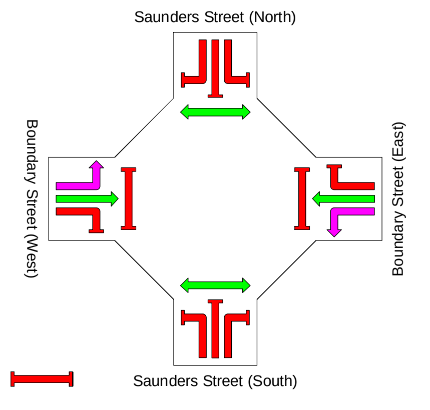
**Phase A**



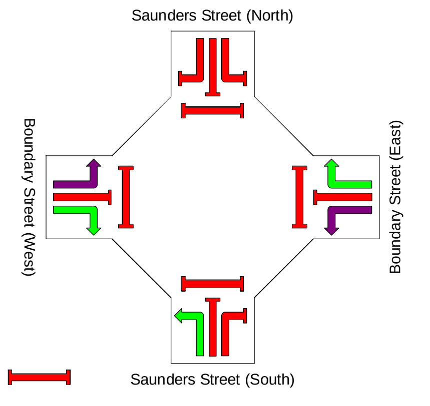

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

Processed: Tuesday, 23 August 2011 11:26:41 AM
SIDRA INTERSECTION 5.0.1.1427

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2036 (post stage d ops)\4 Boun-

# MOVEMENT SUMMARY

**Site: 2046 AM peak WOD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2046 (Opening Year + 10 years) Without Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 100 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 214 | 3.4 | 0.630 | 27.4 | LOS C | 8.3 | 59.7 | 0.67 | 0.78 | 34.3 |
| 2 | T | 1117 | 2.9 | 0.973 | 71.8 | LOS E | 38.9 | 278.9 | 1.00 | 1.27 | 19.5 |
| 3 | R | 64 | 6.6 | 0.226 | 48.5 | LOS D | 4.0 | 29.4 | 0.91 | 0.76 | 25.8 |
| Approach | | 1395 | 3.2 | 0.973 | 63.9 | LOS E | 38.9 | 278.9 | 0.95 | 1.17 | 21.2 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 120 | 7.9 | 0.253 | 13.9 | LOS B | 3.0 | 22.3 | 0.44 | 0.69 | 43.6 |
| 5 | T | 260 | 7.7 | 0.318 | 35.7 | LOS D | 7.0 | 52.3 | 0.88 | 0.71 | 29.0 |
| 6 | R | 138 | 2.3 | 0.943 | 77.1 | LOS E | 10.1 | 72.4 | 1.00 | 1.08 | 19.2 |
| Approach | | 518 | 6.3 | 0.943 | 41.7 | LOS D | 10.1 | 72.4 | 0.81 | 0.81 | 27.5 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 119 | 3.5 | 0.869 | 53.6 | LOS D | 26.6 | 195.1 | 1.00 | 1.02 | 25.1 |
| 8 | T | 850 | 6.2 | 0.870 | 45.3 | LOS D | 26.6 | 196.5 | 1.00 | 1.03 | 25.4 |
| 9 | R | 201 | 10.2 | 1.000[3] | 52.7 | LOS D | 11.3 | 86.1 | 1.00 | 0.82 | 24.6 |
| Approach | | 1169 | 6.8 | 1.000 | 47.4 | LOS D | 26.6 | 196.5 | 1.00 | 0.99 | 25.2 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 573 | 5.8 | 1.000[3] | 22.4 | LOS C | 18.9 | 138.7 | 0.77 | 0.81 | 37.3 |
| 11 | T | 478 | 7.3 | 0.826 | 43.2 | LOS D | 18.6 | 138.0 | 0.97 | 0.90 | 26.2 |
| 12 | R | 102 | 6.2 | 0.717 | 61.3 | LOS E | 6.9 | 51.1 | 1.00 | 0.85 | 22.4 |
| Approach | | 1153 | 6.4 | 1.000 | 34.5 | LOS C | 18.9 | 138.7 | 0.87 | 0.85 | 30.2 |
| All Vehicles | | 4235 | 5.4 | 1.000 | 48.6 | LOS D | 38.9 | 278.9 | 0.92 | 0.99 | 25.0 |

Level of Service (Aver. Int. Delay): LOS D.  Based on average delay for all vehicle movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E.  LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3  x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 44.2 | LOS E | 0.1 | 0.1 | 0.94 | 0.94 |
| P3 | Across E approach | 53 | 34.4 | LOS D | 0.1 | 0.1 | 0.83 | 0.83 |
| P5 | Across N approach | 53 | 41.4 | LOS E | 0.1 | 0.1 | 0.91 | 0.91 |
| P7 | Across W approach | 53 | 34.4 | LOS D | 0.1 | 0.1 | 0.83 | 0.83 |
| All Pedestrians | | 212 | 38.6 | | | | 0.88 | 0.88 |

Level of Service (Aver. Int. Delay): LOS D.  Based on average delay for all pedestrian movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E.  LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2046 AM peak WOD (Amended Layout & Optimised Signals)**

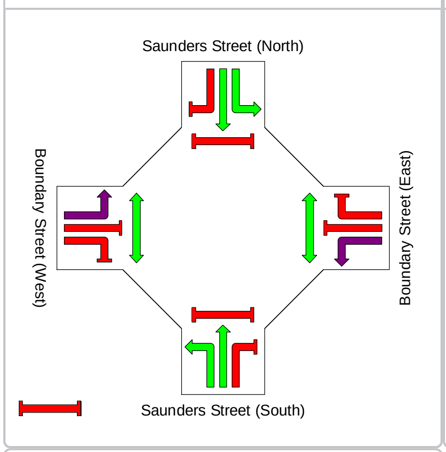
Boundary Street / Saunders Street
2046 (Opening Year + 10 years) Without Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 100 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

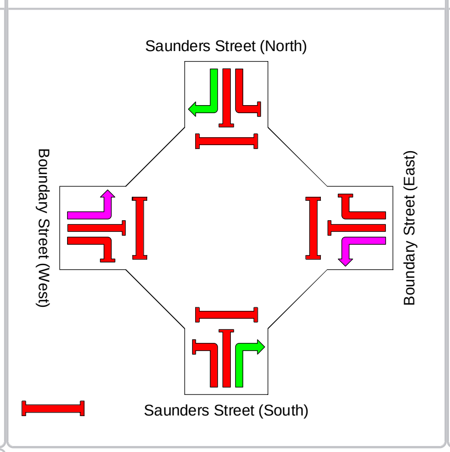
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 30 | 16 | 22 | 8 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 36 | 22 | 28 | 14 |
| Phase Split | 36 % | 22 % | 28 % | 14 % |

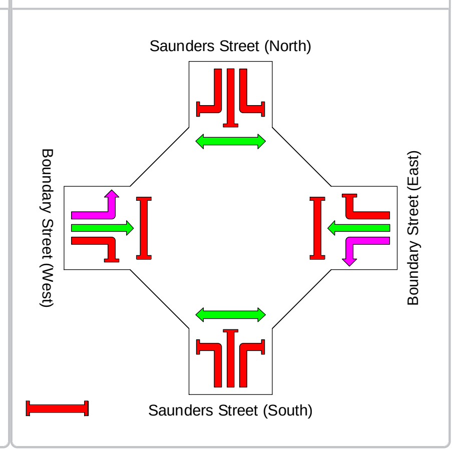
**Phase A**



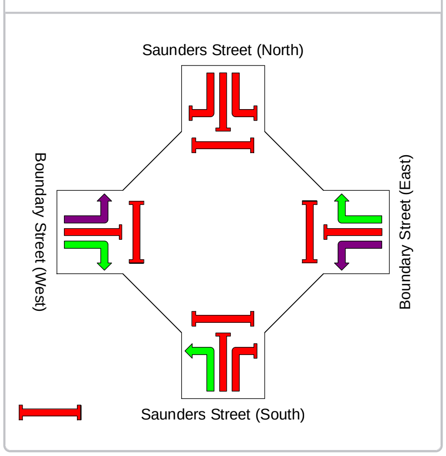

**Phase B**




**Phase C**




**Phase D**




Normal Movement
Slip-Lane Movement
Stopped Movement
Turn On Red
Permitted/Opposed
Opposed Slip-Lane
Continuous Movement
Undetected Movement
Phase Transition Applied

# MOVEMENT SUMMARY

**Site: 2046 AM peak WD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2046 (Opening Year + 10 years) With Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 105 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 214 | 3.4 | 0.656 | 29.1 | LOS C | 8.8 | 63.3 | 0.68 | 0.79 | 33.3 |
| 2 | T | 1117 | 2.9 | 0.958 | 67.2 | LOS E | 38.5 | 276.3 | 1.00 | 1.22 | 20.4 |
| 3 | R | 64 | 6.6 | 0.224 | 50.2 | LOS D | 4.1 | 30.5 | 0.91 | 0.76 | 25.3 |
| Approach | | 1395 | 3.2 | 0.957 | 60.6 | LOS E | 38.5 | 276.3 | 0.95 | 1.13 | 21.9 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 120 | 7.9 | 0.259 | 14.0 | LOS B | 3.1 | 22.9 | 0.43 | 0.69 | 43.5 |
| 5 | T | 284 | 11.9 | 0.343 | 36.9 | LOS D | 7.8 | 60.4 | 0.88 | 0.72 | 28.6 |
| 6 | R | 138 | 2.3 | 0.991 | 95.7 | LOS F | 11.5 | 81.8 | 1.00 | 1.16 | 16.5 |
| Approach | | 542 | 8.5 | 0.990 | 46.8 | LOS D | 11.5 | 81.8 | 0.81 | 0.82 | 25.8 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 119 | 3.5 | 0.862 | 53.8 | LOS D | 27.3 | 200.4 | 1.00 | 1.00 | 25.1 |
| 8 | T | 854 | 6.2 | 0.861 | 45.5 | LOS D | 27.3 | 201.8 | 1.00 | 1.01 | 25.3 |
| 9 | R | 193 | 10.3 | 1.000 [3] | 54.4 | LOS D | 11.3 | 86.1 | 1.00 | 0.82 | 24.2 |
| Approach | | 1166 | 6.9 | 1.000 | 47.8 | LOS D | 27.3 | 201.8 | 1.00 | 0.98 | 25.1 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 558 | 5.8 | 1.000 [3] | 22.4 | LOS C | 18.9 | 138.7 | 0.75 | 0.81 | 37.3 |
| 11 | T | 590 | 8.4 | 0.987 | 70.6 | LOS E | 31.5 | 236.4 | 0.97 | 1.13 | 19.7 |
| 12 | R | 102 | 6.2 | 0.753 | 65.0 | LOS E | 7.3 | 53.7 | 1.00 | 0.87 | 21.6 |
| Approach | | 1251 | 6.9 | 1.000 | 48.6 | LOS D | 31.5 | 236.4 | 0.87 | 0.97 | 25.2 |
| All Vehicles | | 4354 | 5.9 | 1.000 | 52.0 | LOS D | 38.5 | 276.3 | 0.92 | 1.00 | 24.1 |

Level of Service (Aver. Int. Delay): LOS D.  Based on average delay for all vehicle movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F.  LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3  x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 44.8 | LOS E | 0.1 | 0.1 | 0.92 | 0.92 |
| P3 | Across E approach | 53 | 35.2 | LOS D | 0.1 | 0.1 | 0.82 | 0.82 |
| P5 | Across N approach | 53 | 42.1 | LOS E | 0.1 | 0.1 | 0.90 | 0.90 |
| P7 | Across W approach | 53 | 35.2 | LOS D | 0.1 | 0.1 | 0.82 | 0.82 |
| All Pedestrians | | 212 | 39.3 | | | | 0.86 | 0.86 |

Level of Service (Aver. Int. Delay): LOS D.  Based on average delay for all pedestrian movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E.  LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2046 AM peak WD (Amended Layout & Optimised Signals)**

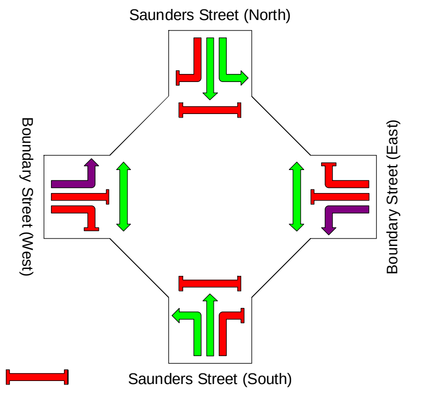
Boundary Street / Saunders Street
2046 (Opening Year + 10 years) With Development
AM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 105 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

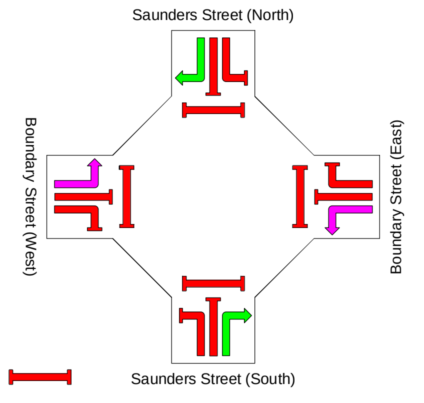
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 32 | 17 | 24 | 8 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 38 | 23 | 30 | 14 |
| Phase Split | 36 % | 22 % | 29 % | 13 % |

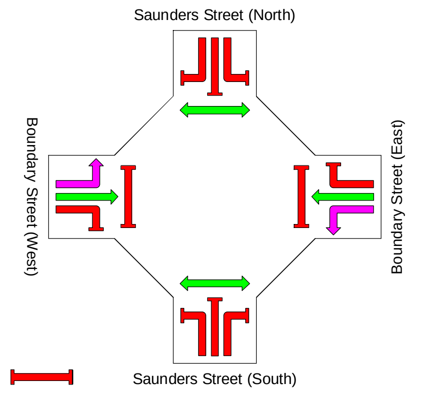
**Phase A**



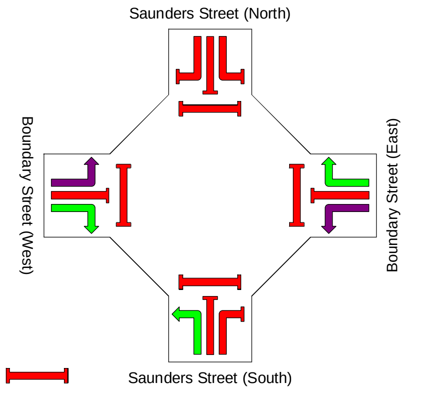

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2046 PM peak WOD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2046 (Opening Year + 10 years) Without Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 180 | 5.8 | 0.485 | 19.0 | LOS B | 6.3 | 46.3 | 0.44 | 0.74 | 39.5 |
| 2 | T | 801 | 6.8 | 0.384 | 18.9 | LOS B | 16.8 | 124.6 | 0.60 | 0.53 | 38.0 |
| 3 | R | 55 | 9.6 | 0.457 | 81.4 | LOS F | 5.3 | 40.3 | 1.00 | 0.75 | 18.6 |
| Approach | | 1036 | 6.8 | 0.486 | 22.3 | LOS C | 16.8 | 124.6 | 0.60 | 0.58 | 36.2 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 173 | 6.7 | 0.786 | 48.6 | LOS D | 11.4 | 84.0 | 0.75 | 0.86 | 25.9 |
| 5 | T | 478 | 7.4 | 0.848 | 72.6 | LOS E | 19.1 | 142.2 | 1.00 | 0.96 | 19.3 |
| 6 | R | 111 | 3.5 | 1.106 | 198.3 | LOS F | 14.9 | 107.8 | 1.00 | 1.25 | 9.3 |
| Approach | | 761 | 6.5 | 1.106 | 85.4 | LOS F | 19.1 | 142.2 | 0.94 | 0.98 | 17.6 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 167 | 3.1 | 1.213 | 262.9 | LOS F | 204.1 | 1471.9 | 1.00 | 1.87 | 7.4 |
| 8 | T | 2366 | 3.6 | 1.211 | 254.9 | LOS F | 204.1 | 1471.9 | 1.00 | 1.82 | 7.4 |
| 9 | R | 122 | 6.7 | 1.000[3] | 97.4 | LOS F | 11.6 | 85.6 | 1.00 | 0.90 | 16.4 |
| Approach | | 2656 | 4.2 | 1.211 | 248.1 | LOS F | 204.1 | 1471.9 | 1.00 | 1.78 | 7.6 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 414 | 12.0 | 0.836 | 28.9 | LOS C | 17.7 | 136.4 | 0.49 | 0.81 | 33.8 |
| 11 | T | 619 | 9.8 | 1.167 | 200.8 | LOS F | 46.1 | 349.8 | 1.00 | 1.46 | 9.0 |
| 12 | R | 105 | 3.4 | 1.053 | 156.4 | LOS F | 12.8 | 92.6 | 1.00 | 1.17 | 11.4 |
| Approach | | 1138 | 8.5 | 1.167 | 134.2 | LOS F | 46.1 | 349.8 | 0.81 | 1.20 | 12.6 |
| All Vehicles | | 5591 | 5.9 | 1.211 | 160.9 | LOS F | 204.1 | 1471.9 | 0.88 | 1.33 | 10.9 |

Level of Service (Aver. Int. Delay): LOS F.  Based on average delay for all vehicle movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F.  LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3  x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 66.6 | LOS F | 0.2 | 0.2 | 0.96 | 0.96 |
| P3 | Across E approach | 53 | 20.4 | LOS C | 0.1 | 0.1 | 0.53 | 0.53 |
| P5 | Across N approach | 53 | 63.8 | LOS F | 0.2 | 0.2 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 20.4 | LOS C | 0.1 | 0.1 | 0.53 | 0.53 |
| All Pedestrians | | 212 | 42.8 | | | | 0.74 | 0.74 |

Level of Service (Aver. Int. Delay): LOS E.  Based on average delay for all pedestrian movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F.  LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2046 PM peak WOD (Amended Layout & Optimised Signals)**

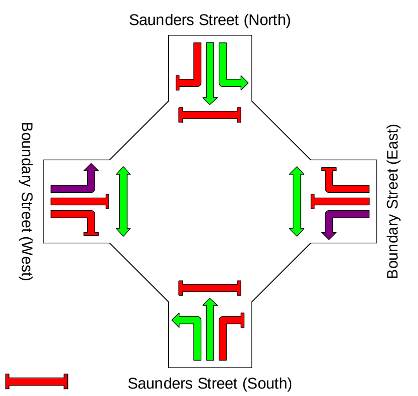
Boundary Street / Saunders Street
2046 (Opening Year + 10 years) Without Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

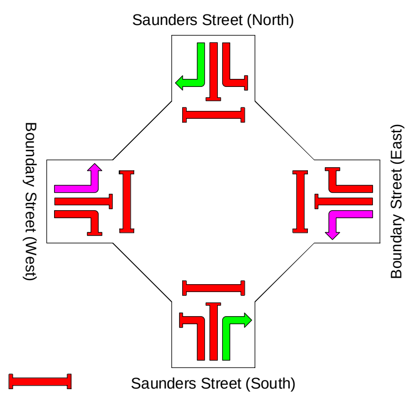
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 81 | 10 | 22 | 8 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 87 | 16 | 28 | 14 |
| Phase Split | 60 % | 11 % | 19 % | 10 % |

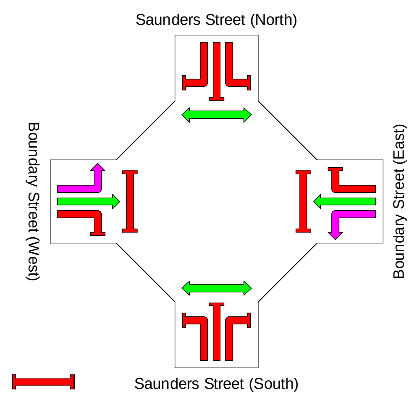
**Phase A**



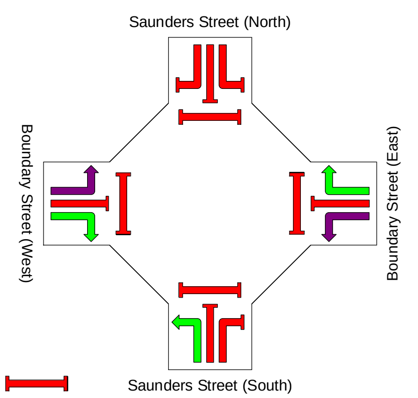

**Phase B**




**Phase C**




**Phase D**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2046 PM peak WD (Amended Layout & Optimised Signals)**

Boundary Street / Saunders Street
2046 (Opening Year + 10 years) With Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South: Saunders Street (South) | | | | | | | | | | | |
| 1 | L | 180 | 5.8 | 0.478 | 18.6 | LOS B | 6.2 | 45.5 | 0.43 | 0.74 | 39.8 |
| 2 | T | 801 | 6.8 | 0.379 | 18.3 | LOS B | 16.6 | 122.9 | 0.59 | 0.53 | 38.4 |
| 3 | R | 55 | 9.6 | 0.507 | 83.0 | LOS F | 5.4 | 40.8 | 1.00 | 0.75 | 18.4 |
| Approach | | 1036 | 6.8 | 0.507 | 21.8 | LOS C | 16.6 | 122.9 | 0.59 | 0.57 | 36.5 |
| East: Boundary Street (East) | | | | | | | | | | | |
| 4 | L | 173 | 6.7 | 0.797 | 50.7 | LOS D | 11.6 | 86.0 | 0.76 | 0.87 | 25.3 |
| 5 | T | 577 | 8.6 | 1.061 | 116.9 | LOS F | 33.8 | 253.7 | 1.00 | 1.16 | 13.9 |
| 6 | R | 111 | 3.5 | 1.106 | 198.3 | LOS F | 14.9 | 107.8 | 1.00 | 1.25 | 9.3 |
| Approach | | 860 | 7.3 | 1.106 | 114.1 | LOS F | 33.8 | 253.7 | 0.95 | 1.12 | 14.3 |
| North: Saunders Street (North) | | | | | | | | | | | |
| 7 | L | 167 | 3.1 | 1.203 | 254.8 | LOS F | 202.3 | 1459.0 | 1.00 | 1.84 | 7.6 |
| 8 | T | 2378 | 3.6 | 1.202 | 246.8 | LOS F | 202.3 | 1459.0 | 1.00 | 1.79 | 7.6 |
| 9 | R | 110 | 6.7 | 1.000 [3] | 115.5 | LOS F | 11.6 | 85.6 | 1.00 | 1.04 | 14.4 |
| Approach | | 2656 | 4.2 | 1.202 | 241.8 | LOS F | 202.3 | 1459.0 | 1.00 | 1.77 | 7.7 |
| West: Boundary Street (West) | | | | | | | | | | | |
| 10 | L | 414 | 12.0 | 0.842 | 29.9 | LOS C | 18.0 | 139.3 | 0.50 | 0.81 | 33.2 |
| 11 | T | 632 | 12.9 | 1.238 | 234.5 | LOS F | 54.2 | 421.0 | 1.00 | 1.56 | 7.9 |
| 12 | R | 105 | 3.4 | 1.053 | 156.4 | LOS F | 12.8 | 92.6 | 1.00 | 1.17 | 11.4 |
| Approach | | 1151 | 9.5 | 1.238 | 153.8 | LOS F | 54.2 | 421.0 | 0.82 | 1.25 | 11.4 |
| All Vehicles | | 5702 | 6.2 | 1.238 | 164.8 | LOS F | 202.3 | 1459.0 | 0.88 | 1.35 | 10.7 |

Level of Service (Aver. Int. Delay): LOS F.  Based on average delay for all vehicle movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F.  LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

3  x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

**Movement Performance - Pedestrians**

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Average Back of Queue Distance m | Prop. Queued | Effective Stop Rate per ped |
|---|---|---|---|---|---|---|---|---|
| P1 | Across S approach | 53 | 66.6 | LOS F | 0.2 | 0.2 | 0.96 | 0.96 |
| P3 | Across E approach | 53 | 19.9 | LOS B | 0.1 | 0.1 | 0.52 | 0.52 |
| P5 | Across N approach | 53 | 63.8 | LOS F | 0.2 | 0.2 | 0.94 | 0.94 |
| P7 | Across W approach | 53 | 19.9 | LOS B | 0.1 | 0.1 | 0.52 | 0.52 |
| All Pedestrians | | 212 | 42.6 | | | | 0.74 | 0.74 |

Level of Service (Aver. Int. Delay): LOS E.  Based on average delay for all pedestrian movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS F.  LOS Method for individual pedestrian movements: Delay (HCM).

# PHASING SUMMARY

**Site: 2046 PM peak WD (Amended Layout & Optimised Signals)**

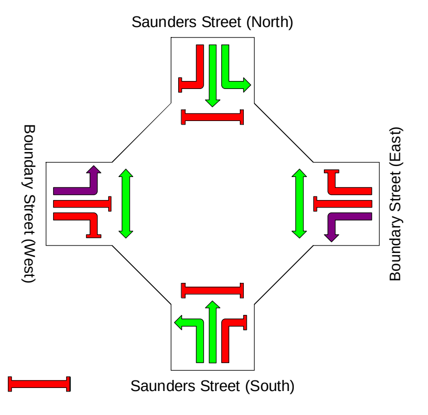
Boundary Street / Saunders Street
2046 (Opening Year + 10 years) With Development
PM peak
Existing Intersection Layout
(Optimised Signal Cycle Time)
Signals - Fixed Time    Cycle Time = 145 seconds

Cycle Time Option: **Optimum Cycle Time (Minimum Delay)**
**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B, C, D**
**Output Sequence: A, B, C, D**

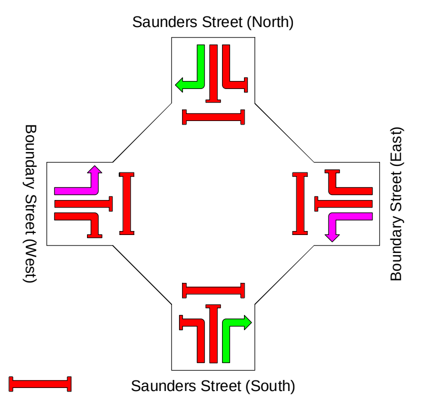
**Phase Timing Results**

| Phase | A | B | C | D |
|---|---|---|---|---|
| Green Time (sec) | 82 | 9 | 22 | 8 |
| Yellow Time (sec) | 4 | 4 | 4 | 4 |
| All-Red Time (sec) | 2 | 2 | 2 | 2 |
| Phase Time (sec) | 88 | 15 | 28 | 14 |
| Phase Split | 61 % | 10 % | 19 % | 10 % |

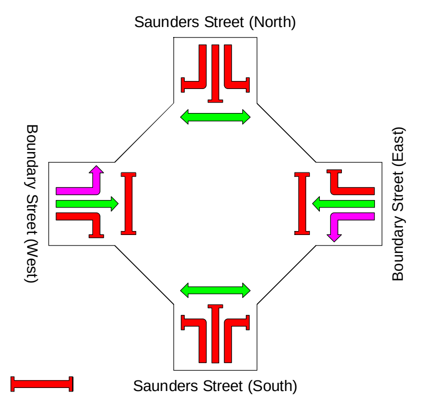
**Phase A**



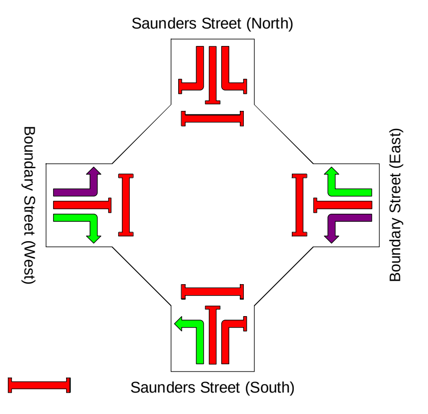

**Phase B**




**Phase C**




**Phase D**




- Normal Movement
- Slip-Lane Movement
- Stopped Movement
- Turn On Red
- Permitted/Opposed
- Opposed Slip-Lane
- Continuous Movement
- Undetected Movement
- Phase Transition Applied


# Port Expansion Project EIS

## Appendix Q8

## Bruce Highway / Townsville Port Access Road SIDRA Summaries

AECOM BMT WBM

# MOVEMENT SUMMARY

**Site: 2014 AM peak WOD**

Bruce HWY / Port Access Road
2014 Without Development
AM peak
(Estimated signal data & assumed layout)
Signals - Fixed Time Cycle Time = 100 seconds (User-Given Cycle Time)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South East: Bruce HWY | | | | | | | | | | | |
| 21 | L | 17 | 6.3 | 0.014 | 8.1 | LOS A | 0.1 | 0.6 | 0.13 | 0.61 | 49.1 |
| 22 | T | 788 | 8.4 | 0.263 | 2.2 | LOS A | 5.9 | 43.9 | 0.25 | 0.22 | 55.4 |
| 23 | R | 463 | 5.0 | 0.795 | 22.3 | LOS C | 17.3 | 126.2 | 0.61 | 0.86 | 37.3 |
| Approach | | 1268 | 7.1 | 0.796 | 9.6 | LOS A | 17.3 | 126.2 | 0.38 | 0.46 | 47.0 |
| North East: Eastern Access Road (to Port) | | | | | | | | | | | |
| 24 | L | 219 | 10.6 | 0.318 | 8.6 | LOS A | 2.0 | 15.3 | 0.20 | 0.65 | 48.7 |
| 25 | T | 29 | 10.7 | 0.135 | 50.9 | LOS D | 1.1 | 8.6 | 0.98 | 0.67 | 24.1 |
| 26 | R | 1 | 0.0 | 0.010 | 58.1 | LOS E | 0.1 | 0.6 | 0.97 | 0.59 | 23.2 |
| Approach | | 249 | 10.5 | 0.318 | 13.8 | LOS B | 2.0 | 15.3 | 0.30 | 0.65 | 43.3 |
| North West: Bruce HWY | | | | | | | | | | | |
| 27 | L | 1 | 0.0 | 0.001 | 8.3 | LOS A | 0.0 | 0.1 | 0.16 | 0.60 | 48.9 |
| 28 | T | 643 | 10.3 | 0.215 | 2.1 | LOS A | 4.7 | 35.5 | 0.23 | 0.20 | 55.6 |
| 29 | R | 1 | 0.0 | 0.002 | 10.3 | LOS B | 0.0 | 0.1 | 0.23 | 0.63 | 46.8 |
| Approach | | 645 | 10.3 | 0.215 | 2.1 | LOS A | 4.7 | 35.5 | 0.23 | 0.21 | 55.5 |
| South West: Eastern Access Road (to Ayr) | | | | | | | | | | | |
| 30 | L | 3 | 33.3 | 0.002 | 8.2 | NA[9] | NA[9] | NA[9] | NA[9] | 0.59 | 49.8 |
| 31 | T | 55 | 5.8 | 0.243 | 51.5 | LOS D | 2.0 | 15.0 | 0.99 | 0.70 | 23.9 |
| 32 | R | 24 | 4.3 | 0.222 | 59.4 | LOS E | 1.8 | 13.2 | 0.98 | 0.71 | 22.9 |
| Approach | | 82 | 6.4 | 0.243 | 52.1 | LOS D | 2.0 | 15.0 | 0.95 | 0.70 | 24.1 |
| All Vehicles | | 2245 | 8.4 | 0.796 | 9.5 | LOS A | 17.3 | 126.2 | 0.35 | 0.42 | 47.0 |

Level of Service (Aver. Int. Delay): LOS A. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

9 Continuous movement

# PHASING SUMMARY

**Site: 2014 AM peak WOD**

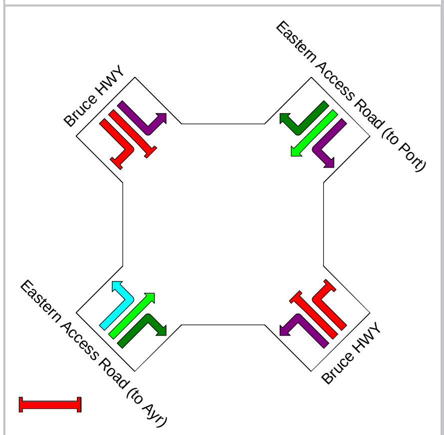
Bruce HWY / Port Access Road
2014 Without Development
AM peak
(Estimated signal data & assumed layout)
Signals - Fixed Time    Cycle Time = 100 seconds (User-Given Cycle Time)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B**
**Output Sequence: A, B**

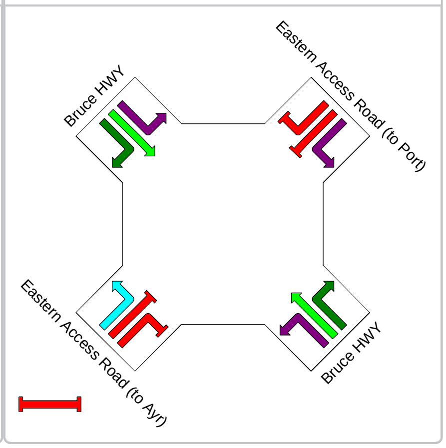
**Phase Timing Results**

| Phase | **A** | **B** |
|---|---|---|
| Green Time (sec) | 6 | 82 |
| Yellow Time (sec) | 4 | 4 |
| All-Red Time (sec) | 2 | 2 |
| Phase Time (sec) | 12 | 88 |
| Phase Split | 12 % | 88 % |

**Phase A**




**Phase B**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

Processed: Monday, 21 November 2011 10:59:34 AM
SIDRA INTERSECTION 5.0.5.1510

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2014 WOD\7 - Bruce HWY - Port Access Road.sip
8000907, AECOM, ENTERPRISE

SIDRA INTERSECTION

# MOVEMENT SUMMARY



Bruce HWY / Port Access Road
2014 With Development
AM peak
(Estimated signal data & assumed layout)
Signals - Fixed Time    Cycle Time = 100 seconds (User-Given Cycle Time)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South East: Bruce HWY | | | | | | | | | | | |
| 21 | L | 17 | 6.3 | 0.014 | 8.1 | LOS A | 0.1 | 0.6 | 0.13 | 0.61 | 49.1 |
| 22 | T | 788 | 8.4 | 0.263 | 2.2 | LOS A | 5.9 | 43.9 | 0.25 | 0.22 | 55.4 |
| 23 | R | 463 | 5.0 | 0.795 | 22.3 | LOS C | 17.3 | 126.2 | 0.61 | 0.86 | 37.3 |
| Approach | | 1268 | 7.1 | 0.796 | 9.6 | LOS A | 17.3 | 126.2 | 0.38 | 0.46 | 47.0 |
| North East: Eastern Access Road (to Port) | | | | | | | | | | | |
| 24 | L | 219 | 10.6 | 0.318 | 8.6 | LOS A | 2.0 | 15.3 | 0.20 | 0.65 | 48.7 |
| 25 | T | 36 | 20.6 | 0.173 | 51.3 | LOS D | 1.4 | 11.2 | 0.98 | 0.68 | 23.9 |
| 26 | R | 1 | 0.0 | 0.011 | 58.3 | LOS E | 0.1 | 0.6 | 0.97 | 0.59 | 23.1 |
| Approach | | 256 | 11.9 | 0.318 | 14.8 | LOS B | 2.0 | 15.3 | 0.32 | 0.65 | 42.4 |
| North West: Bruce HWY | | | | | | | | | | | |
| 27 | L | 1 | 0.0 | 0.001 | 8.3 | LOS A | 0.0 | 0.1 | 0.16 | 0.60 | 48.9 |
| 28 | T | 643 | 10.3 | 0.215 | 2.1 | LOS A | 4.7 | 35.5 | 0.23 | 0.20 | 55.6 |
| 29 | R | 1 | 0.0 | 0.002 | 10.3 | LOS B | 0.0 | 0.1 | 0.23 | 0.63 | 46.8 |
| Approach | | 645 | 10.3 | 0.215 | 2.1 | LOS A | 4.7 | 35.5 | 0.23 | 0.21 | 55.5 |
| South West: Eastern Access Road (to Ayr) | | | | | | | | | | | |
| 30 | L | 3 | 33.3 | 0.002 | 8.2 | NA[9] | NA[9] | NA[9] | NA[9] | 0.59 | 49.8 |
| 31 | T | 74 | 10.0 | 0.335 | 52.1 | LOS D | 2.7 | 20.8 | 0.99 | 0.72 | 23.7 |
| 32 | R | 24 | 4.3 | 0.229 | 59.5 | LOS E | 1.8 | 13.3 | 0.98 | 0.71 | 22.9 |
| Approach | | 101 | 9.4 | 0.335 | 52.5 | LOS D | 2.7 | 20.8 | 0.96 | 0.72 | 23.9 |
| All Vehicles | | 2271 | 8.7 | 0.796 | 10.0 | LOS A | 17.3 | 126.2 | 0.36 | 0.42 | 46.4 |

Level of Service (Aver. Int. Delay): LOS A.  Based on average delay for all vehicle movements.  LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E.  LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

9 Continuous movement

# PHASING SUMMARY

**Site: 2014 AM peak WD**

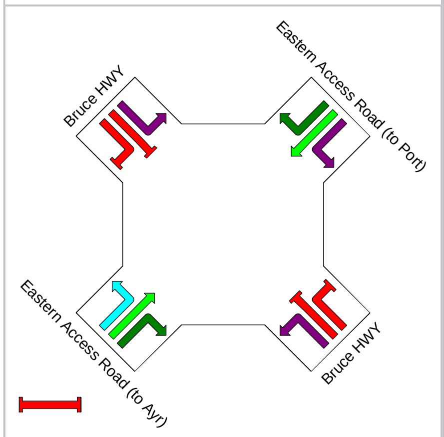
Bruce HWY / Port Access Road
2014 With Development
AM peak
(Estimated signal data & assumed layout)
Signals - Fixed Time    Cycle Time = 100 seconds (User-Given Cycle Time)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B**
**Output Sequence: A, B**

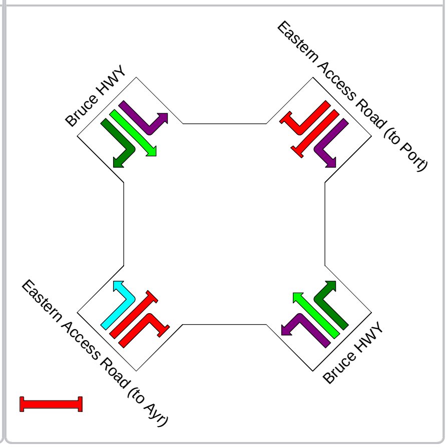
**Phase Timing Results**

| Phase | **A** | **B** |
|---|---|---|
| Green Time (sec) | 6 | 82 |
| Yellow Time (sec) | 4 | 4 |
| All-Red Time (sec) | 2 | 2 |
| Phase Time (sec) | 12 | 88 |
| Phase Split | 12 % | 88 % |

**Phase A**




**Phase B**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

# MOVEMENT SUMMARY

**Site: 2014 PM peak WOD**

Bruce HWY / Port Access Road
2014 Without Development
PM peak
(Estimated signal data & assumed layout)
Signals - Fixed Time    Cycle Time = 100 seconds (User-Given Cycle Time)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South East: Bruce HWY | | | | | | | | | | | |
| 21 | L | 32 | 6.7 | 0.026 | 8.2 | LOS A | 0.2 | 1.3 | 0.14 | 0.62 | 49.0 |
| 22 | T | 846 | 11.1 | 0.328 | 5.8 | LOS A | 9.4 | 71.9 | 0.41 | 0.36 | 50.0 |
| 23 | R | 298 | 10.6 | 0.844 | 44.3 | LOS D | 17.4 | 133.1 | 0.85 | 1.00 | 27.2 |
| Approach | | 1176 | 10.8 | 0.844 | 15.6 | LOS B | 17.4 | 133.1 | 0.51 | 0.53 | 41.2 |
| North East: Eastern Access Road (to Port) | | | | | | | | | | | |
| 24 | L | 522 | 5.8 | 0.696 | 11.7 | LOS B | 14.1 | 103.6 | 0.61 | 0.79 | 45.5 |
| 25 | T | 77 | 6.8 | 0.121 | 38.4 | LOS D | 2.4 | 17.8 | 0.88 | 0.66 | 28.0 |
| 26 | R | 1 | 0.0 | 0.004 | 44.8 | LOS D | 0.1 | 0.5 | 0.85 | 0.61 | 27.0 |
| Approach | | 600 | 6.0 | 0.695 | 15.2 | LOS B | 14.1 | 103.6 | 0.65 | 0.78 | 42.1 |
| North West: Bruce HWY | | | | | | | | | | | |
| 27 | L | 1 | 0.0 | 0.001 | 8.2 | LOS A | 0.0 | 0.1 | 0.15 | 0.60 | 48.9 |
| 28 | T | 820 | 10.9 | 0.317 | 5.7 | LOS A | 9.1 | 69.4 | 0.40 | 0.36 | 50.1 |
| 29 | R | 1 | 0.0 | 0.003 | 15.1 | LOS B | 0.0 | 0.2 | 0.38 | 0.63 | 42.5 |
| Approach | | 822 | 10.9 | 0.317 | 5.8 | LOS A | 9.1 | 69.4 | 0.40 | 0.36 | 50.1 |
| South West: Eastern Access Road (to Ayr) | | | | | | | | | | | |
| 30 | L | 3 | 33.3 | 0.002 | 8.2 | NA[9] | NA[9] | NA[9] | NA[9] | 0.59 | 49.8 |
| 31 | T | 40 | 10.5 | 0.064 | 37.8 | LOS D | 1.3 | 9.7 | 0.87 | 0.62 | 28.2 |
| 32 | R | 24 | 8.7 | 0.106 | 47.7 | LOS D | 1.6 | 11.9 | 0.89 | 0.72 | 26.1 |
| Approach | | 67 | 10.9 | 0.106 | 40.0 | LOS D | 1.6 | 11.9 | 0.83 | 0.66 | 28.0 |
| All Vehicles | | 2665 | 9.8 | 0.844 | 13.1 | LOS B | 17.4 | 133.1 | 0.52 | 0.53 | 43.3 |

Level of Service (Aver. Int. Delay): LOS B. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS D. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

9 Continuous movement

# PHASING SUMMARY

Site: 2014 PM peak WOD

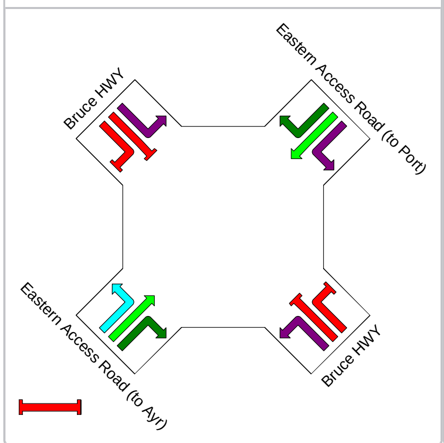
Bruce HWY / Port Access Road
2014 Without Development
PM peak
(Estimated signal data & assumed layout)
Signals - Fixed Time    Cycle Time = 100 seconds (User-Given Cycle Time)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B**
**Output Sequence: A, B**

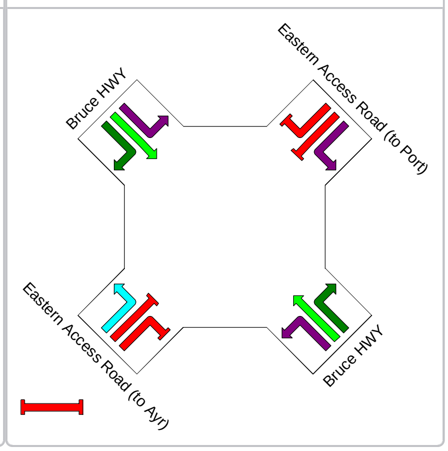
**Phase Timing Results**

| Phase | **A** | **B** |
|---|---|---|
| Green Time (sec) | 17 | 71 |
| Yellow Time (sec) | 4 | 4 |
| All-Red Time (sec) | 2 | 2 |
| Phase Time (sec) | 23 | 77 |
| Phase Split | 23 % | 77 % |

**Phase A**




**Phase B**




| | |
|---|---|
| Normal Movement | Permitted/Opposed |
| Slip-Lane Movement | Opposed Slip-Lane |
| Stopped Movement | Continuous Movement |
| Turn On Red | Undetected Movement |
| | Phase Transition Applied |

Processed: Monday, 21 November 2011 11:03:26 AM
SIDRA INTERSECTION 5.0.5.1510

Project: J:\Projects\60161996\4. Tech Work Area\4.3 Engineering\Traffic\SIDRA\2014 WOD\7 - Bruce HWY - Port Access Road.sip
8000907, AECOM, ENTERPRISE

# MOVEMENT SUMMARY

**Site: 2014 PM peak WD**

Bruce HWY / Port Access Road
2014 With Development
PM peak
(Estimated signal data & assumed layout)
Signals - Fixed Time    Cycle Time = 100 seconds (User-Given Cycle Time)

**Movement Performance - Vehicles**

| Mov ID | Turn | Demand Flow veh/h | HV % | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | 95% Back of Queue Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South East: Bruce HWY | | | | | | | | | | | |
| 21 | L | 32 | 6.7 | 0.026 | 8.3 | LOS A | 0.2 | 1.5 | 0.15 | 0.62 | 49.0 |
| 22 | T | 846 | 11.1 | 0.328 | 5.8 | LOS A | 9.4 | 71.9 | 0.41 | 0.36 | 50.0 |
| 23 | R | 298 | 10.6 | 0.844 | 44.3 | LOS D | 17.4 | 133.1 | 0.85 | 1.00 | 27.2 |
| Approach | | 1176 | 10.8 | 0.844 | 15.6 | LOS B | 17.4 | 133.1 | 0.51 | 0.53 | 41.2 |
| North East: Eastern Access Road (to Port) | | | | | | | | | | | |
| 24 | L | 522 | 5.8 | 0.693 | 11.7 | LOS B | 14.1 | 103.6 | 0.61 | 0.79 | 45.5 |
| 25 | T | 96 | 9.9 | 0.154 | 38.7 | LOS D | 3.0 | 22.5 | 0.89 | 0.67 | 27.9 |
| 26 | R | 1 | 0.0 | 0.004 | 45.7 | LOS D | 0.1 | 0.5 | 0.86 | 0.61 | 26.7 |
| Approach | | 619 | 6.5 | 0.692 | 15.9 | LOS B | 14.1 | 103.6 | 0.66 | 0.77 | 41.4 |
| North West: Bruce HWY | | | | | | | | | | | |
| 27 | L | 1 | 0.0 | 0.001 | 8.3 | LOS A | 0.0 | 0.1 | 0.16 | 0.60 | 48.9 |
| 28 | T | 820 | 10.9 | 0.317 | 5.7 | LOS A | 9.1 | 69.4 | 0.40 | 0.36 | 50.1 |
| 29 | R | 1 | 0.0 | 0.003 | 15.1 | LOS B | 0.0 | 0.2 | 0.38 | 0.63 | 42.5 |
| Approach | | 822 | 10.9 | 0.317 | 5.8 | LOS A | 9.1 | 69.4 | 0.40 | 0.36 | 50.1 |
| South West: Eastern Access Road (to Ayr) | | | | | | | | | | | |
| 30 | L | 2 | 0.0 | 0.001 | 7.6 | NA[9] | NA[9] | NA[9] | NA[9] | 0.60 | 49.8 |
| 31 | T | 46 | 20.5 | 0.079 | 38.1 | LOS D | 1.5 | 12.2 | 0.87 | 0.63 | 28.1 |
| 32 | R | 24 | 8.7 | 0.110 | 48.7 | LOS D | 1.6 | 12.1 | 0.90 | 0.72 | 25.8 |
| Approach | | 73 | 15.9 | 0.110 | 40.8 | LOS D | 1.6 | 12.2 | 0.85 | 0.66 | 27.7 |
| All Vehicles | | 2689 | 10.0 | 0.844 | 13.4 | LOS B | 17.4 | 133.1 | 0.52 | 0.54 | 43.0 |

Level of Service (Aver. Int. Delay): LOS B. Based on average delay for all vehicle movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS D. LOS Method for individual vehicle movements: Delay (HCM).
Approach LOS values are based on average delay for all vehicle movements.

9 Continuous movement





SIDRA INTERSECTION

# PHASING SUMMARY

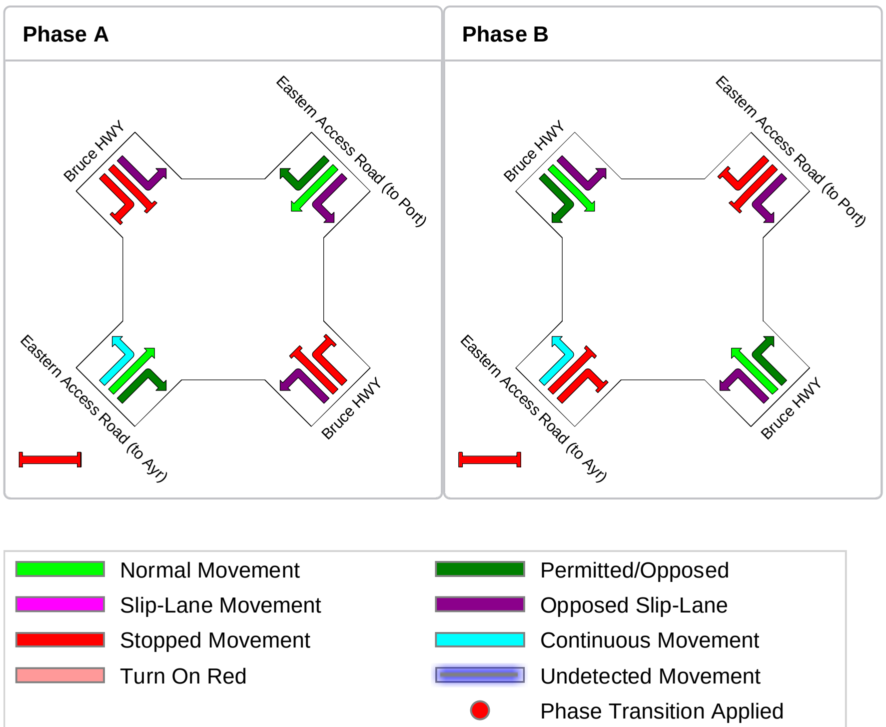
Site: 2014 PM peak WD

Bruce HWY / Port Access Road
2014 With Development
PM peak
(Estimated signal data & assumed layout)
Signals - Fixed Time    Cycle Time = 100 seconds (User-Given Cycle Time)

**Phase times determined by the program**
**Sequence: Four-phase**
**Input Sequence: A, B**
**Output Sequence: A, B**

**Phase Timing Results**

| Phase | **A** | **B** |
|---|---|---|
| Green Time (sec) | 17 | 71 |
| Yellow Time (sec) | 4 | 4 |
| All-Red Time (sec) | 2 | 2 |
| Phase Time (sec) | 23 | 77 |
| Phase Split | 23 % | 77 % |




# Port Expansion Project EIS

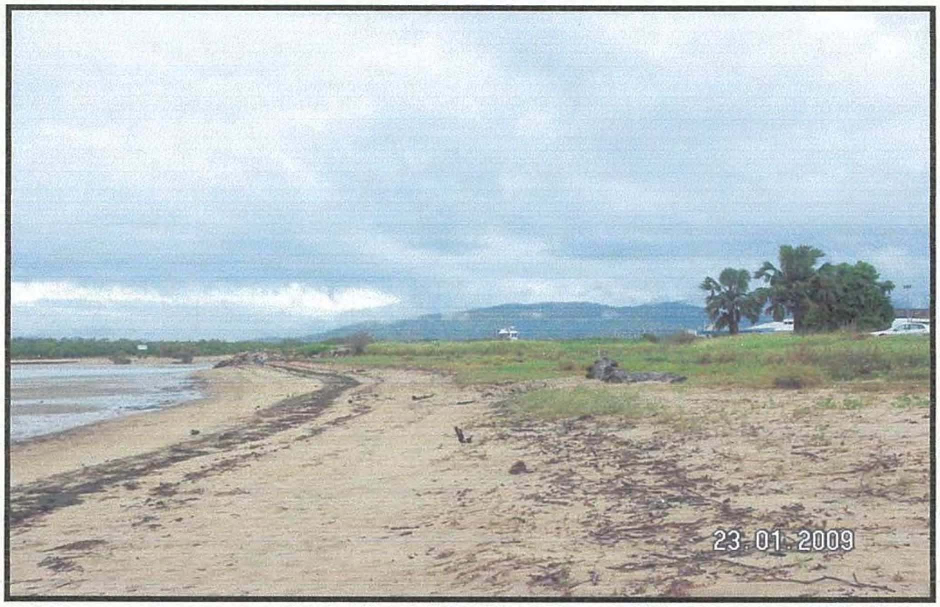
## Appendix R1

## Indigenous Cultural Heritage Report

AECOM BMT WBM

# INDIGENOUS CULTURAL HERITAGE REPORT
# PORT OF TOWNSVILLE LIMITED (POTL)
# TOWNSVILLE MARINE PRECINCT & PORT EXPANSION PROJECTS

**JANUARY 2009**
**[Report Finalised March 2009]**




*Prepared by*

**Michele Bird* and Nicolaas Heijm****
**Northern Archaeology Consultancies Pty Limited***
**& Segue Pty Limited****
**PO Box 118**
**Castletown, Hyde Park QLD 4812**

*In Conjunction with*

**ENDORSED ABORIGINAL PARTIES FOR BINDAL & WULGURUKABA TRADITIONAL OWNERS**

*On Behalf of*

**PORT OF TOWNSVILLE LIMITED (POTL)**

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## EXECUTIVE SUMMARY

This report presents the results of an indigenous cultural heritage investigation for the proposed Port of Townsville Limited (POTL) Marine Precinct and Port Expansion development areas at Ross River and Ross Creek, Cleveland Bay, Townsville.

The principal aims of this cultural report have been to identify and document the indigenous cultural heritage values of the project areas, assess the potential impacts to these values as a result of the development projects and provide recommendations to protect and manage existing and potential indigenous cultural sites and values.

This investigation has provided clear evidence that the overall Cleveland Bay coastline, including the POTL project areas, has significant Aboriginal cultural heritage values. This evidence comes from various sources including ethnography, ethnohistory, anthropology, oral history, the Aboriginal archaeological record, and of course, from the Traditional Owners themselves. The area retains indigenous cultural significance by virtue of the following:-

The POTL study area is part of *Gurambilbarra* traditional homelands and the Traditional Owners maintain an enduring 'connection to country' (in the context of this report 'homelands' refers to both land and sea country, thereby incorporating both the onshore and offshore project areas); locations within or close to the project areas have Aboriginal language names (eg: Ross Creek, Ross River and Ross Island); Ross Creek and Ross River are integral components of the local Aboriginal creation story – the *Gabul* (carpet python) myth cycle; the project areas and surrounds were used traditionally for foraging, camping and for other cultural purposes such as meeting places and corroborees; land areas in the vicinity of the Port of Townsville contain tangible archaeological evidence in the form of shell middens, stone artefact scatters, scarred trees, rock shelters with paintings, ceremonial sites and a burial ground; current archaeological evidence indicates that Aboriginal people occupied the Cleveland Bay coastline and the adjacent coastal plains of Townsville for at least the last 4,000 years; Ross Creek, Ross River and Ross Island represented one of the frontiers between European and Aboriginal societies in the first decades of Townsville's existence; the project areas (where accessible to the public) continue to be visited today by local Aboriginal people, mainly for fishing and beach foraging.

This report concludes that it is unlikely that the proposed POTL development projects will have any major detrimental impacts to the Aboriginal archaeological record of Cleveland Bay. Areas to be impacted by the projects predominantly include sub-tidal areas and reclaimed lands only several decades in age (eg: Benwell Road beach). It is predicted that the prehistoric archaeological record of this area is very likely to have been obliterated by existing (and historical) development of the Port, prolonged dredging at the mouths of Ross River and Ross Creek, and more natural processes of erosion and deposition as a result of storm surge and cyclonic events.

From the Traditional Owners point of view, they generally feel that the current POTL projects will have no greater impact on Aboriginal cultural values than the many previous development projects which have resulted in dramatic alterations to the original configuration of the Cleveland Bay coastline and waterways (eg: The Strand redevelopment, the existing Port of Townsville and associated facilities, reclamation of land for the Casino Complex and Townsville Entertainment Centre, marina, apartment developments and breakwaters, etc). Despite these many previous developments and alterations to the natural landscape, Aboriginal people have maintained their 'connections to country'.

In short, while alterations to the environment in the further development of the Port of Townsville will impact Traditional Owner cultural values, Cleveland Bay, the Townsville coastline and major waterways such as Ross Creek and Ross River will nevertheless continue to be fundamental and significant places in their culture.

# 1. INTRODUCTION

The Port of Townsville Limited (POTL) is the proponent for the proposed Townsville Marine Precinct Project and the Port Expansion Project. POTL is a government owned corporation and a port authority under the *Transport Infrastructure Act 1994*. POTL is responsible for managing and developing the Port of Townsville. The Port of Townsville is situated between the mouths of the Ross River and Ross Creek in Cleveland Bay. Cleveland Bay is defined by Cape Pallarenda, Cape Cleveland and Magnetic Island.

The proposed Townsville Marine Precinct project will be situated at the mouth of Ross River. This project will involve reclamation of approximately 34 hectares of land on Lot 773, EP2211 for a commercial marine precinct. The subject land at Lot 773 is known locally as the South Townsville beach or Benwell Road beach (Figure 1). This proposal incorporates the possible construction of a breakwater on the eastern side of the mouth of Ross River to protect the marine precinct from sediment infill and wave action.

The proposed Port of Townsville Expansion project will be situated to the north of the proposed Marine Precinct and will involve expansion seaward of the northern breakwater, directly adjacent to Platypus Channel on Ross Creek. It will involve the reclamation of a finger of land comprising approximately 40 hectares, and provide for allocation of up to seven new berths (Figure 2).

On 22 August 2008 the Coordinator General declared the Townsville Marine Precinct project a *'significant project for which an Environmental Impact Statement (EIS) is required'*, pursuant to Section 26(1)(a) of the *State Development and Public Works Organisation Act 1971*. The Department of Infrastructure and Planning is managing the EIS process on behalf of the Coordinator General. GHD Pty Ltd has been commissioned by POTL to undertake the EIS investigations. The objective of the EIS is to ensure that all potential environmental, social and economic impacts of the project are identified and assessed, and where possible, how any adverse impacts would be avoided or mitigated.

Under the provisions of the *Aboriginal Cultural Heritage Act 2003 (ACHA)*, a Cultural Heritage Management Plan (CHMP) is mandatory for projects subject to a full EIS. There is currently no registered 'Native Title Party' as defined by *ACHA* for the Townsville region (including the POTL project areas), nor is there a registered 'Aboriginal Cultural Heritage Body' for the Townsville area. On that basis, POTL identified the relevant Aboriginal Parties for the project areas via a public notification process (notice day of May 12th 2008), as per the provisions of Section 61 of the *ACHA*. The 'Endorsed Aboriginal Parties' for the POTL projects include 18 people who identify as Bindal, Wulgurukaba and/or Garumbilbarra representatives, who responded (in writing) to the public notice. The public notice is reproduced in Appendix 1 of this report.

POTL has placed a high priority on establishing and maintaining communications with the Aboriginal Parties to address indigenous cultural heritage matters for the proposed projects and to develop a project CHMP. Consultation between POTL and the Aboriginal Parties has been carried out over an extended period from June 2008 to the present (March 2009). POTL has entered into discussions with the Aboriginal Parties for both the Marine Precinct project (currently subject to the EIS process), as well as the Port Expansion project (this project is planned to commence in approximately one year). For the purposes of this cultural heritage investigation the main points of contact at POTL have included Margaret Card (Environmental Consultant), Esther Slocombe (Governance and Legal Advisor) and Mel Marke (Manager, Major Projects).

From June 2008 a series of meetings and negotiations between POTL representatives and the Aboriginal Parties culminated in the signing of a (combined) CHMP for the Marine Precinct and the Port Expansion projects on 5th September 2008. This CHMP was approved and registered by the Chief Executive of the Department of Natural Resources and Water (NRW) on 23 December 2008 (POTL and Aboriginal Parties 2008). Amongst other things, the CHMP provides for the preparation of a Cultural Heritage Report as a means to identify, document and manage the Aboriginal cultural heritage values of the project areas. It is intended that the recommendations of this Cultural Heritage Report will be incorporated into the project CHMP as an updated

Schedule (as per Section 3.4 of the CHMP). At this stage a further meeting is planned with the Aboriginal Parties (in March 2009) to discuss and review this cultural heritage report and its recommendations.

*[Postscript 18 March 2009: A meeting between POTL and the Aboriginal Parties was held on 17 March 2009].*

POTL commissioned Northern Archaeology Consultancies Pty Ltd (NAC) (Michele Bird) to prepare this Cultural Heritage Report, in conjunction with the Aboriginal Parties. The project archaeologist was endorsed by the Aboriginal Parties as an acceptable consultant at the initial project meeting in July 2008. The project archaeologist's role has included attendance at project meetings, provision of cultural heritage and archaeological advice where required, consultation with the Traditional Owners, background historical and archival research, and compilation of this Cultural Heritage Report.

NAC subsequently commissioned Nicolaas Heijm (Segue Pty Ltd) to assist in compiling ethnographical and ethnohistorical information pertaining to the POTL project areas, particularly Ross Creek and Ross River. It is noted that this current report for POTL draws on some of the ethnohistorical and ethnographical background previously collated for the proposed nearby Townsville Ocean Terminal project in Cleveland Bay (see Bird and Heijm 2007).

This Cultural Heritage Report has been prepared as a means to address the provisions of the *ACHA* (Part 7 CHMP process), the project CHMP (Sections 3.4 and 3.5) and also the Terms of Reference for the cultural heritage component of the EIS for the Marine Precinct project (see below).

### 1.1 Terms of Reference and Project Brief

The Queensland Government outlined the Terms of Reference (ToR) for the proposed Marine Precinct project in November 2008 under Part 4 of the *State Development and Public Works Organisation Act 1971* (Queensland Government 2009).

With regard to the cultural heritage component of the EIS, the ToR state the following:-

*A cultural heritage study may be required which will describe indigenous and non-indigenous cultural heritage sites and places, and their values. In accordance with the relevant cultural heritage legislation, such a study must be conducted by an appropriately qualified cultural heritage practitioner and must include the following:-*

- *Liaison with relevant indigenous community/communities concerning places of significance to that community (including archaeological sites, natural sites, story sites, etc);*
- *Appropriate community involvement in field surveys;*
- *A systematic survey of the proposed development area to locate and record indigenous and non-indigenous cultural heritage places;*
- *Significance assessment of any cultural heritage sites/places located;*
- *The impact of the proposed development on cultural heritage values;*
- *A report of work done which includes background research, relevant environmental data and methodology, as well as results of field surveys, significance assessment and recommendations.*

In Section 3.12.2 the ToR outline the requirements for a project CHMP as follows:-

*The potential environmental harm to cultural heritage values in the vicinity of the project should be managed under a Cultural Heritage Management Plan (CHMP) developed specifically for the project. The CHMP will provide a process for the management of cultural heritage places both identified and subsurface at the project sites. It is usual practice for the CHMP to be based on information contained in* *archaeological and/or anthropological reports on the survey area and cultural reports and/or other information from affiliated Traditional Owners. The CHMP should address and include the following:-*

- *A process for including indigenous people associated with the development areas in the protection and management of indigenous cultural heritage;*
- *Processes for mitigation, management and protection of identified cultural heritage places and material in the project areas, including associated infrastructure developments, both during the construction and operational phases of the project;*
- *Provisions for the management of the accidental discovery of cultural material, including burials;*
- *The monitoring of foundation excavations and other associated earthwork activities for possible subsurface cultural material;*
- *Cultural awareness training or programs for project staff;*
- *A conflict resolution process.*

The Project Brief from POTL states that the consultant is to assist POTL with indigenous cultural heritage matters related to the preparation of a Cultural Heritage Report and CHMP, incorporating both the Townsville Marine Precinct project and the Port Expansion project. This work is to include addressing POTL's Duty of Care under *ACHA*, and also addressing the relevant ToR for the Marine Precinct project as outlined by the Coordinator General for the project EIS.

The scope and objectives of this indigenous cultural heritage study have included:-

- A literature review of relevant archaeological, ethnohistorical and other relevant cultural heritage data pertaining to the project areas;
- Consultation of relevant cultural heritage databases and registers to ascertain if any indigenous cultural heritage sites and values have previously been recorded in the project areas, and immediate surrounds;

- Assisting POTL in consultation with Aboriginal Traditional Owners and indigenous stakeholders as required, to obtain cultural heritage feedback on the projects;
- Undertake field inspections/site surveys (as required) of the proposed development areas, in conjunction with nominated representatives from the relevant Aboriginal groups/parties, to identify areas of indigenous cultural heritage significance and value;
- Attend project meetings and/or provide cultural heritage input where required to facilitate the signing and completion of a project CHMP;
- Preparation of a Cultural Heritage Report which:-

➢ Describes results of any cultural site inspections or fieldwork;
➢ Identifies areas of indigenous cultural and spiritual significance within or adjacent to the project areas;
➢ Reports on cultural and heritage issues identified during consultation with Aboriginal stakeholders;
➢ Formulates recommendations on actions required for the protection of indigenous cultural heritage values.

## 2. PROJECT LOCATION AND DESCRIPTION

The following background information relating to the Marine Precinct project and the Port Expansion project has been compiled from several sources including project Fact Sheets (Environment and Behaviour Consultants 2008a, 2008b, 2009), the Terms of Reference for the Marine Precinct Project (Queensland Government 2009) and other information supplied by POTL personnel (Mel Marke and Esther Slocombe).

POTL administers the Port of Townsville, which has a land and sea jurisdiction in excess of 400 square kilometres. The Port of Townsville is situated between the mouths of the Ross River and Ross Creek in Cleveland Bay.

The Port of Townsville is Queensland's third largest port trading about 10 million tonnes each year. It serves a geographically large hinterland including the significant mining and mineral processing activities located to the west. The commercial port contains a wide range of mainly bulk cargo handling operations through nine (9) berths.

In 2006 POTL (formerly known as the Townsville Port Authority), together with the Queensland Department of Infrastructure and Offices of the Shareholding Ministers undertook a 12-month process to prepare a Port Master Plan to guide the future development of the port for the next 25 years.

The focus of the study was on the cargo handling and shipping operations of the port, and particularly aimed at quantifying the demand, assessing capacity requirements and identifying the channel, berth, land and transport infrastructure needed to accommodate growth.

The study concluded that under a high growth scenario, the Port of Townsville could grow from 10 to 27 million tonnes per annum by 2030 and that meeting the infrastructure demands of such growth is best achieved by providing focus in three key areas.

1. Securing the port boundaries via the City/Port Strategic Plan.
2. Driving existing assets harder via Inner Harbour Rationalisation.
3. Providing for the future via Port Expansion and the Eastern Access Corridor.

## 2.1 Marine Precinct Project

The Townsville Marine Precinct is a proposal for a commercial marine precinct at the mouth of Ross River. The project will include reclamation of Lot 773 at Benwell Road (Figures 1 and 3). A catalyst for the development of the Marine Precinct project is the construction of the Townsville Port Access Road by the Queensland Department of Main Roads (DMR). The DMR project involves construction of a low-level fixed bridge across Ross River. The development of the Marine Precinct will enable a number of commercial marine activities from sites upstream of the future bridge to relocate prior to the completion of the Townsville Port Access Road.

As a purpose built commercial marina facility, the Townsville Marine Precinct will provide an opportunity to co-locate marine-dependant industries. It will enable the region's existing marine industry to expand and diversify. With increasing trade, commercial and residential growth in Townsville, strategic planning activities for the city have focused on providing opportunities to relocate existing old commercial marine facilities spread around Ross Creek, Ross River and South Townsville into a new, purpose-built facility on Ross River, which will incorporate current best practice environmental management.

The proposed Townsville Marine Precinct will be located on the western bank of the mouth of Ross River at Benwell Road. As noted, the total area of the precinct will be approximately 32 hectares, extending east from Benwell Road beach. It is possible that a breakwater will be required on the eastern side of the mouth of Ross River to protect the marine precinct from sediment infill and to ensure protection of vessels from wave action. A number of different breakwater options are currently being considered and investigated as part of the project (refer Figures 1 and 3).

A Marine Precinct, situated at the mouth of Ross River has been proposed in various forms since the 1970's. The first concept plans were drawn in 1977. In 1991 the first environmental studies commenced to examine the potential impacts of developing a marine precinct in the eastern port area (refer Sinclair Knight Merz 1991, 1992). An EIS was finalized in 1995. Amongst other things, the 1995 EIS investigated migratory bird surveys, surveys of public use of the beach at Lot 773, sea-grass surveys and water quality monitoring.

Expected benefits of the proposed Marine Precinct project include:-

- Provision of a marine precinct sheltered from prevailing waves where commercial marine activities in Townsville can be consolidated;
- Provision of an area in Ross River for relocation of the existing trawler fleet which is required to occur prior to completion of the bridge linking the Port Access Road to Townsville Port;
- Restriction of westward long-shore sediment transport into the navigation channel and subsequent reduction in the requirement to dredge in the longer term;
- Consideration of provision of mooring areas for vessels currently on buoy and pile moorings in Ross Creek.

The concept master plan for the proposed Marine Precinct project incorporates onshore and offshore elements as listed below:-

- Staging

Development works may be completed in stages. For Stage 1 it is anticipated that certain mandatory capabilities will be in place and operational by the time the bridge across Ross River is completed (2011) so that minimal disruption occurs to the functioning of current marine capabilities in Townsville. Other stages will be developed over the following 5-10 years in accordance with market demand.

- Permitted uses

The intended tenants of the Marine Precinct will be marine-related industries similar to those already in business in Ross River and Ross Creek. It is expected that there will be opportunities for expansion of some business types and inclusion of new business types, provided they are marine-related and with approval of POTL. Residential development or hotel accommodation will not be permitted in the Marine Precinct.

- Access to the Precinct

Two dedicated access points will be provided from Benwell Road, one at the end of Boundary Street and one near the end of Archer Street. The final design of the access is still under negotiation with DMR.

- Marine industry allotments

A commercial spillway, barge ramp, ship-lift, docking facility, work berths, chandlery and associated marine facilities are proposed. At a minimum the Marine Precinct will provide the capability for replication of existing marine industries that may choose to relocate to the new facility. It is anticipated that there will also be room for expansion of marine industries or for new marine-related industries to locate in the facility.

- Trawler berths

Approximately 50 permanent trawler berths and two trawler maintenance berths are proposed. The potential for temporary berths or loading/unloading berths for peak times is being considered.

- Volunteer coastguard

Consideration will be given to relocation of the existing Townsville coastguard office and mooring into this area.

- Private pile moorings

Depending on the final configuration, the inside of any breakwater could accommodate some pile moorings. The existing pile moorings upstream in Ross River will most likely remain in place and be available for vessels able to motor underneath the proposed new bridge. Alternative mooring sites may be available in Ross Creek.

- Services

Site services including power, water, sewage, storm water drainage and telecommunications will be provided to the proposed development.

- Breakwater

Two breakwater design options are currently being considered (see Figure 1). Hydrological, sediment transport and other investigations to be undertaken during the EIS process will assist in the location and configuration of a final breakwater design. Other options being examined, with the aim of reducing potential environmental impacts, include offshore configurations that do not connect to land. Although the 'no breakwater' option will be fully examined, it is considered that a breakwater is likely to be required to:-

- Provide shelter for the commercial marine area and pile moorings from prevailing wind and waves;
- Provide a sheltered swing basin for commercial vessels entering and leaving the facility;
- Provide a sheltered departure point to Cleveland Bay for smaller recreational boats;
- Restrict westward long shore sediment transport into the navigation channel and reduce the requirement to dredge the Ross River channel in the longer term;
- Provide an effective barrier between the common use areas and the sensitive environmental areas on the eastern side of Ross River;
- Allow sand to accrete on the eastern side of the wall to provide an alternative migratory bird roosting and nesting area.

Breakwater options being considered are outlined below:-

'No breakwater'

- No protected anchorage in which to moor boats from upstream on pile moorings;
- No protection for pile moorings from flood flows in Ross River;
- No protection for the external face of the Marine Precinct from wave effects;
- No protection for the navigation channel from long-shore sediment flow;
- No direct impacts on benthic habitat or migratory bird habitat on the sand spit/sand bar.

Option 1: Longer more distant breakwater option

The potential advantages/disadvantages of this option include:-

- A large area available for pile moorings (for upstream vessels) including an allowance for growth;
- Protection for moored vessels during flood events in Ross River (pile moorings would be located out of the main flow channel);
- Protection for moored vessels from boat wash from vessels motoring up Ross River;
- Channel width sufficient for a swing circle by larger vessels that may use the Marine Precinct in the future;
- The largest footprint and therefore greater potential loss of benthic habitat and migratory bird habitat on the sand spit/sand bar;
- Opportunity for sand accretion on the eastern side of the breakwater as possible compensatory habitat for migratory birds;
- The greatest cost.

Option 2: Shorter, closer breakwater option

Option 2 is a lower cost option but it has a number of limitation/disadvantages. The potential disadvantages are:-

- Limited allowance for increased demand for pile moorings;
- Decreased protection (less than option 1) for moored vessels during flood events in Ross River, as they would be moored closer to the main flow channel;
- Less protection from boat wash from vessels motoring up Ross River;
- Channel width too small for a swing circle by larger vessels that may use the Marine Precinct in the future;
- Potential loss of benthic habitat and migratory bird habitat on the sand spit/sand bar (although less than option 1).

Other options

Other potential options being examined include smaller intermediate breakwater configurations that may not connect to land.

- Reduced allowance for pile moorings;
- Less rock required;
- Less benthic habitat loss;
- Less opportunity for sand accretion as compensatory habitat because of deeper water;
- Less impact on the sand spit/sand bar because the breakwater will not connect to land;
- Potentially less protection for small vessels using Ross River and for the front face of the Marine Precinct.

- Dredging

Port of Townsville undertakes an approved program of maintenance dredging to maintain the navigability of channels, within the Port area, including the Ross River. The Ross River channel dredging program is sufficient to provide access for the commercial, defence and recreational vessels that currently use Ross River. It is not anticipated that development of the Marine Precinct will increase the requirement for maintenance dredging.

Capital dredging will be required for the initial development of the project to obtain the necessary depth for vessel movements. Capital dredging would also be required to provide a swing basin and mooring area for any pile moorings adjacent to any breakwater. The depth and volume of dredge material will be determined by final design after further investigations during the EIS.

It is anticipated that some dredge spoil will be used as reclaim fill for the project (Lot 773). The preferred method of dredging to reclaim would be to use cutter suction dredge discharging through pipes directly into the reclamation area. Any material that is determined unsuitable as engineering fill may be extracted with an excavator rather than cutter suction dredge.

Offshore dumping may be considered for the disposal of unsuitable fill. The EIS will include a review and assessment of both onshore and offshore disposal options, with the potential impacts of both options feeding into the considerations for the preferred breakwater configuration.

## 2.2 Port Expansion Project

The proposed Port of Townsville Expansion project will be situated to the north of the proposed Marine Precinct and will involve expansion seaward of the northern breakwater (Figures 2 and 3). It will involve the reclamation of a finger of land comprising approximately 40 hectares, and provide for allocation of seven new berths. The project may be developed in stages as demand increases, but approvals will be sought for the entire footprint.

The Port Expansion project provides for a re-focus of the Inner Harbour on general and bulk cargo with the new Outer Harbour, in the long run, to be centred on dry bulk trades. The rationalisation for the Inner and Outer Harbours is that it will increase port operational efficiency and reduce operating and maintenance costs. In addition, the Port Expansion seaward of the northern breakwater will provide opportunity to attract new trades and respond to growth of existing trades. It is considered that if this development does not occur, the port's capacity will be constrained by berth capacity and available land in the existing harbour. The preferred concept plan for the Port Expansion may provide allocation for up to seven new berths.

It is hoped that a benefit of the Port Expansion will be to reduce dredging costs for Berth 11 as a result of new breakwaters which will likely be required to protect the new development. Furthermore, as a result of new breakwaters protecting the port expansion it is anticipated that there will be improved ship access to the Inner Harbour and Berth 11.

The flexibility to link the Port and Townsville State Development Area with service corridors suitable for pipelines and conveyors is an expected outcome of geographical positioning of the Port Expansion. These corridors will be planned with sufficient capacity to accommodate growth well into the future.

# 3. CULTURAL HERITAGE MANAGEMENT AND LEGISLATION

The term 'cultural heritage' includes, very broadly, all places and values of archaeological, traditional, historical or contemporary significance. Cultural heritage assessments investigate the value, or significance, of particular items, sites and places to the whole or particular sections of our society, and it is one of the steps in the process of management and conservation of cultural heritage values. The cultural heritage assessment process operates on the basis that indigenous and non-indigenous cultural heritage should be conserved and protected and that development proponents have a statutory responsibility to protect such values.

## 3.1 The Burra Charter

Indigenous cultural heritage in Queensland is protected by the *Aboriginal Cultural Heritage Act* (*2003*) *(ACHA).* Like all Australian states and territories, Queensland legislation derives its philosophical principles from *The ICOMOS Charter for the Conservation of Places of Cultural Significance (The Burra Charter) 1977* (Australia ICOMOS Inc. 1992). The following definitions are central to the Charter:-

- 'Conservation' means all the processes of looking after a place so as to retain its *cultural significance*' (Article 1.4).

- Cultural significance is defined as meaning *'aesthetic, historic, scientific or social value for past, present or future generations*' (Article 1.2).

The Burra Charter recognises that cultural significance can be based on one or more values: aesthetic, historic, scientific and social but it notes that other categories of cultural significance may be developed as understanding of a particular place increases (Article 2.6). Article 5 states that *"Conservation of a place should take into consideration all aspects of its cultural significance without unwarranted emphasis on any one aspect at the expense of others"*.

The Burra Charter has not always been found appropriate for places of significance to Aboriginal people. For this reason Australia ICOMOS in 2001 adopted a *Statement on Indigenous Cultural Heritage* as its guiding principle:-

- Indigenous people of Australia have a unique status as the original owners and custodians of their traditional lands. The traditional rights and knowledge of Aboriginal people and Torres Strait Islanders are recognised and respected. The relationship of indigenous people to their land is the essence of their cultural heritage, and therefore, of their survival;

- Indigenous cultural heritage is a fundamental and inseparable part of the cultural heritage of all Australians;

- Indigenous cultural perspectives require an integrated view of heritage which includes social significance and natural features and landscapes, which are given meaning through culture;

- Indigenous cultural heritage is expressed in many ways and in many kinds of places – such as places with contemporary community associations; places and landscapes which hold strong spiritual meaning; places that tell the story of conflict and survival; places with archaeological material remaining from Indigenous use and occupation of the land; places where community life has flourished; and places that reflect the political struggle of Indigenous people for social justice;

- Indigenous cultural heritage has significance for indigenous people and communities for social, spiritual and historical reasons, and may also have significance for non-Indigenous people and communities. Places with shared heritage values should be managed to conserve and enhance them all, and involve all associated communities – indigenous and non-indigenous;

- The Indigenous cultural heritage significance of places can only be determined by the indigenous communities themselves;

- Indigenous people must be effectively involved in decisions affecting their heritage, and in managing places significant to them. Land managers must respect the rights of indigenous people to make decisions about their own heritage;

- Indigenous communities need to have control over information about their heritage. There may be instances where indigenous communities do not want information about their cultural heritage to be generally available.

## 3.2 Queensland State Legislation

### 3.2.1 Aboriginal Cultural Heritage Act 2003

Under this Act 'Cultural Heritage' is defined as anything that is:-

(a) a significant Aboriginal area in Queensland; or

(b) a significant Aboriginal object; or,

(c) evidence, of archaeological or historic significance, of Aboriginal occupation of an area of Queensland (Section 8).

Aboriginal Cultural Heritage includes:-

- archaeological sites (such as artefact scatters, hearths, stone tool knapping areas, scarred trees and stone arrangements);
- places that have traditional stories or traditional knowledge associated with them;
- historically important places (such as old stockmen's' camps or tracks); and,
- places that are important today (such as food or ochre-getting places or places used for recreational purposes).

The Queensland Department of Natural Resources and Water (NRW) is the administering and compliance authority of the *Aboriginal Cultural Heritage Act*.

The following principles are fundamental to the operation of the Act:

- recognition, protection and conservation of Aboriginal cultural heritage should be based on respect for Aboriginal, cultural and traditional practices;
- Aboriginal people should be recognised as the primary guardians, keepers and knowledge holders of Aboriginal cultural heritage;
- it is important to respect, preserve and maintain knowledge, innovations and practices of Aboriginal communities and to promote understanding of Aboriginal cultural heritage;
- activities involved in recognition, protection and conservation of Aboriginal cultural heritage are important because they allow Aboriginal people to reaffirm their obligations to "law and country";
- there is a need to establish timely and efficient processes for the management of activities that may harm Aboriginal cultural heritage.

The accent of this legislation is on *"the protection of areas of cultural significance whether or not they actually contain physical evidence of the past" (Section 12(2),* rather than just significant objects or items.

Under the Act, a significant Aboriginal area or object must be significant to Aboriginal people because of either or both of the following:

(a) Aboriginal tradition;

(b) the history, including contemporary history, of any Aboriginal party for the area (Sections 9, 10).

Section 11 of the Act stipulates that *"if a particular object or structure is evidence of Aboriginal occupation, the area immediately surrounding that object etc is also evidence of Aboriginal occupation...the object or structure cannot be separated from its context without destroying or diminishing the object or structure's significance as evidence of Aboriginal occupation".*

Section 12 provides information about identifying significant Aboriginal areas. It is not necessary for an area to contain markings or other physical evidence indicating

Aboriginal occupation or otherwise, for example, the area might be a ceremonial place, a birthing place, a burial place or the site of a massacre. If significant objects exist in the area and their significance is intrinsically linked to the location, then the objects themselves make the place significant and if appropriate both the area and objects become significant. In identifying a significant area, authoritative information may be had from anthropological, biogeographical, historical and archaeological sources.

The Act exerts blanket protection over *all* indigenous cultural heritage in Queensland regardless of the Native Title status of that land. Cultural heritage items and places of significance to Aboriginal people may exist in areas where Native Title has been extinguished such as freehold land.

The Act contains a general Duty of Care to take all reasonable and practical steps to be aware of, and to avoid harming, Aboriginal cultural heritage. Section 23(1) requires that a person must exercise due diligence and reasonable precaution before undertaking an activity that may harm Aboriginal heritage. Everyone has a responsibility to exercise Duty of Care. Duty of Care Guidelines attached to the Act set out key indicators of compliance which include, but are not limited to, the following:-

- proof of consultation with the registered native title applicants;
- cultural heritage studies undertaken in association with the registered native title applicants;
- searches of cultural heritage information contained in the cultural heritage register and database held by the Cultural Heritage Coordination Unit within NR&W;
- a Cultural Heritage Management Plan (CHMP) or other agreement with the registered native title applicants.

There are substantial penalties for failing to safeguard the Aboriginal cultural heritage values of Queensland. These penalties consist of:- $75,000 for an individual; $750,000 for a corporation; Injunctions issued by the Land and Resources Tribunal; Stop Orders issued by the Minister, for an activity that is harming or is likely to harm Aboriginal cultural heritage objects or values.

The previous state permitting system for cultural heritage studies has been replaced by agreement-based arrangements including Cultural Heritage Management Plans (CHMP), which may be formally reviewed by the State. The CHMP is now a key tool in the process of heritage management. Management plans describe the heritage significance of a place and the policies, agreed by all parties, required to retain these values.

Wherever an Environmental Impact Statement (EIS) is undertaken, a cultural heritage management plan is mandatory if the project requires some form of permit, approval or licence. This means that high-impact developments will be able to go ahead only when an effective CHMP (containing the results of a cultural heritage study) has been agreed between the proponent and Native Title Party/ies, and the CHMP is registered with the State Authority.

Where the legislation does not automatically require a mandatory cultural heritage management plan, the legislation allows for the development of voluntary CHMPs as a measure to encourage industry to adopt best practice. Any activity undertaken in accordance with a cultural heritage management plan approved under the legislation satisfies the Duty of Care requirement.

A register of Aboriginal Cultural Heritage is maintained within the Cultural Heritage Unit, Department of Natural Resources and Water (NR&W). This register contains information that has been collated by the Environmental Protection Agency between the 1930s and the commencement of the Act in early 2004. This information is confidential and basic details will be provided to authorised persons on an 'as needs' basis. A database of Aboriginal Cultural Heritage consisting of information collected since the Aboriginal Cultural Heritage Act commenced is also being maintained within this Unit.

An Aboriginal Cultural Heritage Body is a corporation that has been approved by the Minister of the NRW as an approved cultural heritage body for an area. The cultural heritage body is the initial contact point for cultural heritage issues within a Native Title area and it usually represents the registered Native Title claimant group for that area.

The function of this body is to identify the Native Title Parties for an area. A cultural heritage body must have the written support of a significant proportion of the Native Title Applicants of an area.

### 3.2.2 Queensland Heritage Act 1992

This Act provides for the conservation and protection of places and items of non-indigenous origin and of indigenous origin that derive from the post-European contact history of Queensland. Under this Act, places and items must be entered into a Queensland Heritage Register in order to be protected. Substantial penalties may apply for damage to a place or items that has been entered on the Register. From 2005 the Queensland Heritage Council has adopted the revised Burra Charter as a guideline for making decisions under the *Queensland Heritage Act 1992.*

In order for a place to be entered onto the Queensland Heritage Register (Section 23 [1]) it must satisfy at least one of the following significance criteria:

- important in demonstrating the evolution or pattern of Queensland's history;
- important in demonstrating rare, uncommon or endangered aspects of Queensland's heritage;
- has potential to yield information that will contribute to an understanding of Queensland's history;
- important in demonstrating the principal characteristics of a particular class of cultural places;
- important in exhibiting particular aesthetic characteristics valued by the community or a particular cultural group;
- important in demonstrating a high degree of creative or technical achievement at a particular period;
- has a strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
- the place has a special association with the life or work of a particular person, group or community of importance in Queensland's history.

## 3.3 Federal Legislation

### 3.3.1 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

A new Federal heritage system came into effect on 1 January 2004 to protect Australia's national heritage places. Nationally important heritage values will have legal protection under the *Environment Protection and Biodiversity Conservation Act 1999.*

Under the new system, national heritage joins six other matters of national environmental significance (NES matters) already specifically protected under the EPBC Act. By law, no one can take any action that has, will have, or is likely to have, a significant impact on any of these matters without approval from the Australian Government Minister for the Environment and Heritage. There are severe penalties for those who do. An action includes a project, development, undertaking, an activity, or series of activities.

If the Minister decides that the action is likely to have a significant impact on a matter of national environmental significance, then the action requires approval under the EPBC Act. If the Minister decides that the action is not likely to have a significant impact on a matter of national environmental significance, then the action does not require approval under the Act. If the Minister's decision is that an action does not require approval, a person will not contravene the Act if the action is taken in accordance with that decision. If the Minister's decision is that an action requires approval, then an environmental assessment of the action must be carried out. The Minister decides whether to approve the action, and what conditions (if any) to impose, after considering the environmental assessment.

The main elements of the new heritage system include:-

- the creation of a new advisory body, the Australian Heritage Council;
- the creation of both a National Heritage List and a Commonwealth Heritage List;
- retention of the existing Register of the National Estate.

The National Heritage List records places with outstanding natural and cultural heritage values that contribute to Australia's national identity.

The Commonwealth Heritage List will comprise natural, indigenous and historic heritage places owned or managed by the Australian Government. These include places connected to defence, communications, customs and other government activities that also reflect Australia's development as a nation.

The new laws also established the Australian Heritage Council, which replaces the Australian Heritage Commission as the Australian Government's independent expert advisory panel on heritage matters. The Australian Heritage Council consists of a Chair and six members, including two indigenous people with appropriate heritage experience or expertise.

When a place that may have indigenous heritage values is nominated to the National or Commonwealth Heritage Lists, the Australian Heritage Council must seek the views of indigenous people with rights or interests in the place as part of its assessment. The Council must present these indigenous views to the Minister so he/she can take these into account when making decisions as to the listing of the place.

Under the new laws there are penalties for anyone who takes an action that results, or will result in, a significant impact on the national heritage values, to the extent they are indigenous heritage values, of a place. The laws also enable indigenous people to seek Federal Court injunctions against any activities that have a significant impact on the national indigenous heritage values of a listed place. Indigenous people will be involved in developing management plans for places with indigenous heritage significance on the National or Commonwealth Heritage List. National heritage places on indigenous land will be managed through conservation agreements, which will operate in the same way as Indigenous Protected Areas.

### 3.3.2 Australian Heritage Commission Act 1975-1990

This Act is comprehensive in its approach, covering a wide range of culturally significant places. Classes of items which might be placed on the Register of the National Estate include those of the historic environment (including buildings and structures, modified landscapes and archaeological sites); the natural environment; and items from the Aboriginal environment (both archaeological sites and unmodified natural features such as story places and sacred sites). Section 30 provisions protect items on the Register from unnecessary destruction by actions of Federal Government Departments, agencies and instrumentalities. State Governments and private developers are not constrained by the provisions of this Act unless Federal funding is involved. However, the Register provides guidance to the value of places.

### 3.3.3 Aboriginal and Torres Strait Islander Heritage Protection Act 1986

The purpose of the *Aboriginal and Torres Strait Islander (ATSI) Heritage Protection Act 1986* is to preserve and protect areas and objects of particular significance to Aboriginal Australians from injury or desecration. This legislation can provide particular protection for sacred sites. Any steps necessary for the protection of a threatened place are outlined in a gazetted Ministerial Declaration (Sections 9 and 10), and this can include the prevention of development. As well as providing protection to areas, it can also protect objects by Declaration, and in particular Aboriginal skeletal remains (Section 12). Heavy penalties may be levied in the case of contravention of provisions of a Declaration (Section 22). Although this is a Federal Act, it can be invoked in a State if the State is unwilling or unable to provide protection for such sites or objects.

## 3.4 Cultural Significance Assessment

The assessment of significance forms an integral part of cultural heritage studies. According to Bowdler (1984:1) *"....an assessment of the significance of a place or a site is necessary to decide what should be done with it, and if some form of conservation or protection is indicated, a clear statement of significance should indicate how that preservation should be carried out".*

As noted, the Burra Charter defines 'significance' as *"aesthetic, historic, scientific or social value for past, present or future generations"*. It is important to note that the concept of significance is multi-faceted, and any one cultural heritage site may have different kinds of significance at different times and to different interest groups.

In making an assessment of significance the following steps need to be taken:-

- to understand the nature of the 'fabric' or all the physical material of the place (Burra Charter: Definitions, Article 1);
- to make a close, systematic examination of the fabric to understand its significance; this examination should be supplemented by other information about the place;
- to understand that the focus of both research potential and representativeness change over time. As research interests, archaeological methods and techniques change through time, or as sites become rarer in an area that has been subject to major physical disturbance of one form or another, the criteria for assessing site significance must be re-evaluated. Consequently, as many sites as possible should be conserved to account for these changing values.

### 3.4.1 Scientific (Archaeological) Significance Assessment

The scientific significance of a place is assessed according to its:-

- research potential
- representativeness

'Archaeological research potential' refers to a site's ability to provide unique information on past human activities particularly everyday life, which more often than not is not available in documentary sources (Pearson and Sullivan 1999). Specifically, archaeological sites can supplement other information on local histories by identifying physical relics of human activities, past climates and vegetation patterns by analysis of pollen grains, and past diets and resources by the identification and analysis of plant, shell and bone remains. Such information may relate to questions of local culture history spanning tens or even thousands of years or to even more general questions relating to the evolution of cultures.

'Representativeness' refers to the ability of one site or a sample of sites to represent as accurately as possible the range and frequency of site types in a particular area. The notion of representativeness is also related to the maintenance of site diversity. The rarer a site, the greater its significance. In areas not well represented by physical, archaeological remains, all sites must be considered significant until proven otherwise. Older sites, those that contain particular attributes, or a mixture thereof, that are not found elsewhere, or those in which the archaeological material is unusually well preserved would potentially fall within the category of unique.

The scientific significance of a site generally increases as its potential to provide information increases. For any given place the significance will be greater where evidence of its association or the event that created it survives *in situ* than where it has been changed or evidence of context does not survive.

### 3.4.2 Sites/Places of Significance to Traditional Owners

Indigenous people are the primary sources of information on the value of indigenous heritage places and how they are best conserved. This principle underlies Queensland's *Aboriginal Cultural Heritage Act 2003.*

The criteria used by Aboriginal people to assess cultural significance may be quite different from those used to make assessments of scientific significance. Significance assessments by Aboriginal people may be based on traditional, historical, contemporary and other cultural values. Criteria such as rarity, uniqueness and representativeness are often not relevant in this type of assessment Such places may be significant because of a past event, because of association with a story or because of an inherent spiritual quality associated with the place. Such places may not exhibit any visible indicator of their significance.

Significant cultural places are not restricted to the period prior to contact with Europeans. Often events from the contact period and the more recent past may be so important to the local Aboriginal communities that they become significant and this is reinforced in Sections 9 and 10 of the *Aboriginal Cultural Heritage Act 2003*. If these events relate to a specific place in the landscape, then that place (i.e. the site) may become sacred or highly significant to the local Aboriginal communities.

Scientific significance assessment is not necessarily consistent with Aboriginal people's cultural evaluations, but the Aboriginal cultural values of a site or place may, under the *Aboriginal Cultural Heritage Act*, override other forms of significance assessment.

## 4. TRADITIONAL OWNER CONSULTATION

Identification of indigenous stakeholders and Aboriginal interest groups is a crucial first step in undertaking any level of cultural heritage investigations for a proposed development project.

In Queensland, the *Aboriginal Cultural Heritage Act 2003 (ACHA)* defines what constitutes a 'Native Title party', an 'Aboriginal party' and an 'Aboriginal Cultural Heritage Body' for the purposes of cultural heritage investigations (see especially Part 4, Sections 34 to 37 of *ACHA*).

Under the provisions of *ACHA*, the current lack of a Registered Native Title Claim in the wider Townsville region (including the POTL project areas) means that there is no 'Native Title Party' for the development areas and no registered 'Aboriginal Party'. Similarly, there is currently no registered 'Aboriginal Cultural Heritage Body' as defined by *ACHA* for the wider Townsville area (excluding Magnetic Island).

For some 15 years there have been two distinct Aboriginal groups who claim to have traditional affiliations with the wider Townsville region. These groups are the **Bindal** people and the **Wulgurukaba** people.

The following information is provided as a general background to the current situation regarding Aboriginal affiliations to the wider Townsville region and the current status of Native Title Claims.

Until early 2005, the Bindal people held a Registered Native Title Claim (QC99/21) over various parcels of land in the wider Townsville region. This Native Title Claim was struck-out by the Federal Court in March 2005. The current status of this claim is listed as finalized/struck out on the National Native Title Tribunal Register.

A new Native Title Claim for Townsville (the Gurambilbarra claim) was lodged with the National Native Title Tribunal (as of 13 April 2005). Six (6) Traditional Owners were listed as Applicants to the Gurambilbarra claim.

The Gurambilbarra Native Title claim was subject to the Native Title Registration Test in early April 2006. Information as listed on the National Native Tribunal Register is that the Gurambilbarra claim (claim QC05/9-1) was 'Not Accepted' for registration in 2006 (decision date of 5 April 2006). The claim failed to meet several conditions which are necessary to pass the registration test.

The Gurambilbarra Claim was again subject to the Native Title Registration test in early April 2008. This claim failed the registration test for a second time and was not accepted for registration (as at 10th April 2008). Very recently, on 10th October 2008 the Federal Court of Australia dismissed the Gurambilbarra Native Title claim.

Under Section 34 of the *ACHA* the Bindal people would appear to qualify as a 'Native Title Party' for the Townsville area, in that they have held a previous <u>registered</u> Native Title claim, and even though that claim has failed, there is no other registered Native Title Claim for the area, and there is not, and never has been, a Native Title holder for the area (see Part 4, Section 34 (1) of *ACHA*).

Over the past 15 years or more, the consultation process for cultural heritage projects in Townsville has generally included representatives from both the Bindal and Wulgurukaba Traditional Owner groups. In fact, the involvement of both groups has become established procedure in undertaking cultural heritage studies and impact assessment projects. Most importantly, the two Aboriginal groups have viewed this approach as appropriate cultural protocol, pending the outcome of the lengthy and ongoing Native Title process.

Because the POTL Marine Precinct project is subject to an EIS, the proponent has a mandatory responsibility to prepare a CHMP for the project, as per Part 7 of the *ACHA*. As previously noted, POTL identified the relevant Aboriginal Parties for the proposed port projects (both the Marine Precinct and Port Expansion projects) via a public notice in the Townsville Bulletin; notice day of 12th May 2008 (see Appendix 1).

A total of 18 people responded to the public notice and were subsequently endorsed by POTL as 'Aboriginal Parties' for the proposed projects. The 'Endorsed Aboriginal Parties' for the POTL projects include people who would generally claim to represent one or more of the main Aboriginal stakeholder/interest groups in the Townsville area, the Wulgurukaba people, the Bindal people and/or the (then) Gurambilbarra Native Title applicants (this claim now dismissed as noted above).

The following people are 'Endorsed Aboriginal Parties' for the POTL projects (listed in alphabetical order):-

Angie Akee, Jacqueline Bell, Alice Dowden, Christine George, Iris Glenbar, Vicki Glenbar, Michelle Hegarty, Pam Hegarty, Kelvin Lampton, Madeline Lea, Norman Mohamed, Gresham Ross, Dorothy Savage, Eddie Savage, Vincent Singleton, Eddie Smallwood, Beverley Underwood and Virginia Wyles.

Consultation between POTL and the Aboriginal Parties commenced in early June 2008 and it is ongoing at the current time (to March 2009). Initial consultation (including endorsement of the respondents to the public notice) was via written correspondence in early June 2008.

Over some four (4) months, a series of meetings have been held between the parties. Each meeting has been attended by the Aboriginal Parties (or the majority of these representatives as listed above), POTL personnel (Mel Marke, Matthew O'Halloran, Esther Slocombe and Margaret Card), legal representatives (Michael Owens for the Aboriginal Parties and Henry Prokuda for POTL) and the project archaeologist (M. Bird).

A summary of the project meetings is presented as follows:-

- **24 July 2008 – Meeting 1**

AM: Initial project meeting including a detailed presentation on the two proposed projects by POTL personnel (Mel Marke and Matthew O'Halloran). General discussions on the projects with a review of draft concept plans and aerial photographs of port lands (both historical and current aerial photos).

POTL provided a tour of the existing Port infrastructure for the Aboriginal Parties, including the proposed Marine Precinct and Port Expansion development areas. The tour included a stopover and inspection of the Benwell Road beach. During the tour, Mel Marke pointed out the location of the two development projects and provided background information on technical aspects relating to the projects (eg: dredging and reclamation processes, etc).

PM: Continuation of discussions regarding the proposed development projects, as well as preliminary discussions regarding the development of a CHMP.

- **19 August 2008 – Meeting 2**

AM: EIS consultants GHD Pty Ltd presented the Aboriginal Parties with information on the EIS process and ongoing environmental investigations and studies for the Marine Precinct project (eg: ecological monitoring program, sea grass, migratory birds, land mammals, plants, mega fauna studies, water quality, etc).

Environment and Behaviour Consultants (EBC) (Arwen Rickett) presented the Aboriginal Parties with an overview of the Social Impact Assessment being conducted as part of the Marine Precinct EIS.

These two sessions were incorporated into the consultation process to address some of the queries raised by the Aboriginal Parties during the initial 24 July 2008 meeting. The Aboriginal Parties requested feedback and information on environmental studies and they requested the opportunity to provide feedback into the Social Impact

Assessment (as both the Traditional Owner community and the wider indigenous community of Townsville).

PM: Introduction and tabling of a draft CHMP.
Review and discussion of the CHMP by the Aboriginal Parties and POTL with some resolutions for amendments to the first draft of the CHMP.

- **4 and 5 September 2008 – Meetings 3 and 4**

Meeting 3 on 4 September 2008 was a closed meeting of the Endorsed Aboriginal Parties with their legal representative (Michael Owens) to review and discuss the latest draft of the CHMP.

Feedback from that meeting was later conveyed to Henry Prokuda (POTL's legal representative) and Esther Slocombe (POTL representative), resulting in several amendments to the draft CHMP. This revised document was then resubmitted to the Aboriginal Parties and their legal representative for further review at the commencement of Meeting 4 on 5 September 2008.

AM: As noted, Meeting 4 on 5 September 2008 included further review and discussion of the draft CHMP by the Aboriginal Parties and POTL (with their respective legal representatives). Several amendments were made to the latest version of the draft CHMP until the parties agreed that the document could be finalized.

PM: Agreement and finalisation of the CHMP with signing by POTL and the Aboriginal Parties.

As noted, the NRW approved the final CHMP on 23 December 2008, pursuant to Section 107 of the *ACHA.*

The project archaeologist's consultation with the Aboriginal Parties for the POTL projects has been ongoing (on an intermittent basis) since the initial project meeting in July 2008. During the project meetings various cultural heritage management issues have been raised and discussed by the Traditional Owners and these have been documented for inclusion in this report.

Discussions with the Aboriginal Parties over the duration of the Port projects has been aimed at determining if there are any major cultural heritage concerns, issues or constraints that might affect the development project. Discussions both on-site and off-site have been aimed at recording any oral history associated with the development area, any information on known cultural sites, places and landscapes, and particularly, any information on the indigenous cultural heritage values of the project areas and surrounds. During the tour of the Marine Precinct and Port Expansion project areas on 24 July 2008 the project archaeologist held discussions with a number of Traditional Owner representatives regarding the overall (surface and subsurface) archaeological and cultural heritage potential of the project areas.

In November/December 2008 the project archaeologist carried out further consultation with the Aboriginal Parties to assist Environment and Behaviour Consultants (EBC) in distributing and gaining feedback to a Social Impact Questionnaire relating to the Marine Precinct project, and particularly the Benwell Road beach. The results of the social impact study (for the indigenous community and the wider Townsville community) will be reported separately by EBC as part of the broader EIS investigations.

The project recommendations outlined in this report have been formulated in consultation with the Aboriginal Parties, mostly during the various project meetings and the site inspection on 24 July 2008. Some Traditional Owners have contacted the project archaeologist in the ensuing months to provide further thoughts and comments regarding cultural heritage issues for the Port projects.

A draft copy of this report will be provided to the Aboriginal Parties (and their legal representative) for review and comment, prior to submission of a final report to POTL. A further meeting with the Aboriginal Parties is envisaged in March 2009 to review and discuss this cultural heritage report and to confirm the project recommendations in Section 10. As per the usual cultural protocol, a final copy of this cultural report will be forwarded to the Aboriginal Parties for their records.

*[Postscript 18 March 2009: A meeting between POTL and the Aboriginal Parties was held on 17 March 2009. The meeting discussed and reviewed the Cultural Report and its recommendations. The report and recommendations (with some minor amendments) were endorsed by the Aboriginal Parties and POTL. The amended recommendations have been added to the project CHMP as Schedule 1].*

## 5. ENVIRONMENTAL BACKGROUND

The Port of Townsville is situated between the mouths of the Ross River and Ross Creek in Cleveland Bay. As noted in Section 2 of this report, the proposed Marine Precinct project includes reclamation of some 34 hectares of land at Lot 773 adjacent to Benwell Road. The Marine Precinct development area consists of a narrow strip of reclaimed land (Benwell Road beach) and sub-tidal areas at the mouth of Ross River. The Port Expansion project area consists entirely of sub-tidal areas, seaward of the existing northern breakwater.

The most notable feature of the development areas for the POTL projects is the very high level of past disturbance and landscape/seascape modifications that date back to the earliest days of the European settlement of Townsville (circa 1864).

A short (and very summarized) history of the development of the 'Townsville Harbour' is provided below to illustrate the dramatic alterations to the natural environment (and the cultural landscape) of this section of the Townsville coastline and its waterways (refer Taylor 1980 for a detailed history of the Townsville Harbour). To place this discussion in some context, two early photographs of Magazine Island and Ross Creek shortly after European settlement (ca. 1870) are included in this report to show the largely unimproved and undisturbed landscape of the 'Townsville Harbour' (see Figures 4 and 5).

In 1864, upon the European settlement of Townsville, Melton Black selected a site on Ross Creek for a harbour. At this time, a sand bar at the mouth of the creek and a rock bar inside the creek allowed only shallow vessels to navigate the creek channel (Pringle 1989). In the 1870's the need for a port at Townsville became urgent with the opening of the western goldfields. As early as 1871 major works were being undertaken at Ross Creek to remove rocks from the bed of the creek to make it navigable for vessels (Taylor 1980:25). During the early 1870's it was proposed that a jetty be built from Magazine Island to form the basis of a harbour for Townsville and to protect the entrance to Ross Creek (Pringle 1989:5).

In 1874 major construction works commenced to link Ross Island (from a point adjacent to Flagstaff Hill) with Magazine Island. Magazine Island was a small granitic island once located near the mouth of Ross River and so-named as a result of the early (circa 1870) construction of an explosives magazine on the southern shores of the island (Lawrence 1989). Magazine Island was eventually completely 'removed' and the granite was used as fill to build later breakwaters and port reclamation works (see below).

*"At Cleveland Bay a stone breakwater some 400 feet long has been run from the mainland on the south side of the creek to Magazine Island. Through this opening a constant supply of sand from Ross River had previously poured into the entrance of the port (Ross Creek) forming a series of bars and shoals – this movement of sand has been entirely arrested by the breakwater"* (Portmaster's report to the Colonial Treasurer, 26 April 1874, quoted in Taylor 1980:25).

Ballasting for the road and railway along the breakwater/causeway between Flagstaff Hill and Magazine Island was completed in 1878. Around this time the jetty was also extended a further 680 lineal feet. The Port Master of the time reported on the *"constant blasting at Magazine Island, in connection with the jetty works at Townsville"* (quoted in Taylor 1980:32).

In 1875 there was much discussion in Townsville regarding the construction of a bridge over Ross Creek. The first bridge was eventually constructed across the creek near its mouth, but was later dismantled because it was an obstruction to shipping (Taylor 1980:28). A swing bridge known as Victoria Bridge was then completed in 1889.

In 1883-84 the first dredging of the Townville Harbour was undertaken. The first task of the dredges was to *"cut a channel into Ross Creek.....opposite the outer end of Magazine Island jetty"* (Taylor 1980:32). The dredged material was mainly clay with sand and mud in the upper layers. The dredging continued over a prolonged period to 1889 (through rock platforms in the bed of Ross Creek) to form Platypus Channel. A major cyclone in March 1890 caused the deposition of large quantities of silt over the previously dredged areas along Platypus Channel (Pringle 1989:6).

In 1887 construction of the eastern and western breakwaters commenced; the eastern breakwater was completed in 1889. Nisbet (as reported in Lawrence 1989:22) noted that the eastern breakwater construction was proceeding well, *"there being an abundance of rock, of the hardest description, on Magazine Island".*

Dredging has been carried out to maintain Townsville's navigation waterways for over 100 years (Sinclair Knight 1991:22). Dredged material has been historically dumped in various locations in Cleveland Bay. Sinclair Knight (1991:25) reports that Cleveland Bay has been filling up with land-derived sediments deposited by the numerous creeks and rivers in the area for the last 3,000 years. These recent sediments comprise varying amounts of sand and mud, including *"massive or bedded grey mud up to 4 m thick and cross bedded delta sediments of old tidal and river channel systems".* Underlying the sand and mud layers there are stiff clays comprised of beds 1 to 2 m thick in a layered sequence of consolidated Pleistocene sediment of varying grain sizes.

Pringle (1989) has carried out a detailed investigation of the long-term effects of dredging in Cleveland Bay (and especially at the Townsville Port). Pringle notes that the history of dredging in Cleveland Bay is closely linked to the development of the Port of Townsville (Pringle 1989:5).

Pringle (1989) has reported that near the Ross River mouth large scale coastal changes have taken place and these are directly linked to dredging.

*"Reclamations along the west coast of Ross River mouth have been taking place for a long period as the Harbour and adjacent industrial area have expanded. Between 1968 and 1970, 2,300,000 m3 of sand were pumped ashore from the adjacent intertidal sandbanks for a major reclamation. In 1979-80 about 400,000 m3 of sand was removed from the Ross River bed immediately upstream of Goondi Creek for an 8 hectare reclamation east of the Harbour's Eastern Breakwater"* (Pringle 1989:62).
Pringle concludes *"the result of the long history of dredging and construction work at the mouth of Ross River has been to move the main channel westwards from its former position across the intertidal zone, so that it now lies almost due north of the mouth"* (Pringle 1989:63).

Pringle (1989) has documented some of the dramatic impacts of cyclones and flooding along the Ross River channel, including some of the major erosion and depositional events since records have been kept. Major erosion recorded near the mouth of Ross River between 1952 and 1959 and between 1965 and 1972 is attributed to the effects of cyclones and associated storm surges. Pringle (1989) also notes that during major floods and cyclones siltation may be more widespread. Major accretion in Platypus Channel of 600,000 cubic yards of sediment was recorded as a result of cyclone Althea in 1971 (see also Sinclair Knight 1991:22 and Taylor 1980).

Benwell Road beach at Lot 773 (in the Marine Precinct development area) is currently a narrow sandy beach with extensive mudflats exposed at low tide. Near the Port entrance on Benwell Road the shoreline is lined with mangroves which have colonized the area in relatively recent times (over the past two decades). Benwell Road beach is a popular recreational area for local South Townville and Railway Estate residents and it is known to be a good area for collecting yabbies and bait.

Sinclair Knight reports that the Benwell Road beach *"is not a natural beach, but is the result of port developmental works completed within the last two decades"* (1992:3). The beach is in fact reclaimed land that is permanently leased to the Port for port-related uses. It is designated as Strategic Port Land in the Port Land Use Plan. This beach was planned for redevelopment by the Port in the 1990's, but was not required at that time. Port of Townsville has allowed continued public access to the beach area until such time as the land is required (and it is now required as part of the proposed Marine Precinct project).

A sequence of aerial photographs of the Port and the Benwell Road section of coastline dating from 1941 to 2007 (as provided by POTL) clearly show that the existing Benwell Road beach did not exist prior to 1977 (see Figures 6 to 10). In the 1941 and 1964 aerial photographs this area comprised extensive sand and mudflats on the western side of the mouth of Ross River. What appear to be some vegetated sand dunes or beach ridges near the mouth of the river (in the 1941 aerial photograph; Figure 6), are no longer in existence. If these coastal deposits were in fact sand dunes or old beach ridges they might possibly have contained intact Aboriginal archaeological sites and remains.

The 1977 aerial photograph (Figure 8) shows reclamation works in progress in areas adjacent to Benwell Road and the initial formation of what is now the existing beach strip. It is very clear from the aerial photographs that major reclamation works took place at the Port between 1964 and 1977 (Figures 7 and 8).

Overall, the evidence from the aerial photographs illustrates that between 1941 and 2007 there have been dramatic changes to the configuration of the coastline near the mouth of Ross River and along the coastline that now forms the Benwell Road beach.

The high level of previous disturbance and landscape/seascape modification within the POTL project areas has important implications for archaeological and cultural heritage potential. These implications are discussed in detail in Section 9 of this report.


Plate 1: View of Benwell Road beach facing east towards Ross River.


Plate 2: View of Benwell Road beach facing east towards Ross River.


Plate 3: View of Benwell Road beach facing Port of Townsville.


Plate 4: Benwell Road beach car park facing Port of Townsville.

# 6. THE ABORIGINAL CULTURAL LANDSCAPE

## 6.1 Approach and Methodology

Section 6 of this report provides a compilation of background anthropological and ethnographical information relating to the POTL project areas, in the wider context of Cleveland Bay. Unfortunately, there are few detailed specific references to Ross Creek and Ross River in the ethnographical literature, and by necessity the following literature review refers to the broader Cleveland Bay coastline and the immediate Townsville coastal plain.

This literature review attempts to place the Ross River and Ross Creek project areas in the context of the wider Aboriginal cultural landscape of Townsville *(Gurambilbarra).* Before the European settlement of Townsville in 1864, the Aboriginal Traditional Owners occupied a vast area across the Townsville coastal plains. The existing Shire boundaries in the region are of course modern constructs, which are not particularly relevant to traditional Aboriginal territories, clan group boundaries and Aboriginal subsistence and settlement patterns.

Background ethnographical and anthropological information (in Section 6.2) derives from extended research by Nicolaas Heijm (Segue Pty Limited). Heijm's anthropological research in the Townsville region began in 1990. To the present, it has covered the bulk of ethnographic and oral history material dealing with the *Murri* (Aboriginal) society of the region. He has searched the correspondence files of the Queensland Colonial Secretary, the Queensland Aboriginal Protectorates and other records at Queensland State Archives, as well as the 19th century Townsville newspapers (including the Port Denison Times, Cleveland Bay Express, Cleveland Bay Herald, Townsville Herald, North Queensland Herald, Townsville Daily Bulletin and others). Heijm's research has included several dozen anthropological fieldtrips in the greater Townsville region (including Palm Island), which have involved standard anthropological participant observation methodology and directed oral history interviews with Aboriginal Elders and others.

## 6.2 Aboriginal History and Ethnography

### 6.2.1 An Historical Sketch of Townsville (*Gurambilbarra)*

The Ross River and Ross Creek study areas are part of a traditional country called *Gurambilbarra* in the Townsville language[1]. Its name is derived from *Gurambil,* the language name of Cape Pallarenda, and can be translated as "people of Cape Pallarenda". The reference to Cape Pallarenda in the name is metonymic, for *Gurambilbarra* includes the catchment basins of the Ross and Black Rivers and extends inland as far as the Hervey Range and eastwards to include Magnetic Island. The Cape was the main living place of the area before the European settlement of the region. Historical records, among them Dalrymple (Dalrymple and Smith 1860) and Rowe (1931), indicate that a large number of people lived at *Gurambil* before the founding of Townsville in 1864.

Price's wordlists of 1885 provide local Aboriginal language names for areas located within or immediately adjacent to the POTL project areas. Relevant language names as follows (the phonemic transcriptions in brackets were produced by N. Heijm):-

- Ross Creek "Cal'ghimg'a" (Galgimga)
- Ross River "Cal'bee'dee'ra" (Galbidira)
- Ross Island "Muth er'el" (Madhil)
- Magazine Island "Go-Your" (Guyur)

Captain Cook's expedition of 1770 provides the earliest documented reference to Aboriginal people at Townsville. Few details are recorded as Cook made his observations from approximately 10 kilometres out to sea:-

[1] The "Townsville language" might be thought a perverse way of referring to a language considerably older than the city. But although we know about names of particular dialects, no name has been recorded for the regional language as a whole, neither of the names that have historically been attached to it, neither "Coonambella" (in Price 1885) nor "Wulgurukaba" (in Tindale 1974), are proper language names. It is quite possible the language had no proper name. In the absence, a more descriptive but more cumbersome label might be the "the Palms Islands-Magnetic Island-Ross and Black River language" but for the purposes of this report, the "Townsville language" keeps things simple.

*".....the whole appear'd to have the most ruged (sic) rocky and barrenest surface of any we have seen. However it is not without inhabitants as we saw smooks (sic) in several place(s) in the bottom of the Bay"* (Beaglehole 1955:270-271).

P.P. King made the first recorded landing in Cleveland Bay in 1819. Both King and Alan Cunningham, the official botanist on the *HMS Mermaid*, remarked on the appearance of the coast abutting Cleveland Bay. From a vantage point on Cape Cleveland they looked to the west and saw:-

*".....lagoons on the low western shores of the Bay appearing to extend to the base of the bounding range....about which were native fires arising..."* (Cunningham in Gibson-Wilde 1984:3).

*"...the view obtained was neither so useful nor so extensive as I had expected, the coast for six miles back is low, and occupied by a large body of water, beyond which is a range of flat-topped and precipitous rocky hills"* (King in Gibson-Wilde 1984:3).

The day following these observations Cunningham explored what was probably Castle Hill. A number of huts were observed *"of capacious circular form and neatly thatched with foliage of pandanus"* (Cunningham in Gibson-Wilde 1984:3). The smoke of many fires was seen around the foothills in the three days they spent in Cleveland Bay.

In 1841 Stokes' *Beagle* expedition landed on Magnetic Island and Shelley Beach near Cape Pallarenda. They encountered friendly people with whom they exchanged gifts (Stokes 1846:337). In 1847 the expedition of *HMS Fly,* led by J. Beete Jukes, registered friendly interchanges and exchange of gifts in the vicinity of Cape Cleveland. Jukes described the people he met as *"...the most friendly and communicative we have yet seen on the coast"* (Jukes 1847:59-62).

Perhaps the most detailed account of early contact between European explorers and Aboriginal people is outlined in Dalrymple's account of his landings at Cleveland Bay in the course of the 1860 *Spitfire* Expedition, *"in search of the River Burdekin on the* *north east coast of Australia".* On the morning of 15 September 1860, the *Spitfire* was anchored off the northern coast of Cape Cleveland. A bush fire was raging in the hills of the Cape, and Aboriginal people were seen on the beach. A survey party went ashore accompanied by Dalrymple, "the botanical collector" and an Aboriginal man named Jamie Alexander. While the survey party was taking bearings, the remainder of the party took positions higher up on some rocks. There they were met by a group of Aboriginal people. Dalrymple describes the encounter:-

*"Some blacks came down and we gave them biscuit and tobacco, etc., being kind and civil to them, which they seemed to appreciate. They, however, began to feel us all over, and especially the Botanist, who was in good condition – smacking their lips and giving other unmistakable evidences of their relish for human flesh, and a desire to gratify it. More blacks came down; they attacked us with stones and spears, when we were necessitated to fire upon them, repulsing them with loss"* (Dalrymple and Smith 1860:23).

As other records make plain, the smacking of lips expressed nothing more threatening than astonishment, nor was the 'shampooing' of the Botanist anything but inquisitiveness (cf. Jukes 1847:59-62). The *Spitfire* Expedition's disastrous response were the first shots fired in the ensuing invasion of the region.

The killing was later reported by James Morrill, a survivor of the *Peruvian* shipwreck of 1846, who lived with the Mount Elliot people for some 15 years before crossing the frontier back into European society at Inkerman Station in 1863 (Morrill 1863). Sometime before 1860, Morrill had requested the people with whom he was living *"if they ever saw white men again to try and make them understand that there was a white man living there with them".* With the party from the *Spitfire,* they:-

*".....tried their hardest, but seem to have failed; the white men became alarmed and thought they meant mischief, whereas it was only their earnestness in trying to make them understand. Nothing is said in the report about shooting the natives, but one raw bone stout able-bodied blackfellow, a friend of mine, was shot dead by someone in the*

*boat, and another was wounded; and the hideous yelling was the noise they usually make over their dead"* (Morrill 1863:13-14).

Two days after the landing at Cape Cleveland, the *Spitfire* Expedition sailed around Magnetic Island. Dalrymple noted the sand banks connecting the island to the mainland and that:-

*".....natives and canoes were seen on the beach, and the smokes of their bush fires rose from all parts of the island as we coasted its western side to our anchorage between it and the mainland, in the south corner of Halifax Bay"* (Dalrymple and Smith 1860:24).

The following day (18 September 1860), the expedition sailed as far north as 19 degrees (about as far as Rollingstone), before deciding that the mouth of the Burdekin River must lie to the south. The *Spitfire* was turned about and that evening anchored in the south corner of Halifax Bay. Of the people of southern Halifax Bay, Dalrymple wrote;-

*"Numerous natives were seen all along the beach, and their smokes rose from every part of the coast, hills, and islands towards the afternoon, rolling up in huge volumes across the sun, tingeing every object with a lurid glare, and greatly impeding our view of the country from the masthead"* (Dalrymple and Smith 1860:25).

On 19 September 1860, Dalrymple, Captain Smith and a shore party landed at Cape Pallarenda and ascended its peak. Dalrymple described the *"salt water swamps, mud flats, and low plains, covered with large ant hills, [that] stretched for some seven miles to the south"* (Dalrymple and Smith 1860:25). He also described the large population of Aboriginal people by whom he felt increasingly threatened. Matters soon came to a head:-

*"The whole coast country seems to swarm with blacks, whom we found here, as elsewhere, very hostile.....From the hill top three large camps of them were seen on the flat close below. They saw and saluted us with loud yells, sent away the old men and gins with the camp equipage, and prepared for a move in our direction.....Mr. Smith had just finished his observation on the hilltop, when a number of these natives came over the shoulder, and*

*seeing us descending, got between us and the boats. At the bottom of the hill we had to descend about 30 feet of precipitous rocks right in the face of the natives, who poised their spears, yelling and dancing in a very hostile manner, which for the safety of the party obliged us to fire upon them, when they retreated. We made a slow and orderly retreat to the boats, halting at intervals to face about and fire upon the more daring who followed us up, throwing spears. We had just shoved off, when about forty armed natives appeared on the beach, having crossed the hills by two different routes to cut off our retreat"* (Dalrymple and Smith 1860:25-26).

*"The aborigines on Magnetical Island having watched the boats' crews away from the vessel, came down on the 'Spitfire', armed, in two canoes, but were repulsed by Mr. Bousfield, by a discharge of the brass gun. Having completed the examination of Halifax Bay, Mr. Smith weighed, stood round the island, and again anchored in Cleveland Bay, which we also carefully explored"* (Dalrymple and Smith 1860:25-26).

Our knowledge of the Aboriginal use of the shores of Cleveland Bay will now always be limited by the destruction of much of the prehistoric archaeological record of the area (cf. Kennedy 1947, 1948). However, documentary and ethnographic data show the area was an important part of a foraging territory that included Cape Pallarenda, the dunes, flats and shores of the Town Common area and the riverine habitats of the Ross and Black River corridors. It further included Magnetic Island: the first European settlers observed a steady traffic of people canoeing over from the Cape to forage the island's rich resources[2]. If the tides were low enough it was possible to wade almost the whole distance from Kissing Point at Townsville to Magnetic Island, the final part of the journey requiring a short swim across the channel just inside West Point (Porter 1983; MacQueen 1952). In pre-contact times, the Aboriginal use of the Cleveland Bay coastline would very likely have involved *Wambaluna*, a freshwater lagoon that then existed in what is now North Ward. C.S. Rowe saw it in its pristine state and described it as the *"most desirable spot in Cleveland Bay"* (Rowe 1931:17; see section 6.2.2 below).

[2] The canoe of the region, called a *wulguru* was constructed of three strips of bark sewn together with lawyer cane. The design enabled covering fairly large distances – say those between Kissing Point and the Palm Islands – by riding tidal currents.

The Traditional Owners of Townsville are placed in their country through the creation story of *Gabul*, the Carpet Python, for whom the central place or site on the Townsville mainland is the Ross River.

According to Heijm's anthropological research, the Ross River formed an important track of *Gabul*. Heijm's account of the Gabul myth cycle for the Herbert River and Ross River areas is outlined in summary below. The *Gabul* myth cycle highlights the point that the Ross River forms a significant and integral part of the Aboriginal cultural landscape, in a broad area of the coastline extending from the Herbert River to Townsville:-

*"The Gabul story recounts the travels of Gabul or Carpet Python down the Herbert River, through the Hinchinbrook channel to what are now the islands of the Palm group and Magnetic Island, and up the Ross River. This cycle is well known on the Palm Islands and to mainland families.*

*The Gabul cycle contains two distinct narratives. One tells of the creation of the Hinchinbrook channel, the Palms and Magnetic Island, and the Ross River. The other concerns the encounter of a Palm Islands' Clever Man with Gabul. The track of Gabul is much the same in both narratives. Gabul's travels began at a particular pool near Abergowrie. From here, Gabul created the Herbert River, and then the Hinchinbrook Channel. After creating the Hinchinbrook Channel, Gabul traveled southwards. Wherever the Snake stopped to rest, the Snake's excrement created an eminence. In this way, Gabul created first Pelorus Island, then Orpheus, Fantome, Curacao, and Great Palm Island. On Great Palm Island, Gabul made Bambu Creek and stopped in one of its deep pools, called Deep Pool. When the daughters of the Palm Islands people swam in Deep Pool, Gabul swallowed the prettiest of them, the daughter of a Clever Man. The Old Man came to look for his daughter. The others who had been swimming in the pool told him that Gabul had eaten her. The Old Man followed the Snake's track. It led him around the back of Mt. Bentley and down Carpet Snake Creek, then to Barber, Esk, Brisk, Falcon, Havannah, Rattlesnake, Saddle Back, Herald and Magnetic Islands, each of them places Gabul had made as he rested.*

*The Old Man caught up with Gabul at the western point of Magnetic Island. The Snake could see that the Old Man wanted revenge but said to him that he didn't want to be killed. The Old Man said he wanted his daughter back and that he did not want to kill the Snake. So the Old Man used magic to make the Snake disgorge the girl. Then he made the green ants clean the Snake's belly slime from her body and used smoke to dispel the sickness. The Snake continued up the Ross River. The Old Man and his daughter went back to Great Palm Island. The girl's mother had been gathering fire wood, but was so overjoyed to see her daughter again that she had to be told not to drop her bundles carelessly, but to put them down gently so as not to disturb the still very sick girl.*

*From Magnetic Island, Gabul traveled to the mainland. A girl from the mainland had been promised to the son of a senior lineage on Magnetic Island, but the son would not wait for the girl to reach marriageable age. He appealed to Gabul for help. Gabul took him to steal the girl. Gabul formed the Ross River as they traveled. The son and the girl drowned on the journey back to Magnetic Island. Gabul continued up the Ross River and eventually traveled to the Mount Spec area"* (as recorded and transcribed by N. Heijm 2003).

### 6.2.2 The Founding of Townsville and Early Settlement History

Early in November 1864 the partnership of Robert Towns and John Melton Black set in motion their plans for the construction of Townsville. On 5 November, Black and a work party of sixteen men arrived at Cleveland Bay (Black 1865):-

*"Ross Island and Magazine Island were in their original wild unimproved condition. The latter was a bare rocky eminence, separated from Ross Island by a saltwater channel. Ross Island was practically, except in certain parts, a mere ti-tree swamp. A creek (also named Ross) was fordable near its mouth at low tide and the mangroves on its banks spread across what is now Flinders Street. The shallow waters of the creek were the haunt of the crocodile and the adjacent bush harboured different tribes of hostile natives"* (Programme, Townsville Jubilee Carnival, quoted in Taylor 1980:14).

The exploring party set up camp at *Wambaluna* Lagoon (North Ward). C.S. Rowe, a member of the founding expedition, described its magnificence:-

*"The Cleveland Bay expedition was started in October1864. Sixteen men were engaged to carry out the operations. W. A. Ross and myself set off with a bullock team, via the head of Station Creek, thence over the range into the valley of Reid River, and after negotiating a steep rocky pinch, we found fairly good travelling. At the crossing we buried half a ton of iron; and this lightened our load. We then proceeded to Ross River and camped in the vicinity of Aitkenvale. Next day rode round Castle Hill and came to the lagoon near the beach, where we afterwards formed our camp"* (Rowe 1931).

*"We arrived here on November 5th, 1864. The lagoon was then a delightful spot. The beautiful clear water was surrounded by lofty trees, whose branches interlocked overhead;*

*and on hot days its pleasant shade made it the most desirable spot in Cleveland Bay"* (Rowe 1931).

Having camped in the garden spot of the region, the expedition soon set about razing it to the ground:-

*"But when a saw-pit was set to work there was soon a great change. Most of the fine trees were converted into building material which I carted away with a bullock team. The cutting down of those trees seemed to me an act of vandalism, but I was powerless to prevent it "* (Rowe 1931).

When the Traditional Owners tried to stop the timber cutters, the invaders responded with force[3]:-

*"After our arrival at the lagoon, a log hut was constructed. But the men getting timber in the bay further north were hunted away by the blacks. We had an interview with those niggers, and requested them forcibly and firmly to keep to their ground near Cape Marlow [Cape Pallarenda]. On this occasion the bay was named after me - Rowe's Bay"* (Rowe 1931).

By December 1865, a little more than a year after the founding party had arrived, *Wambaluna* and other lagoons on the coastal plain had all but dried out:-

*"The reporter with the Governor's party noted that the lagoons were nearly all dried up and water was being obtained from "a creek some two or three miles distant" or from wells near the beach[4]....In the vicinity of Kissing Point a German called Robinson had established a vineyard"*[5] (Gibson-Wilde 1984:56).

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[3] There are few records of the activities of the native police in Townsville. We know that native police under Lieutenant Kennelly arrived soon after the founding party. On 21 November 1864 Black wrote to Towns:

"I have had to supply the Native Police, who have been down here now for some ten days" (Black 1865).

Kennedy, an officer with the native police, records the slaughter of an old man near *Gurambil* (Kennedy 1902:107-111).

[4] Gibson-Wilde cites *the Port Denison Times* 15 July 1865.

[5] Gibson-Wilde cites Viator, "Mrs. C. Robinson - Townsville's oldest resident" *Cummins and Ca*mpbells December 1933:41

In the first decades of Townsville's existence, Kissing Point seems to have marked a frontier between the town and the quarter to which Aboriginal people were restricted. The city's first municipal boundary in fact ran just north of Kissing Point; joining the coast at Rowes Bay in the vicinity of the present Rowes Bay Caravan Park. The boundary had been gazetted early in 1866, a few months after the first buildings went up (Gibson-Wilde 1984:63).

In 1869, the first move to "letting them in" was made when a party of prominent "gentleman of Townsville" ventured to make peaceable contact with the Cape Pallarenda people. Their efforts reflected a shift in the character of the frontier engagement from open hostility to bringing Aboriginal people onto the stations. The party set off in the direction of Cape Pallarenda. As the following passage shows, after passing Kissing Point, they entered the "other" domain:-

*"The question at to the propriety of inducing the wild blacks to venture into the town has been under consideration for some time past by a number of gentlemen in Townsville, who answered it in the affirmative on Thursday last, when they sallied forth with the intention of carrying their resolution into effect. The party consisted of Dr. Callaghan; Messrs. W. A. Ross, Gardiner, and Johnson Allingham. They were accompanied by a black boy, who is in the employ of Mr. Allingham, and who is well acquainted with the language of the coast blacks. They started at about nine o'clock in the morning, in the direction of Cape Marlow, and just after leaving Kissing Point behind them, they came upon a few gins who were digging yams for their lords and masters. A brief conversation with them resulted in their expressing their willingness to come into town; but previous to doing so, they offered to go in search of some of the male members of their tribe. The offer was accepted, but the sable damsels searched in vain. The blackfellows were all too closely planted, and the gins would not or could not find them. After wasting several hours in a vain search for the black fellows, the party determined to make their way into town with the captured gins, and report progress. Accordingly they made tracks homewards, the gins following them, in much glee, apparently, at the novelty of the situation in which they found themselves, They arrived at the back yard of the Criterion Hotel shortly after dusk, and were regaled with beef and other things congenial to their tastes; and about two hours afterwards Mr. James Gordon, P.M. distributed blankets to them, giving one to each. They seemed to be delighted with these presents, and promised to do all*

*that lay in their power to make their spouses return with them on an early date. They carried out their promise on the following (last) evening, when they returned with five blacks, who are to be supplied with blankets and sent to report to their fellows. It is to be hoped that this experiment of introducing the blacks into town will not turn out a failure, and that no attempt will be made to abuse the confidence they appear to possess in the pacific intentions of the white man. We perceive that some uneasiness is experienced in Bowen at the large number of blacks who have taken advantage of the privilege which has been extended them of coming into town, and that it has been resolved to send a telegram to the Government asking that the blacks may be kept beyond a certain boundary, and urging the necessity for increased police protection. This does not augur well for the success of the experiment in the neighbouring town"* (*Cleveland Bay Express*, 15 May 1869).

In the event, the Townsville Council repudiated the invitation a week later:-

*"The Mayor [W.A. Alpin] stated that he had been called upon by the Police Magistrate during the day to ask him to get an expression of opinion from the Council as to the propriety of letting blacks into the town. He (the Mayor) stated that as far as his opinion went he was quite adverse to allowing them in; but he did not see how the Council could act in this matter".*

*"Alderman Ross said he had also been called upon, and it was his opinion that the blacks should be allowed within the precincts of the town during the day and be made to camp out at night. He thought they should be permitted to fish and hunt about in order that they should not be compelled to starve. But so that this should take place, security be given for their lives, that they should not be shot down".*

*"Alderman Carter entirely disapproved of the blacks being admitted into the town.*
*The Town Clerk said that the first day they came in they rushed Mr. Brodziak's house and frightened his servant girls, besides having stolen a quantity of clothes from Mrs. Higginson".*

*"After some further discussion Alderman Carter moved:- That the members of the Municipal Council express their entire disapprobation of allowing the wild blacks to come in to town as they consider that they would become a public nuisance. Alderman Coleman seconded the*

*motion. Alderman Walker said that as Mr. Gordon had brought the blacks into town he had better get them out again. He had better give them the blankets furnished by the government for that purpose as a removal of the black's winter clothing from the courthouse would greatly improve the appearance of that building".*

*"Alderman Ross moved an amendment:;- That as this council had nothing whatever to do with the blacks coming into town, no expression of opinion should be given on the subject. As there was no seconder to the amendment the original motion was carried"* (*Cleveland Bay Express*, 22 May 1869).

Murri people paid several visits to Townsville in the weeks that followed the overture by Gordon and the others. During the week of 29 May 1869 there were visits from the group that had been approached originally. The editor of the Cleveland Bay Express took exception to their nudity, and reproached the police (Cleveland Bay Express, 29 May 1869). A week later - on a Sunday morning – about 100 Murri people from "Dotswood and Hinchinbrook[6]" arrived on Ross Island. There they consulted with people "on the beach" before crossing to the mainland where they began to appropriate such items of European material culture as took their interest:-

*"Not even the precincts of the court house were held sacred by these marauders. One of them made ingenious use of a spear to fish the cloth from the magisterial table through the bars of the window, and were successful in carrying it away in triumph. They were after some trouble induced to leave the town, and people believed that they would not be further troubled by them"* (*Cleveland Bay Express*, 5 June 1869).

It did not end there, it was discovered that a cow belonging to Commerford, the dairyman at Wambaluna, had been speared. Sergeant's Higgins and Francis set out to investigate:-

*"They met with a mob of blacks under Mt Marlow [Cape Pallarenda], by whom they were informed that the mob that passed through Townsville on Sunday morning, and who have recently arrived from Dotswood and Hinchinbrook, were the actual perpetrators, and that*

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[6] Presumably not Hinchinbrook Island, but from the area of Hinchinbrook Station inland from the southern half of Halifax Bay.

*they have gone away. This information satisfied the police, and they returned to town. But on Thursday last some carriers looking for cattle on the plains discovered the remains of two cows and one bullock that had been speared, and the cows were recognized as having been the property of Mr. Commerford, the bullock being one of a team belonging to Mr. Aitkinson. Several other cattle were seen with spears in them, and there is no doubt that the blacks have been making a regular foray"* (*Cleveland Bay Express,* 5 June 1869).

On 18 June 1869, similar events took place. "A large mob of blacks" crossed from Ross Island to the "beach" and were told that "their room was preferred to their company". They "strolled away, without making any demonstration, in the direction of Cape Marlow [Cape Pallarenda] ....." (*Cleveland Bay Express,* 19 June 1869).

These events ushered in a period of attacks on livestock at Townsville and Hinchinbrook Stations[7]. On 7 August the Cleveland Bay Express reported attacks on horses and cattle "upon the Plains" adjacent to Townsville (*Cleveland Bay Express,* 7 August 1869). In May of 1870, Hamilton reported that more than 100 cattle had been killed at Hinchinbrook Station. His house had been rushed and attempts made to kill a stockman and a Murri employee named Jemmy:-

*"These are the same mob of blacks that have played such havoc with the telegraph posts and wire on the Cardwell line. It appears that their first idea in thus destroying the line was to prevent it bearing tidings of their ill-doings to Native Police camps, they having been incautiously informed by some of the native troopers that it was intended for that purpose. Subsequently however, they have discovered that they can convert the wire into fish hooks, many of which, manufactured in an ingenious way, have lately been found in their possession. We are informed by Mr. Hamilton that since committing the outrages to which we have referred the blacks have migrated to the plains in the*

[7] The attacks seem to be an expansion of the campaign waged at Dotswood Station, where the attrition of cattle and horses had continued for almost two years. Costin, at Dotswood Station, described the campaign as:
"killing cattle wholesale, not for the purpose of food, but unmercifully destroying them, and not only [*sic;* probably should read "even"] taking small portions of each beast. I have repeatedly written tot he authorities on this subject, and still we have no protection granted us. This state of affairs cannot last long, we shall have to take the law into our own hands, and then they will be utterly annihilated" (*Cleveland Bay Express,* 28 March 1868).

*vicinity of Townsville, where they believe they will not be molested for their misdeeds......" (Cleveland Bay Express,* 7 May 1870).

They appear to have taken up residence. In late June of 1870, "a large number of wild blacks" came into the town. The Express was again scandalized by their nudity:- "if the blacks are allowed to come into town they should be sufficiently clothed to render continual indecent exposure impossible" (*Cleveland Bay Express,* 25 June 1870). In August, Sergeant Higgins, who had been patrolling along the Cardwell Road, returned to Townsville via Cape Pallarenda and reported that he:-

*"....came across a camp near Mt Marlow [Cape Pallarenda], containing upwards of 300 blacks, who evidently have, from the more than usual substantial nature of their gunyahs, made up their minds for a long stay in the favoured spot they have selected "* (*Cleveland Bay Express,* 13 August 1870).

The Townsville Council was still attempting to restrict the entry of Aboriginal people into the town more than a decade later. In 1879, the municipal clerk wrote to the Queensland Colonial Secretary on behalf of Mayor E.A. Head:-

*"I have the honour by direction of the Mayor to solicit your assistance to prohibit the blacks remaining within the Municipal Boundary before 6 a.m. during the week and not at all on Sundays- Many of the blacks frequenting the town in daylight are almost in a State of Nudity - There is no way of preventing these disgraceful exhibitions without the assistance of those in authority. The Council, therefore, respectfully request you to issue instructions to the police to the above effecting order that they may rid the town of these nuisances"* (Townsville Municipal Council 1879).

A newspaper report from 1876 indicates that the area around Kissing Point in particular, continued to be occupied by Aboriginal people:-

*"Three Europeans undertook to do a little aboriginal canoeing on their own account on Sunday afternoon and with that intent borrowed one of the darkey's canoes that was lying at Kissing Point. Their excursion came to a very speedy termination however and not in the*

*most satisfactory manner either for they had not proceeded above a hundred yards from the shore when the canoe turned turtle and her crew were naturally cast into the waves. Seeing the accident a number of darkies rushed to the scene and succeeded in rescuing the shipwrecked mariners without injury"* (*Townsville Herald*, 31 October 1876).

After about 1885, there are regular reports of Aboriginal people living along the shores of Cleveland Bay. Kissing Point appears to have remained one of the main living and meeting places. One of the most detailed reports is Robertson's account of a "corroboree" held at Kissing Point in 1884 (Robertson 1928:92-95):-

*"Forty-four years ago [in 1884?] the late Sir Archibald Forbes, the famous war correspondent, visited Townsville*[8]*. At that time the Cleveland Bay aborigines were numerous, and, on learning of the arrival of the Big Chief, they sent a runner with a message-stick - a piece of brigalow about four inches long by half an inch in diameter - bearing on it various hieroglyphics. This messenger had his body painted skeleton fashion with white clay, and was fully equipped with native weapons. Forbes smiled when he saw the fearsome-looking native, who gravely handed him the message-stick. When asked to interpret the message, he did so as follows:-"*

*"Big corroboree to-night alonga camp, Kissum Point, you come longa mates". Then, pointing to some special marks at the end of the stick, he added: "This pfeller say, bling blenty lum."*

*"Forbes consented, and a party of friends, including myself, left the hotel that night for the corroboree. It was one of those calm tropical moonlight nights, with a few fleecy clouds passing lazily along and occasionally obscuring the brilliance of the moonbeams. The scene of the corroboree was ideal. Looming in the background was Castle-hill, abrupt, rugged, double-peaked. Underneath the ridge of Kissing Point were the gunyahs of the Cleveland Bay tribe. In the foreground lay Magnetic Island with its lofty ridges clearly cut against the moonlight. Between the island and the beach was the large expanse of Cleveland Bay, the waters of which rippled quietly.*

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[8] Forbes had been the London Daily News' foreign correspondent and had written a number of books, including a best-selling history of the Afghan wars. He was likely to have been on a lecture tour of Australia when he visited Townsville. Forbes was something of a celebrity. His public lectures in which he recounted his war experiences were popular events – he said that his tour of the colonies had earned him 12,000 pounds.

*A large fire was burning in the centre of the ground, and several smaller lights flickered weirdly along the edge of the mangroves. Near the gunyahs the lubras and milla-millas were seated on the sandy ground. They formed the orchestra, beating time on the tightly rolled opossum rugs, resonant logs, and boomerangs. The old warriors received the distinguished guest with a natural quiet courtesy, and one very old chief made a speech of welcome, which was interpreted by one of the blacktrackers. After a tot of rum had been served round the corroboree began.*

*The first item was a ceremonial dance performed by ten of the warriors, all of whom were decorated skeleton fashion. It was said to be an ancestral dance of a very ancient order. This was followed by a war-dance of a seemingly ferocious character. How the opposing warriors missed killing one another was really a marvel, as with each rush and quick thrust of the spears they just touched each other's breasts.*

*Other dances portrayed the hunting of various animals. In one instance it was the chase of a kangaroo by four warriors, The kangaroo was represented by a fifth man, who held no enviable position. At one phase of the chase the warriors, giving a hoarse guttural call, threw their spears with such accuracy that two struck the ground in front of the man's shoulders, and two on each side of his waist, thus pinning him.*

*But the best item of the night was the Brolga-dance. There were about twenty performers, decorated with streaks and daubs of white and red clay, with down and feathers in their hair. They formed a circle, and, bowing their bodies towards the centre, chuckled in undertones to the gentle tapping of the boomerangs and the beating of the logs. They then danced with intricate movements and went through a turn which resembled a set of quadrilles. In perfect time to a rising accompaniment the performers threw out their arms, extended their necks down and up, and cried in imitation of the brolga bird. Finally they whirled about, flapped their arms and ended the dance abruptly as if by common impulse. This dance impressed Forbes more than any of the others.*

*The whole programme was wonderful in its savage simplicity. The weirdly painted natives, issuing from the dense blackness of the bush to perform the dances, looked more like wraiths than human beings"* (Robertson 1928:92-95).

Around 1890 a new living place was established at Rowes Bay between Jason and Mundy Creeks. It is likely that military operations at Kissing Point, which began in earnest in 1889, pushed people out to Rowes Bay. The new camp was in a good spot for foraging, particularly for the "black prawn" and Burdekin Plum that occurred there, but the Town Common and the shores of Rowes Bay and Cape Pallarenda continued to be used. Cape Pallarenda was a favoured spot for oyster collecting and Shelley Beach, on the northern shore of the Cape, for spear fishing. Initially the Rowes Bay people had used *gunyas* - huts constructed of a framework of cane arches thatched with grass. In subsequent decades, they began to use sheet metal attached to timber frameworks, producing the humpy style of accommodation. The Rowes Bay people treated their camp as an exclusive area and allowed few whites into its inner precincts. Conversely, the people from the camp rarely ventured into the central part of Townsville although some of the children eventually attended Belgian Gardens State School.

In 1893 an additional camp was established on Castle Hill (*North Queensland Herald,* 22 February 1893). It was located above the present day Stagpole Street until cyclone Leonta destroyed it in 1903. The people who were living there are said to have moved to Rowes Bay at that time. By then the Rowes Bay camp had probably become the largest in Townsville (*Townsville Daily Bulletin,* 25 December 1902). It was arranged along a spit that in those days extended northwards from Kissing Point and was separated from the main shore at Rowes Bay by a mangrove swamp in the outlet of Jason Creek. The mangroves provided seclusion and enabled residents to control entry to the camp.

Oral history reports suggest that the population at the Rowes Bay camp began to decline after about 1920. Some reports attribute this decline to the influenza epidemic of 1919. This is certainly possible, but no records of the effect of the epidemics in the Townsville region have yet been found. Records show that areas adjacent to Townsville were affected. A major factor for the decline was probably the Queensland Government's regime of forcibly "removing" people not employed by Whites under employment "agreements", mostly to the settlements at Yarrabah and Palm Island. Working without an employment agreement was the "reason for removal" most frequently given in the removal records of the time. Records of removals from Townsville run from 1900 to 1974. They show that removals peaked in the years between 1916 and 1925 when 74 persons were transported. Some of the people we know from the removals records to have been taken from Rowes Bay are ancestors of Townsville's contemporary Traditional Owner groups (Queensland Department of Native Affairs 1915-1936).

The Rowes Bay population probably continued to decline until the outbreak of World War 2 which brought Murri people back to Townsville to work. At the end of the war, people from Rowes Bay started to move to Happy Valley, just south of the main airstrip at Townsville Airport. Others moved to Garbutt where they lived in Army barracks that had been taken over by the Housing Commission. The Rowes Bay camp was forcibly disbanded in 1957 (Gibson-Wilde 1991). Its demolition was probably linked to housing developments near Cape Pallarenda. Some of the remaining residents moved to Happy Valley, others to Garbutt or Roseneath near Mount Stuart.

Document records and the oral history remembered by Townsville people suggest that Ross Island was an accepted meeting place for people venturing into the territory of the Townsville Traditional Owners. In particular, the use of Ross Island as a meeting place came to the fore during the period of Murri resistance following the European settlement of Townsville and the North Kennedy district. The early documented history also shows that Murri people moved freely between Ross Island and what was clearly the major residential area at Kissing Point and *Gurambil* or Cape Pallarenda. In many later records, Ross Island was used for food gathering, residential purposes and ceremonial purposes (see Annotated Bibliography by Heijm and Bathgate in Bird 2003a).

Robertson described another "corroboree" which he attended on Ross Island in 1881. "In the darkness of the night", he and a friend crossed Ross Creek at the West End bridge and walked over the flat towards the camp:-

*"Just picture a low, flat area of country, with dense mangroves in the background, a muddy creek known to harbour crocodiles, a large fire, and a few smaller ones, before*

*which appeared the naked figures of the aborigines. The effect was intensified by the occasional screech of a curlew or the howl of a dog. The eeriness and weirdness of the scene was enough to make one's hair stand on end"* (Robertson 1928:63).

The ceremony, which involved the singing and dancing of Story, finished long after midnight. Afterwards, ten of the "old warriors" saw Robertson and his companion safely back to Flinders Street. Robertson claimed that "in later years he visited the camp on many occasions" and added that "their descendants are now to be found on the beautiful Palm Island Reservation, whither they have been removed by the government" (Robertson 1928:63).

Heijm's anthropological research also indicates that there were post-settlement Murri camps in South Townsville among the sandhills of an area once known as "Murder Island" (Heijm pers. comm.). Murder Island was not a true island, but an area of sand hills and mangroves separated from Ross Island by a tidal inlet known as Saltwater Creek. It included the area between Benwell Road and Martin and Hubert Streets (now South Townsville), as well as the old Rifle Range Reserve, now part of the Townsville Port lands. Heijm's informants also recalled another South Townsville camp located between Boundary Street and Bundy Creek. When the area was subdivided for housing after the turn of the century, Aboriginal people continued to live there for a time. One informant recalled being told by his grandparents of a "corroboree" ground on the mud flat just southwest of where the "gutter" crosses Boundary Street near the bowling green at Victoria Park.

None of Heijm's informants could clearly recall when or how either of the two Murder Island camps broke up. One informant noted that a Murri family stayed on at Murder Island in the 1930's at the spot where the powerhouse was later built. Another informant reported that sand from Murder Island was used in the construction of a sea wall around the Pilot Station on the foreshores of the Townsville Harbour. The informant noted that Murri people camped on Murder Island would have been forced to move at that time. The wall was under construction from about 1934 to 1938. It was originally built of rock and rubble but in March 1937 a king tide accompanied by a northerly swell caused damage along its northern section. Repairs were made by *"hand packing and cement grouting of the upper portion of the wall for its full length"* (Taylor 1980:145). In 1958, Pilot Hill itself was removed and used as material to widen the Eastern Breakwater (Taylor 1980:181).

Some of the best documentation of the location of post-contact camps around Ross Creek is included in a "hookworm" report by Dr. Hastings Willis. In 1921, Hastings Willis had surveyed the incidence of hookworm in the Townsville district as part of the Australian Hookworm Campaign. He reported that hookworm was endemic on Ross Island and conjectured that the two foci of incidence of the disease, one in the neighbourhood of Saltwater Creek on Murder Island, the other near the mouth of Ross River, "owe their origin to the old Aboriginal encampment on Ross Island". He added, "there is still considerable fouling of the ground in this area which is quite sufficient to explain the continuance of the infectivity though the aborigines have been moved elsewhere" (Hastings Willis 1921). As noted above, the rate of removals from Townsville under the *Protection of Aborigines and Restriction of the Sale of Opium Act 1897* increased in the years just before Hastings Willis' survey. In fact, they peaked in 1920. So it is likely that Murder Island and the area along the Ross River had been occupied by Aboriginal people until this time. Hastings Willis indicated the approximate position of the "old" camp on a map accompanying his report (see Figure 11): both foci of hookworm incidence as shown on that map are in the areas remembered to have been associated with Aboriginal living places.

Highland (1993) notes that Ross Island was a long-standing Aboriginal encampment area predating the 1920's. Highland notes that by 1889 there were two main living camps on the fringes of Townsville – one at North Ward and the other at Ross Island. Langan (n.d.) reports that from about 1868 there was a large native encampment on Ross Island and that the blacks in that area were in the habit of regularly visiting other tribes who lived at Rowes Bay and Cape Pallarenda. He reports that there was a rocky bar across Ross Creek and at low tide the local Aboriginal people used it as a crossing place.

# 7. THE ABORIGINAL ARCHAEOLOGICAL RECORD

## 7.1 Cultural Heritage Register and Database Searches

A search of the Queensland Department of Natural Resources and Water (NRW) Cultural Heritage Register and Database is an established procedure for cultural heritage investigations in Queensland, and it is one of the criteria for addressing the Cultural Heritage Duty of Care Guidelines under the *ACHA.*

As a result of an earlier request from POTL (Catherine Hobbs in 2006) the project archaeologist submitted a search request to NRW in September 2006 for all of the lands that POTL holds tenure to. The search results were forthcoming from NRW on 20 October 2006 (see Appendix 2).

For the purposes of the current proposed Marine Precinct and Port Expansion projects confirmation was sought from POTL in April 2008 to ensure that all land parcels to be impacted by the two development projects were included in the original (2006) search request to NRW. POTL personnel confirmed that this was the case.

In response to the search request for POTL lands, the NRW advised the following:-

*".......no Aboriginal cultural heritage is recorded on the Cultural Heritage Database and Register in your specific search area, from the data provided by you. However, it is probable that the absence of recorded Aboriginal cultural heritage places reflects a lack of previous cultural heritage surveys of the area. Therefore, our records are not likely to reflect a true picture of the Aboriginal cultural heritage values of the area".*

*"All significant Aboriginal cultural heritage in Queensland is protected under the Aboriginal Cultural Heritage Act 2003, and penalty provisions apply for any unauthorised harm. Under the legislation a person carrying out an activity must take all reasonable and practical measures to ensure the activity does not harm Aboriginal*

*cultural heritage. This applies whether or not such places are recorded in an official register, and whether or not they are located in, on or under private land".*

*"Aboriginal cultural heritage which may occur on the subject property is protected under the terms of the Aboriginal Cultural Heritage Act 2003, even if Natural Resources and Water has no records relating to it".*

Searches were also carried out of Federal cultural heritage registers and databases, including the Australian Heritage Database and the Register of the National Estate. There are no listings on the Australian Heritage Database for the POTL project areas.

The Register of the National Estate contains one listing for the "Ross River to Alligator Creek Coastal Area". This area is listed as an 'Indicative Place' based on its 'Natural Values'. Cultural values are not included in this listing. The "Ross River to Alligator Creek Coastal Area" is located outside the boundaries of the POTL project areas. However, the northern boundary of this 'Indicative Place' (on the east bank of the Ross River) lies immediately adjacent to the Marine Precinct development area. The listing includes *"about 3,880 hectares comprising the coastal plains east-south-east of Townsville from the south bank of Ross River to the west bank of Alligator Creek, and including the area along the coast to 1 km offshore".* The listing also notes *"Ross River south bank is an important wildlife habitat".*

## 7.2 Previous Archaeological Research

Much of the following information relating to the Aboriginal archaeology of the Townsville region has been sourced from unpublished consultancy reports for Environmental Impact Studies or related impact assessment projects (eg: for infrastructure development such as roads, powerlines, pipelines, residential subdivisions, industrial developments, mining, coastal reclamation works, etc). This section provides a review of some relevant archaeological research to provide a contextual and chronological framework for the current investigation for the POTL project areas (see also Bird and Heijm 2007).

This archaeological review is intended to provide an indication of the types, density and distribution of known Aboriginal cultural sites and values along the coastal fringes of Cleveland Bay. Specifically, this review refers to documented archaeological evidence from nearby localities including Ross River, Pallarenda, the Townsville Town Common and Kissing Point. More detailed overviews of the archaeological record for the wider Townsville coastal plain and nearby offshore islands such as Magnetic Island, Palm Island and Rattlesnake Island are reported in Bird (2003b, 2005), (Hatte (1997) and Northern Archaeology Consultancies (2002). It should be noted that the following is by no means an exhaustive archaeological literature review.

Archaeological research in Townsville over the past two decades has recorded a diversity of Aboriginal archaeological sites, including shell middens, stone artefact scatters, rock shelters with paintings and cultural deposits, scarred trees, stone quarries, ceremonial places and burial sites. By far, the most common Aboriginal archaeological sites are coastal and estuarine shell middens and low-density stone artefact scatters. The results of many archaeological investigations clearly show that coastal beach ridges and hinterland granitic outcrops have the highest archaeological potential of all landforms in the wider Townsville region.

Several previous archaeological investigations provide a chronological framework for the Aboriginal occupation of the Townsville coastal plain. So far, the majority of the known (coastal) Aboriginal archaeological sites date to within the last 1,000 years. However, several hinterland sites (rock shelters with intact well preserved cultural deposits) have revealed basal dates for Aboriginal occupation approaching 4,000 years BP.

Brayshaw (1977, 1990) carried out pioneering archaeological research around Townsville in the 1970's. Excavations at a rock shelter at the base of Hervey Range on the western perimeter of the Townsville coastal plain revealed basal dates for Aboriginal occupation of 1,455 years BP (Brayshaw 1977). Human bone representing up to eight individuals was recovered from the cultural deposit.

Turtle Rock on Table Top Station is located on the summit of Hervey Range. This site has been the subject of extended archaeological research by Mardaga-Campbell and Campbell (1985) and Knight (1986). It is a large granite overhang used by Aboriginal people at various times in the last 4,000 years as a burial site, a camping site, painting site and a ceremonial place.

Lee Long (1990) undertook excavations at two granite rock shelters, one at Cape Cleveland and the other in the Mount Elliott area. The Cape Cleveland site (White Rock Bay 4) is located on the coast behind a mangrove-lined shoreline. This shelter was found to contain a thick deposit of estuarine shellfish with up to 20 different species represented in the deposit. A radiocarbon date of 1,550 BP was obtained from charcoal within the floor deposit. The Mount Elliott shelter is located on the lower slopes of the range and was occupied at least 3,300 years BP.

The Townsville RAAF Base and Town Common are located on the coastal plains to the northwest of the POTL project areas. Previous archaeological surveys across the Town Common have located low-density shell middens and stone artefact scatters on old dune ridges along the edges of freshwater lagoons (in an environmental context not dissimilar to that which was likely to have existed at *Wambaluna* Lagoon near Kissing Point) (Bird 2000).

Brayshaw (1977, 1990) has recorded several Aboriginal archaeological sites in the vicinity of the Town Common. Several rock art sites containing paintings of marine creatures in red ochre are located near Cape Pallarenda. These paintings are located amongst granite boulders in rock shelters and overhangs along the foothills of the Many Peaks Range. As well as marine-like creatures, a number of the paintings depict oval or kidney-shaped 'shield' paintings with distinctive and intricate patterns.

Two sub-surface beach ridge deposits containing what appear to be Aboriginal shell middens have been identified and dated on the Town Common. The first deposit has been dated to between 800 and 1,000 years BP (Hopley 1970; Hopley and Murtha 1975). The second deposit, charcoal that was excavated to a depth of about 70 cm, was dated to approximately 4,500 years BP (Belperio 1978).

Field surveys of the coastal plains within the Department of Defence RAAF Base have located one Aboriginal archaeological site, a low-density shell midden and stone artefact scatter (Bird 2000). The midden was located on the Town Common side of an existing fence line separating the RAAF Base boundary and the Common. This site was discovered on an old raised dune ridge and it consisted of several small, discrete scatters of shell eroding out of the face of the dune. The edge of the dune ridge was cleared and truncated by the fence line. Scatters of shell were observed over an area of approximately 100 m along the dune face. At the time, it was considered highly likely that additional shell material might remain buried within the beach ridges.

As part of Bird's (2000) cultural heritage study, there was an investigation to gather oral history on the usage and Aboriginal significance of the area that is now occupied by the RAAF Base and the Town Common (see also Hatte 1998). The results of the oral history investigations provided a clear indication that the RAAF Base, formerly part of the coastal wetlands and saltpans, forms part of a cultural landscape that is significant to Aboriginal people. Though the Town Common has decreased in area since European settlement, its significance to indigenous people is enduring. Oral history interviews with Traditional Owners at this time (1999-2000) confirmed that this area has long been targeted as a rich hunting, gathering and fishing place.

A highly significant Aboriginal cultural heritage site has been recorded at Sandfly Creek (on the Cleveland Bay coastline to the south of Ross River). Archaeologists first recorded the Sandfly Creek Aboriginal burial ground in the early 1990's. Hatte (1994) recorded at least ten human burials eroding from secondary sand dunes along an old Holocene shoreline south of Ross River. The burials were associated with other cultural material including shell, stone artefacts, stone manuports and hearthstone. Following Hatte's preliminary study, Bonhomme and Craib (1995) attempted to determine the full extent of the burial site by using ground-penetrating radar to detect possible sub-surface deposits of bone. The results of this latter work proved inconclusive.

In March 2004 a cultural heritage study was carried out at the proposed Happy Valley Reserve for Aboriginal Purposes (Bird, Heijm and Hatte 2004). This Reserve is located some 4 km northwest of Ross Creek and Ross River. Local Aboriginal people have used Happy Valley as a camping place for almost a century (in conjunction with the historical camps at Rowes Bay). Today, at any one time there may be between 30 and 100 people living on the site.

While the cultural heritage survey at Happy Valley did not locate any archaeological evidence for the prehistoric Aboriginal occupation of the area, anthropological research revealed that this location has continuing high socio-cultural significance to local Aboriginal people (Bird, Heijm and Hatte 2004).

The cultural significance of Happy Valley is particularly relevant to the current investigation at POTL, as it highlights that there are enduring (complex and integrated) indigenous cultural values along this sector of the Cleveland Bay coastline (incorporating Ross Creek, Ross River, Rowes Bay, Kissing Point and Cape Pallarenda). Bird and Heijm's recent (2005) cultural heritage report regarding the Aboriginal cultural heritage values of Kissing Point *(Garabarra)* provides further confirmation that the Cleveland Bay coastline has an enduring cultural significance to Aboriginal Traditional Owners.

More than a decade ago Hatte carried out a cultural heritage survey and assessment of the Jezzine Barracks site at Kissing Point (Hatte 1995). The Terms of Reference for this study were to assess whether any Aboriginal archaeological sites or evidence for the prehistoric/historic Aboriginal occupation of this area could still be identified on the site. In particular, anecdotal and historical reports of Aboriginal middens at Kissing Point (eg: Kennedy 1947) were to be investigated and verified during the field survey.

No archaeological evidence for significant Aboriginal cultural heritage sites or materials was found during the 1995 cultural survey at Jezzine Barracks. Hatte concluded *"in spite of the documented history and oral accounts of the Aboriginal usage of the site, there is no longer any physical (archaeological) evidence of this usage"* (Hatte 1995:5). No evidence of Kennedy's (1947) reported shell middens (or associated stone artefacts) was discovered during the field investigations, despite searches of locations assessed as being likely places for these campsites to occur.

Hatte noted that the greatest impediment to the long-term survival and preservation of Aboriginal cultural sites at Kissing Point was the prolonged history of disturbance and landscape modification. Jezzine Barracks has been the site of continuous military activity for over a century. Historical research indicates that the military use of the site dates to the early 1880's when a timber battery was constructed on the headland. By 1889 the fort was under construction and there were several other buildings on the site (barracks, sergeants quarters and officers quarters). The site was used intensively in World War 2 as a Radio Direction Finding Station.

Hatte (1995) noted that the entire area had been subject to extensive alteration for the installation of buildings, car parks, pathways, terracing and other infrastructure (including a firing range on the northwestern corner of the site). The summit of the headland at Kissing Point had been extensively excavated (to a depth of several metres) for the construction of the fort over 100 years ago. Ethnohistorical information indicates that parts of the site have been subjected to extensive filling since European settlement (eg: Kennedy's reference to the reclamation of swamplands near Kissing Point) (Kennedy 1947).

Today, the site contains the 1891 coastal fortifications (now a museum), several World War 2 buildings, a bellman hanger, training depot and office buildings, a parade ground and numerous small ancillary buildings. Hatte concludes *"the site has been transformed within the last 100 years or more from an Aboriginal landscape into a European one"* (Hatte 1995:5). In short, the potential for locating intact Aboriginal archaeological sites (in either surface or subsurface deposits) within the Jezzine Barracks project area was assessed as very low.

Hatte's (1995) report referred to some uncorroborated local reports that indicated that until the 1950's and possibly later, an Aboriginal fish trap constructed of stone was visible on the flats just off the shoreline on the western side of Kissing Point, between the headland and Rowes Bay (Hatte 1995:4). Subsequent field inspections (in 1995) found no traces of a possible stone-wall fish trap in this area. Hatte suggested that while it is no longer possible to establish the validity of this report, this would appear to be a suitable location for a fish trap. A number of fish traps exist at similar locations along the mainland coast and on nearby offshore islands such as Palm Island, Rattlesnake Island, Orpheus Island and Hinchinbrook Island (Hatte and Heijm 1999; O'Keefe 1991; Campbell 1982). If a fish trap were at one time located at Rowes Bay, it could quite conceivably have been destroyed during cyclone Althea in 1971, when much of the coastline and some of the road between Rowes Bay and Cape Pallarenda were washed away (cf. Bird 1992).

Detailed cultural surveys along the channel of Ross River were carried out in 2003 for the (then) Thuringowa Council's Riverway Project (Bird 2003a). While the cultural surveys did not locate any tangible Aboriginal archaeological sites on the riverbanks, the Traditional Owners reported that the river maintains a high level of cultural significance to them. While landscape disturbance and modification since European settlement have greatly altered the natural landscape along the river channel, the cultural significance of the river to the Traditional Owners has not diminished (Bird 2003a). Both archaeological and ethnographic records indicate that major watercourses such as Ross River were focal points for Aboriginal subsistence and settlement, in the immediate post-contact and settlement period. In pre-contact times there is no doubt that Ross River and Ross Creek would have provided a plethora of natural resources, playing an important role in the local Aboriginal economy and subsistence cycles.

A number of archaeological sites have been recorded in hinterland areas along Ross River. Two rock shelters containing Aboriginal paintings are located on the foothills of Mount Stuart Range, overlooking the Ross River in the Department of Defence Mount Stuart Training Area (MSTA). Paton and Hatte (1998) have carried out detailed recording of the rock paintings. According to them the paintings (at site MSTA 5) fall naturally into five sections or panels. The predominant motif is the human, possibly male, stick figure, which is concentrated in several loose linear arrangements along the front of the shelter. Panels 1 and 3 have approximately 168 stick figures, with 66 others on the central panel of the rear wall among or superimposed over other motifs. Several other figures appear to occur exclusively at this site, including a white hatched and dotted figure and a possible female figure which is located in the centre of the rear wall. One kidney-shaped 'rainforest shield' painting was also identified at this site. At least four shades of red were noted, especially among the stick figures. This may be attributed either to the use of different coloured ochres and may indicate a series of painting sessions, but it may also be attributed to the effects of natural weathering processes such as percolation through the rock, and salt or oxate deposition over different figures.

Rock paintings at another rock shelter at Mount Stuart (MSTA 3) are distributed along the northeastern and southern faces of the rock shelter, again overlooking the Ross River. The main painting is a red linear figure extending from approximately 2 to 8 m from the eastern corner. This linear figure is the only known example of such a motif in the Townsville region. Several unidentifiable figures are located closer to the corner, covered in a black film tentatively identified as oxalate (Paton and Hatte 1998).

In 1985 Brayshaw carried out an assessment of a 200-hectare site at Stuart for a proposed phosphate terminal. A pipeline route extending west across the Ross River to South Townsville was also surveyed. Brayshaw discovered two scarred trees at Stuart which she described as "shield or container sized scars" (Brayshaw 1990:163). Brayshaw generally noted a high degree of landscape disturbance on the southern side of the Ross River:-

......*"to the south (of Ross River) there has also been disturbance - transmission lines, old and new sewage treatment plants, post contact habitation and clearing for grazing*" (Brayshaw 1985:6).

Horsfall (1987) and Border (1991) carried out an assessment in connection with the proposed relocation of the Queensland Rail marshalling yards to Oonoonba and Stuart. Horsfall recorded several small shell scatters of no more than one dozen shells near mangrove-lined tidal creeks to the west and east of Ross River. One scarred tree was located near the Townsville City Council sewage treatment plant to the west of Sandfly Creek. Most middens consisted of *Saccostrea spp.* (rock oysters) and *Telescopium telescopium.* Some sites contained flaked glass pieces indicating post-contact site establishment.

Border's (1991) surveys in the Stuart area traversed the coastal plain between Stuart Creek and the Ross River. He noted that the main historical feature of the area was its use as a World War II military camp. He noted the presence of concrete slabs, the remains of a vehicle repair workshop and old military vehicles. Border concluded that:-

*"No archaeological sites or materials were found in any of the surveyed areas. Past archaeological surveys, and this study, suggest that archaeological sites are rare in coastal wetlands or seasonally flooded environments and those that do exist are likely to be superficial and of recent age"* (Border 1991:9).

Gorecki (1995) has undertaken an archaeological survey of the low coastal plains around the Ross River. His survey was focused around the banks of the Ross River at Idalia, and particularly the site of the old Ross River Meatworks. Random and stratified slow vehicle traverses and foot surveys were conducted over grazing lands on the Ross River Meatworks Holdings and extending north easterly to Oonoonba. No Aboriginal archaeological sites were located. Gorecki noted:-

*"An overall assessment of the landscape, including its severe modification and land use, suggests that the likelihood of finding Aboriginal relics away from the (Ross) river bank is extremely remote; further the likelihood of finding relics in an undisturbed context is virtually nil"* (Gorecki 1995:16).

In October 1999 Bird undertook cultural surveys for the proposed Townsville Port Access Road Project (Eastern Transport Corridor) by the Department of Main Roads (Bird 1999). The development corridor traverses Heleen Downs Station (Collinta Holdings) and sections of the east bank of Ross River. Three Aboriginal cultural sites were located, including a low-density shell scatter, a small scatter of stone artefacts and a small cluster of bone (the latter has since been confirmed as macropod bone, rather than human bone). All of the recorded sites were found on the beach ridges on the eastern side of Ross River. The shell scatter contained several shell species including *Telescopium telescopium, Nerita sp., Terebralia sulcata* and *Anadara sp.* Most of the shell was heavily fragmented. A single small flake of milky quartz was associated with the shell, scattered around the base of a large Burdekin plum tree.

Despite a general paucity of Aboriginal cultural remains, there was clear evidence in the form of shell scatters and stone artefacts that Aboriginal people occupied this area. Importantly, the surface archaeological evidence recorded near the mouth of Ross River is similar to the type and density of surface archaeological remains originally discovered at Sandfly Creek. The discovery of the extensive archaeological deposits at Sandfly Creek (including human burials) was made following clear and grade operations in preparation for sand mining. Hatte (1994) notes that the main cultural deposit at Sandfly Creek was buried within the beach ridge system, some 30 to 50 cm below surface level.

During the Port Access Road cultural heritage study, some oral history was recorded from Aboriginal Elders regarding the use and occupation of the coastal plains east and south of the Ross River (Bird 1999). There is surviving oral history to indicate that in post-contact times some Aboriginal camps were located under the large mango trees lining Stuart Creek. Some senior Traditional Owners noted that lagoons and wetlands on the coastal plains south of Ross River once had a plethora of food and other natural resources that were targeted and exploited by Aboriginal people (see also Bird 2006). The east bank of Ross River was reported to be a 'well known place' for collecting oysters.

Cultural surveys for the Townsville Port Access Road also located a number of European historical sites including the remains of an old sewage treatment plant constructed by the Townsville City Council in the 1930's, a concrete bunker dating to World War II and what appeared to be an old squatters camp (ca. 1960's). All these sites are located on the beach ridges on the east bank of Ross River above highest astronomic tide (HAT) (refer Bird 1999 for details on these non-indigenous cultural sites).

In October 2004 Bird undertook a cultural survey of areas to be impacted for the upgrade of the Townsville City Council Cleveland Bay sewage treatment plant to the south of Ross River (Bird 2004). Field surveys failed to locate any Aboriginal cultural sites or materials. Much of the proposed development area consists of low-lying wetlands that are subject to tidal inundation. The archaeological potential of these low-lying areas was assessed as low to negligible. Archaeological surface surveys of elevated beach ridges and dunes within the Cleveland Bay sewage plant were constrained by grass and vegetation cover. Despite an apparent dearth of Aboriginal archaeological evidence on the beach ridges, the overall cultural heritage potential of this landform was assessed as high. It is possible that intact archaeological sites and materials lie buried within the stable, well-vegetated beach ridges in areas surrounding the current sewage treatment plant (cf. Bird 1999).

An article in the Townsville Naturalist in 1970 describes an *"Aboriginal stone artefact mine"* near the channel of Ross River. This quarry site is described as being located on a small hill near the Ross River, not far from the Aitkenvale Reserve. The hill rises to some 50 feet above the surrounding coastal plain and consists of weathered granite and basalt. The basalt apparently shows evidence of having been quarried. A few *"hammerstones and roughly shaped axe blanks"* were found on the site (Anonymous 1970).

In summary, and to reiterate the results of archaeological research round Townsville, the coast and immediate hinterland were a focus for Aboriginal activity, at least in the late Holocene period (over the last 4,000 years BP). There is increasing archaeological evidence to indicate that Aboriginal people targeted certain landforms for subsistence activities and occupation sites, including coastal beach ridges and sand dunes, major and/or reliable watercourses, and hinterland granitic rock outcrops and shelters. Archaeological research confirms that relict coastal beach ridges commonly contain Aboriginal shell middens, stone artefact scatters, hearth areas and sometimes, human burials. Rock shelters and overhangs often contain rock paintings (usually in red ochre) and cultural deposits (often with human burials). Both major and ephemeral watercourses tend to have archaeological evidence for campsites in the form of hearths and low-density stone artefact scatters. Highly disturbed areas on the Townsville coastal plain have frequently been found to contain very little intact or surviving archaeological evidence for Aboriginal occupation, given the prolonged and intensive European settlement of the region.

### 7.3 Site Inspection of POTL Project Areas

The literature review in Section 7.2 above highlights the fact that a diversity of Aboriginal archaeological sites has been recorded along the coastal fringes of Cleveland Bay, and in areas surrounding the POTL project areas at Ross Creek and Ross River. At this stage, a systematic archaeological survey of the POTL project areas has not been undertaken and consultation with the Aboriginal Parties has generally indicated that a further cultural field inspection (in addition to the site inspection on 24 July 2008) is not warranted.

As already noted in this report, the entire project area for the Port Expansion project consists of sub-tidal areas. There are simply no land areas to survey as part of this project. Similarly, the majority of the Marine Precinct development area is sub-tidal, inter-tidal or reclaimed land (Benwell Road beach). Based on the available geomorphological evidence and the history of Townsville Port reclamation works (see Section 5 above), the coastal beach deposits along this narrow strip of coast can reasonably be expected to be no more than a few decades in age. On this basis, there is no expectation that prehistoric Aboriginal archaeological sites will be located along this section of very recent coastline.

The only possible archaeological potential of the coastal deposits might be for historical archaeological sites. The term 'historical' is used very tentatively in this regard as it would seem unlikely that sites or relics more than a few decades in age will be located within these very recent (reclaimed) deposits.

Cursory inspection of the Benwell Road beach with the Aboriginal Parties on 24 July 2008 revealed that the narrow coastal fringe has dense cover of grasses and coastal dune vegetation such as *Ipomoea pes-caprae* (goat's-foot convolvulus). Even if cultural (surface) surveys were attempted in this area (to assess the possible potential for historical archaeological sites), there is negligible to zero ground surface visibility at the current time. This was confirmed during a further recent site visit to Benwell Road beach by the project archaeologist on 23 January 2009 (at the time of writing) (see Plates 1 to 4).

The predicted cultural heritage and archaeological potential of the Marine Precinct and Port Expansion project areas is further considered in Section 9 below. It must be noted that based on the available geomorphological, historical and environmental evidence the project archaeologist has assessed the overall prehistoric archaeological potential of the development areas as negligible (with the exception of the east bank of Ross River in areas above highest astronomic tide [HAT]).

While the potential for historical archaeological sites in the development areas might also be reasonably assessed as low, the issue of cultural monitoring for existing land areas (Benwell Road beach and east bank of Ross River) during development works is considered in this report (see Sections 9 and 10 below).

# 8. ABORIGINAL CULTURAL VALUES OF THE POTL PROJECT AREAS

## 8.1 Identified Aboriginal Cultural Values

This cultural heritage study has provided clear evidence that the Cleveland Bay coastline, including the POTL project areas at Ross River and Ross Creek, have significant Aboriginal cultural heritage values. This evidence comes from various sources including ethnography, ethnohistory, anthropology, oral history, the (surrounding) Aboriginal archaeological record, and most importantly, from the Aboriginal Traditional Owners themselves.

As noted in Section 3.4, the criteria Aboriginal people use to assess cultural significance is usually quite different from that used to make scientific significance assessments. Significance assessments by Aboriginal people may be based on traditional, historical, contemporary and other cultural values. In some instances the scientific significance assessment of a site may not be consistent with Aboriginal people's perceptions and evaluations of a site. The Aboriginal cultural heritage values of a site or place may override other forms of significance assessment. Aboriginal people's perception of a site's significance may have no relationship to the size or complexity of the site. That is, sites considered as highly significant to Aboriginal people may include single artefacts, small, diffuse sites, or large complex sites.

In addition to tangible archaeological sites, sites of significance to Aboriginal people may include natural features or other components of the landscape (eg: mountain ranges, river systems, particular stands of vegetation, story places, ceremonial sites and Dreaming tracts). It is important to note that the Traditional Owner's perception of 'cultural heritage' extends beyond just the physical or tangible archaeological record. To Aboriginal people, the significance of their homelands is most often manifested in their enduring 'connection to country', rather than tangible archaeological sites or artefacts. Burke *et. al.* (2000:38) note that *"generally speaking, virtually all of the land has some inherent significance for Aboriginal people, although sacred and secular sites can possess special Aboriginal significance"* (cf. Ross 1996).

This cultural heritage investigation has found that the enduring Aboriginal cultural heritage values of the POTL Marine Precinct and Port Expansion project areas are as follows:-

- The POTL project sites are part of *Gurambilbarra* traditional homelands. Both the land and sea country in the project areas remain significant components of the Aboriginal cultural landscape of the greater Townsville region. The Traditional Owners (Aboriginal Parties) retain an enduring 'connection to country'. They describe the project areas as having immeasurable cultural and spiritual values. Their 'connection to country' has not diminished despite the historical dispossession of land and sea country, and despite the dramatic alterations to the physical configuration and the cultural integrity of the landscape since European settlement;

- Ross Creek and Ross River have Aboriginal language names – Ross Creek "Cal'ghimg'a" (Galgimga) and Ross River "Cal'bee'dee'ra" (Galbidira) (after Price 1885 with phonemic transcriptions by N. Heijm). These language names are in themselves of significant heritage value as very few language names survive for local landforms and landmarks in the Townsville region;

- Ross Creek and Ross River are integral components of the local Aboriginal creation story – the *Gabul* (Carpet Python) myth cycle - which explains the creation (and configuration of the landscape) of the Halifax Bay and Cleveland Bay coastlines;

- The coastal area now occupied by POTL (including Ross Creek, Ross River and what was once parts of Ross Island) was used traditionally for fishing, foraging, camping and for other cultural purposes. There is some evidence to indicate that it was a popular meeting place for large gatherings of Aboriginal people and that corroborees were sometimes held in this area. It formed an integral part of a large foraging and living area on the Cleveland Bay coastline that included Cape Pallarenda, Rowes Bay, the Town Common, Ross River channel and Magnetic Island;

- Land areas adjacent to and surrounding the Cleveland Bay coastline, including POTL lands, contain tangible archaeological evidence for the Aboriginal use and occupation of this landscape, in the form of shell middens, stone artefacts, scarred trees, rock shelters with paintings, ceremonial sites and burial places (eg: Sandfly Creek Aboriginal burial ground south of Ross River). It is reasonable to assume that much archaeological evidence has been obliterated by the prolonged European settlement and alteration of this landscape (especially along the coastal fringe) and that many more archaeological sites once existed along the shores of the bay;

- Current archaeological evidence indicates that Aboriginal people occupied the Cleveland Bay coastline in the late Holocene period (over at least the last 4,000 years BP);

- Ross Creek, Ross River and Ross Island represented one of the historical frontiers between European and Aboriginal societies in the first decades of Townsville's existence. The picture that emerges from the historical record is that Aboriginal people continued to occupy this area for many decades following the European settlement and occupation of Townsville;

- Parts of the POTL project area (Benwell Road beach) are visited by Traditional Owners and local Aboriginal people, mainly for the purposes of fishing, yabbying, collecting shellfish and other recreational activities (see Section 8.2 below).

## 8.2 Feedback from Endorsed Aboriginal Parties

As noted in Section 4, much of the feedback from the Aboriginal Parties regarding the POTL projects was compiled during the various project meetings between July and September 2008, including the site inspection on 24 July 2008. A summary of the main discussion points, concerns and issues relative to cultural heritage and other matters is presented below.

- Aboriginal cultural values of the project area

The Traditional Owners reported on the enduring cultural significance of Cleveland Bay, Ross Creek and Ross River. They noted that the coastline has significance as a 'dreaming place' (Gabul myth cycle) and as important fishing and hunting grounds in pre-contact and post-contact times. Several Traditional Owners referred to the 'big Murri camps' that were once located along the shores of the bay and along Ross River. They noted that the traces of these camps are 'long gone' as a result of the modern disturbance of the landscape. Despite the prolonged impacts to the physical and cultural integrity of the Cleveland Bay coastline the Traditional Owners asserted that they maintain an active interest in land management and land development issues in their homelands (incorporating both land and sea country).

- Potential impacts to flora/fauna

Some Traditional Owners raised concerns about potential impacts to the local environment and specifically flora and fauna within Cleveland Bay as a result of the proposed POTL projects (eg: sea-grass beds, turtle and dugong populations, fish habitat and fish species, offshore reefs, mangroves, fringing coastal vegetation, etc). Their concerns related mainly to the potential impacts of dredging operations as part of the proposed reclamation works for both projects. Some concerns were also raised about the potential environmental impacts of any new breakwaters near the mouth of Ross River.

Feedback presented at the project meeting on 19 August 2008 by GHD Pty Ltd was that the potential environmental impacts of the Marine Precinct project (including breakwater design and construction, as well as future dredging operations) are to be fully investigated as part of the current EIS. Environmental monitoring programs are currently underway. The Aboriginal Parties will have the opportunity to review and provide their feedback on the environmental reports compiled during the EIS process.

Some Traditional Owners raised the issue of the Environmental Reserve to be established on the east bank of the Ross River as part of the Townsville Port Access Road (Eastern Access Corridor) project. This area is outside the tenured lands and jurisdiction of POTL and it is expected that Townsville City Council (TCC) are to be the Trustees of this area. On that basis, POTL could not provide any feedback on the future environmental or cultural heritage management of this Environmental Reserve.

- Social Impact Assessment

The Aboriginal Parties indicated that they wished to be involved in providing feedback for the social impact study being conducted as part of the Marine Precinct EIS. To this end, copies of a Social Impact Questionnaire compiled by EBC were distributed to the Aboriginal Parties in November/December 2008. Consultation was carried out over several weeks to gain feedback from the Aboriginal Parties to be incorporated into the final social impact assessment by EBC.

- Contemporary use of Benwell Road beach

Several Traditional Owners commented that they would be disappointed at the loss of Benwell Road beach as a result of the Marine Precinct project. One Elder noted that she regularly visits this area with her grandchildren and that she teaches them about 'sea country' and 'bush tucker' along the river. She noted that the area is good for collecting shellfish and fishing. Other Traditional Owners reported that they have long used the area along the rock walls of Ross River for fishing at high tide.

Information concerning the contemporary use of the Benwell Road beach and concerns regarding the loss of the beach were documented during consultation with the Traditional Owners as part of the Social Impact Questionnaire.

- Recognition and acknowledgement of Traditional Owners

The Traditional Owners noted that they would like to be acknowledged and recognized as the original inhabitants of the Townsville region in some appropriate way as part of the POTL development projects (such as street names, appropriate signage or story boards in parkland associated with the developments). This issue has been addressed as per Sections 4.2 and 4.3 of the existing CHMP.

- Archaeological potential of sub-tidal areas

Some Traditional Owners suggested that there might be potential for locating sub-tidal archaeological sites or finds within the POTL project areas. Comparisons were made between the POTL project sites and the archaeological finds on the Nelly Bay (Magnetic Island) reef flat during construction of the Nelly Bay Harbour project in the 1990's. The archaeological potential of sub-tidal areas is further discussed and assessed in Section 9 below.

## 9. ASSESSMENT OF POTENTIAL CULTURAL HERITAGE IMPACTS

This cultural heritage investigation has provided clear evidence that the POTL project areas at Ross River and Ross Creek are located within a broad cultural landscape that retains significant Aboriginal heritage values. As assessment of the potential impacts of the proposed POTL projects on these identified cultural heritage values is outlined below. The assessment of impacts is based on two main criteria:- i). potential impacts to Aboriginal cultural values, and ii). potential impacts to the Aboriginal archaeological record.

- Impacts to Aboriginal Cultural Values

All development projects along the Cleveland Bay coastline have the potential to negatively impact on the Aboriginal cultural heritage values of this significant cultural landscape. Consultation with Traditional Owner representatives during the course of this investigation has generally indicated that they have no major cultural heritage objections to the POTL development projects, and on this basis they have entered into discussions and a CHMP agreement with POTL. This is despite the fact that this project will significantly alter the current configuration of the coastline with reclamation of land and the possible construction of additional breakwaters.

The Traditional Owners generally feel that the current project will have no greater impact on cultural values than the many previous development projects which have resulted in dramatic alterations to the original configuration of the coastline and waterways of Cleveland Bay. As previously noted, reclamation and construction works for the Port have been undertaken periodically since the European settlement of Townsville in the 1860's (Taylor 1980). In more recent times major development works have been undertaken for the Strand redevelopment, construction of the Casino Complex and Townsville Entertainment Centre, existing marinas and breakwaters. Despite these many developments and alterations to the landscape, Aboriginal people maintain their 'connection to country'.

In short, while alterations to the environment in the further development of the Port of Townsville will impact Traditional Owner cultural values, Cleveland Bay, the Townsville coastline and major waterways such as Ross Creek and Ross River will nevertheless continue to be fundamental and significant places in their culture.

Throughout this investigation the Traditional Owners have reiterated that they maintain an active interest in 'caring for country'. On this basis, they wish to take an active role in managing the cultural heritage and environmental values of the project areas, via ongoing discussions with POTL and the existing CHMP.

- Impacts to the Aboriginal Archaeological Record

As noted in Section 7.3, the potential for locating intact prehistoric Aboriginal archaeological sites and materials is assessed as very low to negligible for the POTL project areas. The reasons for this assessment are outlined in detail below. Any land areas with some predicted residual archeological potential (for historical and/or prehistorical archaeological sites and/or values) are also considered and discussed (eg: Benwell Road Beach and the east bank of Ross River).

The vast majority of the POTL project areas comprise sub-tidal areas. With the exception of Benwell Road beach and the margins of the east bank of Ross River (for the Marine Precinct project) all of the development areas are inundated and well below high water mark.

The archaeological potential of sub-tidal areas in Cleveland Bay can reasonably be assessed as very low to negligible on the basis of many factors, but primarily the prolonged history of major taphonomic disturbance and alteration to the seabed and watercourses, mainly as a result of dredging. This report has discussed the long-term impacts of dredging at the mouth of Ross River and Ross Creek at Townsville Port (Section 5 and Pringle 1989). Over more than 100 years regular dredging has taken place at the Port to maintain navigable channels at Ross River and Ross Creek. The end result of the long-term dredging operations is that intact sub-tidal coastal deposits simply do not exist within the POTL project areas.

Given the long history of dredging at the Port and the fact that maintenance and capital dredging works are still carried out by POTL on a periodic basis, the age of sediments in the upper layers of sub-tidal areas at Ross River and Ross Creek are relatively recent. Based on information provided by POTL and discussed at the project meeting on 24 July 2008, the age range of the upper layers of sub-tidal sediments (from maintenance and capital dredging works) for the Marine Precinct project are estimated at between 2 to 30 years old. If any prehistoric Aboriginal archaeological sites were once located in sub-tidal deposits in the Marine Precinct project area then it must be concluded that these would have long been obliterated by the prolonged and repeated dredging in this section of Cleveland Bay.

Long-term preservation of inorganic materials (such as stone artefacts) in sub-tidal deposits is problematic, especially given the site's taphonomic history and the very high levels of previous disturbance (and the considerable potential for displacement). Apart from the preservation and taphonomic factors, there is also the issue of visibility and the sheer difficulty of detecting archaeological remains or deposits in this context. This is assuming that archaeological remains have survived sea level rise and local fluctuations in sea level (cf. Belperio 1978; Hopley and Murtha 1975).

Some Traditional Owners have raised the issue of the archaeological remains (Aboriginal stone artefacts) found at the Nelly Bay Harbour development site on Magnetic Island and the possibility for similar archaeological finds within the POTL project areas (cf. Gorecki and Greer 1988; Mardaga-Campbell, Greer and Hatte 1989; Northern Archaeology Consultancies 2002). From an archaeological perspective there is very little similarity between the two locations, and particularly their archaeological and geomorphological contexts. The stone artefacts at Nelly Bay were discovered on an old emerged intertidal reef flat, probably dating to 5 or 6,000 years ago. At the POTL project sites there are no emerged intertidal reefs and the project sites consist of sub-tidal and/or reclaimed lands (with the exception of the east bank of Ross River).

The point is reiterated that the greatest impediment to finding intact Aboriginal archaeological sites in the POTL project areas is the very long history of disturbance and alteration to the landscape and seascape as a result of the prolonged European settlement and development of this area. In addition to the major impacts to sub-tidal areas of the bay at the mouths of Ross River and Ross Creek, there have been dramatic changes to land areas as well. In fact the whole configuration of the coastline has been quite dramatically altered since European settlement. This point is clearly illustrated when one compares the early (ca. 1870) photographs of Ross Creek (Figures 4 and 5) with more recent aerial photographs of the Port lands (Figures 6 to 10).

Pringle (1989) noted that one major effect of long-term dredging is that the channel of Ross River has actually moved westwards from its previous location across the intertidal zone. The major implication of this change in the course of the river is that any prehistoric Aboriginal archaeological sites which might have been located along the banks of the original river channel (in the late Holocene period over the past few thousand years), would now have been destroyed. It is very reasonable to assume, based on the known Aboriginal archaeological record of Townsville, as well as the ethnohistorical information presented in this report, that major Aboriginal base camps and occupation sites are likely to have been located along the channel of Ross River and Ross Creek, in pre-contact times and at the time of European settlement.

Many areas along the Cleveland Bay coastline that were inhabited by Aboriginal people no longer exist as a result of modern development and landscape modification. For example, from the ethnographic record we know that sizeable camps of Aboriginal people resided at Murder Island and Magazine Island. These areas were obliterated for ensuing developments, no doubt along with their prehistoric archaeological record. It is well documented that granite from Magazine Island was used as fill in reclamation works and for construction of major Port developments including breakwaters, jetty's and bridges (Taylor 1980). Where archaeological evidence does survive on the coastal fringe it is often located in the more outlying (and less disturbed) areas of Townsville (eg: Sandfly Creek burial ground to the south of Ross River). Kennedy (1947, 1948) provides some examples of the destruction of Aboriginal campsites along the Cleveland Bay coastline since European settlement:-

*"Most of the Townsville middens have been destroyed by modern civilization. There was one on the strand near Landsborough Street, but, during the last war fortifications were built on the site, and all traces of the middens were obliterated. Another, on Kissing Point, which was also a corroboree ground, has been removed for reclamation of swamp land"* (Kennedy 1947:27).

*"....In past years this locality was a camping place and one of the corroboree grounds of the Aborigines...... In those days the mangroves extended almost to the base of the hill which constitutes the Point, and with the swamps on one side and the sea on the other, a good supply of food was assumed to the natives. Now the only evidence of their occupation is an occasional stone artefact found there"* (Kennedy 1948:31).

In addition to the long history of human impacts to the landscape and seascape of the POTL project areas this coastline has also been subject to periodic cyclonic events. Pringle (1989) and Taylor (1980) have described major erosion and deposition of sediments as a result of cyclones and storm surge at the mouths of Ross Creek and Ross River in the recent past. Cyclones have the potential to alter the configuration of the coastline and its archaeological record as demonstrated by Bird (1992) at Wunjunga in the Lower Burdekin region. Some 50% of coastal shell middens recorded in 1987 were obliterated by cyclonic storm surge in 1989 and 1992 as a result of cyclones Charlie and Aivu. The configuration of the coastline was dramatically altered by a major breach in coastal dunes as a result of the combination of storm surge and inland flooding pushing through a narrow weakened section of sandy coastline. It is reasonable to suspect that erosion and deposition of sediments as a result of past cyclones have had some impact on the archaeological record along the Cleveland Bay coastline and the POTL project areas.

This cultural heritage investigation suggests that there are two areas associated with the Marine Precinct project where there may be some level of (residual) archaeological and cultural heritage potential.

The first area to be considered is the east bank of the Ross River. Potential impacts to the coastal margins on the east bank may occur if a breakwater is constructed as part of this project. Previous archaeological surveys of the east bank of the river for the Townsville Port Access Road project (Bird 1999) have located low-density Aboriginal archaeological sites such as shell middens and stone artefacts within the dune complexes on this eastern side of the Ross River. There is a high level of cultural sensitivity from the point of view of the Traditional Owners in this relatively undisturbed area of dunes and old beach ridges, given their contextual similarity and geographical proximity to the beach ridges at the Sandfly Creek Aboriginal burial ground.

Non-indigenous cultural sites including a concrete bunker dating to World War 2 and the remains of a 1930's Townsville City Council sewage plant (concrete tanks and other structures) are also located on the east bank of Ross River (see Section 7.2 above and Bird 1999 for a detailed discussion on the cultural finds on the eastern bank).

The Main Roads development corridor on the east bank for the Townsville Port Access Road is to be subject to a stringent cultural monitoring program during development works (as per an existing [2005] CHMP between Department of Main Roads and the Bindal and Wulgurukaba peoples). On that basis, any proposed work by POTL on the east bank of Ross River would therefore be expected to be subject to cultural monitoring. It is noted that at this stage, the potential impacts to the east bank as a result of the Marine Precinct project have yet to be fully determined, pending ongoing assessment of the various proposed breakwater options. A cultural monitoring program for any proposed works above highest astronomic tide (HAT) on the east bank would ensure that any unrecorded cultural sites or values could be identified, documented and managed appropriately during the course of the development project (see Recommendations in Section 10).

The second area to be considered for potential cultural heritage impacts is the coastal strip at Benwell Road beach. As previously noted in this report the prehistoric archaeological potential of this area is assessed as negligible, based on the fact that the beach is reclaimed land that is only a few decades old. There is some potential that historical archaeological sites or relics (Aboriginal and/or non-indigenous) might be located in these coastal deposits, but again the point is emphasized that the term 'historical' is used tentatively in this context, given the maximum age of this coastal strip.

Quite apart from the project archaeologist's assessment of cultural heritage potential, the Traditional Owners have indicated that they feel that cultural monitoring of the Benwell Road beach area is warranted for development works in this area. The Traditional Owners feel that there is some potential for historical 'Murri' camps to be located in this area.

It must be said that the request for cultural monitoring by Traditional Owners along this section of coast (on the margins of Ross River) goes more to the issue of acknowledging the enduring and immeasurable Aboriginal cultural values of this area and its cultural sensitivity, than to addressing issues of 'archaeological potential'. That is, the request for cultural monitoring is more about addressing intangible cultural values and 'caring for country' than it is about management of the archaeological record. An Elder from the Aboriginal Parties made some important comments during the consultation process to sum up the Traditional Owners point of view regarding the need for cultural monitoring along Benwell Road beach, regardless of the archaeological assessment of this area.

*"Townsville Port has had this land for many years; they have been using and changing this land since white people came; we have been locked out of this land; land that our ancestors owned and lived on; the sites left by our old people, middens and such, are gone now. We need to monitor the land to make sure there are no sites there and so we can still care for our country".*

It is noted that the Department of Main Roads has advised that the Benwell Road beach and adjacent area is planned for resumption as part of the Townsville Port Access Road (Eastern Access Corridor) project. On that basis, there is a possibility that Main Roads will resume this land and begin to develop it for the road corridor, prior to any development works by POTL. Main Roads are addressing their cultural heritage duty of care in this regard via separate discussions with Aboriginal Parties (ongoing at the time of writing) and as part of an existing CHMP between Main Roads and the Bindal and Wulgurukaba peoples.

Since relative sea level stabilization some 6,000 years ago there is no doubt that Aboriginal people occupied and utilized the coastal fringes of Cleveland Bay, including the Ross Creek and Ross River project areas. As already noted, the inherent difficulty in locating traces of this early occupation along the present shoreline is the high degree of disturbance which has occurred from both modern developments (over the past 150 years), and ongoing natural geomorphic processes. Areas we know to have been frequented by Aboriginal people, at least in the early settlement period, were the immediate coastal fringe, the mouth of watercourses and associated sand bars, mangrove forests, sand dunes and beach ridges. All of these areas have been subject to dramatic change over time.

In conclusion, from an archaeological perspective it is predicted that it is highly unlikely that the proposed POTL development projects will have any major detrimental impacts to the prehistoric and historic Aboriginal archaeological record of Cleveland Bay (either along the coastal fringe and foreshore, or within the sub-tidal marine zone).

## 10. PROJECT RECOMMENDATIONS

The following Recommendations are made as a result of the cultural heritage investigations for the POTL Marine Precinct and Port Expansion projects.

These Recommendations are made following consultation with the Aboriginal Parties and as a means to address cultural heritage management issues for the proposed projects. It is noted that some of the listed recommendations have been addressed as per the existing (September 2008) project CHMP (as indicated below where appropriate).

*[Postscript 18 March 2009: These recommendations were discussed and amended at a meeting between POTL and the Aboriginal Parties on 17 March 2009. Postscripts are added below where appropriate. Amended recommendations have been added to the project CHMP as Schedule 1].*

**Recommendation 1:**
It is recommended that a cultural monitoring program be implemented by POTL for any proposed extractive works to impact the east bank of Ross River above highest astronomic tide (HAT) as part of the Marine Precinct project.

At this time the potential impacts, if any, to the east bank of Ross River are not fully known as a result of the ongoing EIS investigations regarding proposed breakwater design and construction options for the Marine Precinct project.

The Aboriginal Parties request that POTL inform them of the outcomes of the ongoing EIS studies and the final project decision and recommendations regarding breakwater construction design and options.

It is recommended that there be further discussions between POTL and the Aboriginal Parties as a means to agree on and confirm the timing, duration, number of personnel, logistical and other arrangements for a cultural monitoring program for any extractive works to be undertaken above HAT on the east bank of Ross River.

*[Postscript 18 March 2009: Updated information was provided by POTL relative to a new proposed breakwater option for the Marine Precinct project. It is noted at this time that no works are proposed for the east bank of Ross River and that the current proposed breakwater (as at 18 March 2009) is intended to be generally as shown in Figure 12 in this report. See also Schedule 1 of the project CHMP].*

**Recommendation 2:-**

The Aboriginal Parties request that a cultural monitoring program be implemented by POTL for any proposed development works to impact the Benwell Road beach (Lot 773) as part of the Marine Precinct project.

Considering the history of extensive reclamation of this area, it is recommended that there be further discussions between POTL and the Aboriginal Parties regarding any requirement for cultural monitoring at Lot 773.

[As already noted, it is possible that Main Roads will resume part of Benwell Road beach for the construction of the Townsville Port Access Road (Eastern Access Corridor) prior to the Marine Precinct project. In this case, the issue of cultural monitoring for this parcel of land will not be the responsibility of POTL. The duty of care to address cultural heritage management issues for the development of this land will pass to the landholder/developer, which in this case will be Department of Main Roads].

*[Postscript 18 March 2009: Recommendation 2 amended and agreed upon as follows as per Schedule 1 of the project CHMP:-*

*"That a cultural monitoring program be implemented by POTL for any proposed extractive works to impact the Benwell Road beach above highest astronomic tide (HAT) as part of the Marine Precinct project. Provided that if monitoring occurs pursuant to a cultural heritage management plan prepared by Main Roads for the same area, monitoring under the POTL CHMP need not occur"].*

**Recommendation 3:-**

No recommendation is made for a cultural monitoring program for the sub-tidal and inundated Port Expansion development area.

**Recommendation 4:**

In the event that any Aboriginal cultural heritage sites, materials or values are discovered during development operations in the POTL project areas, the following recommendation should apply:-

All development work and other activities at that location should cease, pending a thorough inspection of the find/s by representatives of the Aboriginal Parties. Optimally, the finds should be demarcated and protected from any potential impacts with pegs, flagging tape and/or other appropriate temporary barriers with a reasonable buffer area around them (the 'reasonable' buffer zone to be determined by the Site Supervisor or other appropriate on-site personnel). Development work can continue outside the demarcated buffer zone. Following their assessment of the find/s, the Aboriginal Parties will provide advice on appropriate management action. Depending on the cultural significance of the find/s, the Aboriginal Parties and/or the development proponent may wish to seek independent technical advice from the project archaeologist and/or the Cultural Heritage Coordination Unit, Department of Natural Resources and Water. Development work at the location of the finds should not recommence until appropriate cultural heritage management action has been implemented to the satisfaction of all stakeholders (Refer CHMP, Section 3.7 and Schedule 1).

**Recommendation 5:**

In the unlikely event that human skeletal material is discovered during development works, it is recommended that all development operations cease immediately within 100 m of the remains. Optimally, the finds should be demarcated and protected from any potential impacts with pegs, flagging tape and/or other appropriate temporary barriers. The Queensland Police, Cultural Heritage Coordination Unit of the Department of Natural Resources and Water, as well as Aboriginal Traditional Owner representatives should be contacted as a matter of urgency. Currently, the

Queensland Police, Department of Natural Resources and Water and Aboriginal Traditional Owner groups have established policy and procedures to ensure that confirmed indigenous burials are treated in a manner consistent with Aboriginal traditions. Minimal disturbance to the remains should be a priority, and advice should be sought from Aboriginal Elders on ways to deal with the material in a culturally appropriate and sensitive manner. A copy of the Department of Natural Resources and Water 'Burial Policy' is available from NRW and/or the project archaeologist (Refer CHMP, Section 3.8 and Schedule 1).

**Recommendation 6:**

Personnel and contractors involved in the development project should undertake a cultural heritage induction prior to commencement of development operations. Workers must be provided with information on the types of Aboriginal cultural heritage sites likely to be found in the project area, along with specific guidelines to follow in the event of the discovery of cultural finds, or suspected cultural finds. Workers should be made aware of the provisions of the *Aboriginal Cultural Heritage Act 2003* and in particular, the 'Duty of Care Guidelines' under this legislation (Refer CHMP, Section 3.6 and Schedule 1).

**Recommendation 7:-**

During the course of this cultural heritage study the Traditional Owners have raised some concerns regarding environmental aspects relating to the proposed development project (such as potential impacts to sea grass beds, fish habitat, water quality, pollution, dugong and turtle populations in Cleveland Bay, etc). On this basis, the Traditional Owners request that they have the opportunity to review and provide feedback on expert environmental reports compiled as part of the EIS process.

*[Postscript 18 March 2009: Recommendation 7 amended and agreed upon as follows as per Schedule 1 of the project CHMP:-*

*"POTL shall provide each of the Endorsed Parties with a CD copy of the Environmental Impact Statement (EIS) once it goes on public display. On each occasion that the Port meets with the Endorsed Parties, the Port shall provide an update on issues arising out*

*of the EIS. The Port shall continue to provide to the Endorsed Parties Fact Sheets and newsletters on progress of the EIS"].*

**Recommendation 8:-**

The Traditional Owners request that POTL acknowledge and recognise the Aboriginal history, use and occupation of the Ross River and Ross Creek project areas via story boards, interpretive signage, naming of Port precincts and/or street names, or other appropriate means as agreed upon by the Parties, as part of the Marine Precinct and Port Expansion projects (Refer CHMP, Section 4 and Schedule 1).

**Recommendation 9:-**

Once endorsed by the Aboriginal Parties and POTL it is recommended that the above-listed recommendations are incorporated into the existing (September 2008) Cultural Heritage Management Plan for the Marine Precinct and Port Expansion projects, in the form of an appropriate Schedule or Addendum (see Schedule 1 of CHMP, dated 17 March 2009).

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LEGEND

| Proposed Marine Precinct | | | | |
|---|---|---|---|---|
| Stage 1 | Shed | Fuel Berth | Potential Temp. Hardstand Site | Breakwater Option C (Preferred) |
| Stage 2 | Maintenance (Open Hardstand) | Marine Infrastructure | Unloading Berth | Min and Max Option |
| Stage 3 | Industrial Shed | Ramp | Trawler/Commercial Berth | |
| | Barge Berth | Shed - Stage 3 | Work Berths | |

1:10,000 (at A4)
0 50 100 150 200 250
Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Job Number 42-15399
Revision A
Date 01 July 2009

## Marine Precinct and Breakwater Reference Design

Figure 1-2

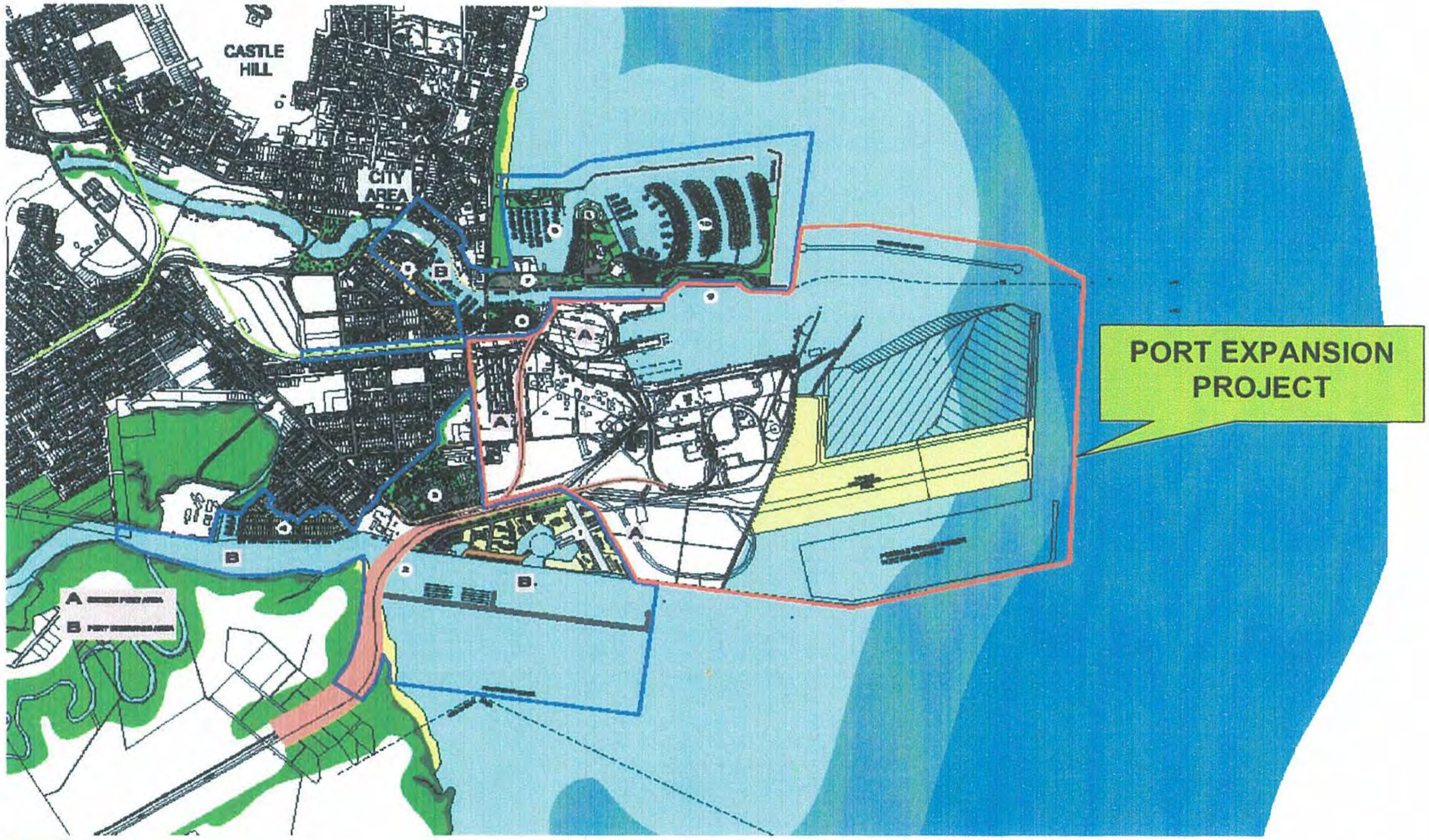
G:\42\15399\GIS\Projects\EIS\42-15399_006_rev_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au



Data source: Marine Precinct - ©The State of QLD (Port of Townsville LTD) 2009; Aerial (flown 2004) - ©The State of Queensland (Department of Environment and Resource Management). Created by: TH

# Port Expansion Project




TOWNSVILLE CITY-PORT STRATEGIC PLAN

Queensland Government
Department of Infrastructure

**Figure 2: Port Expansion Project, Proposed Development Area.**

# Footprint of both projects

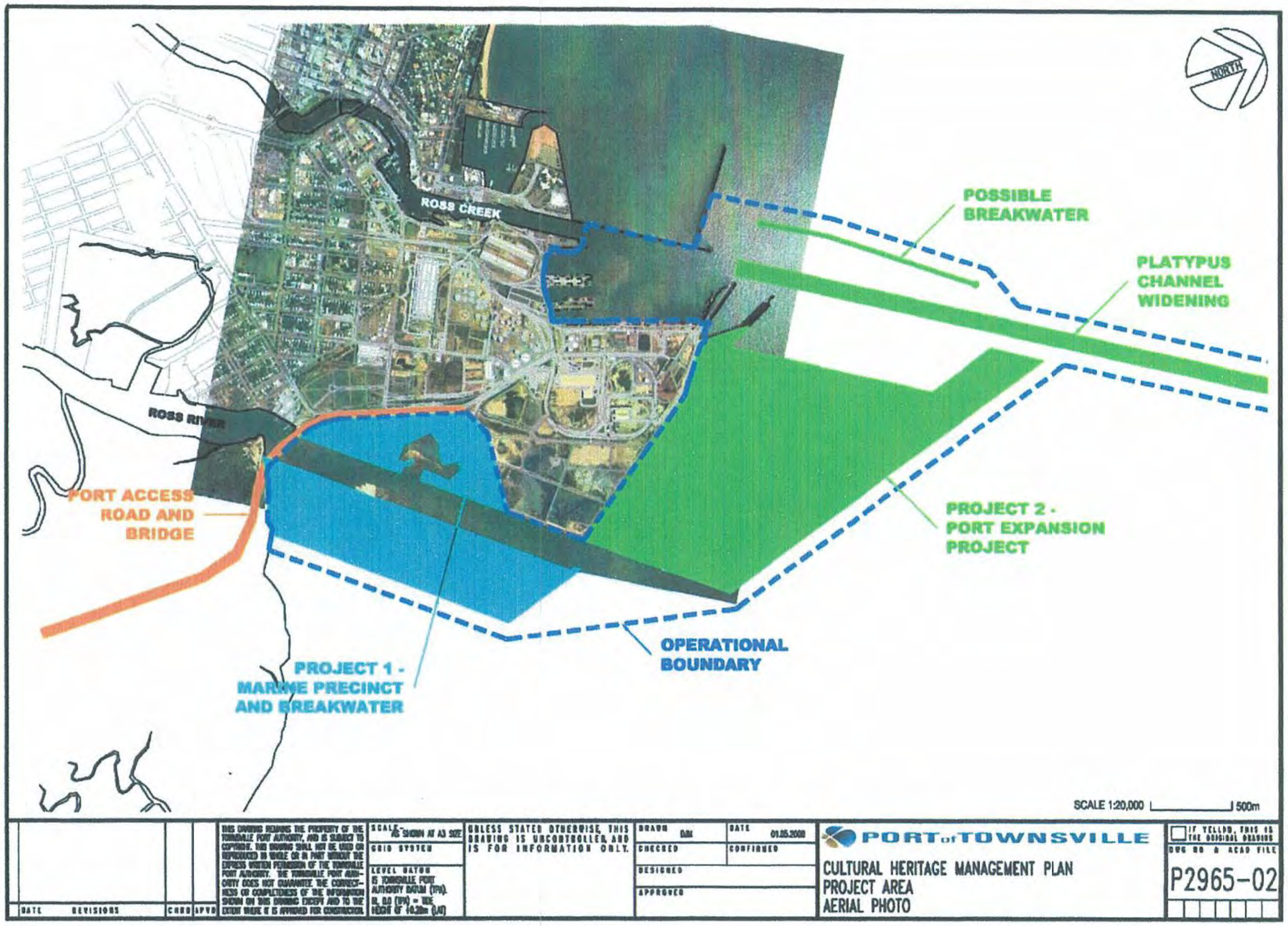



Figure 3: Development Footprint, Marine Precinct and Port Expansion Projects.

Figure 4: Magazine Island and Ross River c. 1870 (from Gibson-Wilde 1984).

**Figure 5: "Panoramic View of Townsville and Surrounds, ca. 1870" (Daintree 1870).**

# 1941 Air Photo

Figure 6: Aerial photograph, Port of Townsville 1941 (Source: POTL).

# 1964 Air Photo

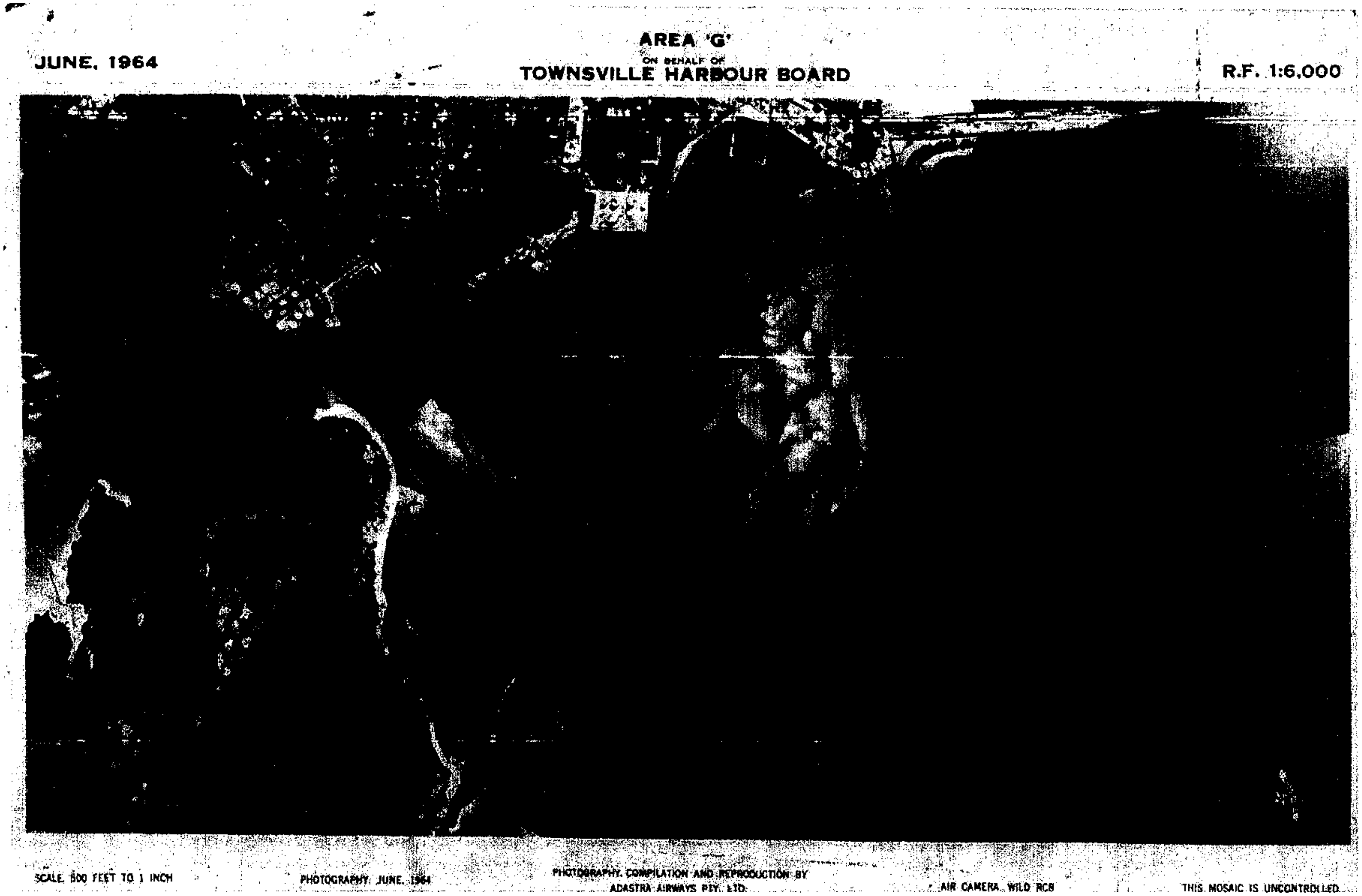



Figure 7: Aerial photograph, Port of Townsville 1964 (Source: POTL).

# 1977 Fishing Boat Haven concept

G 801/1

TOWNSVILLE HARBOUR BOARD
FISHING BOAT HAVEN
PRELIMINARY LAYOUT

**Figure 8: Aerial photograph, Port of Townsville 1977 (Source: POTL).**

## 1993 Air Photo

**Figure 9: Aerial photograph, Port of Townsville 1993 (Source: POTL).**

# 2007 Air Photo

**Figure 10: Aerial photograph, Port of Townsville 2007 (Source: POTL).**

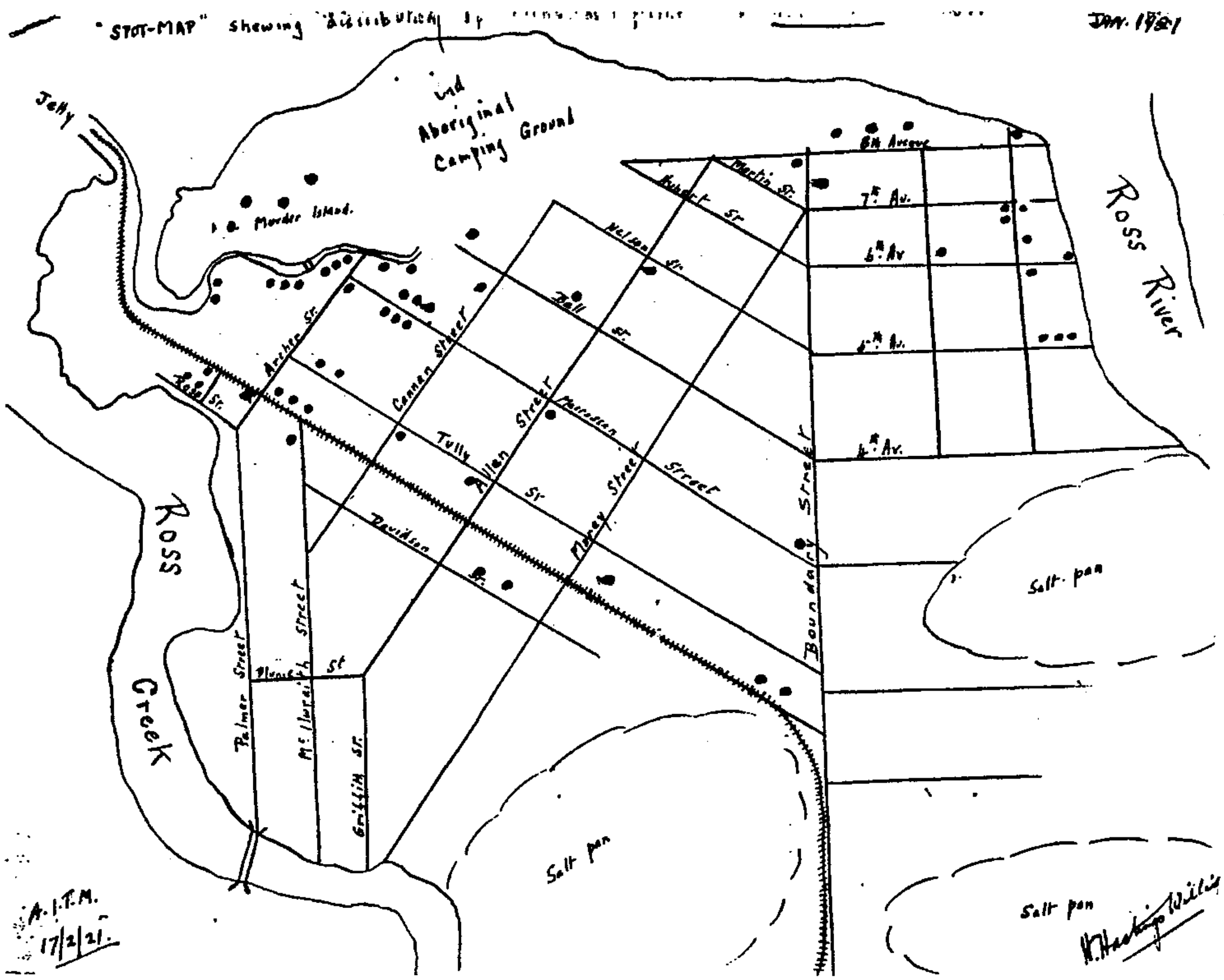



**Figure 11: Hastings Willis map showing Aboriginal Camps, Murder Island c. 1921.**


**Figure 12:** **Proposed breakwater design option (draft only) as at 17 March 2009.**

## ***APPENDIX 1***

**CHMP PUBLIC NOTICE**

PUBLIC NOTICE

# CULTURAL HERITAGE MANAGEMENT PLAN

## *Aboriginal Cultural Heritage Act 2003*

## *Aboriginal Party*

PORT of TOWNSVILLE

Nexus North Queensland

Port of Townsville intends to develop a Cultural Heritage Management Plan for the Project pursuant to Part 7 of the *Aboriginal Cultural Heritage Act 2003* (QLD).

**Project:** The Project will incorporate two proposed developments at the Port of Townsville.

1. The development of a Marine Precinct at the mouth of Ross River. The concept of a marine facility at the mouth of Ross River has been promoted since the mid 1970s. This development will involve reclamation of Lot 773 on EP2211 for the establishment of a purpose-built facility for marine-related activities. The development could also include the creation of a breakwater on the eastern side of Ross River to protect the Marine Precinct and Ross River channel from wave action and siltation. It is intended that a number of pile moorings will be made available adjacent to the proposed breakwater.
2. Expansion of the Port of Townsville. This development will involve expansion of Port infrastructure northwards from current Port activities and may involve reclamation of new land, creation of revetment walls, a breakwater, swing basins, wharves, widening and deepening of the Platypus Channel and sea channel.

**Sponsor's name:** Port of Townsville

**Contact Details:** For further information please contact Mr Mel Marks, Manager Major Projects, Port of Townsville on (07) 4781 1500.

**Address for service:** The Chief Executive, Port of Townsville, Administration Building, Benwell Road, Townsville. PO Box 1031 Townsville QLD 4810.

For the purpose of this Notice the Notice Day is **Monday 12 May 2008.**

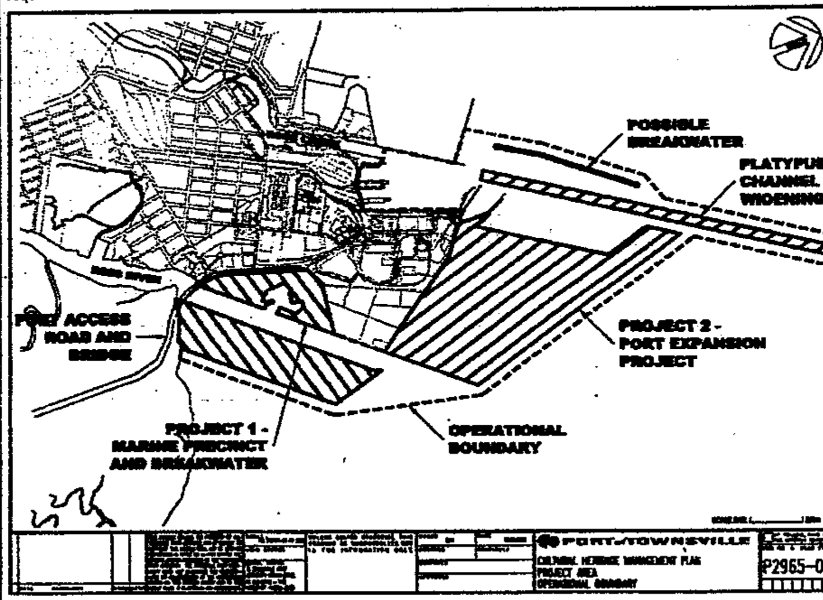
The Cultural Heritage Management Plan will be developed for the following area.

**Project 1:**
Plan area: Marine Precinct - Strategic Port Land, Lot 773 on EP2211; and
Breakwater - State Waters heading approximately northwards from the eastern bank of Ross River mouth (see map below).
County of: Elphinstone
Parish of: Coonambelah
Locality: Townsville
Nearest Town: Townsville -- the project is within the Townsville City boundaries.
Other identifiable features: Lot 773 is sometimes known as the South Townsville Beach or the Benwell Road beach.

**Project 2:**
Plan area: State waters extending northwards from the current extent of Port infrastructure (see map).
County of: Elphinstone
Parish of: Coonambelah
Locality: Townsville
Nearest Town: Townsville -- the project is within the Townsville City boundaries.

If you are or you have been nominated as an Aboriginal party (as defined by Part 4 of the *Aboriginal Cultural Heritage Act 2003*) to act on their behalf and you wish to take part in developing the Cultural Heritage Management Plan, you must give a **written notice** to the Chief Executive Officer of the Port of Townsville advising that you wish to take part, by Friday 20 June 2008.

The Port of Townsville may elect not to endorse any Aboriginal party if the Port of Townsville is not advised in writing within the required time.



## *APPENDIX 2*

## NRW CULTURAL HERITAGE REGISTER & DATABASE SEARCH RESULTS

Queensland Government

Natural Resources and Mines

Author: Nicole Flynn
File CLH/000054/File Reference NoCHCU201006R1
Your ref:
Cultural Heritage Coordination Unit
Phone 07 3238 3838

20 October 2006

Ms Michele Bird
Northern Archaeology Consultancies
Po Box 118
Castletown Hyde Park
Qld 4812

Dear Ms Bird

**Cultural Heritage Search - Townsville Port & adjacent land**

I refer to your application, dated 13 September 2006, in which you requested advice on Aboriginal cultural heritage places recorded on the above location.

I wish to advise that no Aboriginal cultural heritage is recorded on the Cultural Heritage Database and Register in your specific search area, from the data provided by you. However, it is probable that the absence of recorded Aboriginal cultural heritage places reflects a lack of previous cultural heritage surveys of the area. Therefore, our records are not likely to reflect a true picture of the Aboriginal cultural heritage values of the area.

All significant Aboriginal cultural heritage in Queensland is protected under the *Aboriginal Cultural Heritage Act 2003,* and penalty provisions apply for any unauthorized harm. Under the legislation a person carrying out an activity must take all reasonable and practical measures to ensure the activity does not harm Aboriginal Cultural Heritage. This applies whether or not such places are recorded in a official register and whether or not they are located in, on or under private land.

Locked Bag 40
WOOLLOONGABBA
Queensland 4 102 Australia
**Telephone** (07) 3238 3838
**Facsimile** (07) 3238 3842
**Website** www.nrm.qld.gov.au
ABN 83 705 537 586

Aboriginal cultural heritage, which may occur on the subject property, is protected under the terms of the *Aboriginal Cultural Heritage Act 2003* even if Natural Resources & Mines has no records relating to it.

Please refer to our website ***www.nrm.qld.gov.au/cultural_heritage/index.html*** for a copy of the gazetted Cultural Heritage duty of care guidelines, which set out reasonable and practical measures for meeting the duty of care.

Should you have any further queries, please do not hesitate to contact me on (07) 3238 3839.

Yours sincerely

Nicole Flynn

for Paul Travers
**Director**
**Cultural Heritage Coordination Unit**
**Indigenous Services**

## Recorded Cultural Heritage Sites

| Location | Fileno | Attribute | Latitude |
|---|---|---|---|
| **Ross River** | | | |
| 600SP137141 | | Currently no Cultural Heritage recorded | |
| 601SP137141 | | Currently no Cultural Heritage recorded | |
| 30EP2355 | | Currently no Cultural Heritage recorded | |
| 23RP703387 | | Currently no Cultural Heritage recorded | |
| 24RP703387 | | Currently no Cultural Heritage recorded | |
| 25RP703387 | | Currently no Cultural Heritage recorded | |
| 113RP703387 | | Currently no Cultural Heritage recorded | |
| 114RP703387 | | Currently no Cultural Heritage recorded | |
| 115RP703374 | | Currently no Cultural Heritage recorded | |
| 116RP703374 | | Currently no Cultural Heritage recorded | |
| 778EP2231 | | Currently no Cultural Heritage recorded | |
| 672EP2031 | | Currently no Cultural Heritage recorded | |
| 777EP2231 | | Currently no Cultural Heritage recorded | |
| **Ross Creek** | | | |
| 674EP2163 | | Currently no Cultural Heritage recorded | |
| 784EP2254 | | Currently no Cultural Heritage recorded | |
| 785EP2254 | | Currently no Cultural Heritage recorded | |
| 705EP2163 | | Currently no Cultural Heritage recorded | |
| 800EP837705 | | Currently no Cultural Heritage recorded | |
| 300EP2352 | | Currently no Cultural Heritage recorded | |
| 709SP135285 | | Currently no Cultural Heritage recorded | |
| 779SP129549 | | Currently no Cultural Heritage recorded | |
| 780SP129549 | | Currently no Cultural Heritage recorded | |
| 587SP130947 | | Currently no Cultural Heritage recorded | |
| 588SP130947 | | Currently no Cultural Heritage recorded | |
| 781SP130971 | | Currently no Cultural Heritage recorded | |
| 782SP130971 | | Currently no Cultural Heritage recorded | |
| 1SP126611 | | Currently no Cultural Heritage recorded | |
| 3SP126611 | | Currently no Cultural Heritage recorded | |
| 4SP126611 | | Currently no Cultural Heritage recorded | |
| 5SP126611 | | Currently no Cultural Heritage recorded | |
| 701SP126611 | | Currently no Cultural Heritage recorded | |
| 363EP776 | | Currently no Cultural Heritage recorded | |
| 433EP1121 | | Currently no Cultural Heritage recorded | |
| 613EP1805 | | Currently no Cultural Heritage recorded | |
| 704EP2163 | | Currently no Cultural Heritage recorded | |
| 703EP2163 | | Currently no Cultural Heritage recorded | |
| 488SP135285 | | Currently no Cultural Heritage recorded | |
| 499EP2382 | | Currently no Cultural Heritage recorded | |
| 792EP2351 | | Currently no Cultural Heritage recorded | |
| 164EP2079 | | Currently no Cultural Heritage recorded | |
| 1SP119461 | | Currently no Cultural Heritage recorded | |
| 772SP119461 | | Currently no Cultural Heritage recorded | |
| 596CP896278 | | Currently no Cultural Heritage recorded | |
| 4-6T118110 | | Currently no Cultural Heritage recorded | |
| 648EP1980 | | Currently no Cultural Heritage recorded | |
| 1-3T118110 | | Currently no Cultural Heritage recorded | |
| **Port** | | | |
| 1RP701959 | | Currently no Cultural Heritage recorded | |
| 259T11868 | | Currently no Cultural Heritage recorded | |
| 11T118191 | | Currently no Cultural Heritage recorded | |
| 791EP2348 | | Currently no Cultural Heritage recorded | |
| 601EP1802 | | Currently no Cultural Heritage recorded | |
| 549EP1758 | | Currently no Cultural Heritage recorded | |
| 577CP909895 | | Currently no Cultural Heritage recorded | |
| 757SP150572 | | Currently no Cultural Heritage recorded | |
| 1SP129182 | | Currently no Cultural Heritage recorded | |
| 2SP129182 | | Currently no Cultural Heritage recorded | |
| 621SP157595 | | Currently no Cultural Heritage recorded | |

Projection: GDA94

## Recorded Cultural Heritage Sites

| Location | Fileno | Attribute | Latitude |
|---|---|---|---|
| 318EP2024 | Currently no Cultural Heritage recorded | | |
| 448SP126597 | Currently no Cultural Heritage recorded | | |
| 449SP126597 | Currently no Cultural Heritage recorded | | |
| 450SP126597 | Currently no Cultural Heritage recorded | | |
| 294EP1977 | Currently no Cultural Heritage recorded | | |
| 389EP1977 | Currently no Cultural Heritage recorded | | |
| 587CP896279 | Currently no Cultural Heritage recorded | | |
| 700EP2140 | Currently no Cultural Heritage recorded | | |
| 13SP148848 | Currently no Cultural Heritage recorded | | |
| 169SP164760 | Currently no Cultural Heritage recorded | | |
| 758SP130956 | Currently no Cultural Heritage recorded | | |
| 6SP150574 | Currently no Cultural Heritage recorded | | |
| 430EP1068 | Currently no Cultural Heritage recorded | | |
| 773EP2211 | Currently no Cultural Heritage recorded | | |
| Cape Cleveland | | | |
| 2RP737733 | Currently no Cultural Heritage recorded | | |
| 5RP736696 | Currently no Cultural Heritage recorded | | |
| 6RP736696 | Currently no Cultural Heritage recorded | | |
| **Breakwater Marina** | | | |
| 793EP2273 | Currently no Cultural Heritage recorded | | |
| 794EP2273 | Currently no Cultural Heritage recorded | | |
| 797CP909884 | Currently no Cultural Heritage recorded | | |
| 798CP909884 | Currently no Cultural Heritage recorded | | |
| **Gordon Creek** | | | |
| 1-8T11895 | Currently no Cultural Heritage recorded | | |
| 15T11895 | Currently no Cultural Heritage recorded | | |
| 16T11895 | Currently no Cultural Heritage recorded | | |
| 1RP730111 | Currently no Cultural Heritage recorded | | |
| 2RP732944 | Currently no Cultural Heritage recorded | | |
| 200EP2053 | Currently no Cultural Heritage recorded | | |
| 199EP2036 | Currently no Cultural Heritage recorded | | |
| 12-18K103939 | Currently no Cultural Heritage recorded | | |
| | | | |

Projection: GDA94


# Port Expansion Project EIS

**Appendix S1**

**Queensland Coastal Plan Assessment Findings**

AECOM BMT WBM

## *Viewpoint 1 - The Rocks Guest House - Cleveland Terrace, Melton Hill*

| Findings of the Queensland Coastal Plan: Determining Scenic Preference in the Coastal Zone (Annex 3) Assessment | | | |
|---|---|---|---|
| | Pre-change Scenic Preference Rating (SPR) | Post-change Scenic Preference Rating (SPR) | Significant Change : N = no., Y = Yes |
| Viewpoint 1: | 2.9 ±0.7 | Not applicable as Pre-change SPR was less than 5. | N/A |

The Project complies with Queensland Coastal Plan (QCP), the Pre-change Scenic Preference Rating was less than 5.

Photo: The Rocks Guest House - Cleveland Terrace, Melton Hill

SEQ SPRAT-1 — **SEQ S**cenic **P**referece **R**ating **A**ssessment **T**ool for One view

Version 1.0 12 May 05
© 2005 SEQ Regional Scenic Amenity Study

**Inputs**

| | Visual Domains | Percent | | | Percent |
|---|---|---|---|---|---|
| 1 | BUSH | **1%** | 3 | RURAL | 0% |
| 2 | COAST | **4%** | 4 | URBAN | **95%** |
| | | | | *TOTAL (Visual Domains)* | **100%** |

| | Visual Elements - Built | Percent | | Visual Elements - Natural | Percent |
|---|---|---|---|---|---|
| 1 | Buildings low non-resetidential | 0% | 1 | *Coastal vegetation* | 0% |
| 2 | Buildings low residential | **46%** | 2 | *Crops pasture animals* | 0% |
| 3 | *Building low solitary* | 0% | 3 | Euc forest etc | **1%** |
| 4 | Building medium - high | **2%** | 4 | *Garden* | **6%** |
| 5 | Buildings trees grass | 0% | 5 | *Grass mown* | 0% |
| 6 | Built elements water | 0% | 6 | *Grass natural* | 0% |
| 7 | *Farm elements* | 0% | 7 | Grass unmanaged | 0% |
| 8 | Fence | **4%** | 8 | Modified vegetation | 0% |
| 9 | Mines, Quarries, Dumps | 0% | 9 | *Mud* | 0% |
| 10 | Park cultural buildings | 0% | 10 | *Native pine* | 0% |
| 11 | Park elements | 0% | 11 | *Pine forest* | 0% |
| 12 | Path | **3%** | 12 | Rainforest | 0% |
| 13 | *People* | 0% | 13 | Rock | 0% |
| 14 | *Retaining wall* | 0% | 14 | *Sand* | **0%** |
| 15 | Road freeways | 0% | 15 | Trees planted | **19%** |
| 16 | Roads | **5%** | 16 | Water bay | **4%** |
| 17 | Signs | **0%** | 17 | Water constructed | 0% |
| 18 | Towers cables poles | **2%** | 18 | Water inland | 0% |
| 19 | Vehicles | 0% | 19 | Water ocean estuary | 0% |
| 20 | *Built misc* | **8%** | 20 | *Natural misc* | 0% |
| | | | | ***TOTAL (built + natural)*** | **100%** |

**Output**

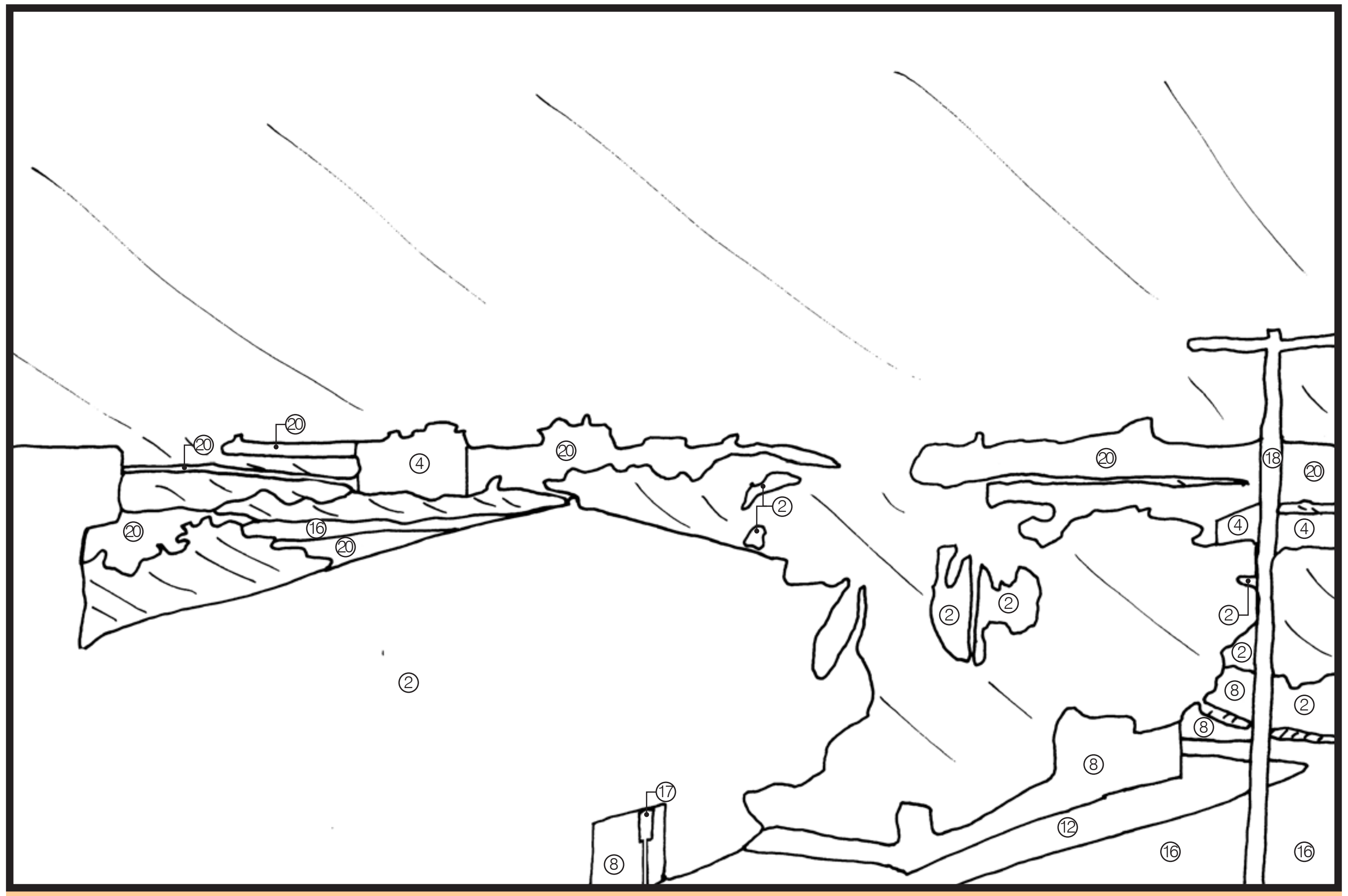
| | | +/- |
|---|---|---|
| **SCENIC PREFERENCE RATING (1-10)** | **2.9** | **0.7** |

## *Assessment & Results - Pre-Change Scenic Preference Rating (SPR)*

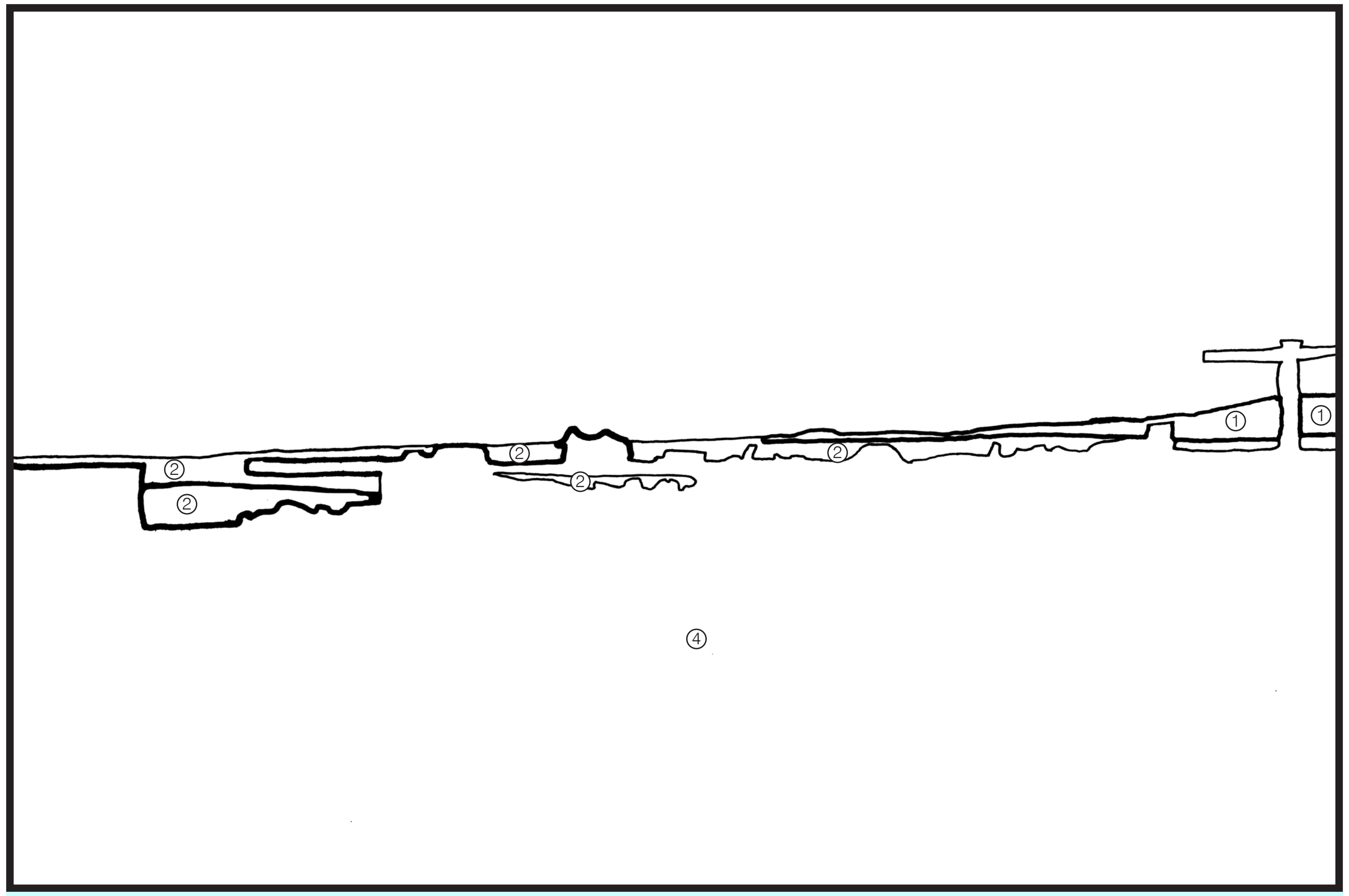
Results table measured area (ImageJ software) to percentages

| | | area in cm2 | percentage |
|---|---|---|---|
| Visual Domains | 1. bush | 1 | 1.04% |
| | 2. coast | 4 | 4.17% |
| | 3. rural | | 0.00% |
| | 4. urban | 91 | 94.79% |
| | TOTAL (cm) | 96 | 100.00% |
| | | | |
| Natural | 3. euc forest etc. | 0.93 | 0.97% |
| | 4. garden | 5.65 | 5.92% |
| | 14. sand | 0.14 | 0.15% |
| | 15. trees planted | 18.37 | 19.24% |
| | 16. water bay | 3.73 | 3.91% |
| Built | 2. buildings low - res | 44.39 | 46.49% |
| | 4. buildings high | 1.54 | 1.61% |
| | 8. fence | 3.99 | 4.18% |
| | 12. path | 3.17 | 3.32% |
| | 16. roads | 4.54 | 4.75% |
| | 17. signs | 0.09 | 0.09% |
| | 18. towers cables poles* | 1.67 | 1.75% |
| | 20. built misc | 7.27 | 7.61% |
| | TOTAL (cm) | 95.48 | 100.00% |

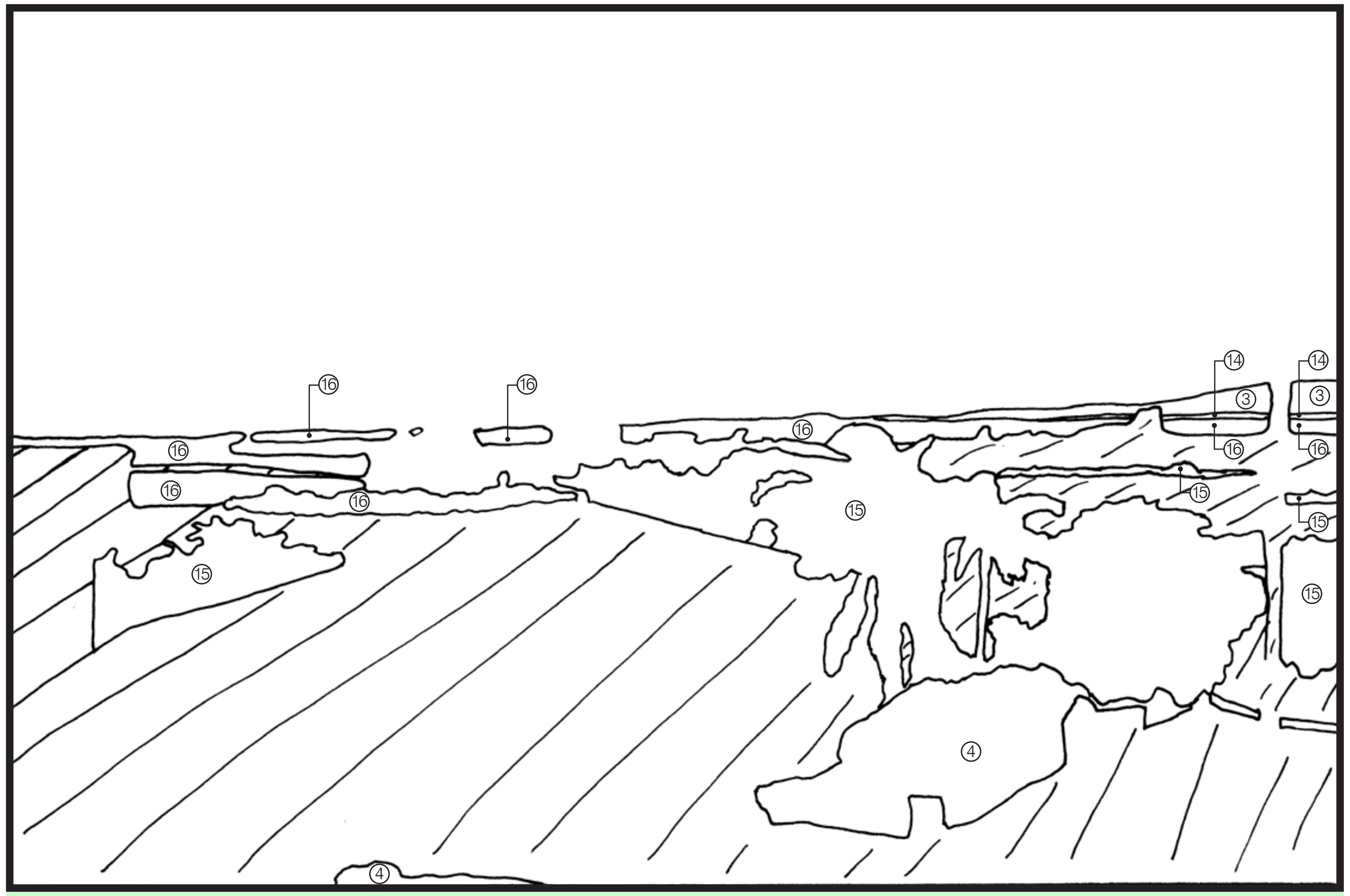
*Powerlines excluded from SPR calculations as within skyline. This method allows for a higher SPR calucation and therefore illustrates the worst case scenario



Built - Pre-Change



Visual Domains - Pre-Change



Natural - Pre-Change

## *Viewpoint 3 - Castle Hill*

| Findings of the Queensland Coastal Plan:<br>Determining Scenic Preference in the Coastal Zone (Annex 3) Assessment | | | |
|---|---|---|---|
| | Pre-change Scenic Preference Rating (SPR) | Post-change Scenic Preference Rating (SPR) | Significant Change :<br>N = no., Y = Yes |
| Viewpoint 1: | 2.4 ±0.4 | Not applicable as Pre-change SPR was less than 5. | N/A |

The Project complies with Queensland Coastal Plan (QCP), the Pre-change Scenic Preference Rating was less than 5.

Photo: Castle Hill

SEQ SPRAT-1 **SEQ S**cenic **P**referece **R**ating **A**ssessment **T**ool for One view

Version 1.0 12 May 05


**Inputs**

| | Visual Domains | Percent | | | Percent |
|---|---|---|---|---|---|
| 1 | BUSH | 3% | 3 | RURAL | 0% |
| 2 | COAST | 28% | 4 | URBAN | 69% |
| | | | | *TOTAL (Visual Domains)* | 100% |

| | Visual Elements - Built | Percent | | Visual Elements - Natural | Percent |
|---|---|---|---|---|---|
| 1 | Buildings low non-residential | 6% | 1 | *Coastal vegetation* | 0% |
| 2 | Buildings low residential | 19% | 2 | *Crops pasture animals* | 0% |
| 3 | *Building low solitary* | 0% | 3 | Euc forest etc | 3% |
| 4 | Building medium - high | 18% | 4 | *Garden* | 2% |
| 5 | Buildings trees grass | 0% | 5 | *Grass mown* | 0% |
| 6 | Built elements water | 3% | 6 | *Grass natural* | 0% |
| 7 | *Farm elements* | 0% | 7 | Grass unmanaged | 1% |
| 8 | Fence | 0% | 8 | Modified vegetation | 0% |
| 9 | Mines, Quarries, Dumps | 0% | 9 | *Mud* | 0% |
| 10 | Park cultural buildings | 0% | 10 | *Native pine* | 0% |
| 11 | Park elements | 0% | 11 | *Pine forest* | 0% |
| 12 | Path | 0% | 12 | Rainforest | 0% |
| 13 | *People* | 0% | 13 | Rock | 0% |
| 14 | *Retaining wall* | 0% | 14 | *Sand* | 0% |
| 15 | Road freeways | 0% | 15 | Trees planted | 11% |
| 16 | Roads | 3% | 16 | Water bay | 28% |
| 17 | Signs | 0% | 17 | Water constructed | 1% |
| 18 | Towers cables poles | 0% | 18 | Water inland | 0% |
| 19 | Vehicles | 0% | 19 | Water ocean estuary | 0% |
| 20 | *Built misc* | 5% | 20 | *Natural misc* | 0% |
| | | | | *TOTAL (built + natural)* | 100% |

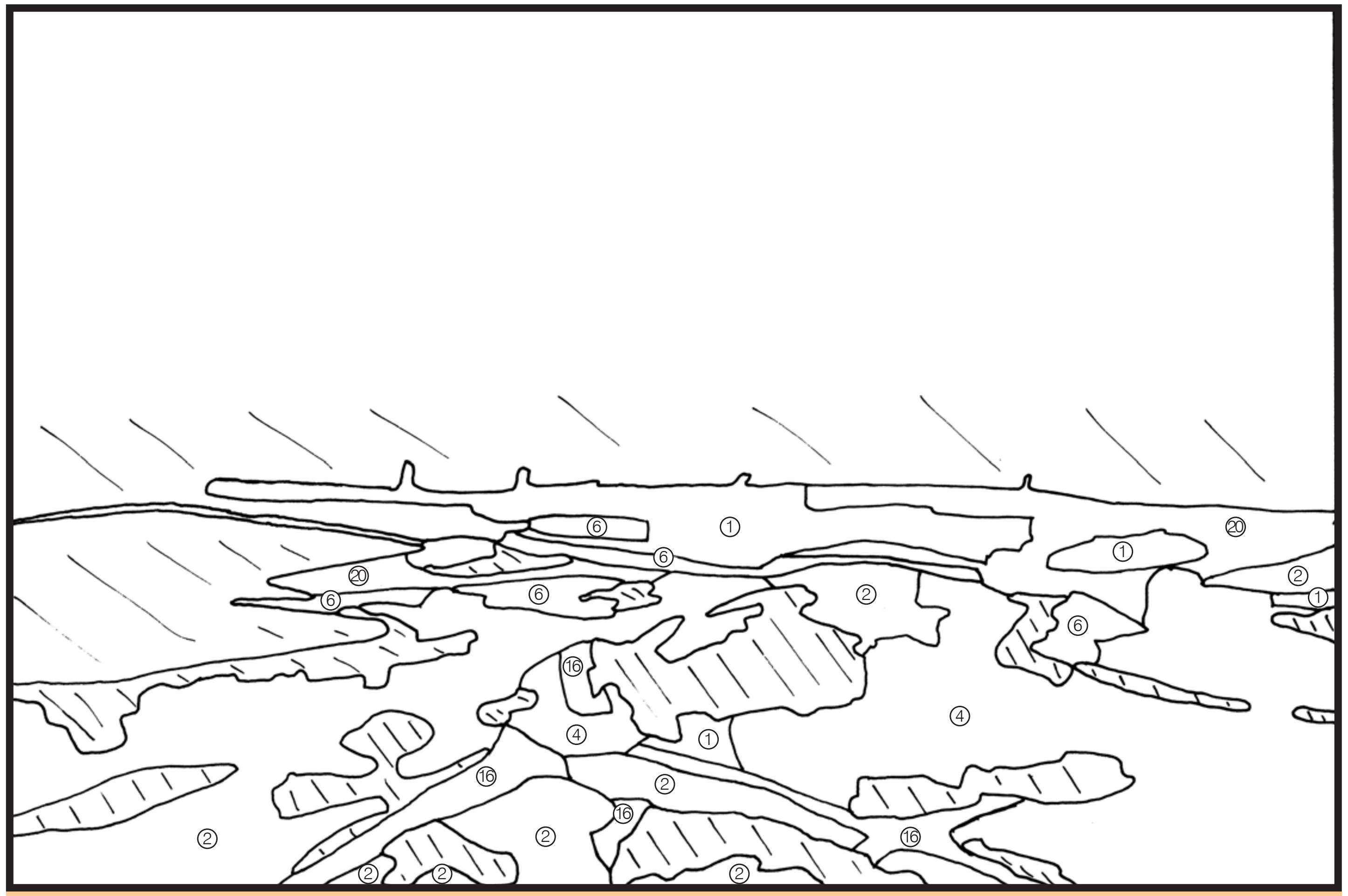
**Output**

| | | +/- |
|---|---|---|
| SCENIC PREFERENCE RATING (1-10) | 2.4 | 0.4 |

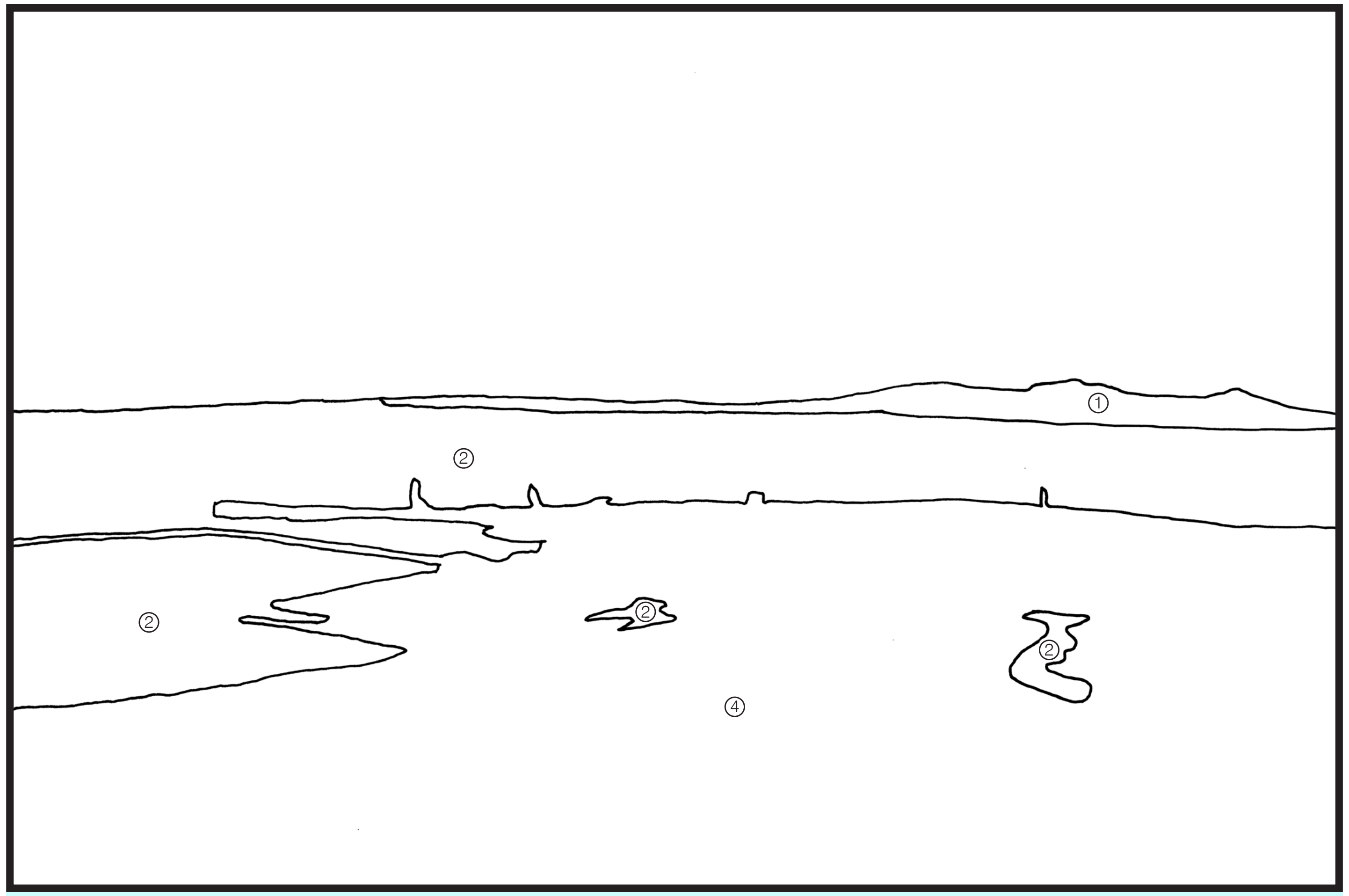
## *Assessment & Results - Pre-Change Scenic Preference Rating (SPR)*

Results table measured area (ImageJ software) to percentages

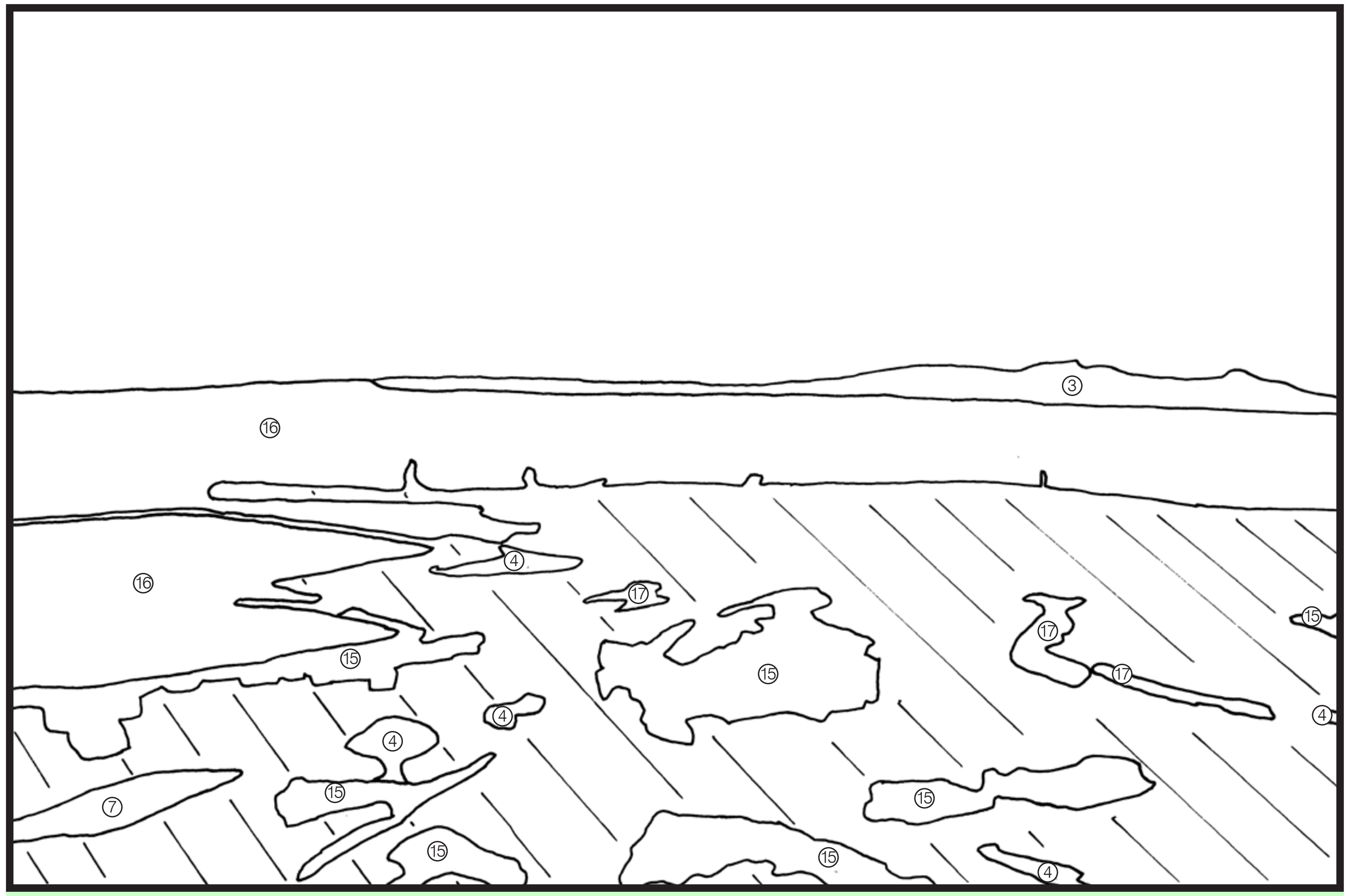
| | | area in cm2 | percentage |
|---|---|---|---|
| Visual Domains | 1. bush | 3.07 | 2.89% |
| | 2. coast | 30.06 | 28.33% |
| | 3. rural | | 0.00% |
| | 4. urban | 72.98 | 68.78% |
| | TOTAL (cm) | 106.11 | 100.00% |
| | | | |
| Natural | 3. euc forest etc. | 3.2 | 3.04% |
| | 4. garden | 1.64 | 1.56% |
| | 7. grass unmanaged | 1.13 | 1.07% |
| | 15. trees planted | 11.51 | 10.92% |
| | 16. water bay | 29.1 | 27.61% |
| | 17. water constructed | 0.89 | 0.84% |
| Built | 1. buildings low - non res | 6.57 | 6.23% |
| | 2. buildings low - res | 20.26 | 19.23% |
| | 4. buildings high | 19.08 | 18.11% |
| | 6. built elements water | 2.98 | 2.83% |
| | 16. roads | 3.57 | 3.39% |
| | 20.built misc - port tarmac | 5.45 | 5.17% |
| | TOTAL (cm) | 105.38 | 100.00% |



Built - Pre-Change



Visual Domains - Pre-Change



Natural - Pre-Change

### *Viewpoint 9 - Passenger Ferry route between Townsville & Magnetic Island*

| Findings of the Queensland Coastal Plan:<br>Determining Scenic Preference in the Coastal Zone (Annex 3) Assessment | | | |
|---|---|---|---|
| | Pre-change Scenic Preference Rating (SPR) | Post-change Scenic Preference Rating (SPR) | Significant Change : N = no., Y = Yes |
| Viewpoint 9: | 7.9 ±0.2 | 7.8 ±0.2 | N |

The Project complies with Queensland Coastal Plan (QCP), An acceptable level of scenic preference change (ie. no change in Scenic Prerence Rating is predicted) was determined through the assessment of this photograph.

Photo: Passenger Ferry route between Townsville & Magnetic Island (Pre-change)

SEQ SPRAT-2 **SEQ S**cenic **P**referece **R**ating **A**ssessment **T**ool for Two views

Version 1.0 12 Mar 05
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**Inputs**

| | **Visual Domains** | **View 1** | **View 2** | | | **View 1** | **View 2** |
|---|---|---|---|---|---|---|---|
| 1 | BUSH | **5%** | **5%** | 3 | RURAL | 0% | 0% |
| 2 | COAST | **93%** | **92%** | 4 | URBAN | **2%** | **3%** |
| | | | | | ***TOTAL (Domains)*** | **100%** | **100%** |

| | **Visual Elements - Built** | **View 1** | **View 2** | | **Visual Elements - Natural** | **View 1** | **View 2** |
|---|---|---|---|---|---|---|---|
| 1 | Buildings low non-residential | **1%** | **2%** | 1 | *Coastal vegetation* | 0% | 0% |
| 2 | Buildings low residential | 0% | 0% | 2 | *Crops pasture animals* | 0% | 0% |
| 3 | *Building low solitary* | 0% | 0% | 3 | Euc forest etc | **4%** | **4%** |
| 4 | Buildings medum - high | **1%** | **1%** | 4 | *Garden* | 0% | 0% |
| 5 | Building trees grass | 0% | 0% | 5 | *Grass mown* | 0% | 0% |
| 6 | Built elements water | 0% | 0% | 6 | *Grass natural* | 0% | 0% |
| 7 | *Farm elements* | 0% | 0% | 7 | Grass unmanaged | 0% | 0% |
| 8 | Fence | 0% | 0% | 8 | Modified vegetation | 0% | 0% |
| 9 | Mines, Quarries, Dumps | 0% | 0% | 9 | *Mud* | 0% | 0% |
| 10 | Park cultural buildings | 0% | 0% | 10 | *Native pine* | 0% | 0% |
| 11 | Park elements | 0% | 0% | 11 | *Pine forest* | 0% | 0% |
| 12 | Path | 0% | 0% | 12 | Rainforest | 0% | 0% |
| 13 | *People* | 0% | 0% | 13 | Rock | **0%** | **1%** |
| 14 | *Retaining wall* | 0% | 0% | 14 | *Sand* | **0%** | **0%** |
| 15 | Road freeways | 0% | 0% | 15 | Trees planted | **0%** | **0%** |
| 16 | Roads | 0% | 0% | 16 | Water bay | **93%** | **92%** |
| 17 | Signs | 0% | 0% | 17 | Water constructed | 0% | 0% |
| 18 | Towers cables poles | 0% | 0% | 18 | Water inland | 0% | 0% |
| 19 | Vehicles | 0% | 0% | 19 | Water ocean estuary | 0% | 0% |
| 20 | *Built misc* | **0%** | **0%** | 20 | *Natural misc* | 0% | 0% |
| | | | | | ***TOTAL (built + natural)*** | **100%** | **100%** |

**Output**

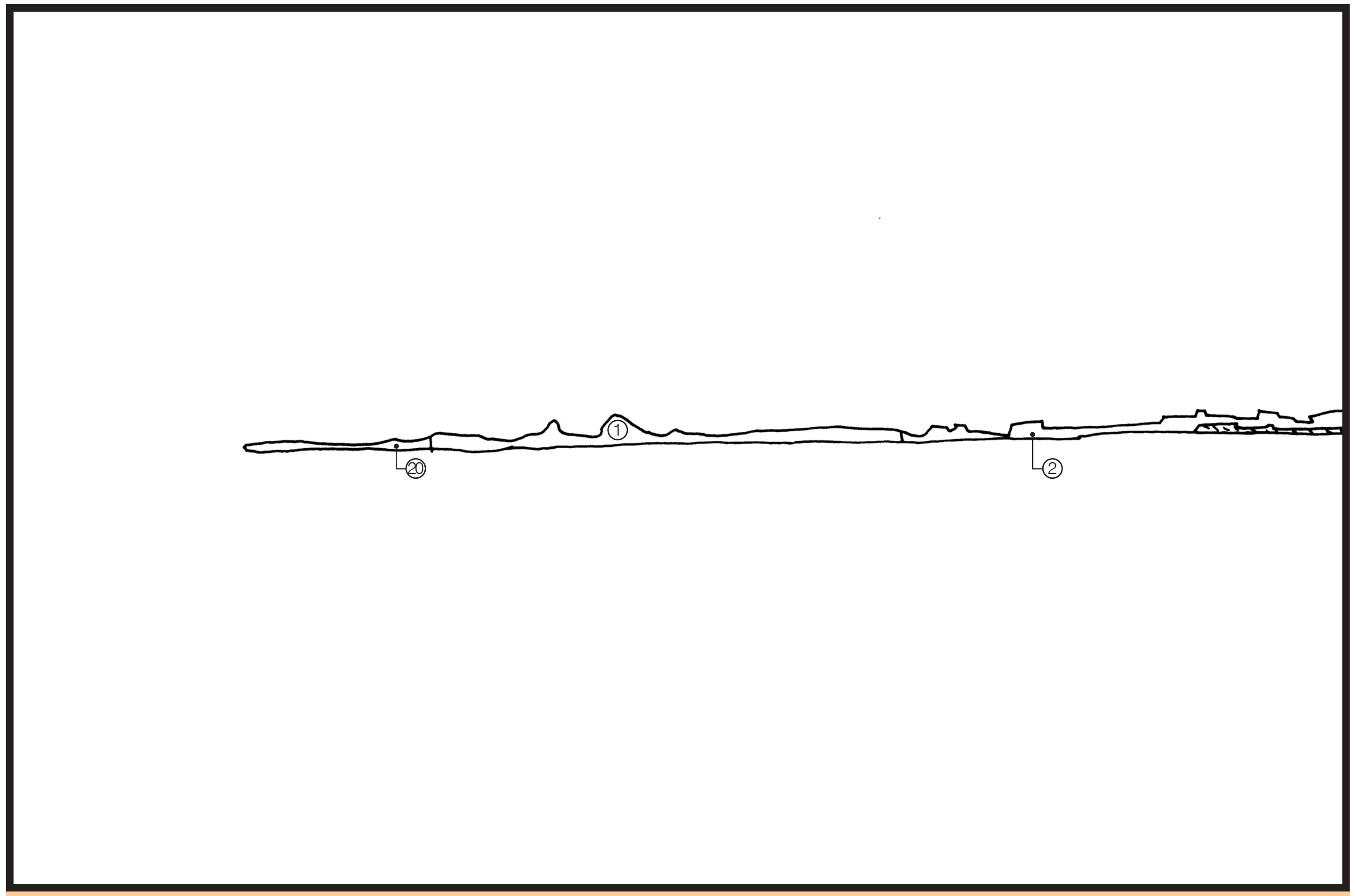
| | **View 1** | **View 2** | **Difference** | **Direction** | **Statistically significant?** |
|---|---|---|---|---|---|
| **SCENIC PREFERENCE RATING (1-10)** | **7.9** | **7.8** | **-0.1** | **decrease** | **N** |

Photo: Passenger Ferry route between Townsville & Magnetic Island (Post-change visualisation)

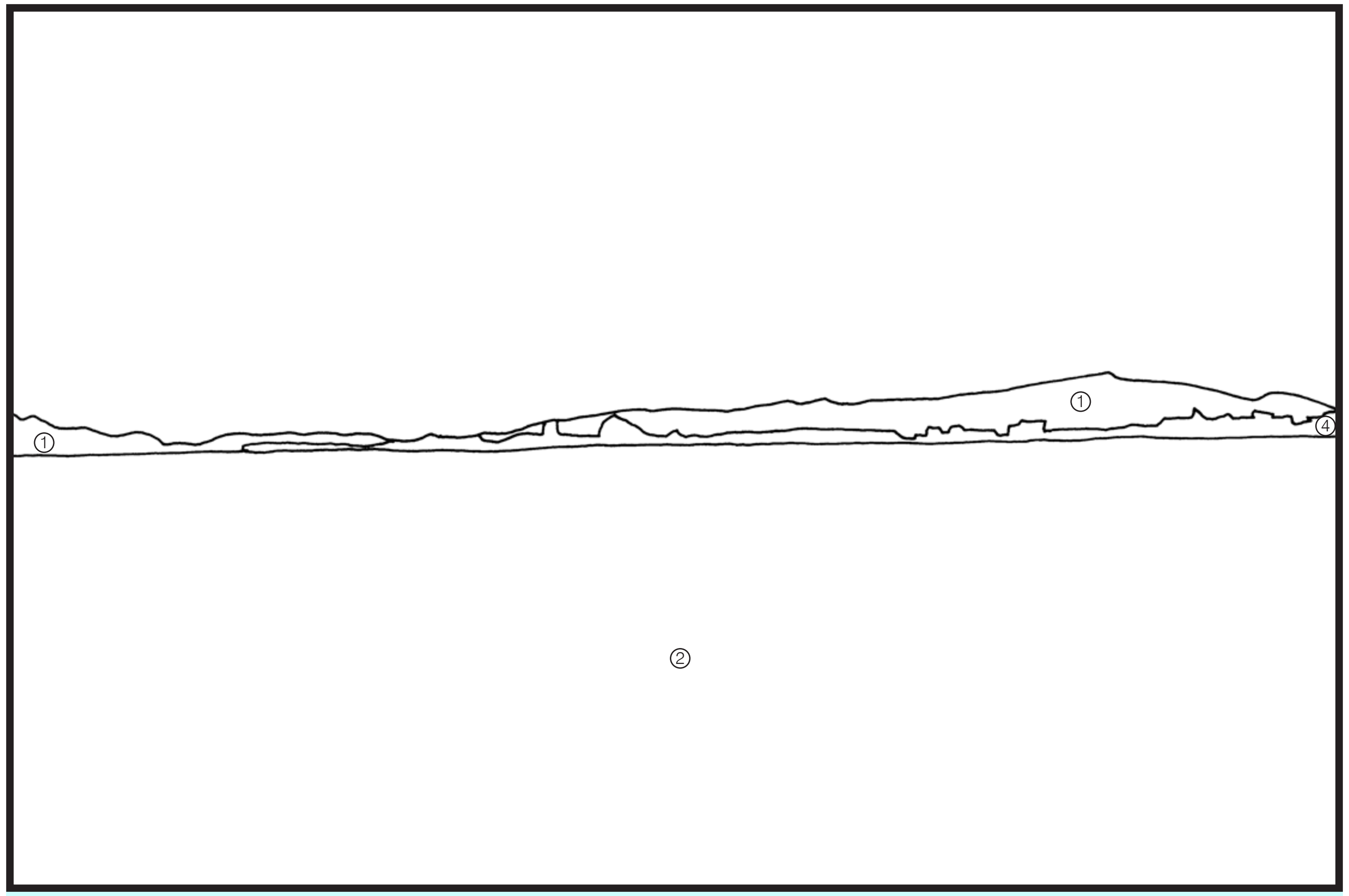
## *Assessment & Results - Pre-Change Scenic Preference Rating (SPR)*

Results table measured area (ImageJ software) to percentages

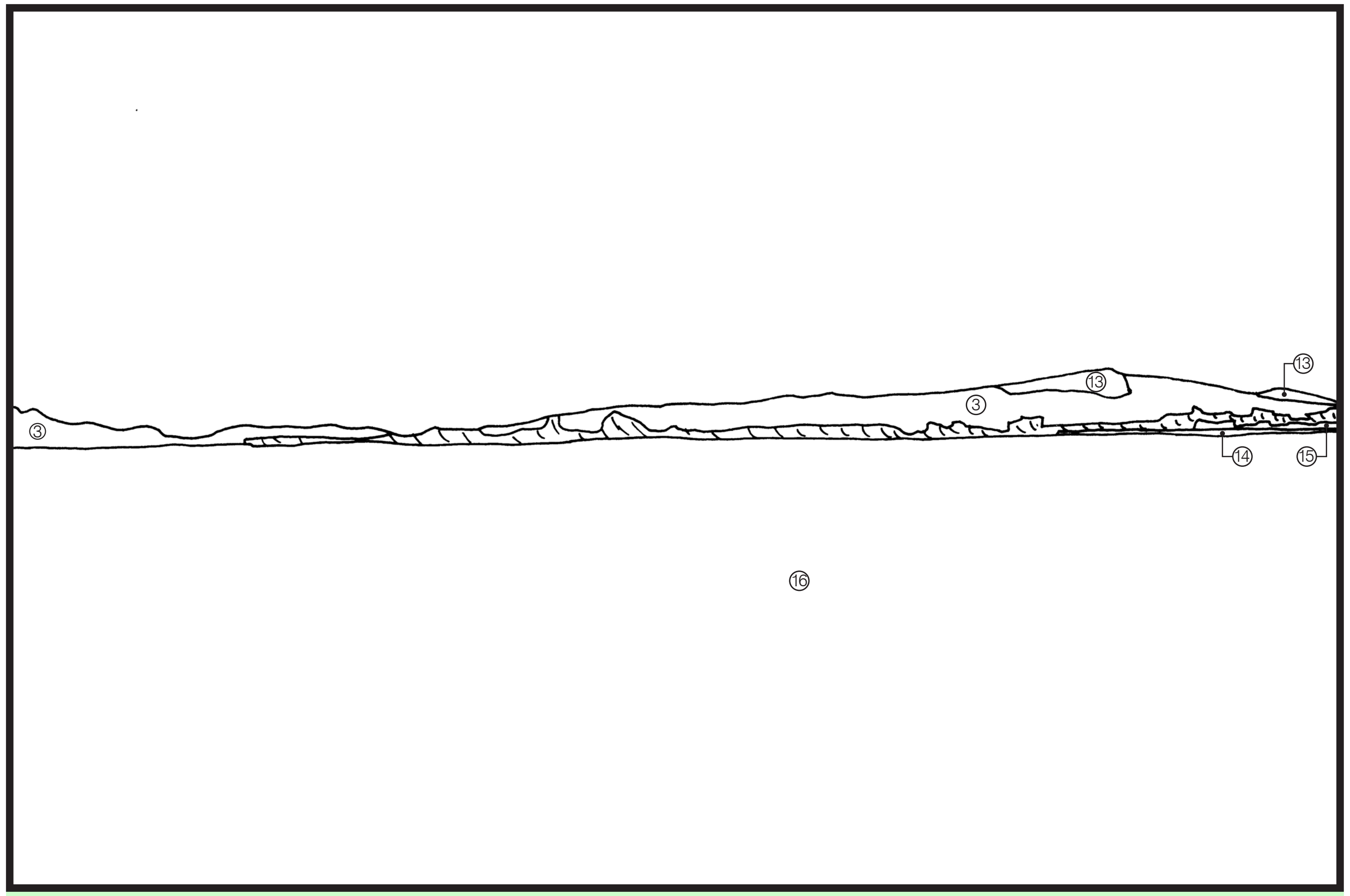
| | | area in cm2 | percentage |
|---|---|---|---|
| Visual Domains | 1. bush | 4.61 | 4.61% |
| | 2. coast | 93.9 | 93.16% |
| | 3. rural | | 0.00% |
| | 4. urban | 2.48 | 2.23% |
| | TOTAL (cm) | 100.99 | 100.00% |
| | | | |
| Natural | 3. euc forest etc. | 4.33 | 4.30% |
| | 13. rock | 0.42 | 0.42% |
| | 14. sand | 0.17 | 0.17% |
| | 15. trees planted | 0.14 | 0.14% |
| | 16. water bay | 93.17 | 93.24% |
| Built | 1. buildings low - non res | 0.95 | 0.94% |
| | 2. buildings med - high | 0.6 | 0.60% |
| | 20. built misc - port tarmac | 1.01 | 0.20% |
| | TOTAL (cm) | 100.79 | 100.00% |



Built - Pre-Change



Visual Domains - Pre Change

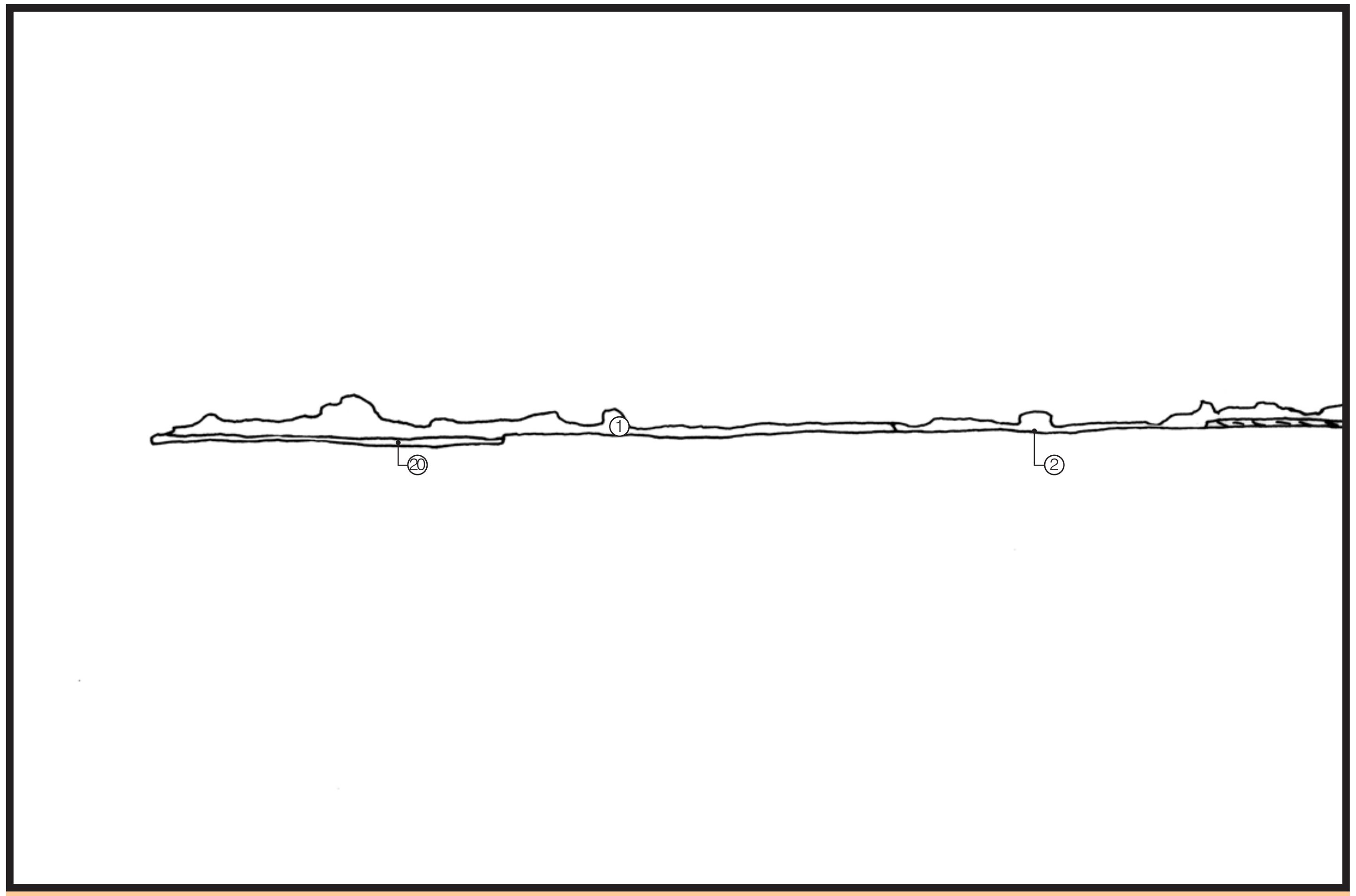


Natural - Pre Change

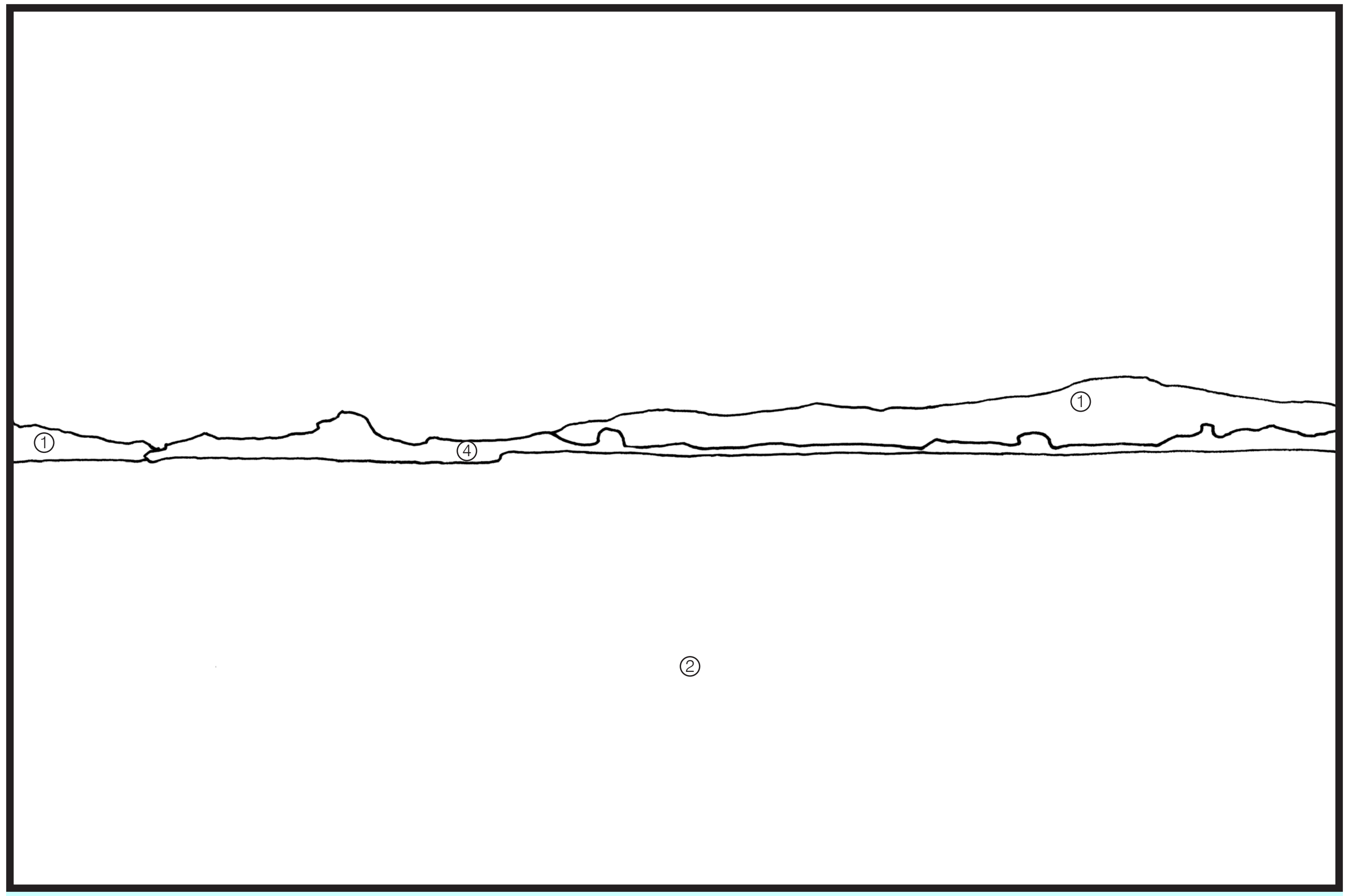
## *Assessment & Results - Post-Change Scenic Preference Rating (SPR)*

Results table measured area (ImageJ software) to percentages

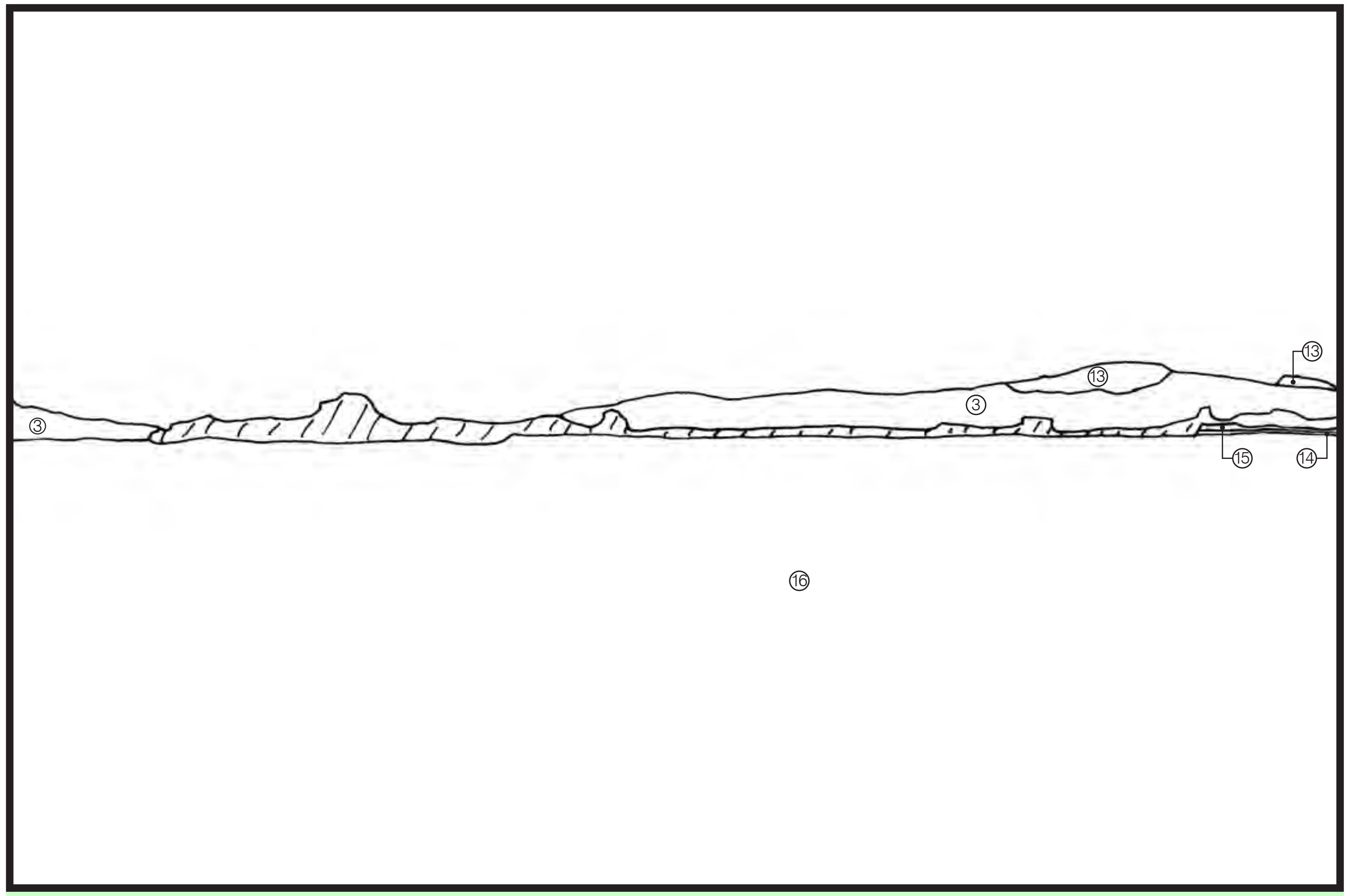
| | | area in cm2 | percentage |
|---|---|---|---|
| Visual Domains | 1. bush | 5.24 | 5.11% |
| | 2. coast | 94.42 | 92.14% |
| | 3. rural | | 0.00% |
| | 4. urban | 2.81 | 2.74% |
| | TOTAL (cm) | 102.47 | 100.00% |
| | | | |
| Natural | 3. euc forest etc. | 4.56 | 4.45% |
| | 13. rock | 0.55 | 0.54% |
| | 14. sand | 0.07 | 0.07% |
| | 15. trees planted | 0.09 | 0.09% |
| | 16. water bay | 94.62 | 92.31% |
| Built | 1. buildings low - non res | 1.6 | 1.56% |
| | 2. buildings med - high | 0.72 | 0.70% |
| | 20. built misc - port tarmac | 0.29 | 0.28% |
| | TOTAL (cm) | 102.5 | 100.00% |



Built - Post-Change



Visual Domains - Post-Change



Natural - Post-Change


# Port Expansion Project EIS

## Appendix S2
## Obtrusive Light Study

AECOM BMT WBM

Port of Townsville Limited
15 October 2012
Document No. 60161996-RE-POT-EL-0001_0

# Townsville Port Expansion EIS

## Obtrusive Light Study

# Townsville Port Expansion EIS

Obtrusive Light Study

Prepared for

Port of Townsville Limited

Prepared by

**AECOM Australia Pty Ltd**
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ABN 20 093 846 925

In association with

Steve Hare

15 October 2012

60161996

AECOM in Australia and New Zealand is certified to the latest version of ISO9001 and ISO14001.

# Quality Information

Document Townsville Port Expansion EIS

Ref 60161996

Date 15 October 2012

Prepared by Steve Hare

Reviewed by Rick Morrison

Revision History

| Revision | Revision Date | Details | Authorised | |
|---|---|---|---|---|
| | | | Name/Position | Signature |
| 0 | 2/8/11 | For Information | Rick Morrison Principal Lighting Engineer | |
| A | 15-Oct-2012 | Final Copy | Rick Morrison Principal Lighting Engineer | |
| | | | | |
| | | | | |

# Table of Contents

# Executive Summary

The Port of Townsville has commissioned an environmental impact study (EIS) for the proposed expansion of the port facility.  Part of the EIS is to assess the visual impact of the proposed port expansion's lighting installation.

In order to carry out the assessment, an indicative design of how the port expansion could be lit was created and the resultant light spill measured from this.

# 1.0 Scope

The purpose of this component is to calculate what impact the lighting installation will have on the surrounding area to the port. To facilitate this process, A schematic lighting layout has been produced which is a guide to the possible layout of lighting within the stages of the reclamation and expansion project. This schematic design has been studied under the Australian Standard for the Control of the obtrusive effects of outdoor lighting (AS4282-1997) and the impact on both residential and commercial properties is tabled herein. The results of the Obtrusive Lighting Study provide for categories of obtrusiveness, characterised as – beneficial, negligible, low, moderate, high, and very high. The likelihood and duration has also been considered and from this it can be deduced whether the level of obtrusive light is expected to be acceptable, or whether the spill light needs to be monitored or mitigated.

# 2.0 Environmental Impacts

Lighting, in its very essence, is there to be seen, but the wrong influence in the wrong place can be detrimental to an area, opposed to being a benefit and can become a nuisance to those affected by it. Light can be defined as 'Obtrusive' in a number of ways. It can light areas that should be dark i.e. direct illumination of bedrooms or other areas where light is not wanted. Outside of the residential environment, poorly designed lighting installations can cause disruption to traffic routes by means of glare disabling a driver or pedestrian's view of the route ahead. There is also the effect of 'sky glow' too. This is the spill of light from luminaires into the sky, which lightens the sky and impacts upon astronomical observations.

Lighting can also cause concern in areas where the inhabiting nature are sensitive to light. Some species require a level darkness in order to procreate. If this is the case, local conservationists can advise on what measures should be taken to minimise the effects on the local wildlife.

Outside of night time hours, lighting installations can still have negative impacts upon an environment. They can be viewed negatively if the columns used are too tall for its surroundings or are simply indiscrete in their nature and are detrimental to the aesthetic appeal of an area.

In terms of lighting a port, it is generally the night time effects that can be the problem. Ports by their very nature harbour many large towers, cranes, warehouses, ships and container stacks, so the lighting columns do not stand out during daylight hours. Concern must be given to the lighting installation to minimise the effects mentioned above so the environmental impact is reduced.

# 3.0 Lighting Model

## 3.1 Design Assumptions

The lighting model has been based on the general layout plan for the port expansion. All buildings have been assumed to be 10m high. This results in a worst case scenario as the increased shadowing effects from the taller buildings will in turn require more lighting stations to suitably illuminate the necessary areas.

All areas have been designed to have a maintained average illuminance of 20Lux in accordance with the recommendations of CIE129-1998. The results achieved are comfortably over the specified level of 20Lux, thus resulting in a worst case scenario being considered.

## 3.2 Lighting Equipment

While the existing port lighting is understood and documented, at this stage, the lighting equipment that will ultimately be used can only be assumed. The validity of the results is therefore dependent upon the equipment installed. It should be noted that the selection of the lighting equipment has a large impact on its effectiveness and suitability to reduce obtrusive light.

The lighting model produced uses two types of lighting arrangement; 15m light poles with a standard, functional road luminaires and asymmetrical floodlights mounted at 25m high with 2000W lamps. The luminaires used in the model are typical of those used at present in port

### 3.3 Calculations

A model of the expansion has been created using lighting software AGi32 v2.2. Calculation grids were placed on the nearest boundaries of the surrounding area that could be affected by spill light. These boundaries were formed by the shipping channel and the adjacent, existing port area. A calculation grid was also added at the nearest residential boundary to measure the potential impact on local residents.

# 4.0 Results of the Lighting Model

The results of the lighting model calculations indicate that there is no major or considerable impact upon the surrounding area from the lighting installation. With the nearest residential properties being almost 2km away, the vertical illuminance measured at those boundaries was 0Lux. The shipping channel was only slightly brighter with a maximum vertical illuminance of 0.1Lux. The adjacent port experienced the most light spill, with a maximum of 17Lux at any one point. This is measured within the existing industrial grounds of the client's grounds.

Two extracts from AS4282-1997 (**Tables 2.1 and C1**) detailing the stipulated lighting levels for the measurement of obtrusive light are shown below.

From these tables it is clear that the expected light spill on residential properties is well within the recommended maximum levels of vertical illuminance.

The maximum vertical illuminance of 17Lux measured at the port boundary is over the prescribed level of 5Lux at commercial windows during curfew hours. It should be noted that this is only applicable for residential buildings on commercial grounds. It should also be noted that at detail design stage with more exact data the lighting design can be tailored to suit the surrounding area to minimise obtrusive light.

## TABLE 2.1

## RECOMMENDED MAXIMUM VALUES OF LIGHT TECHNICAL PARAMETERS FOR THE CONTROL OF OBTRUSIVE LIGHT

(See Clause 2.7)

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | | Recommended maximum values | | |
| **Light technical parameter** | **Application or calculation conditions (see also Figure 2.1 and Section 5)** | **In commercial areas or at boundary of commercial and residential areas*** | **Residential areas** | |
| | | | **Light surrounds†** | **Dark surrounds‡** |
| Illuminance in vertical plane ($E_v$) | *Pre-curfew:* Limits apply at relevant boundaries of nearby residential properties, in a vertical plane parallel to the relevant boundary, to a height commensurate with the height of the potentially affected dwellings. Values given are for the direct component of illuminance | 25 lx | 10 lx | 10 lx |
| | *Curfewed hours:* Limits apply in the plane of the windows of habitable rooms of dwellings on nearby residential properties. In the absence of development (i.e. vacant allotment), the limits apply on the potentially affected property, in a vertical plane parallel to the relevant boundary, at the minimum setback permitted for a dwelling, to a height commensurate with land use zoning provisions. Values given are for the direct component of illuminance | 4 lx | 2 lx | 1 lx |
| Luminous intensity emitted by luminaires ($I$) | *Pre-curfew:* Limits apply to each luminaire (irrespective of the number on a head frame) in the principal plane, for all angles at and above the control direction, when aimed in accordance with the installation design | Limits as determined from Table 2.2. Alternatively, the limits and method of assessment associated with curfewed hours may be applied, at the discretion of the designer (see Clauses 2.7.1 and 2.7.2) | | |
| | *Curfewed hours:* Limits apply in directions where views of bright surfaces of luminaires are likely to be troublesome to residents, from positions where such views are likely to be maintained, i.e. not where momentary or short-term viewing is involved | 2 500 cd | 1 000 cd | 500 cd |
| Threshold increment ($TI$) | Limits apply at all times where users of transport systems are subject to a reduction in the ability to see essential information. Values given are for relevant positions and viewing directions in the path of travel | 20% based on adaptation luminance ($\bar{L}$) of 10 cd/m$^2$ | 20% based on adaptation luminance ($\bar{L}$) of 1 cd/m$^2$ | 20% based on adaptation luminance ($\bar{L}$) of 0.1 cd/m$^2$ |

* Applies to residential accommodation in commercial areas or at the boundary between commercial and residential areas. The term 'commercial' is used as a generic description for zoning which provides for urban uses other than residential.

† Where the affected property abuts roads that are lit to Category V5 or higher in accordance with AS/NZS 1158.1.1.

‡ Where the affected property abuts roads that are lit to Category B1 or lower in accordance with AS 1158.1, or where there is no lighting.

TABLE C1

RECOMMENDED MAXIMUM PERMISSIBLE VALUES OF VERTICAL ILLUMINANCE ($E_v$) ON WINDOWS OF DWELLINGS ARISING FROM LIGHTING (EXCEPT ROAD LIGHTING) DURING HOURS OF DARKNESS (After Ref. 6)

| Location | Maximum $E_v$, lx | |
|---|---|---|
| | 0600 h to 2200 h | 2200 h to 0600 h |
| Health services and residential areas | 1 | 1 |
| Mixed areas | 3 | 1 |
| Central, business and industrial areas | 15 | 5 |

# 5.0 Risk Assessment

## 5.1 Magnitude of Impact

As the lighting installation specification is not known at this point, it can not be definitely said what impact the lighting will have. Depending on how well the installation is designed, the lighting will fall under the magnitude of minor to moderate impact. A design using full cut-off luminaires and asymmetrical floodlights with zero tilt angle i.e. the protective glass installed parallel to the ground, will result in minor risk. If luminaires with curved protective glass are used and floodlights that need to be aimed in the azimuth plane, the risk may then become moderate. The effects will only be localised, so the affect will not be higher than this.

## 5.2 Likelihood of Impact

The port lighting is required for any night time, dusk and dawn activities to be carried out safely once the port is in operation. It is almost certain that work will be carried out during these times, therefore, the likelihood is classed as almost certain.

## 5.3 Duration

The lighting installation is likely to be installed for as long as the port is operational. It is impossible to predict how long the port will be in operation for, but it will be well in excess of 5 years, and in modern terms, a permanent installation. The lighting equipment on the other hand will have a service life of approximately 20-25years, depending on equipment selection. Therefore, the impact has been considered as long term opposed to permanent.

### 5.4 Summary

| Value/ Element | Description of Impact | | | | Summary of Key Mitigation Measures | Residual Risk |
|---|---|---|---|---|---|---|
| | Primary Impacting Process | Magnitude of Impact | Likelihood of Impact | Risk Rating (before mitigation) | | |
| Port Expansion Exterior Lighting – including access roads | Obtrusive light on surrounding area | **Minor to Moderate** – Possible light intrusion to existing port buildings and visual line of site to residences | **Almost Certain** | Medium-high | Luminaires to be of full cut-off and flood lights to be asymmetric type. Luminaires should be installed with protective glass parallel to the ground | **Medium** |

# 6.0 Conclusion

It is clear that the port expansion lighting, based on this model and its assumptions will not cause a considerable impact upon the surrounding environment. Nevertheless, if the wrong equipment is used or the design is not carried out with due care the impact on the local environment may become a concern. It is, therefore, imperative that a professional engineering firm is employed to minimise the impact of the lighting on the surrounding environment.


# Port Expansion Project EIS

**Appendix T1**

**Trade Forecast Report**

AECOM BMT WBM

Deloitte Access Economics

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# Port of Townsville Trade Outlook

## Port of Townsville Limited

## 2 April 2012

# Contents



# Glossary

| | |
|---|---|
| ABARES | Australian Bureau of Agricultural and Resource and Economics and Sciences |
| BITRE | Bureau of Infrastructure, Transport and Regional Economics |
| BREE | Bureau of Resources and Energy Economics |
| DAE | Deloitte Access Economics |
| mtpa | million tonnes per annum |
| OECD | Organisation for Economic Cooperation and Development |
| PEP | Port Expansion Project |
| POTL | Port of Townsville Limited |

# 1 Summary

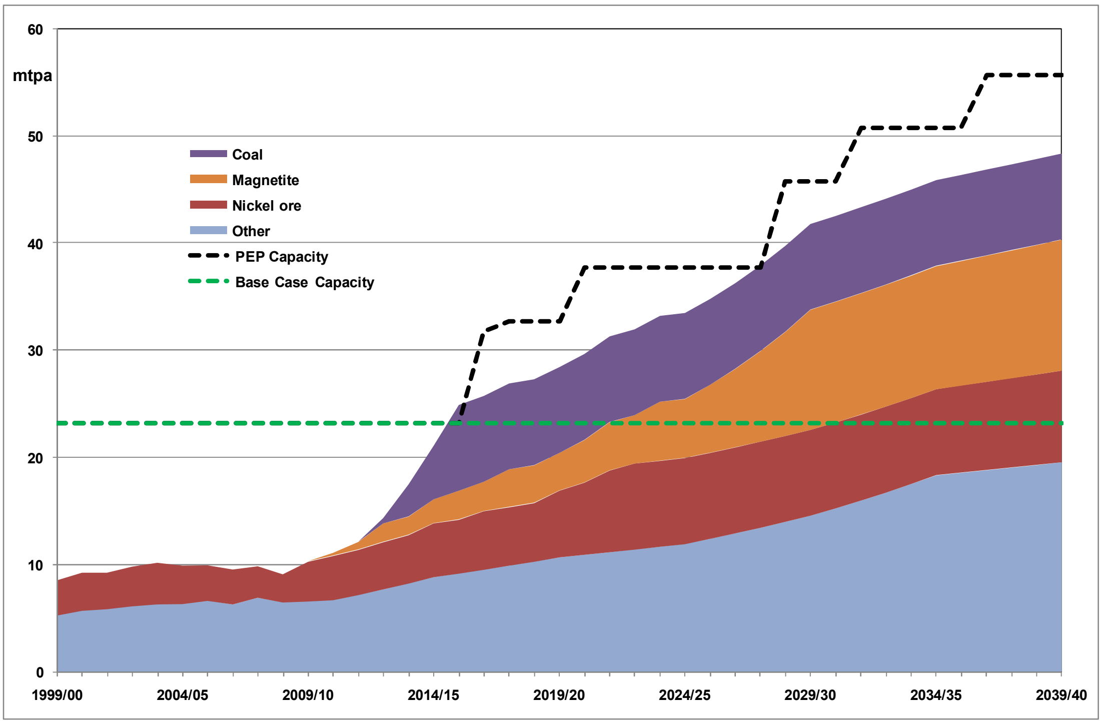
The Port of Townsville Limited (POTL) has prepared trade forecasts to 2039/40 fiscal year, which underpin the need for the Port Expansion Project (PEP). Deloitte Access Economics (DAE) has conducted a review of the forecasts maintained by POTL, focusing on the economic factors and global economic outlook underpinning the forecasts.

The forecasts are based on a detailed assessment of individual resource projects, particularly in nickel, magnetite, copper, coal, and fertilizer, being developed by several major resource companies. Supporting the forecasts summarised here is a detailed mine-by-mine analysis of port capacity needs. The export of magnetite is a trade that has recently been introduced to Townsville following several magnetite mine developments. The coal export trade could be a possible new trade, which may be developed at Townsville to handle coal exports from the northern end of the Galilee Basin.

The result is that the port's current trade of 11 million tonnes per annum (mtpa) in 2010/11 is expected to more than double to nearly 25mtpa in the near future once the new mines are developed and commence exporting. This will exceed the current capacity of the port, which is approximately 23mpta in the EIS base case, as shown in Chart 1.1. The base case includes some capacity-increasing projects currently underway (such as the dual conveyor for Berth 11, and Berth 12) but excludes the additional capacity that would be created by the PEP. Chart 1.1 summarises the POTL trade forecasts, base case capacity and PEP capacity, which would be delivered in several stages over the next three decades.

The timings shown in the chart, of each stage of the PEP capacity expansions and the commencement of new trades, are indicative for the purposes of illustrating the potential development of the port. The exact timing of when new trades will commence and when future new capacity will come on line will depend on a range of factors, such as the development and approval of new mines in the Northern Economic Triangle region.

### Chart 1.1: POTL trade forecast versus current and proposed capacity




*Source: POTL, AECOM*

Trade is expected to be around triple the current volume – 33.4mtpa – by 2024/25. By the time trade reaches this level of 33.4mpta, the major components of total port trade would be:

- Coal exports, 24% of total.
- Nickel ore imports, 24% of total.
- Magnetite exports, 16.5% of total.
- Fertilizer exports and fertilizer component imports, 10.5% of total.
- Other mineral concentrate exports (eg copper, lead, zinc, cobalt), 9.5% of total.
- Sugar and molasses, which currently comprise 13% of total trade, are expected to decline to a 4% share. This is due to the resource trades growing and diluting the share of agricultural products passing through the port as a per cent of the port total, not because of any expected reduction in the export tonnage of sugar and molasses.
- General cargo is expected to account for 1.5% of the total tonnage passing through the port in 2024/25.

POTL is well-positioned to handle coal exports from the northern end of the Galilee Basin, reducing rail and ship travel distances to the nearest alternative port at Abbot Point.

A risk to the forecasts is the concentration of total trade in three commodities: nickel, coal and magnetite. By the time trade reaches 33.4mtpa in 2024/25, nearly two-thirds of total tonnage is expected to be in these three commodities. That noted, in the resources sector, it is common to see ports handling large volumes of a small number of commodities (often only one commodity), so in many respects, POTL is more diversified than most other bulk ports, and it also handles trades such as motor vehicles and general cargo.

Other general risks, not specific to Townsville but relevant for all resource-driven projects, are: a softening in the outlook for China; and, the impact of policies to address global warming. These risks could cause trade growth for key Townsville commodities to be lower than currently expected. Equally, it is also possible that continued strength in China could result in additional ore deposits in the region (not currently included in the forecasts) being developed, particularly magnetite, coal, and other ores, resulting in higher port throughput than currently expected. Increasing interest from India, and the (so far) modest impact on coal export growth from recent climate change policy announcements, mitigates these risks.

The timing and staging of the port expansion allows some flexibility in meeting future trade demand. Once the initial sea wall phase of construction is complete, there is some flexibility in the timing of later stages depending on when future resource projects commence. As such, POTL can adjust the timing of later stages of capital expenditure, if actual trade growth turns out to be more rapid than forecast.

*In summary, the strong demand from China and India for North Queensland's resource exports is driving the development of new mines along the Townsville-Mt Isa corridor, which in turn, are serviced by the Port of Townsville. Based on our review of the POTL forecasts, economic factors and global outlook, the forecasts are a reasonable basis for planning purposes and for the EIS purpose of estimating impacts. The PEP results in sufficient capacity being delivered ahead of expected demand, avoiding bottlenecks or capacity constraints at the port from impacting on trade growth opportunities, and sufficient flexibility to accommodate demand, if trade growth driven by the mining boom is more rapid than expected.*

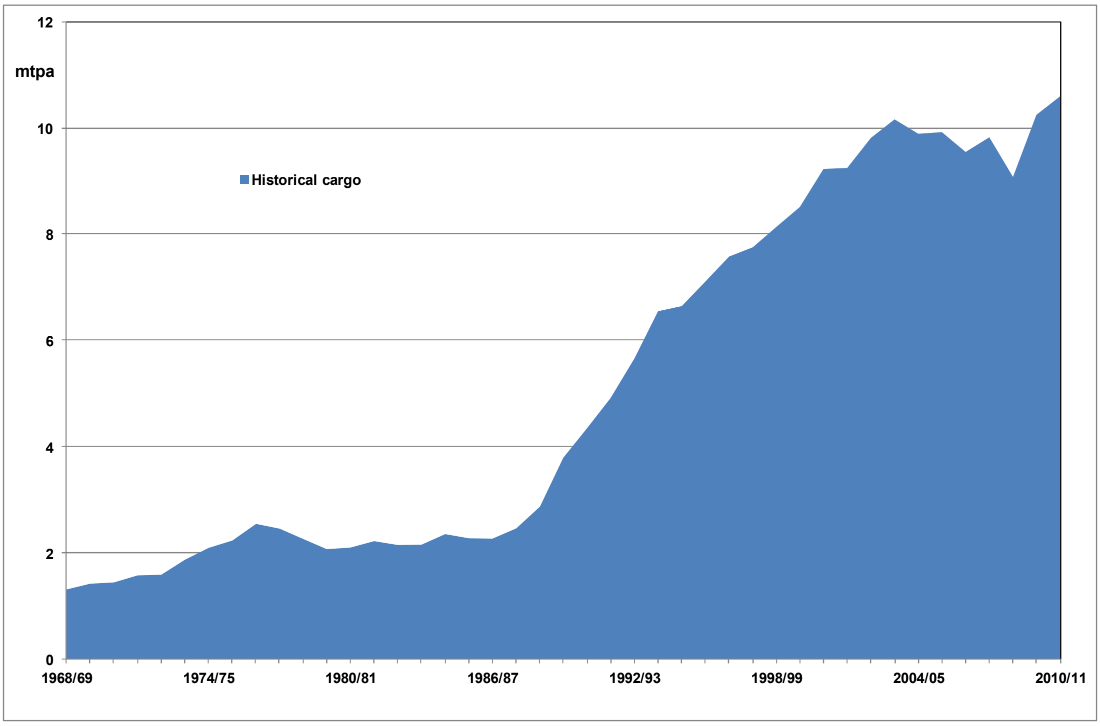
# 2 Port of Townsville trade profile

## 2.1 Background

The Port of Townsville Limited (POTL) is a state government owned corporation that serves as the primary port for the import and export of general cargo, motor vehicles, molasses, oil and bulk commodities in north and northwest Queensland. Trade through the port has increased dramatically over the past 25 years – in the mid 1980s trade had averaged around 2.3mtpa. Trade increased rapidly in the mid-1990s following the commencement of nickel ore imports. From 2000/01 to 2008/09, trade was in the range 9.1mtpa to 10.2mtpa. Chart 2.1 summarises historical trade tonnage.

During the 2010/11 financial year, a record 10,601,136 tonnes of cargo passed through the Port of Townsville, which was an increase of 3.4% on the previous year's results. This performance is attributed to a number of factors such as the economic recovery of Townsville, enhanced production and capacity in local refineries and mines along with the underlying increase in demand for commodities. Based on a combination of methods (reviewed in a later section) POTL is predicting growth to increase in the future.

### Chart 2.1: POTL historical cargo volumes

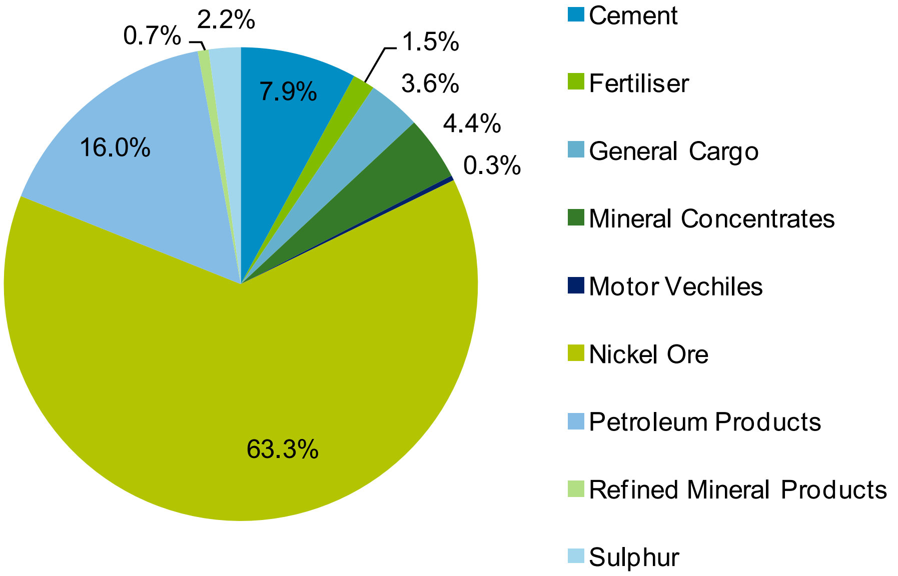


Townsville has a unique mix of commodities compared with other resource-endowed regions in Australia. This fact is illustrated in the POTL trade composition, which is currently dominated by nickel ore, fertiliser, cement, petroleum products, mineral concentrates, general cargo and sugar. Currently, the resources sector represents approximately 96% of Townsville's imports and 76% of exports. Nickel ore is the largest volume import (63.3% of total import tonnage in 2010/11), with the other two significant import volumes being petroleum products (16.0%) and cement (7.9%).

Based on 2010/11 tonnage, the largest export commodities are mineral concentrates (35.2% of total export tonnage) followed by sugar (20.3%), fertiliser (17.5%), and refined mineral products (17.5%). In addition, Townsville has become the first port in Queensland to export magnetite concentrates when Xstrata recently completed its local facility.

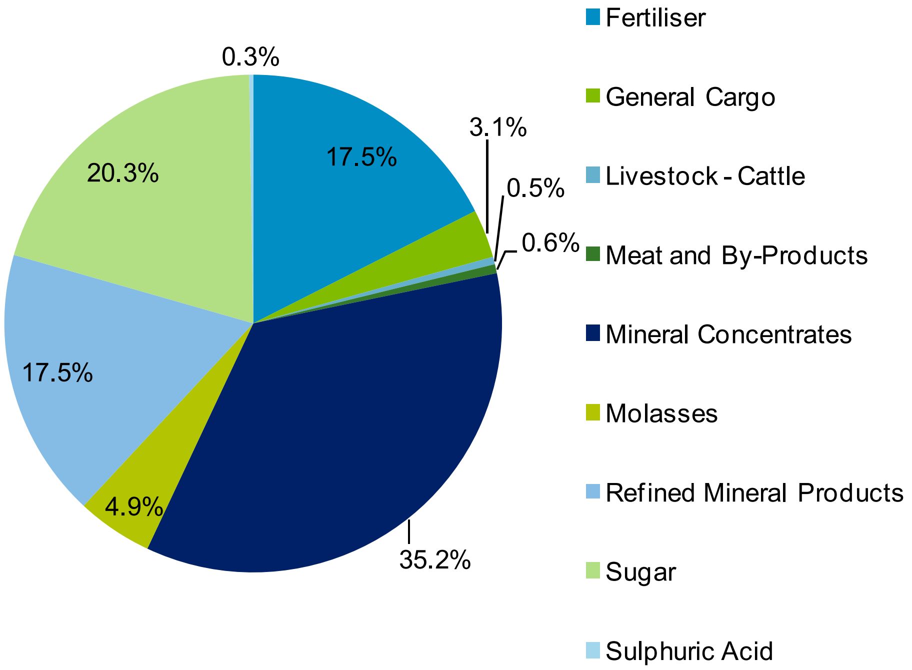
The port currently has 55% of total trade as imports (due to the large nickel ore import trade) and 45% of total trade as exports. Over time, exports are expected to grow more strongly than imports (in turn, due to resource projects), so that when trade reaches 33.5mtpa by around 2026/27, exports are expected to become 54% of the port's total trade, with imports 46% of the total.

### Chart 2.2: Port of Townsville import composition 2010-11




Source: POTL, Trade by commodity statistics

### Chart 2.3: Port of Townsville export composition 2010-11




Source: POTL, Trade by commodity statistics

# 3 Economic overview

Consistent with the trade composition of POTL, the outlook focuses on the key resource commodities of nickel ore, iron ore, copper, zinc, coal and fertiliser. Iron ore is used as a proxy for magnetite in some of what follows, since magnetite is a relatively new and emerging input into steelmaking, and the global demand for iron ore is likely to be a reasonable proxy for other steelmaking inputs (noting that magnetite is also used for coal washing, so the coal outlook is also relevant for magnetite).

The global economic outlook will be analysed followed by a view on the Australian economy. The dynamic nature of Australia's commodity sector will also be highlighted with particular reference to the port's key commodities.

Macroeconomic factors such as economic growth rates along with industrial production growth rates provide insight in the likely demand growth for many industrial commodities. Of particular relevance are the macroeconomic indicators of Australia's major trading partners so that future sources of commodity demand can be identified. Where the export of resource commodities relevant to POTL are concerned, Australia's current major trading partner is China, with India seen as a potential market to increase demand for commodities in the near future.

## 3.1 Global economic outlook

### 3.1.1 Short-term global outlook

Since 2000, emerging economies have been the key driver of world economic growth with the short-term outlook remaining positive. Reforms over previous decades have opened up countries such as China and India, transforming rural, agrarian economies into manufacturing and export-oriented powerhouses. In comparison, export performance in many other developing Asian economies is expected to slow in response to the weaker growth in demand from developed economies. In addition, the materialisation of inflationary pressures, particularly in non-OECD Asia, is expected to lead to lower economic growth as regional governments and central banks tighten fiscal and monetary policies. As a whole, economic growth for developing economies is assumed to average 6.4% in 2011, following growth of 7.3% in 2010[1].

On the other hand, the economic growth of major OECD countries is predicted to be slower, mainly due to weak private sector demand in these economies over the short term. Such an outcome reflects pressure to reduce budget deficits and public sector debt through a combination of spending cuts and increased taxation. The end of stimulus packages implemented during the global economic downturn in 2009, combined with high levels of unemployment and weak property markets have

[1] IMF World Economic Outlook September 2011, available at: http://www.imf.org/external/pubs/ft/weo/2011/02/weodata/index.aspx

all contributed to restrain consumer spending. As a result, economic growth for the OECD region overall is assumed to moderate to 1.9% in 2011, from 3.1% in 2010.[2]

In this setting, world economic growth is assumed to be 4.0% in 2011, following growth of 5.1% in 2010.[3]

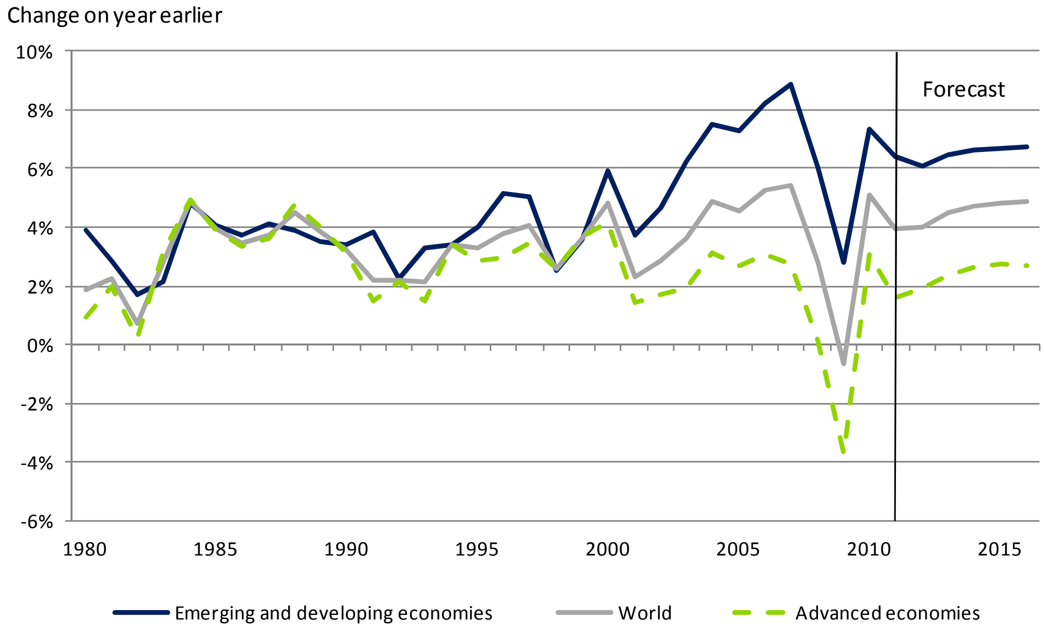
### 3.1.2 Medium-term global outlook

Looking ahead, economic growth for developing countries is assumed to be relatively strong over the medium term to 2015-2016. Despite weak foreign demand, domestic demand in non-OECD Asia is expected to be robust due to intraregional trade and investment flows that will continue to spur economic growth. Economies in Africa, the Middle East and Latin America are also predicted to maintain significant growth in the foreseeable future. For developing countries as a whole, economic growth is assumed to strengthen to 6.7% a year in 2016.[4]

Contrastingly, many governments in OECD economies, particularly in Western Europe, are reconsidering spending commitments along with implementing measures to reduce sizable budget deficits. These measures will depress economic growth in the next several years, as government spending declines and taxes increase. Projections from the International Monetary Fund indicate that in the absence of any concerted efforts for debt reduction, these economies may be perceived by financial markets as risky investment locations. The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) suggests that such views will result in subdued inflows of foreign investment, rising real interest rates and a substantial devaluation of their currencies. In light of this, OECD economic growth is assumed to settle at an annual rate of around 2.8% in 2016.[5]

[2] OECD Economic Outlook 90 (November 2011), available at: http://www.oecd.org/document/18/0,3746,en_2649_33733_20347538_1_1_1_1,00.html#Stats
[3] IMF World Economic Outlook September 2011, available at: http://www.imf.org/external/pubs/ft/weo/2011/02/weodata/index.aspx
[4] Ibid.
[5] DAE forecast

**Chart 3.1: Global economic growth**




Source: IMF *World Economic Outlook*, September 2011

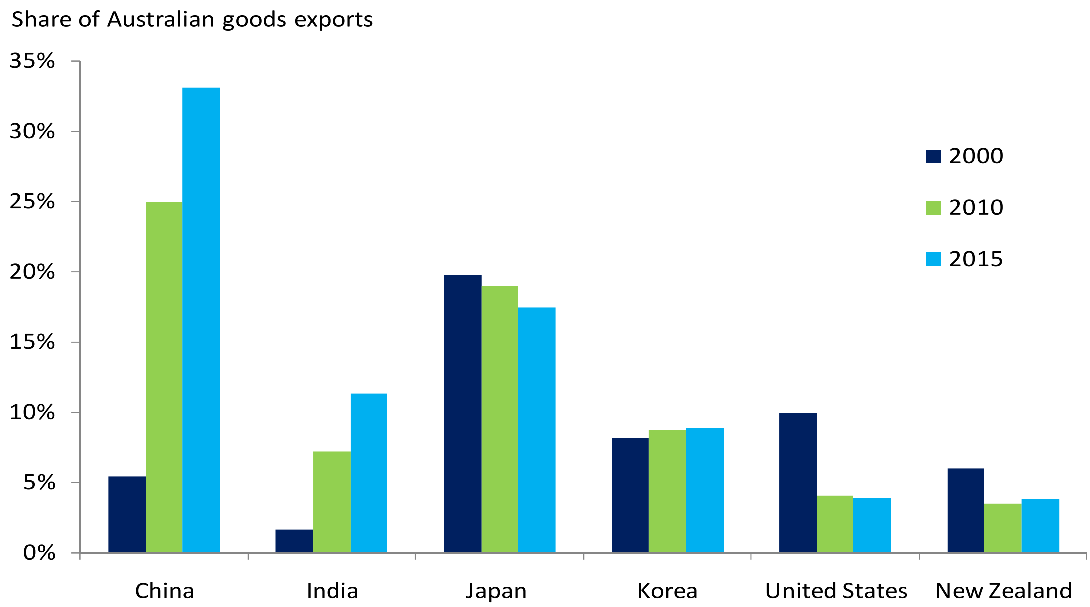
The above chart illustrates the ongoing importance of emerging economies to global growth. Over the next five years, the IMF expects economic growth in emerging and developing countries to exceed growth in advanced countries by approximately 4 percentage points per year. Strong emerging economy growth, particularly in China and India will continue to benefit Australia.

# 3.2 The Australian Economy

Australia's economy is predicted to maintain its status as one of the fastest growing OECD nations in 2010/11, driven by farming and mining production. Over the last decade, Australia's ratio of export prices to import prices has increased 65%. The associated surge in national income has led to strong economic growth in a number of areas leading to skills shortages. On a relative scale, wages, inflation and interest rates have also risen, propelling the Australian dollar to appreciate to record highs against most other currencies, and in trade-weighted terms.

Importantly for Australia, economic growth and development in China is expected to continue over the coming decade. The twin process of industrialisation and urbanisation will support strong demand for Australian resources. While India's service-oriented economy is not considered to be the next China, it is likely to offer export opportunities for Australia. In particular, demand for high-value agricultural goods and services is expected to rise substantially over the medium to long term as India experiences rapid and sustained income growth. In 2015 the share of Australian exports to China is predicted to increase to 33.1%, from 25.0% in 2010. Similarly, the share of Australian exports to India is projected to increase to 11.3% in 2015 compared with 7.2% in 2011. The export shares of some of Australia's key trading partners are shown in Chart 3.2.

### Chart 3.2: Destinations of Australian exports




Source: Australian Bureau of Statistics, IMF

In the short term, the Australian Treasury has estimated that the nation's economy is to grow at an average rate of 3.25%.[6] This is an increase from the 2.10% expansion in 2010/11 due to growth being driven by mining related investment and supported by encouraging private sector demand. Over the medium term economic growth is expected to be moderated in some part due to the Government's pledge to return the budget to surplus by 2012/13. This pledge is now significantly harder to fulfil due to the unexpected government spending required to assist the re-building of flood and cyclone affected areas in Queensland and Victoria and lower than expected revenue collection. In light of such fiscal constraints, it is estimated that in the medium term Australia's economic growth will remain at around 3.25% in 2015/16.[7]

# 3.3 Commodity sector outlook

There are numerous sources of forecasts for metals and bulk mineral commodities, however many focus on the short-term outlook for spot prices and other short-term influences on markets, such as the London Metal Exchange. Short-term fluctuations in commodities prices and demand (for example, due to bad weather or earthquakes) tend not to have much relevance to long-term port planning. Of greater relevance is the underlying long-term demand growth in commodities by emerging countries, particularly China.

ABARES and BREE publishes long-term outlook for key commodities.[8] Short term is defined as the time period over the next 12 months; medium term refers to the

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[6] Australian Treasury, Mid Year Economic and Fiscal Outlook 2011
[7] DAE forecast
[8] ABARES, 2012, Australian Commodities, March quarter. Available: www.abares.gov.au/. BREE, 2012, Resources and Energy Quarterly, March quarter. Available at: www.bree.gov.au/ .

next five years of the outlook period ranging from 2011/12 to 2015/16 and long term thereafter. Further details on individual commodities are available in the ABARES and BREE reports.

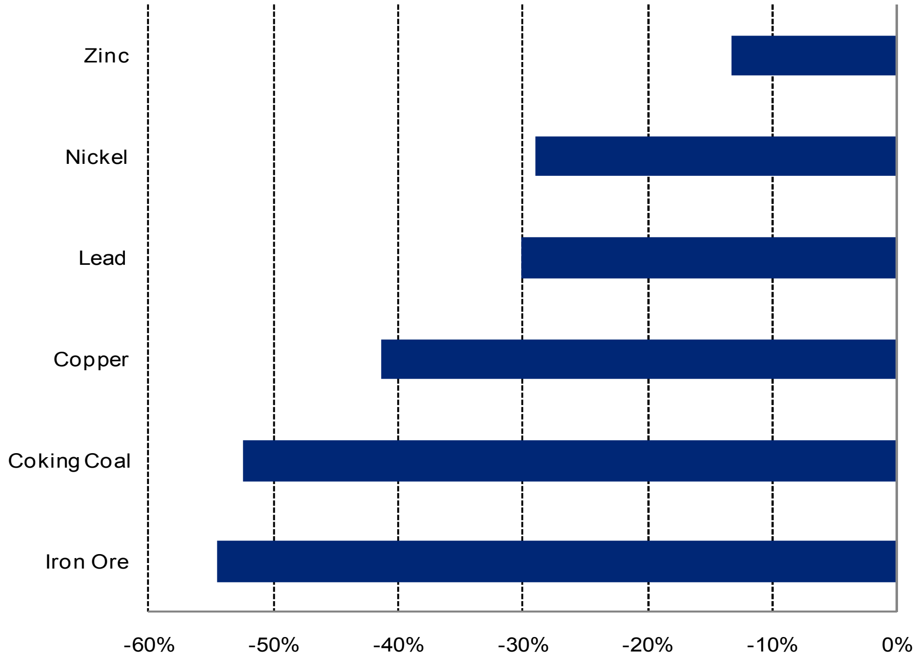
### 3.3.1 Commodity prices

Given that China and India together account for almost 37% of the world's population, both nations' current phase of industrialisation is having a pronounced impact on demand for base metals and coal, as they are key inputs into manufactured goods and large scale infrastructure projects. The resultant surge in industrial commodity demand is best illustrated by China's share of global steel production lifting from 16% in 2003 to 50% in 2009. Over the same period, global steel output rose 55%. Considering China is expected to crave commodities for some time yet, and that India is still set to hit its straps, this provides good news, at least in the medium term, for continued minerals exports from POTL, and the possibility of establishing a coal trade.

Notably, while consumption of these metals and coal are clearly expected to rise, in the long term there is a downward trend in relative mineral prices. This is because commodity prices are determined through interactions between supply and demand. The resource boom of the past few years had been caused by greatly unanticipated demand increases that were met with slow responses in supply. In addition, as supply was gradually increased to reach capacity, the marginal costs of production were raised sharply. However, since then, there have been large scale government and private investments made in the mining sector to enhance capacity and improve infrastructure. The fruits of existing and impending investments are expected to be realised in the medium term. In accordance with the increase in supply, commodity prices are expected to revert back to the historic trend in the long run. Therefore the associated forecasts of the export value to the Australian economy must be adjusted down to incorporate this phenomenon.

This is a widely held view. A survey undertaken by Consensus Economics asks respondents' views on where real commodity prices will move in the long term, relative to current spot prices. The commodities used in this graph represent those most relevant to POTL (and using iron ore as a proxy for magnetite). As Chart 3.3 displays, Australia cannot expect to enjoy today's high prices of its exported resource commodities forever. That noted, port throughput and capacity is driven by the volume rather than the value of the cargo – the next section examines volumes.

**Chart 3.3: Long run change in real (inflation adjusted) commodity prices**




Source: Consensus Economics, 18 April 2011

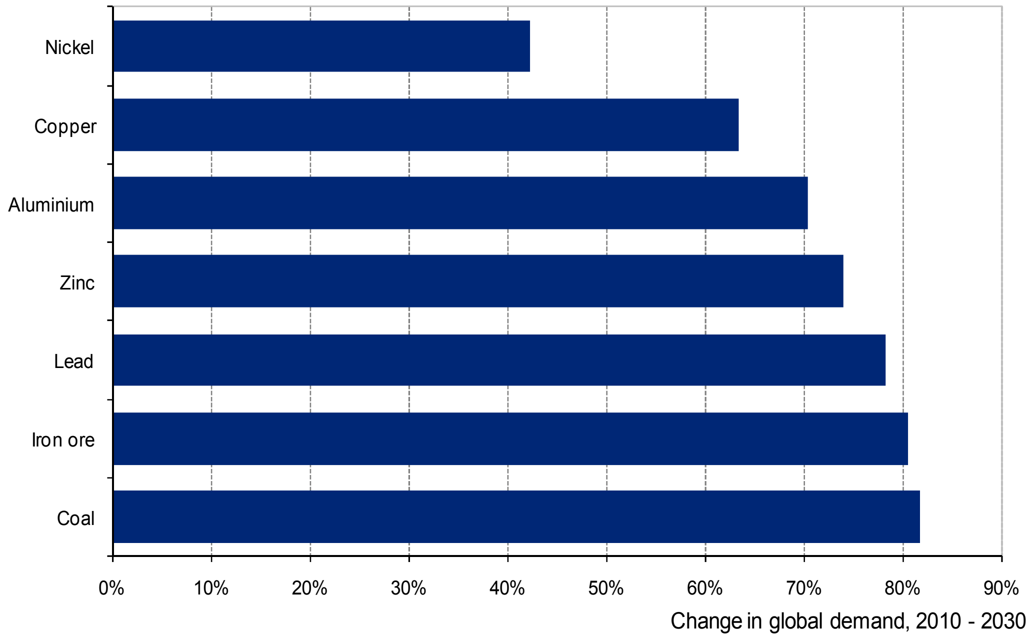
### 3.3.2 Commodity demand

By analysing the link between income per capita and demand for various industrial commodities, DAE has projected growth in commodity demand to 2030. The total increase in global consumption across selected commodities is shown in Chart 3.4, below. Global consumption is expected to rise by between 42% and 82% over the next two decades, with iron ore and coal projected to experience the largest increases in demand. Specifically for POTL, major trades such as nickel and copper are forecast to see the least growth of the commodities, albeit still considerable growth compared with other (non-resource) sectors of the economy. Magnetite (proxied by iron ore) and coal are expected to be the strongest growing commodity trades.

## 3.4 Other sources of port forecasts

As a further cross-check on the POTL forecasts, DAE reviewed other sources of port throughput forecasts.

**Chart 3.4: Forecast growth in global commodity demand, 2010 – 2030**




Source: ABARES, Deloitte Access Economics

The Bureau of Infrastructure, Transport and Regional Economics (BITRE) produces forecasts of trade at the five major Australian containerised ports, out to 2029/30.[9] For non-containerised trade (which includes bulk minerals, but also oil, vehicles, livestock and other commodities), the BITRE provides a forecast of trade for all other Australian ports combined.

As part of the Commonwealth Government's National Ports Strategy, the BITRE is developing an enhanced port forecasting capability, with forecasts for more ports outside the five major capital city ports, but the outputs from that research are not expected until 2012.

In 2009/10, non-containerised trade at Australian ports (excluding the five major capital city ports) was 699.6 million tonnes and the BITRE expects this to increase to 1,365.2 million tonnes by 2029/30. This implies an average annual growth rate of around 3.5% over the next two decades.

This view is repeated in the "MITEZ 50-year freight infrastructure plan" by Juturna Consulting. Juturna Consulting proposes that the gross value added of the Mount Isa to Townsville economic region will grow between 2.9% and 4.6% per year until 2050. Similarly the transport sector is expected to grow between 2.6% and 4.1% per year, providing an increase in gross value added from $525 million currently to between $1.4 and $2.4 billion in 2050.

[9] BITRE, 2010, *Australian maritime activity to 2029–30*. Available: www.bitre.gov.au

# 4 Townville trade forecasts

This section reviews the methods used and resulting trade forecasts for the EIS.

## 4.1 Trade forecast method

Deloitte Access Economics has reviewed the POTL forecasts for the port expansion project, dated 12 August 2011.

Tonnage in 2009/10 was 10.25 million. POTL forecasts that trade will reach 33.4 million tonnes by 2024/25 and 48.3 million tonnes in 2039/40 fiscal year.

POTL generated its forecasts based on a project-by-project assessment of resource sector developments. This method was used because growth in overall tonnage at POTL is largely ‘project-driven’ rather than due to ‘endogenous growth’. For example, the historical growth in POTL tonnage seen in the 1990s was caused by the Yabulu Refinery commencing nickel ore imports, rather than by compounding growth in existing trades.

A characteristic of mining projects is that they ramp up quickly to the operating capacity of the mine, then continue to ship a relatively constant tonnage each year during the lifespan of the mine, until it is depleted, or extended.

As such, tonnage at POTL tends to step upwards (rapidly) then plateau, until the next major project commences. This causes the tonnage history and forecast charts for POTL to visually reflect the ‘staircase’ pattern of project-driven growth, rather than the ‘smooth’ pattern of compounding, endogenously-driven growth.

Statistically fitting a trend growth line to POTL historical data would result in long periods of time where the trend line overshoots or under shoots actual tonnage. Hence, a trend growth rate curve is a poor fit to POTL’s historical outcomes.

That is not to say there is zero endogenous growth at POTL. General cargo and oil grow over time in response to growth in the regional economy. However, these tonnages are swamped by the large resource projects, in terms of the composition of total tonnage.

Due to the modest contribution of endogenous growth within total growth, and the poor statistical fit of growth rate methods, the future infrastructure requirements of POTL will almost entirely be determined by major resource projects, and there are some very large new mines currently under development in the Townsville-Mt Isa corridor. As these projects come on line, they will result in sudden and large increases in demand for berths and other facilities at the port. As such, the methodology used by POTL to forecast trade is well-suited to the statistical features of the data, and is a preferable methodology for this type of port, compared with compound-growth-style forecasting methods often used at ports such as capital city container ports.

The project-based forecasts for non-coal trades reach a tonnage of 25.4mtpa, which is anticipated to be achieved by 2024/25.

The introduction of coal exports is expected to add a further 8mtpa to this non-coal forecast. The coal trade is expected to start in 2016 and ramp up quickly to 8mtpa by 2018, resulting in a total of 33.4mpta in 2024/25.

The importance of resource projects in driving POTL tonnage is highlighted by the following:

- Nearly 50% of the non-coal tonnage growth between 2009/10 and 2024/25 (nearly 7.5mtpa) is expected to come from Yabulu more than doubling in size and diversifying into magnetite.
- A further 16.5% of the growth comes from two other magnetite projects – Ernest Henry and Mount Moss.
- In total, around 65% of the future growth in the port is from nickel and magnetite trades.
- Legend Paradise (fertiliser) and Ivanhoe Merlin (copper) contribute a further 20%.

Thus, around 90% of the non-coal tonnage growth expected between 2009/10 and 2024/25 comes from Yabulu, magnetite, fertilizer and copper projects. Hence, growth is highly dependent on resource projects, which in turn relies on commodity prices remaining at levels that ensure these projects are viable. As noted in the previous section, there is continued growth expected in the volume of demand for these commodities, but some easing of commodity prices from their current highs as more supply comes on line.

These projects are all at varying stages of feasibility, construction and commencement.

- Yabulu – potential for expansion, currently assessing the feasibility of expanding and diversifying into magnetite.
- Magnetite – Mount Moss now exporting, Ernest Henry now exporting.
- Fertiliser – Legend is in the approval process and doing feasibility studies.
- Copper – some construction already started at Merlin.
- Coal – several proponents from the Hughenden area are in discussions with POTL about the possibility of handling coal exports.

In short, several of the projects used by POTL in developing its forecasts are underway, and the rest are going through feasibility processes. There have been some doubts expressed about the market for magnetite and establishing long-term customers for magnetite, but some exports have now occurred and it is rapidly establishing itself as an alternative input into steelmaking, and for coal washing. As well as the projects identified, there are other coal and magnetite projects in earlier stages of feasibility assessment.

A large contributor to growth is an expansion of operations at Yabulu. If an expansion does go ahead, then the additional demands on the port for nickel imports would be significant.

In summary, the POTL forecast of 33.4mtpa by 2024/25, while rapid, is underpinned by a number of real projects and the implied growth rate of 8.2% per annum compound growth between 2009/10 to 2024/25, while a high rate, is consistent with a high-case long-term outlook for the commodities in the Townsville-Mt Isa corridor served by the port. As such, the forecasts are a reasonable basis for estimating the environmental impact of the port expansion needed to accommodate this growth, and the associated economic benefits of accommodating that growth.

From a planning perspective, it is important to have in place master plans and the associated environmental approvals, to enable port capacity to be constructed in a timely fashion as demand grows. The lead times for new port infrastructure projects are very long, so new capacity needs to be planned several years ahead of when it is required.

As shown in Chart 1.1, the PEP provides the infrastructure necessary to ensure capacity is provided ahead of demand over the next three decades, thus avoiding the delays, bottlenecks and constraints on trade associated with insufficient port capacity.

## 4.2 Conclusion

The strong demand from China and India for North Queensland's resource exports is driving the development of new mines along the Townsville-Mt Isa corridor, which in turn, are serviced by the Port of Townsville. Based on our review of the POTL forecasts, economic factors and global outlook, the forecasts are a reasonable basis for planning purposes and for the EIS purpose of estimating impacts.

While the forecasts imply a high average per annum growth rate, the growth is generated by several major new mine developments, rather than assumed growth in existing trades. The PEP results in sufficient capacity being delivered ahead of expected demand, avoiding bottlenecks or capacity constraints at the port from impacting on trade growth opportunities, and sufficient flexibility to accommodate demand, if trade growth driven by the mining boom is more rapid than expected.

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# Port Expansion Project EIS

## Appendix U1

## Queensland Approved (and pending approval) Codes of Practice

AECOM BMT WBM

Current (applicable) Codes of Practice:

Abrasive Blasting Code of Practice 2004
Children and Young Workers Code of Practice 2006
Concrete Pumping Code of Practice 2005
Confined Spaces Code of Practice 2011
First Aid Code of Practice 2004
Formwork Code of Practice 2006
Hazardous Chemicals Code of Practice 2003
Hazardous Manual Tasks Code of Practice 2011
How to Manage and Control Asbestos in the Workplace Code of Practice 2011
How to Manage Work Health and Safety Risks Code of Practice 2011
How to Safely Remove Asbestos Code of Practice 2011
Labelling of Workplace Hazardous Chemicals Code of Practice 2011
Managing Noise and Preventing Hearing Loss at Work Code of Practice 2011
Managing the Risk of Falls at Workplaces Code of Practice 2011
Managing the Work Environment and Facilities Code of Practice 2011
Manual Tasks Involving the Handling of People Code of Practice 2001
Mobile Crane Code of Practice 2006
Occupational Diving Work Code of Practice 2005
Plant Code of Practice 2005
Preparation of Safety Data Sheets for Hazardous Chemicals Code of Practice 2011
Prevention of Workplace Harassment Code of Practice 2004
Scaffolding Code of Practice 2009
Steel Construction Code of Practice 2004
Tilt-up and Pre-cast Construction Code of Practice 2003
Tower Crane Code of Practice 2006
Traffic Management for Construction or Maintenance Work Code of Practice 2008
Work Health and Safety Consultation, Co-operation and Co-ordination 2011
First aid in the workplace (2012)
Construction work
Preventing falls in housing construction
Managing electrical risks at the workplace
Managing risks of hazardous chemicals
Managing risks of plant in the workplace
Safe design of structures
Excavation work Demolition work
Spray painting and powder coating
Abrasive blasting
Welding processes
Preventing and Managing Fatigue in the Workplace
Responding to Workplace Bullying


# Port Expansion Project EIS

Appendix U2

## Additional Australian Standards

Relevant[3] Australian Standards:

AS/NZS ISO 31000:2009 – Risk Management – Principles and Guidelines

AS/NZS ISO 14000 (Set) Environmental management Standards set

AS/NZS 1170.0:2002 Structural design actions –General principles (also 1170.1-4)

AS 1188:1990 Radio transmitters and similar equipment–Safe practices

AS 1319:1994 Safety signs for the occupational environment

AS 1345:1995 Identification of the contents of pipes, conduits and ducts

AS 1428 (Set):2003 Design for access and mobility Set

AS 1499:1996 Personal flotation devices–Type 2

AS 1512:1996 Personal flotation devices–Type 1

AS/NZS 1596:2008 The storage and handling of LP Gas

AS 1657:1992 Fixed platforms, walkways, stairways and ladders, Design, construction and installation

AS 1692-2006 Steel tanks for flammable and combustible liquids

AS/NZS 1715:1994 Selection, use and maintenance of respiratory protective devices

AS 1940-2004 The storage and handling of flammable and combustible liquids

AS 1948:1987 Acoustics–Measurement of airborne noise on board vessels and offshore platforms

AS 2156.1:2001 Walking tracks–Classification and signage

AS 2156.2:2001 Walking tracks–Infrastructure design

AS 2198:1983 Anchors for small boats

AS/NZS 2210.1:1994 Occupational protective footwear–Guide to selection, care and use

AS 2259:1996 General requirements for buoyancy aids

AS 2260:1996 Personal flotation devices–Type 3

AS 2261:1990 Rescue buoys

AS 2262:1979 Float-off buoyancy aids

AS 2342:1992 Development, testing and implementation of information of safety symbols and symbolic signs

AS 2416:2002 Design and application of water safety signs

AS 2423:2002 Coated steel wire fencing products for terrestrial, aquatic and general use

AS 2488:1995 Resuscitators intended for use with humans

AS/NZS 2604:1998 Sunscreen products – Evaluation and classification

AS/NZS 2633:1996 Guide to the specification of colours

AS 2677:1983 Inflatable boats

AS 2700 (Set) Colour Standards for general purposes

AS 2809.2-2008 Road tank vehicles for dangerous goods - Road tank vehicles for flammable liquids

AS 2899.1:1986 Public information symbol signs–General information signs

AS 2899.2:1986 Public information symbol signs–Water safety signs

AS/NZS 3004:2002 Electrical installations–Marinas and pleasure craft at low-voltage

AS 3780-2008 The storage and handling of corrosive substances

AS/NZS 3833:2007 – The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers

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[3] List, while extensive, is not limited.

AS3846:2005 - The handling and transport of dangerous cargoes in port areas

AS/NZS 3661.1:1993 Slip resistance of pedestrian surfaces–Requirements

AS/NZS 3661.2:1994 Slip resistance of pedestrian surfaces–Guide to the reduction of slip hazards

AS 3745:2002 Emergency control organization and procedures for buildings, structures and workplaces

AS 3780:1994 The storage and handling of corrosive substances.

AS 3848.2:1999 Filling of portable gas cylinders–Filling of portable cylinders for self-contained underwater breathing apparatus (SCUBA) and non-underwater self-contained breathing apparatus (SCBA)–Safe procedures

AS 3962:2001 Guidelines for design of marinas

AS 4005 (Set) Recreational Diving Set

AS/NZS 4261:1994 Reusable containers for the collection of sharp items used in human and animal medical applications

AS 4326-2008 The storage and handling of oxidizing agents

AS 4332:2004 Storage and handling of gases in cylinders.

AS 4367:1996 Radio communications equipment used in the inshore boating radio services band

AS/NZS 4399:1996 Sun protective clothing–Evaluation and classification

AS/NZS 4501.2:1999 Occupational protective clothing–General requirements

AS/NZS 4586:2004 Slip resistance classification of new pedestrian surface materials

AS/NZS 4663:2004 Slip resistance measurement of existing pedestrian surfaces

AS/NZS 4801: 2001 Occupational Health and Safety Management Systems – General guidelines on principles, systems and supporting techniques

AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods

AS 60417.2.4:2004 Graphical symbols for use on equipment–Maritime navigation

AS 60417.2.7:2004 Graphical symbols for use on equipment–Safety aspects

HB 76:2004 Dangerous goods, initial emergency response guide

HB 139:2003 Guidance on Integrating the Requirements of Quality, Environment, and Health and

Safety Management System Standards

HB 203:2004 Environmental risk management - Principles and process

HB 246-2004 Guidelines for Managing Risk in Sport and Recreation

HB 436:2004 Risk Management Guidelines Companion to AS/NZS 4360 – 2004 Risk Management


# Port Expansion Project EIS

## Appendix U3

## Risk Management Process and Criteria

This project's preliminary risk assessment has been undertaken in accordance with the Australia/New Zealand Standard AS/NZS ISO 31000:2009 Risk Management Principles and Guidelines (Standards Australia, 2009).

This Standard is the basis of the Port of Townsville Limited's Risk Assessment and Management Policy and also for this preliminary risk assessment. It includes the identification of work related risks to workers, property and operations, an analysis of the consequences of each identified risk and identification of existing safeguards to reduce the likelihood and severity of each issue. Figure 1 summaries the risk management process model presented in the standard.

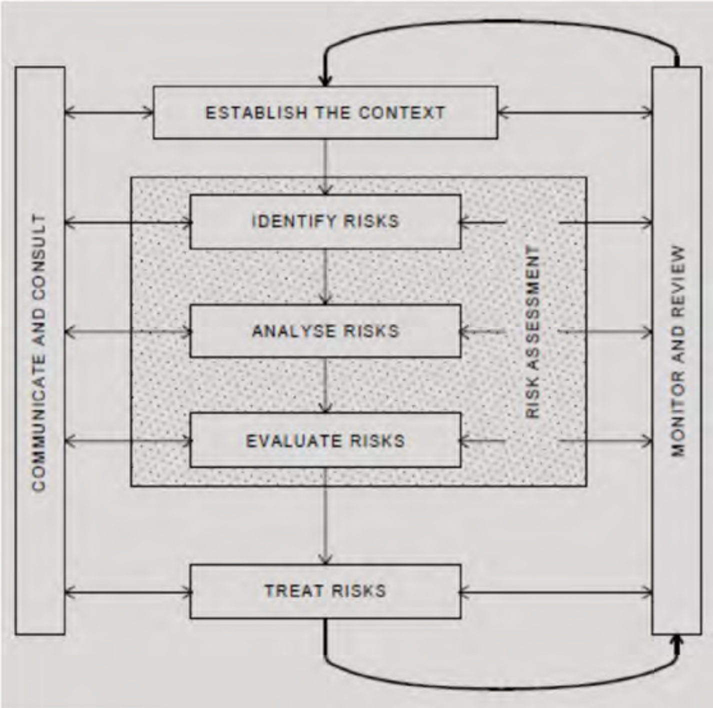


Figure 1 Risk Management Process Model (after AS/NZS ISO 31000:2009)

### Risk Assessment (incorporating risk identification, analysis and evaluation)

This involves the identification of risk stemming from hazards associated with design, build, operations and decommissioning of the project. The risk identification, analysis and evaluation were informed by inputs from stakeholder communication and review of the possible impacts associated with similar works. Qualitative risk analysis incorporates Consequence Analysis and Probability Analysis applied to the Risk Matrix to evaluate the level of risk significance.

### Consequence Analysis

Consequence analysis assesses the level of impact, or consequence, that a hazard may cause. In this chapter, the focus of the consequence analysis is public health and safety, reputation, assets and schedule. Consequence ranges from 'Insignificant' to 'Catastrophic', as described in C1.

### Probability Analysis

The probability analysis assesses the likelihood of occurrence during the lifetime of the Port Expansion Project. The likelihood criteria used in this analysis is included below in C2.

### Risk Matrix

The risk matrix has been adopted to carry out the qualitative risk assessment for the project. The matrix has been equally weighted to consequence and probability and ranging from low to extreme. The hazards and risks identified in this chapter are assessed according the risk matrix shown in C3.

Table C1 Consequence Analysis

| Consequence | Description | | | | |
|---|---|---|---|---|---|
| | Health & Safety | Environmental | Community / Reputation | Asset Loss | Schedule Impact |
| Catastrophic | A single or multiple fatalities or significant irreversible injury to more than 10 people | Irreversible or long term reversible impact on local environment | Substantiated public attention, high widespread news profile, third party actions | Complete loss of assets | > 50 work weeks |
| Major | Irreversible injury or significant impairment to several people | Medium term reversible impact on environment | Substantiated public attention, high news profile, third party actions | Significant loss of assets (> 70%) | > 20 work weeks < 50 work weeks |
| Moderate | Reversible injury requiring hospitalisation | Short term reversible impacts. Negative impact on local receptors | Substantiated public attention, serious complaint, moderate news profile | Major damage to assets | > 8 work weeks < 20 work weeks |
| Minor | An injury with minor first aid treatment required | Negative impact on local receptors. Immediately reversible | Substantiated, repairable damage, low news profile | Minor loss or damage to assets | > 3 work weeks < 8 work weeks |
| Insignificant | No injury, an injury not sufficiently serious to require first aid treatment. | No significant impact on local environmental values | Unsubstantiated, easily repairable damage, no news items | Little or no impact on assets | < 3 work weeks |

Table C2 Probability Analysis

| Likelihood | Description |
|---|---|
| Rare | Has not happened and is highly unlikely but theoretically possible to occur. |
| Unlikely | Has not happened yet but is possible. May occur during construction / life of the Project but probability of occurrence is well below 50%. |
| Possible | Could happen. Less likely than not to occur, probability of occurrence around 50%. |
| Likely | Likely to occur during the life of the project. Probability of occurrence greater than 50%. |
| Almost Certain | Is expected to occur and could possibly occur multiple times during the life of the project. |

Table C3 Risk Matrix (After AS 4360:2004[4] (Standards Australian, 2004))

| Likelihood | Consequence | | | | |
|---|---|---|---|---|---|
| | Catastrophic | Major | Moderate | Minor | Insignificant |
| Almost Certain | Extreme | Extreme | High | High | Medium |
| Likely | Extreme | High | High | Medium | Medium |
| Possible | High | High | High | Medium | Low |
| Unlikely | High | Medium | Medium | Low | Low |
| Rare | High | Medium | Medium | Low | Low |

[4] AS 4360-2004 is superseded by AS/NZS ISO 31000:2009 Risk Management Principles and Guidelines which does not detail a specific risk matrix. This risk matrix continues as common industry practice and is functionally suited to the purpose of this chapter.


# Port Expansion Project EIS

## Appendix U4

## Risk Register

AECOM BMT WBM

AECOM

ANZ

# Risk Assessment Management

Q4AN-231-TP3

| | |
|---|---|
| Project Name | Port of Townsville Expansion Project |
| Project Number | |

| Analysis | | | | | | | | | Controls | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Date Created | Area/Phase | Hazard Description | Unwanted Impacts/Consequences | Consequence Criterion | Before Mitigation (Inherent Risk) | | | Mitigation planned or in place | Main Risk Treatment Category | Interim Risk | | | Further Recommended Actions | Residual Risk | | |
| | | | | | | Likelihood | Consequence | Risk | | | Likelihood | Consequence | Risk/Impact Level | | Likelihood | Consequence | Risk/Impact Level |
| **2.00** | **01-Jan-12** | **Build Phase** | | | | | | | | | | | | | | | |
| 2.01 | 01-Jan-12 | Build | Commercial/Legal | Financial loss and penalty. | Health & Safety | Possible | High | **High** | Builder understand and mitigate their Commercial / Legal risk | Prevention | Rare | Minor | Low | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 2.02 | 01-Jan-12 | Build | Understanding of Project Life-Cycle | Inherent inefficiency, increased build costs, injury, damage, loss and penalty. | Health & Safety | Possible | High | **High** | Builder understands, accepts and uses Project Life-Cycle and Safety in Design information provided by designer. | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 2.03 | 01-Jan-12 | Build | Statutory Requirements, Obligations, Duties, Licences and Permits | Financial loss and penalty. | Health & Safety | Possible | High | **High** | Builder understand their Statutory Requirements, Obligations, Duties, Licences and Permits | Prevention | Rare | Minor | Low | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 2.04 | 01-Jan-12 | Build | Interpretation and Translation of Design to Application | Inherent inefficiency, increased build costs, injury, damage, loss and penalty. | Health & Safety | Likely | Moderate | **High** | Builder understands, accepts and uses Project Life-Cycle and Safety in Design information provided by designer. | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 2.05 | 01-Jan-12 | Build | Physical Risk Sources: Energy, Equipment, Processes and Materials **(Refer Risk Assessment Section 5.00 - Phase Hazards)** | Inadequate risk assessment decisions informing build. Unrecognised consequences and unplanned mitigation. | Health & Safety | Likely | Very High | **Extreme** | Builder draws on Safety in Desing information, also undertakes necessary build-phase risk assessment for Physical Risk Sources: Energy, Equipment, Processes and Materials | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Moderate | **Medium** |
| 2.06 | 01-Jan-12 | Build | Receptor Interface and Interaction (People/Environment/Society/Organisation) | Inadequate risk assessment decisions informing build. Unrecognised consequences and unplanned mitigation. | Health & Safety | Likely | High | **High** | Builder considers Receptor Interface and Interaction (People / Environment / Society / Organisation) to inform and instruct build-phase risk | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 2.07 | 01-Jan-12 | Build | Built Beyond Use, to incorporate Maintenance, Modification, Decommissioning and Disposal | Inadequate risk assessment decisions informing build. Unrecognised consequences and unplanned mitigation. | Health & Safety | Likely | Moderate | **High** | Builder understand, accepts and uses Safety in Design to incorporate Maintenance, Modification, Decommissioning and Disposal in build-phase. | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 2.08 | 01-Jan-12 | Build | Risk Information Transfer | Inherent inefficiency, increased build costs, injury, damage, loss and penalty. | Health & Safety | Likely | Moderate | **High** | Builder (through commissioning and handp-over) intitates a process for Safety in Design Risk Information Transfer | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |

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# Risk Assessment Management

Q4AN-231-TP3

| Project Number | |
|---|---|

| ID | Date Created | Area/Phase | Hazard Description | Unwanted Impacts/Consequences | Consequence Criterion | Before Mitigation (Inherent Risk) | | | Mitigation planned or in place | Main Risk Treatment Category | Interim Risk | | | Further Recommended Actions | Residual Risk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Likelihood | Consequence | Risk | | | Likelihood | Consequence | Risk/Impact Level | | Likelihood | Consequence | Risk/Impact Level |
| **3.00** | **01-Jan-12** | **Operate Phase** | | | | | | | | | | | | | | | |
| 3.01 | 01-Jan-12 | Operate | Commercial/Legal | Financial loss and penalty. | Health & Safety | Possible | High | High | Operator understand and mitigate their Commercial / Legal risk | Prevention | Rare | Minor | Low | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 3.02 | 01-Jan-12 | Operate | Understanding of Project Life-Cycle | Inherent inefficiency, increased operating costs, injury, damage, loss and penalty. | Health & Safety | Possible | High | High | Operator understands, accepts and uses Project Life-Cycle and Safety in Design information provided by designer. | Prevention | Rare | Moderate | Medium | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 3.03 | 01-Jan-12 | Operate | Statutory Requirements, Obligations, Duties, Licences and Permits | Financial loss and penalty. | Health & Safety | Possible | High | High | Operator understand their Statutory Requirements, Obligations, Duties, Licences and Permits | Prevention | Rare | Minor | Low | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 3.04 | 01-Jan-12 | Operate | Risk Management and Continuous Improvement | Inadequate risk assessment decisions informing operation. Unrecognised consequences and unplanned mitigation. | Health & Safety | Likely | High | High | Operator draws on Safety in Desing information, also undertakes necessary operate-phase risk assessment for Physical Risk Sources: Energy, Equipment, Processes and Materials | Prevention | Rare | Moderate | Medium | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 3.05 | 01-Jan-12 | Operate | Fit for Purpose Use (as Designed/Built) | Inherent inefficiency, increased operating costs, injury, damage, loss and penalty. | Health & Safety | Possible | High | High | Operator understand, accepts and uses Safety in Design from both Designer and Builder to incorporate Maintenance, Modification, Decommissioning and Disposal in operate-phase. | Prevention | Rare | Moderate | Medium | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 3.06 | 01-Jan-12 | Operate | Physical Risk Sources: Energy, Equipment, Processes and Materials **(Refer Risk Assessment Section 5.00 - Phase Hazards)** | Inherent inefficiency, increased operating costs, injury, damage, loss and penalty. | Health & Safety | Likely | Very High | Extreme | Operator draws on Safety in Desing information, also undertakes necessary operate-phase risk assessment for Physical Risk Sources: Energy, Equipment, Processes and Materials | Prevention | Rare | Moderate | Medium | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Moderate | Medium |
| 3.07 | 01-Jan-12 | Operate | Receptor Interface and Interaction (People/Environment/Society/Organisation) | Inherent inefficiency, increased operating costs, injury, damage, loss and penalty. | Health & Safety | Possible | High | High | Operator considers Receptor Interface and Interaction (People / Environment / Society / Organisation) to inform and instruct operate-phase risk | Prevention | Rare | Moderate | Medium | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 3.08 | 01-Jan-12 | Operate | Provision of Processes for Use, Maintenance, Modification, Decommissioning and Disposal | Inadequate risk assessment decisions informing operation. Unrecognised consequences and unplanned mitigation. | Health & Safety | Likely | Moderate | High | Operator understand, accepts and uses Safety in Design to incorporate and develop plans for Maintenance, Modification, Decommissioning and Disposal in operate-phase. | Prevention | Rare | Moderate | Medium | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 3.09 | 01-Jan-12 | Operate | Risk Information Transfer | Inherent inefficiency, increased operating costs, injury, damage, loss and penalty. | Health & Safety | Likely | Moderate | High | Operator intitates a process to maintain Safety in Design Risk Information in preparation for probable / future Transfer | Prevention | Rare | Moderate | Medium | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |

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# Risk Assessment Management

Q4AN-231-TP3

| Project Number | |
|---|---|

| ID | Date Created | Area/Phase | Hazard Description | Unwanted Impacts/Consequences | Consequence Criterion | Before Mitigation (Inherent Risk) | | | Mitigation planned or in place | Main Risk Treatment Category | Interim Risk | | | Further Recommended Actions | Residual Risk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis | | | | | | | | | Controls | | | | | | | | |
| | | | | | | Likelihood | Consequence | Risk | | | Likelihood | Consequence | Risk/Impact Level | | Likelihood | Consequence | Risk/Impact Level |
| **4.00** | **01-Jan-12** | **Disposal Phase** | | | | | | | | | | | | | | | |
| 4.01 | 01-Jan-12 | Disposal | Application and Delivery of Processes for Decommissioning and Disposal | Inherent inefficiency, increased operating costs, injury, damage, loss and penalty. | Health & Safety | Likely | High | **High** | Demolition/Disposal Agent draws on Safety in Desing information, also undertakes necessary disposal-phase risk assessment for Physical Risk Sources: Energy, Equipment, Processes and Materials | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 4.02 | 01-Jan-12 | Disposal | Latency of Physical Risk Sources: Energy, Equipment, Processes and Materials **(Refer Risk Assessment Section 5.00 - Phase Hazards)** | Inadequate risk assessment decisions informing demolition / disposal. Unrecognised consequences and unplanned mitigation. | Health & Safety | Likely | Very High | **Extreme** | Demolition/Disposal Agent draws on Safety in Desing information, also undertakes necessary disposal-phase risk assessment for Physical Risk Sources: Energy, Equipment, Processes and Materials | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Moderate | **Medium** |
| 4.03 | 01-Jan-12 | Disposal | Receptor Interface and Interaction (People/Environment/Society/Organisation) | Inherent inefficiency, increased demolition / disposal costs, injury, damage, loss and penalty. | Health & Safety | Possible | High | **High** | Demolition/Disposal Agent considers Receptor Interface and Interaction (People / Environment / Society / Organisation) to inform and instruct disposal-phase risk | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 4.04 | 01-Jan-12 | Disposal | Statutory Requirements, Obligations, Duties, Licences and Permits | Financial loss and penalty. | Health & Safety | Possible | High | **High** | Demolition/Disposal Agent understand their Statutory Requirements, Obligations, Duties, Licences and Permits | Prevention | Rare | Minor | Low | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 4.05 | 01-Jan-12 | Disposal | Commercial/Legal | Financial loss and penalty. | Health & Safety | Possible | High | **High** | Demolition/Disposal Agent understand and mitigate their Commercial / Legal risk | Prevention | Rare | Minor | Low | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |
| 4.06 | 01-Jan-12 | Disposal | Risk Information Transfer | Inherent inefficiency, increased operating costs, injury, damage, loss and penalty. | Health & Safety | Probable | High | **Extreme** | Demolition/Disposal Agent intitates a process to maintain Safety in Design Risk Information Transfer | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Moderate | **Medium** |
| 4.07 | 01-Jan-12 | Disposal | Understanding of Prior Project Life-Cycle | Inherent inefficiency, increased demolition / disposal costs, injury, damage, loss and penalty. | Health & Safety | Likely | Moderate | **High** | Demolition/Disposal Agent understands, accepts and uses Project Life-Cycle and Safety in Design information provided by the Operator. | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and uptake of Safety in Design Information | Rare | Minor | Low |

AECOM

ANZ
## Risk Assessment Management

Q4AN-231-TP3

| Project Number | |
|---|---|

| | | | | Analysis | | | | | | Controls | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Date Created | Area/Phase | Hazard Description | Unwanted Impacts/Consequences | Consequence Criterion | Before Mitigation (Inherent Risk) | | | Mitigation planned or in place | Main Risk Treatment Category | Interim Risk | | | Further Recommended Actions | Residual Risk | | |
| | | | | | | Likelihood | Consequence | Risk | | | Likelihood | Consequence | Risk/Impact Level | | Likelihood | Consequence | Risk/Impact Level |
| **5.00** | **01-Jan-12** | **Phase Hazards** | | | | | | | | | | | | | | | |
| 5.01 | 01-Jan-12 | Biomechanical Hazards | Activities performed by people involving hazardous manual work including but not limited to: Handling Objects, People or Animals; Ergonomics and Posture; Movement of / by People (incl. falls and striking object) | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Possible | High | High | Minimum statutory obligations. | Prevention | Unlikely | Moderate | Medium | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Minor | Low |
| 5.02 | 01-Jan-12 | Mechanical hazards | Interaction of plant and equipment with other plant or with strucuture/s or with a person/s. Includes but not limited to: Vehicle operation and movement (land, water and air); Movement of tools or equipment (powered or manual); Load Shifting and Cranage; Assembly of Structures and Infrastructures. | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Possible | Very High | High | Minimum statutory obligations. | Prevention | Unlikely | Moderate | Medium | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Minor | Low |
| 5.03 | 01-Jan-12 | Chemical hazards | Interaction of hazardous chemicals with other plant or with strucuture/s or with a person/s. Includes but not limited to: Prescribed Hazardous Substances; Chemical Storage and Transportation Processes; Vessels for Chemical Storage; Planned and Unplanned Chemical Emission. | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Possible | Very High | High | Minimum statutory obligations. | Prevention | Unlikely | Moderate | Medium | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Minor | Low |
| 5.04 | 01-Jan-12 | Potential and stored energy hazards | Realisation of potential energy of objects influenced by mass, gravity, inertia or momentum) and their interaction with other plant or with strucuture/s or with a person/s. Includes but not limited to: Raised or elevated objects or structures or contents having mass; Pressure Storage and Transportation Processes; Vessels for Pressurised Gas or Liguid Storage; Planned and Unplanned Stored Energy Release. | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Possible | Very High | High | Minimum statutory obligations. | Prevention | Unlikely | Moderate | Medium | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Minor | Low |
| 5.05 | 01-Jan-12 | Noise and vibration hazards | Noise and Vibration emissions interaction with other plant or with structure/s or with a person/s. Includes but not limited to: Excessive Occupational Noise and Vibration Exposure; Excessive Noise and Vibration Transmission to Environment. | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Likely | High | High | Minimum statutory obligations. | Prevention | Unlikely | Moderate | Medium | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Minor | Low |
| 5.06 | 01-Jan-12 | Thermal hazards | Thermal (temporature, fire or explosion) interaction with other plant or with structure/s or with a person/s. Includes but not limited to: Thermal (hot/cold) emission; Fire or Explosion Transmission to Environment. | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Unlikely | Very High | High | Minimum statutory obligations. | Prevention | Unlikely | Moderate | Medium | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Minor | Low |

AECOM

**ANZ**

# Risk Assessment Management

Q4AN-231-TP3

| Project Number | |
|---|---|

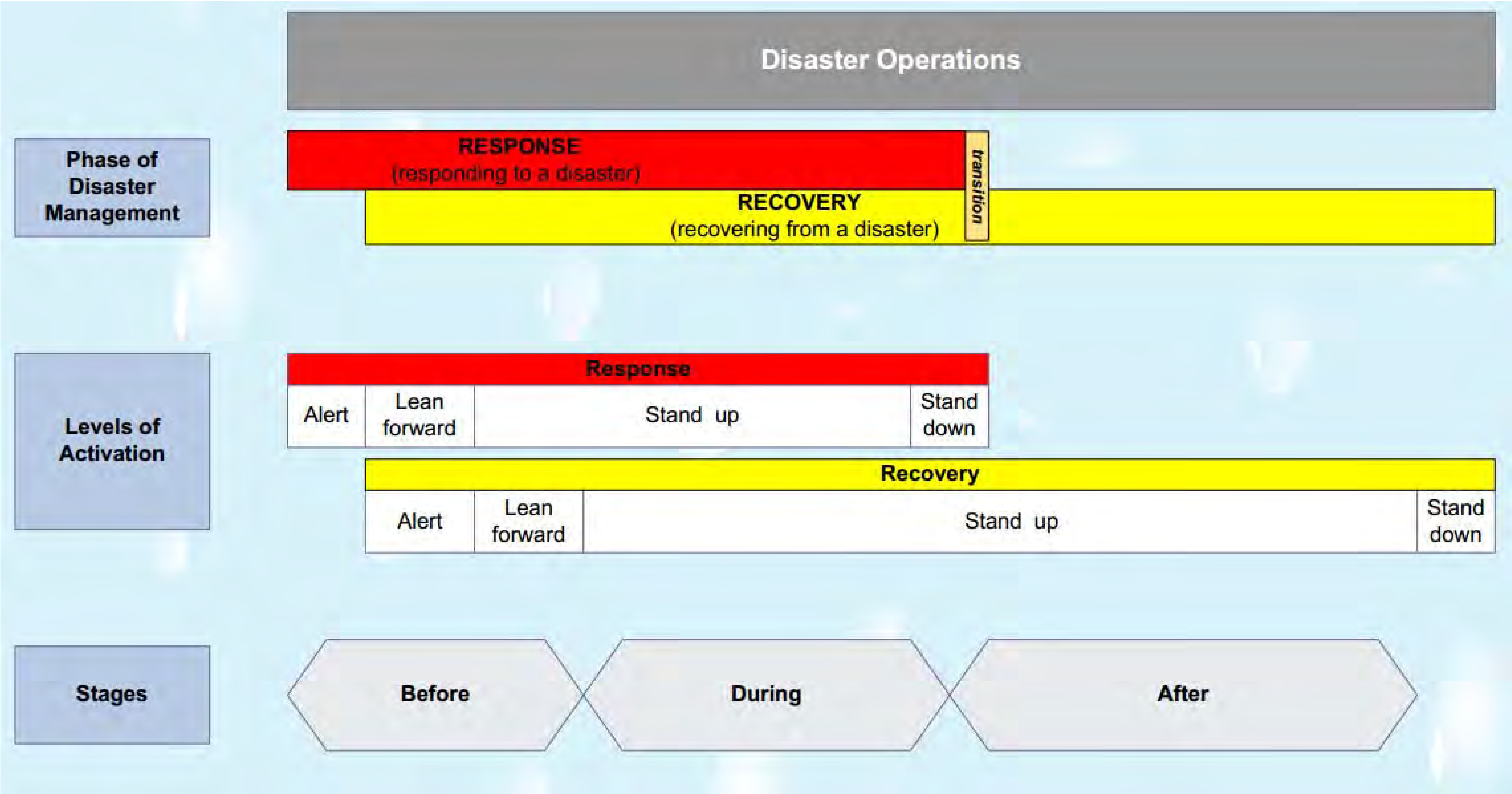
| Analysis | | | | | | | | | Controls | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Date Created | Area/Phase | Hazard Description | Unwanted Impacts/Consequences | Consequence Criterion | Before Mitigation (Inherent Risk) | | | Mitigation planned or in place | Main Risk Treatment Category | Interim Risk | | | Further Recommended Actions | Residual Risk | | |
| | | | | | | Likelihood | Consequence | Risk | | | Likelihood | Consequence | Risk/Impact Level | | Likelihood | Consequence | Risk/Impact Level |
| 5.07 | 01-Jan-12 | Electrical hazards | Electrical conductor interaction with other plant or with structure/s or with a person/s. Includes but not limited to: Persons contacting electrical supply conductors or infrastructutre; Faulty electrical equipment or appliances; Excessive Electro-Magnetic Radiation emission to environment. | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Possible | Very High | **High** | Minimum statutory obligations. | Prevention | Unlikely | Moderate | **Medium** | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Minor | Low |
| 5.08 | 01-Jan-12 | Radiation hazards | Radiation emissions interaction with other plant or with structure/s or with a person/s. Includes but not limited to: Occupational Solar, UV, Non-Ionising and Ionising Radiation Exposure; Regulated and/or Licenced Ratiation Sources; Radiation emission to Environment. | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Unlikely | High | **Medium** | Minimum statutory obligations. | Prevention | Unlikely | Moderate | **Medium** | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Minor | Low |
| 5.09 | 01-Jan-12 | Biological hazards | Biological forms interaction with other plant or with structure/s or with a person/s. Includes but not limited to: Excessive Microbic Exposure and Contamination; Animal or Human Attack; Biologic Agent Transmission to Environment. | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Possible | Very High | **High** | Minimum statutory obligations. | Prevention | Unlikely | Moderate | **Medium** | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Minor | Low |
| 5.10 | 01-Jan-12 | Work stressor hazards | Psychological interaction with a person/s. Includes but not limited to: Occupational Stress; Emissions (noise, vibration, chemical, lighting and percieved or real threat) Transmission to Environment and/or Non-Work Receptor. | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Possible | Minor | **Medium** | Minimum statutory obligations. | Prevention | Unlikely | Minor | Low | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Minor | Low |
| 5.11 | 01-Jan-12 | Natural hazards | Severe natural events interaction with other plant or with structure/s or with a person/s. Includes but not limited to: Cyclone; Storm (Electical, Rain and Wind); Tidal Surge; Waterway Flooding; Earthquake; Fire (Structural or Bush). | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Likely | Very High | **Extreme** | Minimum statutory obligations. | Prevention | Likely | High | **High** | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Likely | Minor | **Medium** |
| 5.12 | 01-Jan-12 | Socio/Political hazards | Human willfull interaction with other plant or with structure/s or with a person/s. Includes but not limited to: Terroism; Anti-Social Behaviour (including Vandalism); Political Protest / Industrial Relations Actions (Stoppages, Blockades etc.) | Personal injury, damage, loss, penalty and increased operating costs,. | Health & Safety | Unlikely | Very High | **High** | Minimum statutory obligations. | Prevention | Rare | Moderate | **Medium** | Stakeholder and Process Owner engagement and the implementation, monitoring and maintenance of process specific controls. | Rare | Moderate | **Medium** |


# Port Expansion Project EIS

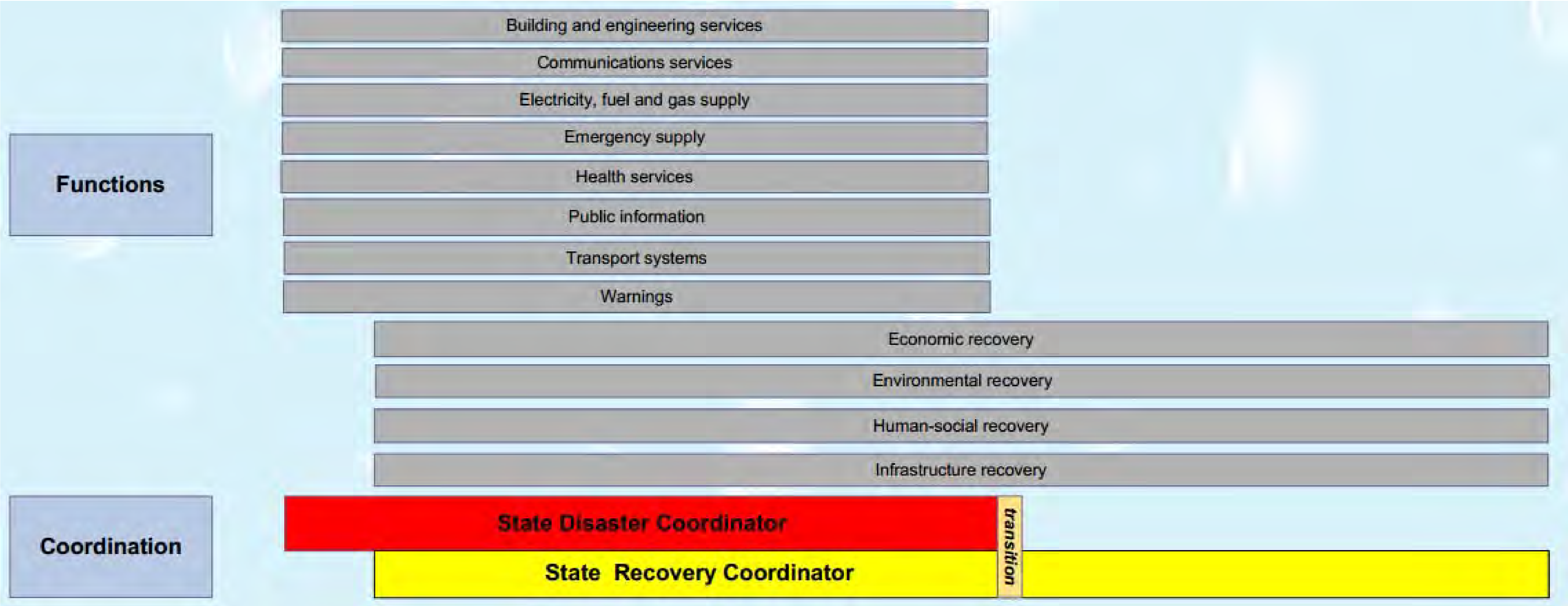
## Appendix V1

## Queensland Disaster Management Plan of Operational Diagram

AECOM BMT WBM


Disaster Operations
Phase of Disaster Management
RESPONSE
(responding to a disaster)
transition
RECOVERY
(recovering from a disaster)
Levels of Activation
Response
Alert
Lean forward
Stand up
Stand down
Recovery
Alert
Lean forward
Stand up
Stand down
Stages
Before
During
After


Activities
Hazard analysis and modelling
Operational planning
Warning
Disaster coordination centre operation and management
Deployments
Rescue
Evacuation
Evacuation centre and emergency accommodation centres
Impact assessment
Reception operations
Logistical support
Mass casualty management and mass fatality management
Volunteer management
Donation management
Resupply
Relief measures for financial and economic wellbeing
Response Debrief
Transition to recovery
Recovery Debrief
Post event debrief


Building and engineering services
Communications services
Electricity, fuel and gas supply
Emergency supply
Health services
Public information
Transport systems
Warnings
Economic recovery
Environmental recovery
Human-social recovery
Infrastructure recovery
Functions
Coordination
State Disaster Coordinator
State Recovery Coordinator
transition


# Port Expansion Project EIS

## Appendix V2

## Consequence Table (Impact Definitions and Likelihood Table for Disaster Risk Assessment

AECOM BMT WBM

Table 1 Impact Category Definitions for Consequences (National Emergency Management Committee, 2010)

| Impact Category Definitions | |
|---|---|
| People | Relates to the direct impacts of the emergency on the physical health of people/individuals and emergency services' (i.e. health system) ability to manage<br>Mortality defined as the ratio of deaths in an area to the population of that area; expressed per 1000 per year |
| Environment | Relates to the impacts of the emergency and its effects on the ecosystem of the area, including fauna and flora |
| Economy | Relates to the economic impact of the emergency on the governing body as reported in the annual operating statement for the relevant jurisdiction, and Industry Sectors as defined by the Australian Bureau of Statistics |
| Public Administration | Relates to the impacts of the emergency on the governing body's ability to govern |
| Social Setting | Relates to the impacts of the emergency on society and its social fabric, including its cultural heritage, resilience of the community |
| Infrastructure | Relates to the impacts of the emergency on the area's infrastructure/lifelines/utilities and its ability to service the community<br>Long-term failure = Repairs will take longer than 6 months<br>Mid- to long-term failure = Repairs may be undertaken in 3 to 6 months<br>Mid-term failure = Repairs may be undertaken in 1 to 3 months<br>Short- to mid-term failure = Repairs may be undertaken in 1 week to 1 month<br>Short-term failure = Repairs may be undertaken in less than 1 week |

Table 2 Consequence Table for Disaster Risk Assessment (National Emergency Management Committee, 2010)

| Consequence Level | People | Environment | Economy | Public Administration | Social Setting | Infrastructure |
|---|---|---|---|---|---|---|
| Catastrophic | Widespread multiple loss of life (mortality › 1 in ten thousand), health system unable to cope, displacement of people beyond ability to cope | Widespread severe impairment or loss of ecosystem functions across species and landscapes, irrecoverable environmental damage | Unrecoverable financial loss › 3% of the government sector's revenues[1], asset destruction across industry sectors leading to widespread business failures and loss of employment | Governing body unable to manage the event, disordered public administration without effective functioning, public unrest, media coverage beyond region or jurisdiction | Community unable to support itself, widespread loss of objects of cultural significance, impacts beyond emotional and psychological capacity in all parts of the community | Long-term failure of significant infrastructure and service delivery affecting all parts of the community, ongoing external support at large scale required |
| Major | Multiple loss of life (mortality › 1 in one hundred thousand), health system over-stressed, large numbers of displaced people (more than 24 hours) | Severe impairment or loss of ecosystem functions affecting many species or landscapes, progressive environmental damage | Financial loss 1-3% of the government sector's revenues[1] requiring major changes in business strategy to (partly) cover loss, significant disruptions across industry sectors leading to multiple business failures and loss of employment | Governing body absorbed with managing the event, public administration struggles to provide merely critical services, loss of public confidence in governance, media coverage beyond region or jurisdiction | Reduced quality of life within community, significant loss or damage to objects of cultural significance, impacts beyond emotional and psychological capacity in large parts of the community | Mid- to long-term failure of significant infrastructure and service delivery affecting large parts of the community, initial external support required |

| | | | | | | |
|---|---|---|---|---|---|---|
| Moderate | Isolated cases of loss of life (mortality › than one in one million), health system operating at maximum capacity, isolated cases of displacement of people (less than 24 hours) | Isolated but significant cases of impairment or loss of ecosystem functions, intensive efforts for recovery required | Financial loss 0.3-1% of the government sector's revenues[1] requiring adjustments to business strategy to cover loss, disruptions to selected industry sectors leading to isolated cases of business failure and multiple loss of employment | Governing body manages the event with considerable diversion from policy, public administration functions limited by focus on critical services, widespread public protests, media coverage within region or jurisdiction | Ongoing reduced services within community, permanent damage to objects of cultural significance, impacts beyond emotional and psychological capacity in some parts of the community | Mid-term failure of (significant) infrastructure and service delivery affecting some parts of the community, widespread inconveniences |
| Minor | Isolated cases of serious injuries, health system operating within normal parameters | Isolated cases of environmental damage, one-off recovery efforts required | Financial loss 0.1-0.3% of the government sector's revenues[1] requiring activation of reserves to cover loss, disruptions at business level leading to isolated cases of loss of employment | Governing body manages the event under emergency regime, public administration functions with some disturbances, isolated expressions of public concern, media coverage within region or jurisdiction | Isolated and temporary cases of reduced services within community, repairable damage to objects of cultural significance, impacts within emotional and psychological capacity of the community | Isolated cases of short- to mid-term failure of infrastructure and service delivery, localised inconveniences |

| | | | | | | |
|---|---|---|---|---|---|---|
| Insignificant | Near misses or minor injuries, no reliance on health system | Near misses or incidents without environmental damage, no recovery efforts required | Financial loss < 0.1% of the government sector's revenues[1] to be managed within standard financial provisions, inconsequential disruptions at business level | Governing body manages the event within normal parameters, public administration functions without disturbances, public confidence in governance, no media attention | Inconsequential short-term reduction of services, no damages to objects of cultural significance, no adverse emotional and psychological impacts | Inconsequential short-term failure of infrastructure and service delivery, no disruption to the public services |

[1] *As reported in the annual operating statement for the relevant jurisdiction, organisation and community*

Table 3 Likelihood Table for Disaster Risk Assessment (National Emergency Management Committee, 2010)

| Likelihood Level | Frequency | Average Recurrence Interval | Annual Exceedance Probability |
|---|---|---|---|
| Almost Certain | Once or more per year | < 3 years | > 0.3 |
| Likely | Once per ten years | 3 – 30 years | 0.031 – 0.3 |
| Possible | Once per hundred years | 31 – 300 years | 0.0031 – 0.03 |
| Unlikely | Once per thousand years | 301 – 3,000 years | 0.00031 – 0.003 |
| Rare | Once per ten thousand years | 3,001 – 30,000 years | 0.000031 – 0.0003 |
| Very Rare | Once per hundred thousand years | 30,001 – 300,000 years | 0.0000031 – 0.00003 |
| Almost Incredible | Less than once per million years | > 300,000 years | < 0.0000031 |

Table 4 Disaster Risk Assessment Matrix (National Emergency Management Committee, 2010)

| | Consequence Level | | | | |
|---|---|---|---|---|---|
| **Likelihood Level** | **Insignificant** | **Minor** | **Moderate** | **Major** | **Catastrophic** |
| Almost Certain | Medium | Medium | High | Extreme | Extreme |
| Likely | Low | Medium | High | High | Extreme |
| Possible | Low | Low | Medium | High | High |
| Unlikely | Low | Low | Medium | Medium | High |
| Rare | Low | Low | Low | Medium | Medium |
| Very Rare | Low | Low | Low | Low | Medium |
| Almost Incredible | Low | Low | Low | Low | Low |


# Port Expansion Project EIS

Appendix W1

## Assessment of Great Barrier Reef World Heritage Attributes in Cleveland Bay

## The Great Barrier Reef Queensland - Statement of Outstanding Universal Value

**Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) 2012**

The following is the Brief Synthesis of the retrospective statement as presented on the DSEWPC website.

### Statement of Outstanding Universal Value

*As the world's most extensive coral reef ecosystem, the Great Barrier Reef (GBR) is a globally outstanding and significant entity. Practically the entire ecosystem was inscribed as World Heritage in 1981, covering an area of 348,000 square kilometres and extending across a contiguous latitudinal range of 14° (10°S to 24°S). The Great Barrier Reef (hereafter referred to as GBR) includes extensive cross-shelf diversity, stretching from the low water mark along the mainland coast up to 250 kilometres offshore. This wide depth range includes vast shallow inshore areas, mid-shelf and outer reefs, and beyond the continental shelf to oceanic waters over 2,000 metres deep.*

*Within the GBR there are some 2,500 individual reefs of varying sizes and shapes, and over 900 islands, ranging from small sandy cays and larger vegetated cays, to large rugged continental islands rising, in one instance, over 1,100 metres above sea level. Collectively these landscapes and seascapes provide some of the most spectacular maritime scenery in the world.*

*The latitudinal and cross-shelf diversity, combined with diversity through the depths of the water column, encompasses a globally unique array of ecological communities, habitats and species. This diversity of species and habitats, and their interconnectivity, make the GBR one of the richest and most complex natural ecosystems on earth. There are over 1,500 species of fish, about 400 species of coral, 4,000 species of mollusk, and some 240 species of birds, plus a great diversity of sponges, anemones, marine worms, crustaceans, and other species. No other World Heritage property contains such biodiversity. This diversity, especially the endemic species, means the GBR is of enormous scientific and intrinsic importance, and it also contains a significant number of threatened species. At time of inscription, the IUCN evaluation stated "...if only one coral reef site in the world were to be chosen for the World Heritage List, the Great Barrier Reef is the site to be chosen".*

***Criterion (vii):** The GBR is of superlative natural beauty above and below the water, and provides some of the most spectacular scenery on earth. It is one of a few living structures visible from space, appearing as a complex string of reefal structures along Australia's northeast coast.*

*From the air, the vast mosaic patterns of reefs, islands and coral cays produce an unparalleled aerial panorama of seascapes comprising diverse shapes and sizes. The Whitsunday Islands provide a magnificent vista of green vegetated islands and spectacular sandy beaches spread over azure waters. This contrasts with the vast mangrove forests in Hinchinbrook Channel, and the rugged vegetated mountains and lush rainforest gullies that are periodically cloud-covered on Hinchinbrook Island.*

*On many of the cays there are spectacular and globally important breeding colonies of seabirds and marine turtles, and Raine Island is the world's largest green turtle breeding area. On some continental islands, large aggregations of over-wintering butterflies periodically occur.*

*Beneath the ocean surface, there is an abundance and diversity of shapes, sizes and colours; for example, spectacular coral assemblages of hard and soft corals, and thousands of species of reef fish provide a myriad of brilliant colours, shapes and sizes. The internationally renowned Cod Hole near Lizard Island is one of many significant tourist attractions. Other superlative natural phenomena include the annual coral spawning, migrating whales, nesting turtles, and significant spawning aggregations of many fish species.*

***Criterion (viii):** The GBR, extending 2,000 kilometres along Queensland's coast, is a globally outstanding example of an ecosystem that has evolved over millennia. The area has been exposed and flooded by at least four glacial and interglacial cycles, and over the past 15,000 years reefs have grown on the continental shelf.*

*During glacial periods, sea levels dropped, exposing the reefs as flat-topped hills of eroded limestone. Large rivers meandered between these hills and the coastline extended further east. During interglacial periods, rising sea levels caused the formation of continental islands, coral cays and new phases of coral growth. This environmental history can be seen in cores of old massive corals.*

*Today the GBR forms the world's largest coral reef ecosystem, ranging from inshore fringing reefs to mid-shelf reefs, and exposed outer reefs, including examples of all stages of reef development. The processes of geological and geomorphological evolution are well represented, linking continental islands, coral cays and reefs. The varied seascapes and landscapes that occur today have been moulded by changing climates and sea levels, and the* *erosive power of wind and water, over long time periods. One-third of the GBR lies beyond the seaward edge of the shallower reefs; this area comprises coninental slope and deep oceanic waters and abyssal plains.*

***Criterion (ix):*** *The globally significant diversity of reef and island morphologies reflects ongoing geomorphic, oceanographic and environmental processes. The complex cross-shelf, longshore and vertical connectivity is influenced by dynamic oceanic currents and ongoing ecological processes such as upwellings, larval dispersal and migration.*

*Ongoing erosion and accretion of coral reefs, sand banks and coral cays combine with similar processes along the coast and around continental islands. Extensive beds of Halimeda algae represent active calcification and accretion over thousands of years.*

*Biologically the unique diversity of the GBR reflects the maturity of an ecosystem that has evolved over millennia; evidence exists for the evolution of hard corals and other fauna. Globally significant marine faunal groups include over 4,000 species of molluscs, over 1,500 species of fish, plus a great diversity of sponges, anemones, marine worms, crustaceans, and many others. The establishment of vegetation on the cays and continental islands exemplifies the important role of birds, such as the Pied Imperial Pigeon, in processes such as seed dispersal and plant colonisation.*

*Human interaction with the natural environment is illustrated by strong ongoing links between Aboriginal and Torres Strait Islanders and their sea-country, and includes numerous shell deposits (middens) and fish traps, plus the application of story places and marine totems.*

***Criterion (x):*** *The enormous size and diversity of the GBR means it is one of the richest and most complex natural ecosystems on earth, and one of the most significant for biodiversity conservation. The amazing diversity supports tens of thousands of marine and terrestrial species, many of which are of global conservation significance.*

*As the world's most complex expanse of coral reefs, the reefs contain some 400 species of corals in 60 genera. There are also large ecologically important inter-reefal areas. The shallower marine areas support half the world's diversity of mangroves and many seagrass species. The waters also provide major feeding grounds for one of the world's largest populations of the threatened dugong. At least 30 species of whales and dolphins occur here, and it is a significant area for humpback whale calving.*

*Six of the world’s seven species of marine turtle occur in the GBR. As well as the world’s largest green turtle breeding site at Raine Island, the GBR also includes many regionally important marine turtle rookeries.*

*Some 242 species of birds have been recorded in the GBR. Twenty-two seabird species breed on cays and some continental islands, and some of these breeding sites are globally significant; other seabird species also utilize the area. The continental islands support thousands of plant species, while the coral cays also have their own distinct flora and fauna.*

*Integrity*

*The ecological integrity of the GBR is enhanced by the unparalleled size and current good state of conservation across the property. At the time of inscription it was felt that to include virtually the entire Great Barrier Reef within the property was the only way to ensure the integrity of the coral reef ecosystems in all their diversity.*

*A number of natural pressures occur, including cyclones, crown-of-thorns starfish outbreaks, and sudden large influxes of freshwater from extreme weather events. As well there is a range of human uses such as tourism, shipping and coastal developments including ports. There are also some disturbances facing the GBR that are legacies of past actions prior to the inscription of the property on the World Heritage list.*

*At the scale of the GBR ecosystem, most habitats or species groups have the capacity to recover from disturbance or withstand ongoing pressures. The property is largely intact and includes the fullest possible representation of marine ecological, physical and chemical processes from the coast to the deep abyssal waters enabling the key interdependent elements to exist in their natural relationships.*

*Some of the key ecological, physical and chemical processes that are essential for the long-term conservation of the marine and island ecosystems and their associated biodiversity occur outside the boundaries of the property and thus effective conservation programs are essential across the adjoining catchments, marine and coastal zones.*

*Protection and management requirements*

*The GBR covers approximately 348,000 square kilometres. Most of the property lies within the GBR Marine Park: at 344,400 square kilometres, this Federal Marine Park comprises approximately 99% of the property. The GBR Marine*

*Park's legal jurisdiction ends at low water mark along the mainland (with the exception of port areas) and around islands (with the exception of 70 Commonwealth managed islands which are part of the Marine Park). In addition the GBR also includes over 900 islands within the jurisdiction of Queensland, about half of which are declared as 'national parks', and the internal waters of Queensland that occur within the World Heritage boundary (including a number of long-established ports).*

*The World Heritage property is and has always been managed as a multiple-use area. Uses include a range of commercial and recreational activities. The management of such a large and iconic world heritage property is made more complex due to the overlapping State and Federal jurisdictions. The Great Barrier Reef Marine Park Authority, an independent Australian Government agency, is responsible for protection and management of the GBR Marine Park. The Great Barrier Reef Marine Park Act 1975 was amended in 2007 and 2008, and now provides for "the long term protection and conservation ... of the Great Barrier Reef Region" with specific mention of meeting "... Australia's responsibilities under the World Heritage Convention."*

*Queensland is responsible for management of the Great Barrier Reef Coast Marine Park, established under the Marine Parks Act 2004 (Qld). This is contiguous with the GBR Marine Park and covers the area between low and high water marks and many of the waters within the jurisdictional limits of Queensland. Queensland is also responsible for management of most of the islands.*

*The overlapping jurisdictional arrangements mean that the importance of complementary legislation and complementary management of islands and the surrounding waters is well recognised by both governments. Strong cooperative partnerships and formal agreements exist between the Australian Government and the Queensland Government. In addition, strong relationships have been built between governments and commercial and recreational industries, research institutions and universities. Collectively this provides a comprehensive management influence over a much wider context than just the marine areas and islands.*

*Development and land use activities in coastal and water catchments adjacent to the property also have a fundamental and critical influence on the values within the property. The Queensland Government is responsible for natural resource management and land use planning for the islands, coast and hinterland adjacent to the GBR. Other Queensland and Federal legislation also protects the property's Outstanding Universal Value addressing such matters as water quality, shipping management, sea dumping, fisheries management and environmental protection.*

*The Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) provides an overarching mechanism for protecting the World Heritage values from inappropriate development, including actions taken inside or outside which could impact on its heritage values. This requires any development proposals to undergo rigorous environmental impact assessment processes, often including public consultation, after which the Federal Minister may decide, to approve, reject or approve under conditions designed to mitigate any significant impacts. A recent amendment to the EPBC Act makes the GBR Marine Park an additional 'trigger' for a matter of National Environmental Significance which provides additional protection for the values within the GBR.*

*The GBR Marine Park and the adjoining GBR Coast Marine Park are zoned to allow for a wide range of reasonable uses while ensuring overall protection, with conservation being the primary aim. The zoning spectrum provides for increasing levels of protection for the 'core conservation areas' which comprise the 115,000 square kilometres of 'no-take' and 'no-entry' zones within the GBR.*

*While the Zoning Plan is the 'cornerstone' of management and provides a spatial basis for determining where many activities can occur, zoning is only one of many spatial management tools and policies applied to collectively protect the GBR. Some activities are better managed using other spatial and temporal management tools like Plans of Management, Special Management Areas, Agreements with Traditional Owners and permits (often tied to specific zones or smaller areas within zones, but providing a detailed level of management not possible by zoning alone). These statutory instruments also protect the Outstanding Universal Value of the property.*

*Many Aboriginal and Torres Strait Island peoples undertake traditional use of marine resource activities to provide traditional food, practice their living maritime culture, and to educate younger generations about traditional and cultural rules and protocols. In the GBR these activities are managed under both Federal and Queensland legislation and policies including Traditional Use of Marine Resource Agreements (TUMRAs) and Indigenous Land Use Agreements (ILUAs). These currently cover some 30 per cent of the GBR inshore area, and support Traditional Owners to maintain cultural connections with their sea country.*

*Similarly non-statutory tools like site management and Industry Codes of Practice contribute to the protection of World Heritage values. Some spatial management tools are not permanently in place nor appear as part of the zoning, yet achieve effective protection for elements of biodiversity (e.g. the temporal closures that are legislated across the GBR* *prohibit all reef fishing during specific moon phases when reef fish are spawning).*

*Other key initiatives providing increased protection for the GBR include the comprehensive Great Barrier Reef Outlook Report, (and its resulting 5-yearly reporting process); the Reef Water Quality Protection Plan; the GBR Climate Change Action Plan; and the Reef Guardians Stewardship Programs which involve building relationships and working closely with those who use and rely on the GBR or its catchment for their recreation or their business.*

*The 2009 Outlook Report identified the long-term challenges facing the GBR; these are dominated by climate change over the next few decades. The extent and persistence of damage to the GBR ecosystem will depend to a large degree on the amount of change in the world's climate and on the resilience of the GBR ecosystem to such change. This report also identified continued declining water quality from land-based sources, loss of coastal habitats from coastal development, and some impacts from fishing, illegal fishing and poaching as the other priority issues requiring management attention for the long-term protection of the GBR.*

*Emerging issues since the 2009 Outlook Report include proposed port expansions, increases in shipping activity, coastal development and intensification and changes in land use within the GBR catchment; population growth; the impacts from marine debris; illegal activities; and extreme weather events including floods and cyclones. Further building the resilience of the GBR by improving water quality, reducing the loss of coastal habitats and increasing knowledge about fishing and its effects and encouraging modified practices, will give the GBR its best chance of adapting to and recovering from the threats ahead, including the impacts of a changing climate.*

## Potential Cumulative Impacts on World Heritage Property

Table A1 Nomination criterion (i): '*be outstanding examples representing the major stages of the earth's evolutionary history*'

| Item | World Heritage Natural Attributes within the GBR[1] | Presence within the influence of POTL PEP | Potential Impact to GBRWHA attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| 1 | *The number and extent of the coral reefs, coral cays and continental islands: 2904 coral reefs covering approximately 20,055 km$^2$; 300 coral cays and 600 continental islands.* | Coral reefs are present in Cleveland Bay (Middle Reef) and around Magnetic Island. | No coral reefs, continental islands or coral cays occur within areas directly affected by the project (i.e. reclamation footprint and harbour basin, dredged channel or DMPA). | Potential indirect impacts to corals located on the eastern and southern Magnetic Island (and Middle Reef) due to channel dredging (i.e. sediment plumes) will be mitigated through the implementation of a range of dredging strategies.<br>The PEP could result in coral stress and colony mortality if corals are in poor condition prior to and during the dredge campaign.<br>No long-term or major changes to the coral communities are expected, therefore no changes to the coverage or extent of coral reefs are expected.<br>No indirect impacts to the extent of Magnetic Island (the only continental island in Cleveland Bay) are expected as a result of PEP.<br>No coral cays occur within Cleveland Bay. | No direct impacts to coral reefs are expected as a result of other proposals.<br>PEP will require capital dredging followed up by maintenance dredging through time of Sea Channel in the vicinity of Magnetic Is fringing corals.<br>No indirect impacts to the extent of Magnetic Island (the only continental island in Cleveland Bay) are expected as a result of PEP and other known projects. |
| 2 | *Reef morphologies reflecting historical and on-going geomorphic and oceanographic processes.* | Coral reefs are present in Cleveland Bay (Middle Reef) and around Magnetic Island. | No coral reefs occur within areas directly affected by the project (i.e. reclamation footprint and harbour basin, dredged channel or DMPA). | As for Item 1.<br>No significant long term changes to reef communities are expected to occur as a result of PEP. Therefore, changes to reef morphology are not expected. | As for Item 1.<br>No significant long term changes to reef communities are expected to occur as a result of PEP and other projects. Therefore, changes to reef morphology are not expected. |

[1] Four nomination criteria and attributes derived from Statement of Outstanding Universal Value http://www.environment.gov.au/heritage/places/world/great-barrier-reef/values.html. Stated natural attributes (listed as Items 1-37) sourced from GBR world heritage values table; EPBC website (Environment Australia, 2003)

| Item | World Heritage Natural Attributes within the GBR[1] | Presence within the influence of POTL PEP | Potential Impact to GBRWHA attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| 3 | *Processes of geological evolution linking islands, cays, reefs and changing sea levels, together with sand barriers, deltaic and associated sand dunes.* | Coral reefs are present in Cleveland Bay (Middle Reef) and around Magnetic Island. | As for Item 1. | As for Item 1. | As for Item 1. |
| 4 | *Record of sea level changes and the complete history of the reef's evolution are recorded in the reef structure.* | Coral reefs are present in Cleveland Bay (Middle Reef) and around Magnetic Island. | As for Item 1. | As for Item 1. | As for Item 1. |
| 5 | *Record of climate history, environmental conditions and processes extending back over several hundred years within old massive corals.* | Coral reefs are present in Cleveland Bay (Middle Reef) and around Magnetic Island. | As for Item 1. | As for Item 1. | As for Item 1. |
| 6 | *Formations such as serpentine rocks of South Percy Island, intact and active dune systems, undisturbed tidal sediments and "blue holes".* | Not present | n/a | n/a | n/a |
| 7 | *Record of sea level changes reflected in distribution of continental island flora and fauna.* | Magnetic Island is a continental island. | No impact | No impact | No impact |

Table A2 Nomination criterion (ii): "*be outstanding examples representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment*"

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP Site | Potential Impact to GBRWHA attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| 8 | *The heterogeneity and interconnectivity of the reef assemblage.* | Coral reefs are present in Cleveland Bay (Middle Reef) and around Magnetic Island.<br>Soft sediment assemblages occur throughout Cleveland Bay. | No coral reefs occur within areas directly affected by the project (i.e. reclamation footprint and harbour basin, dredged channel or DMPA).<br>The harbour construction and channel dredging will not represent a barrier to movements of biota between reefs.<br>The operation of the new harbour will cause highly localised changes to the movement patterns of biota within the port area. The new harbour will have a permanently open entrance and will therefore not isolate any seabed areas.<br>It is not expected that port operation activities, such as dredging activities and shipping movements, will result in significant or long term direct impacts to the movement patterns of biota. | It is not expected that port construction activities and operation will measurably alter physical processes (currents) that facilitate movement of plankton and larvae throughout Cleveland Bay.<br>Dredge plumes represent transient features and are unlikely to represent a barrier to movement patterns of biota.<br>No major long term changes to reef assemblage structure/heterogeneity are expected as a result of PEP. | The PEP will principally occur at and directly adjacent to the existing port facilities. The port area is not known or likely to occur within the vicinity of any regionally important movement corridors for reef biota.<br>Any changes to hydrodynamics resulting from the proposed PEP and other berth expansion projects are unlikely to result in detectable changes to movement patterns of biota among reefs within Cleveland Bay and Magnetic Island, or reefs outside Cleveland Bay. |
| 9 | *The size and morphological diversity of the reef.* | Coral reefs are present in Cleveland Bay (Middle Reef) and around Magnetic Island.<br>Soft sediment assemblages occur throughout Cleveland Bay. | Irreversible loss of 110 ha of subtidal soft sediment habitat within the WHA.<br>The soft-sediment substrate types within the reclamation footprint areas are well represented throughout Cleveland Bay. Therefore, the habitat loss will not result in a reduction in habitat types | No major, temporary or long-term (or irreversible) indirect changes to the size and morphological diversity of the reef are expected as a result of indirect impacting processes. | TMP and the proposed berth expansion projects will principally occur at and directly adjacent to the existing port facilities. This will result in further reductions in subtidal soft sediments. |

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP Site | Potential Impact to GBRWHA attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| | | | present, and therefore the morphological diversity of the reef.<br>No reef-building corals occur in the harbour, dredged channels or DMPA. | | |
| 10 | *On-going processes of accretion and erosion of coral reefs, sand banks and coral cays, erosion and deposition processes along the coastline, river deltas and estuaries and continental islands.* | Sand spit at Ross River mouth supporting migratory birds and intertidal habitat. | Hydrodynamic modelling undertaken as part of the project has predicted there will be no changes to the Ross River mouth or sand spit as a result of the PEP project. | No impacts are predicted. | No impacts. |
| 11 | *Extensive Halimeda beds representing active calcification and sediment accretion for over 10 000 years.* | *Halimeda* beds occur around Cockle Bay (southern Magnetic island), but at the time of 2012 reef surveys, were not found to be a significant (>5% cover) element of the reef benthos at Middle Reef and Magnetic Island reef sites. | No *Halimeda* beds occur within areas directly affected by the project (i.e. reclamation footprint and harbour basin, dredged channel or DMPA). | Potential indirect impacts to low density *Halimeda* located on the eastern and southern Magnetic Island due to channel dredging (i.e. sediment plumes) will be mitigated through the implementation of a range of dredging strategies.<br>No long-term or major changes to the *Halimeda* cover are expected, therefore no changes to long term patterns in sediment accretion associated with *Halimeda* production are expected. | No direct impacts to coral reefs or *Halimeda* beds are expected as a result from proposals.<br>TMP and the proposed berth expansion and channel improvement projects will require capital dredging as well as an increase maintenance dredging requirements.<br>Offshore disposal of dredged material will generate turbid plumes that could result in short term effects to *Halimeda* along the eastern and southern shores of Magnetic Island.<br>No long-term and/or major changes to the *Halimeda* cover are expected presuming appropriate dredge management. |
| 12 | *Evidence of the* | Coral reefs are present in | No coral reefs occur within areas | The project is not expected to | It is unlikely that the cumulative |

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP Site | Potential Impact to GBRWHA attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| | *dispersion and evolution of hard corals and associated flora and fauna from the "Indo-West Pacific centre of diversity" along the north-south extent of the reef.* | Cleveland Bay (Middle Reef) and around Magnetic Island. | directly affected by the project (i.e. reclamation footprint and harbour basin, dredged channel or DMPA). | fundamentally alter dispersion of corals, nor evolutionary patterns in corals. Cleveland Bay is not a key site for marine scleractinian coral endemism. | effects of various projects will fundamentally alter the dispersion patterns from coral spawning, nor evolutionary patterns in corals. |
| 13 | *Inter-connections with the Wet Tropics via the coastal interface.* | As for Item 8. | As for Item 8. | As for Item 8. | As for Item 8. |
| 14 | *Indigenous temperate species derived from tropical species.* | Not relevant | Not relevant | Not relevant | Not relevant. |
| 15 | *Living coral colonies (including some of the world's oldest).* | Coral reefs are present in Cleveland Bay (Middle Reef) and around Magnetic Island. | As for Item 1. | As for Item 1. | As for Item 1. |
| 16 | *Five floristic regions identified for continental islands and two for coral cays.* | Terrestrial areas on Magnetic Island are outside the influence of the PEP project.<br>No coral cays present in Cleveland Bay. | Not relevant | Not relevant | No impact on the terrestrial flora of Magnetic Island. |
| 17 | *The diversity of flora and fauna.* | Typical Cleveland Bay organisms are macroalgae, seagrass, mangroves, saltmarsh, sponges, corals, tunicates, bryozoans, crustaceans, worms, phytoplankton, molluscs, echinoderms, fishes, seabirds, marine reptiles, marine mammals, terrestrial flora, terrestrial fauna. | Irreversible loss of 110 ha of subtidal soft sediment habitat and associated benthic fauna. It is highly unlikely that species with a highly restricted geographic distribution are present in this area. It is therefore unlikely that there will be complete irreversible loss of any species (and therefore a reduction in biodiversity at broader scales).<br>Dredging (direct extraction) and dredged material placement (smothering/burial) will result in | Any indirect changes to marine flora and fauna species (e.g. due to offsite dredge plumes) are expected to be of a temporary nature. No long term changes in the suite of species inhabiting Cleveland Bay are expected.<br>No impacts to terrestrial fauna or flora as a result of PEP are expected. | The same range of impacting processes apply to the various other berth expansion projects. In particular, decreases in water quality and sediment quality are expected within the port area as a result of the proposed projects and PEP.<br>Extensive surveys of the area for a number of projects have not found species with highly restricted geographic distribution. Therefore, it is unlikely that there will be |

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP Site | Potential Impact to GBRWHA attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| | | | the temporary loss of benthic fauna in the disturbance footprint. Macrobenthic communities are resilient to disturbance, and have a range of adaptations to facilitate recovery. Impacts are expected to be short-term and largely restricted to the disturbance footprint and immediate surrounds. No direct impact of terrestrial flora and fauna in the WHA. | | irreversible loss of any species as a result of these projects. Indirect effects to marine biota (e.g. due to dredge plumes) are expected to be of a temporary nature, relying on connectivity and resilience tendencies of the ecosystem for recovery. |
| 18 | *The integrity of the inter-connections between reef and island networks in terms of dispersion, recruitment, and the subsequent gene flow of many taxa.* | As for Item 8. | As for Item 8. | As for Item 8. | As for Item 8. |
| 19 | *Processes of dispersal, colonisation and establishment of plant communities within the context of island biogeography.* | Applies to Magnetic Island, which is outside the influence of the PEP project. | - | - | - |
| 20 | *The isolation of certain island populations (e.g. recent speciation evident in two subspecies of the butterfly Tirumala hamata and the evolution of distinct races of the bird Zosterops spp).* | Not present in relation to PEP. | - | - | - |
| 21 | *Remnant vegetation types (hoop pines) and* | Hoop pines and other remnant vegetation on Magnetic Island | - | - | - |

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP Site | Potential Impact to GBRWHA attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| | *relic species (sponges).* | would be outside the influence of the PEP project. No known relic sponge species have been observed in surveys undertaken to date. | | | |
| 22 | *Evidence of morphological and genetic changes in mangrove and seagrass flora at regional scales.* | Mangrove present on coastline at Cleveland Bay.<br>One of the largest seagrass meadows in the region is present in the south eastern parts of Cleveland Bay. | No direct impacts to seagrass meadows or mangroves are predicted. | No impacts to mangroves are expected as a result of sedimentation.<br>Turbidity and sedimentation are predicted to effect deep-water ephemeral seagrass meadows (if present) adjacent to the dredged areas. However, it is expected that this will be short-term with seagrass recovery expected to occur at time scales measured in years. In relation to existing low levels, biomass reduction would also be small.<br>Further afield, impacts to nearshore seagrasses are not expected if dredging activities are appropriately managed and mitigated as prescribed.<br>It is highly unlikely that any changes in seagrass would result in adverse effects to morphological or genetic changes in mangrove and seagrass at regional scales. | Other proposals could lead to the permanent loss of seagrass (and less likely mangroves) within and directly adjacent to their construction footprint/s. Possible short-term but reversible impacts to seagrass could also occur as a result of dredging and dredged material disposal depending on the latest state of seagrass ecology at the time (given that they change inter-annually). Confirmatory surveys would be needed for the locality.<br>Any cumulative impacts associated with these projects are not expected to cause fundamental changes to morphological and genetic changes in mangrove and seagrass flora at regional scales. |
| 23 | *Feeding and or breeding grounds for international migratory seabirds, cetaceans and sea* | Migratory seabirds, cetaceans and sea turtles are present in Cleveland Bay area. | Direct removal of feeding habitat (110 ha subtidal sediments) for nearshore dolphins due to harbour development. | See Item 22 regarding seagrass meadows, a key food resource for dugongs and green turtle. Seagrass foraging areas in eastern | Localised loss to dolphin feeding habitat is expected as a result of cumulative developments. While these species regularly move within |

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP Site | Potential Impact to GBRWHA attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| | *turtles.* | | Replacement of existing rock wall with a larger rock wall will result in the temporary, highly localised loss of a green turtle foraging habitat.<br>No direct impacts to seagrass (food resource for dugongs and green turtles) will occur as a result of PEP.<br>Acoustic impacts to marine fauna such as dugong, cetaceans, turtles may occur, and will need to be managed through a range of mitigation measures. | Cleveland Bay are not expected to be affected by PEP. Dredge plumes will need to be managed to minimise the risk of impacts to feeding areas around Magnetic Island and towards West Channel via Pallarenda.<br>Temporary loss of roosting and feeding habitat for migratory seabirds on rockwalls.<br>Increased potential for hydrocarbon or other contaminant spill from vessels.<br>The Ross River southbank and sandspit areas used by seabirds for roosting are outside the light spill effect area for PEP project. | and outside Cleveland Bay, the port area is known to represent locally important feeding habitat.<br>Decrease in water quality expected in the port area as a result of increased capital and maintenance dredging campaigns reducing quality at vertebrate feeding grounds.<br>Dredging activities will need to be managed to minimise the risk of cumulative impacts to benthos. Refer to Item 1 regarding construction staging.<br>Increased vessel movements cumulatively increase the risk of vessel strike to marine megafauna. Turtles and possibly dolphins are at most risk from vessel strike by fast-moving water-craft in shallow waters, tending to be faster recreational craft rather than commercial trade vessels of constant speed. Project-specific and port wide management plans will be implemented for port and maritime projects. Project specific dredge management plans will need to be developed to mitigate potential impacts to turtles and cetaceans.<br>Critical whale calving areas do not occur in Cleveland Bay. |

Table A3 Nomination criterion (iii) – "*contain unique, rare or superlative natural phenomena, formulations or features or areas of exceptional natural beauty, such as superlative examples of the most important ecosystems to man*"

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP | Potential Impact to GBRWHA attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| 24 | *Vast extent of the reef and island systems which produces an unparalleled aerial vista.* | PEP does not sit within the vast reef and island systems as it is shore-based. | PEP does not directly intrude on the aerial vista across the vast extent of the reef. | PEP has a small indirect effect on the aerial vista from certain vantage points such as Castle Hill across Cleveland Bay towards the outer lagoon of the GBRWHA. | Other known projects are concentrated on port landside development complex so will not cumulatively affect these values. |
| 25 | *Islands ranging from towering forested continental islands complete with freshwater streams, to small coral cays with rainforest and unvegetated sand cays.* | Magnetic Island is a forested continental island adjacent to parts of the PEP Sea Channel. | PEP does not affect any landside elements of the GBRWHA (including Magnetic Island). | No impact | No impact of PEP or other regional developments on continental islands or coral cays are predicted. |
| 26 | *Coastal and adjacent islands with mangrove systems of exceptional beauty.* | PEP is adjacent to Magnetic Island which is lined at Cockle Bay with mangroves. | There is no direct impact on Cockle Bay, Magnetic Island or Ross River mangroves. | There is no predicted indirect effect on Cockle Bay or Ross River from dredge related suspended sediments. | There are no known cumulative effects on mangroves from the projects identified. |
| 27 | *Rich variety of landscapes and seascapes including rugged mountains with dense and diverse vegetation and adjacent fringing reefs.* | PEP sits within Cleveland Bay on land backing industrial and urbanised settings. | PEP directly appears against the seascape of Cleveland Bay, but not on a variety of landscapes including mountains, vegetation or fringing reefs. | Dredging for PEP has the potential to temporarily affect the seascapes from Magnetic Island. | The rich variety of landscapes is not evidently at risk because of the already developed nature of the inshore waters of Cleveland Bay and the Ross catchment coastline. |
| 28 | *Abundance and diversity of shape, size and colour of marine fauna and flora in the coral reefs.* | The nearest coral reefs are Middle Reef and reef fringing headlands on Magnetic Island. | No impact | Dredging for PEP has the potential to temporarily affect the abundance (coverage) of organisms on fringing reef on Magnetic Island. | Permanent effects on the abundance and diversity of shape, size and colour of sessile marine fauna and flora in the coral reefs will not occur. |

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP | Potential Impact to GBRWHA attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| 29 | *Spectacular breeding colonies of seabirds and great aggregations of over-wintering butterflies.* | Not relevant | No impact | No impact | No impact |
| 30 | *Migrating whales, dolphins, dugong, whale sharks, sea turtles, seabirds and concentrations of large fish.* | PEP is situated in nearshore waters of Cleveland Bay known for population of turtles, dugong and dolphins. | Effects from pile driving may temporarily dissuade habitation patterns of marine vertebrates.<br>Direct removal of feeding habitat (110 ha subtidal sediments) due to port and harbour development. | During construction phases, presence of additional vessels may dissuade animals from local waters around PEP infrastructure. Longer term effects of increased shipping at the Port unlikely to significantly impact local movement patterns of megafauna, unless there was an unplanned emission or spill. | Refer to Item 23.<br>Increased vessel activity from the series of projects may indirectly dissuade habitation patterns of dolphins and dugongs from nearshore Cleveland Bay waters outside of protected marine areas. |

Table A4 Nomination criterion (iv): "*be habitats where populations of rare or endangered species of plants and animals still survive*"

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP Site | Potential Impact to GBRWHA Attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| 31 | *Habitats for species of conservation significance within the 77 broadscale bioregional associations that have been identified for the property and which include over 2900 coral reefs (covering 20,055 km$^2$) which are structurally and ecologically complex.* | 70 marine bioregions are presently recognised in the GBRWHA, three of which occur in the region:<br>▪ NA3 High Nutrients Coastal Strip (non-reefal bioregion)<br>▪ RF2 Central Open Lagoon Reefs (reefal bioregion)<br>▪ RE3 Coastal Central Reefs (reefal bioregion).<br>The GBR Gazetteer mapped 13 reefs covering 987 ha within Cleveland Bay.<br>Cleveland Bay contains a diversity of marine habitat types that is representative of other nearshore areas of the GBRWHA, including intertidal beaches, tidal flats, mangrove forests, saltmarshes, intertidal shoals, subtidal soft sediment habitats, rock walls, coral reefs and rocky shores. These habitats support a range of marine megafauna species of conservation significance, including sea turtles, whales, dolphins and dugong. | Irreversible loss of 110 ha of subtidal soft sediment habitat within the WHA. This represents 0.006% of the total 1,715,400 ha area of High Nutrients Coastal Strip bioregion.<br>This will reduce the availability of feeding habitat for nearshore dolphins (see Item 23), whereas little direct impacts are expected to other protected marine species.<br>Sub-tidal soft sediment habitats within the dredged channels and DMPA will be temporarily impacted by dredging and dredged material disposal. Impacts to the DMPA will be reversible, whereas there will be an increase (irreversible) in water depths in the dredged channel. | Potential short-term, reversible effects to benthos (see Items 22 and 23) and coral colonies (see Item 1). Significant and/or longer-term impacts to marine megafauna are not expected as result of these changes. | Proposed projects will principally occur at and directly adjacent to the existing port facilities. It is expected that the proposed port development activities will result in cumulative, irreversible loss of subtidal soft sediments within and directly adjacent to the port area. Such losses will:<br>▪ not result in changes to the number of bioregions represented in Cleveland Bay<br>▪ not result in changes to the area and number of coral reefs<br>▪ result in an incremental loss in the total area of High Nutrients Coastal Strip and Coastal Central Reefs bioregions within the WHA.<br>Refer to 22 and 23 regarding impacts to species of conservation significance and their habitat. |

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP Site | Potential Impact to GBRWHA Attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| 32 | *Large numbers of islands, including:*<br>▪ *600 continental islands supporting 2195 plant species in 5 distinct floristic regions;*<br>▪ *300 coral cays and sand cays;*<br>▪ *seabird and sea turtle rookeries, including breeding populations of green sea turtles and hawksbill turtles; and*<br>▪ *coral cays with 300-350 plant species in 2 distinct floristic regions.* | Magnetic Island, a continental island, is located in Cleveland Bay approximately 8 km from the mainland. The project will not affect terrestrial areas of Magnetic Island, therefore only marine values are considered here. Magnetic Island does not support sea turtle rookeries or coral cays. | The areas potentially directly affected by PEP are not located at Magnetic Island. | Not applicable – no coral cays or turtle rookeries present at Magnetic Island. | Proposed projects will principally occur at and directly adjacent to the existing port facilities. Impacts to Magnetic Island coral cay, seabird or turtle rookeries are not expected as a result of these projects.<br>An important bird nesting and roosting area is present on a sand spit on the south side at the mouth of the Ross River. Recent surveys have not indicated adverse effect from developments recently completed (TMP) or currently underway (TPAR). Modelling has indicated no direct light spill effect from PEP at that site.<br>Existing rock walls and reclamation areas of the port are used opportunistically by migratory birds (including some seabirds). The increased port rockwall area and PEP reclamation will provide additional opportunistic bird feeding/roosting habitat. |
| 33 | *Seagrass beds (over 5,000 km$^2$) comprising 15 species, 2 endemic.* | Cleveland Bay supports one of the largest seagrass meadows in the region. Eight seagrass species have been recorded in Cleveland Bay.<br>It is now known that one seagrass species is endemic to the GBR region: *Halophila tricostata*. This species has | Potential loss of ephemeral deepwater seagrass (not currently present) at the Dredge Material Placement Area. Seagrass recovery following placement is uncertain given the dispersive nature of the site and noting that seagrass in the DMPA has | Temporary loss of ephemeral deepwater seagrass due to turbid plumes and sedimentation resulting from dredging of the Sea/Platypus Channels. The seagrass species previously recorded in areas potentially affected by turbid plumes are well represented throughout | Refer to Item 22 and 23 above for details regarding potential cumulative impacts. |

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP Site | Potential Impact to GBRWHA Attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| | | not been recorded in Cleveland Bay to date. | only been observed in certain seasonal conditions.<br>The seagrass species previously recorded in the DMPA occur throughout Cleveland Bay. Therefore, it is not expected that dredging activities wo.uld cause the long-term/irreversible loss of any seagrass species within Cleveland Bay. | Cleveland Bay. Through resilience and connectivity processes, it is not expected that dredging activities would cause the long-term/irreversible loss of any seagrass species within Cleveland Bay.<br>No major changes to abiotic habitat conditions (including sediment types, hydrodynamic processes, water depths) will occur outside the dredged channel, DMPA and outer harbour. Seagrass meadow extent will recover to baseline conditions in any areas potentially temporarily affected by turbid plumes/sedimentation, most likely at timescales measured in months to years. | |
| 34 | *Mangroves (over 2,070 km$^2$) including 37 species.* | PEP is adjacent to Magnetic Island which is lined at Cockle Bay with mangroves. | Refer to Item 26 | Refer to Item 26 | Refer to Item 26.<br>Possible short-term but reversible impacts to mangroves could also occur as a result of unplanned emissions or spills to waters. |
| 35 | *Halimeda banks in the northern region and the unique deep water bed in the central region.* | Not present | Refer Item 11 | Refer Item 11 | Refer Item 11 |
| 36 | *Large areas of ecologically complex inter-reefal and lagoonal benthos.* | Diverse coral, algal and benthic communities occur within Cleveland Bay and Magnetic Island areas. | Refer to Item 31 | Refer to Item 31 | Refer to Item 31 |

| Item | World Heritage Natural Attributes within the GBR | Presence within the influence of POTL PEP Site | Potential Impact to GBRWHA Attributes from PEP and other regional projects | | |
|---|---|---|---|---|---|
| | | | Direct | Indirect | Cumulative |
| 37 | *Species of plants and animals of conservation significance.* | Dugong is abundant in Cleveland Bay. Humpback Whales may occasionally calve in Cleveland Bay. Several species of dolphins occur in Cleveland Bay. Several species of marine turtles occur in Cleveland bay and near Magnetic Island. 52 species of shorebirds feed and roost near the Ross River. | Irreversible loss of 110 ha of subtidal soft sediment habitat. This will reduce the availability of feeding habitat for nearshore dolphins (see 23), whereas little direct impacts are expected to other protected marine species.<br>Refer to Items 23; 30 | Refer to Items 23; 30 | Refer to Item 22 and 23 and 30 above for details regarding potential cumulative impacts. |

Table A5- Potential cumulative impacts to cultural and social values of the Great Barrier Reef National Heritage Place

| Cultural and Social Values | Potential Impact of PEP and regional projects to GBR values in Cleveland Bay | | | Potential Cumulative Effects |
|---|---|---|---|---|
| | Fabric<br>Environmental factors (such as noise, air, light, vibration) may affect the integrity of heritage built fabric. | Setting<br>Direct or indirect impacts that would compromise the visual settings that contributes to the place's cultural heritage significance. | Associations<br>Direct or indirect impacts that would affect the community's enjoyment or use of these places or restrict the opportunity for the interpretation, commemoration and celebration of the community's links with the places. | |
| Potential Aesthetic Values | | | | |
| *Visitations to the shoreline and passive enjoyment of seascape vistas. Includes photography, cultivated outdoors experiences, passive recreation and fauna watching.* | Recreational and passive enjoyment at locations such as The Strand and Kissing Point may be diminished because of noise emissions especially during construction phases. | The site and visual setting of the Townsville coastline is substantively developed with no significant impact predicted on matters of cultural heritage significance. | The development is within the existing maritime and industrial coastal landscape and reminiscent of Townsville's maritime history of European settlement. | Wider aesthetic effects from a series of commercial, industrial and public uses such as ports activity, dredging and disposal of dredged material, presence of shipping includes ships in transit in designated shipping lanes and in anchorages (from Magnetic Island vantages), numerous recreational vessel movements and aircraft all in proximity to natural and/or protected areas. In addition, existing coastal development outside the port (including that on Magnetic Island), while enhancing opportunities for further appreciation, currently impinge on the natural aesthetics of the WHA. |

| Cultural and Social Values | Potential Impact of PEP and regional projects to GBR values in Cleveland Bay | | | Potential Cumulative Effects |
|---|---|---|---|---|
| | Fabric<br>Environmental factors (such as noise, air, light, vibration) may affect the integrity of heritage built fabric. | Setting<br>Direct or indirect impacts that would compromise the visual settings that contributes to the place's cultural heritage significance. | Associations<br>Direct or indirect impacts that would affect the community's enjoyment or use of these places or restrict the opportunity for the interpretation, commemoration and celebration of the community's links with the places. | |
| *Recreational craft usage and enjoyment of the marine environment. Recreation is one of the major uses of the GBRWHA. It is woven into the social fabric of coastal communities all along the Queensland coast and generates significant regional economic value.* | Not relevant to built fabric. | The POTL PEP will not affect the existing use of Ross River and Ross Creek by recreational boat users. It should, in fact, have a small beneficial effect by extending the calm water environment further seaward. The PEP is likely to have the greatest effect on boats travelling in a northwest direction from Ross River and southeast from Ross Creek. | There is no evidence of pressure or undue effects on take for recreational and commercial fisheries. | There will be a decrease in the area of seabed and open water available for recreational fishing and boating enjoyment in small parts of Cleveland Bay.<br>Boats heading north from either Ross Creek or Ross River will experience no appreciable increase in travel distance or time. The PEP will not limit yachting opportunities within Cleveland Bay including informal or formal races |
| *Visual impacts including views to and from vistas such as Magnetic Island and Cape Cleveland.* | Not relevant to built fabric. | No visual amenity impact from The Strand shoreline to Magnetic Island or towards Middle Reef. While specific viewsheds (such as from Castle Hill; The Strand) will contain additional developed PEP land, it is within entirely with the context of the existing port activities and infrastructure. Magnetic Island (and passenger ferry) viewpoints illustrated PEP 'visibility' in relation to scenic values of the GBRWHA showing that, during both construction and operation phases, the greatest impact on views would be of moderate significance. | The development is within the existing maritime and industrial coastal landscape and the opportunity for its appreciation is not significantly impeded. | Visual effects, especially at night, from the port being constructed and a myriad of operations as part of a functional port. However, the land use and activity is consistent with its built European heritage. |

| Cultural and Social Values | Potential Impact of PEP and regional projects to GBR values in Cleveland Bay | | | Potential Cumulative Effects |
|---|---|---|---|---|
| | Fabric<br>Environmental factors (such as noise, air, light, vibration) may affect the integrity of heritage built fabric. | Setting<br>Direct or indirect impacts that would compromise the visual settings that contributes to the place's cultural heritage significance. | Associations<br>Direct or indirect impacts that would affect the community's enjoyment or use of these places or restrict the opportunity for the interpretation, commemoration and celebration of the community's links with the places. | |
| Historic Values | | | | |
| ***Lighthouses***<br>*Bay Rock lighthouse (now at the Maritime Museum of Townsville) and Cape Cleveland Lighthouse (20 km east of POTL) both located within the wider study area.* | There will be no direct impacts on any lighthouses. | The POTL PEP will not disturb the wider setting of Cleveland Bay or any of the lighthouses (that are intrinsically linked to ports and maritime purposes). The view from Cape Cleveland where there is a listed lighthouse will encompass the POTL PEP in the far distance but indiscernible from the existing port. | The POTL PEP will not restrict the interpretative values or integrity of any of the lighthouses. | There will not be a cumulative effect to the cultural heritage values of the project area or the broader study area. |
| ***Shipwrecks***<br>*There are 12 known shipwrecks within Cleveland Bay. None of these sites are located within the PEP project area.* | There will be no direct impacts to any known shipwrecks within Cleveland Bay. | The POTL PEP will not disturb the wider setting of Cleveland Bay or any setting of any known shipwreck sites. | POTL PEP continues the theme of rich maritime history of the region, and will not restrict the interpretation of any of the known shipwreck sites. | It is unlikely that there will be any cumulative effect to the cultural heritage values of the project area or the broader study area. |
| ***Aeroplane Wrecks***<br>*There were 161 known aircraft crashes in the Townsville area during World War II and 122 known aircraft crash sites located in Townsville waters. None of these sites are known to be in the PEP project area.* | There will be no direct impacts to any known aeroplane wrecks within Cleveland Bay. | The POTL PEP will not disturb the wider setting of Cleveland Bay or any of the known aircraft crash sites. | The POTL PEP will not restrict the interpretation of any of the known aircraft crash sites. | It is unlikely that there will be any cumulative effect to the cultural heritage values of the project area or the broader study area. |

| Cultural and Social Values | Potential Impact of PEP and regional projects to GBR values in Cleveland Bay<br>Fabric<br>Environmental factors (such as noise, air, light, vibration) may affect the integrity of heritage built fabric. | Setting<br>Direct or indirect impacts that would compromise the visual settings that contributes to the place's cultural heritage significance. | Associations<br>Direct or indirect impacts that would affect the community's enjoyment or use of these places or restrict the opportunity for the interpretation, commemoration and celebration of the community's links with the places. | Potential Cumulative Effects |
|---|---|---|---|---|
| ***Listed Heritage Places***<br>*Other than the GBR National heritage place itself, PEP is 1.8 km from the nearest listed place of heritage significance. None of the listed places are located within or have direct association with the GBRWHA.*<br>*Note the GBRWHA is listed as a National Heritage Place and effects and impacts are described elsewhere in this section.* | There will be no direct impacts any land based heritage listed places within the wider Townsville area. | The POTL PEP will not restrict the interpretation, commemoration, or enjoyment of any of the land based heritage listed places. | There is only one heritage place that is listed for its setting (64 Allen Street, South Townsville). The project will not result in the introduction of new visual elements to the setting of this place and therefore its cultural heritage will not be adversely impacted. | Cumulative effects to cultural heritage values of the project area or the broader study area are not evident.<br>They need to be identified individually based on project footprints and zones of influence. |
| Scientific or Research Value | | | | |
| *Scientific research is essential to understanding the functioning, health and resilience of the Great Barrier Reef. Scientific Research Zones provide opportunities for scientific research in relatively undisturbed areas.* | No impact to scientific research zones. No apparent constraint on research emerges because of PEP activities. Through offset packages, POTL intends to support ongoing research within Cleveland Bay and the GBRWHA to grow the understanding of key marine and coastal processes and management tools. | | | There will be no direct and indirect impact to the six island research stations within the GBRWHA, nor the Cape Ferguson AIMS site. |
| Social Values | | | | |
| *Traditional use of marine resources, mainly through hunting, fishing and collecting.* | No impact is evident | No impact is evident | Implementation of POTL Cultural Heritage Management Plan and ongoing consultation with representatives of the Aboriginal parties in accordance with the CHMP will identify traditional use of resources | Traditional Use of Marine Resources Agreements (TUMRA) are formal agreements than can be developed by Traditional Owner groups and accredited by the |

| Cultural and Social Values | Potential Impact of PEP and regional projects to GBR values in Cleveland Bay | | | Potential Cumulative Effects |
|---|---|---|---|---|
| | Fabric<br>Environmental factors (such as noise, air, light, vibration) may affect the integrity of heritage built fabric. | Setting<br>Direct or indirect impacts that would compromise the visual settings that contributes to the place's cultural heritage significance. | Associations<br>Direct or indirect impacts that would affect the community's enjoyment or use of these places or restrict the opportunity for the interpretation, commemoration and celebration of the community's links with the places. | |
| | | | within the vicinity of the PEP. | GBRMPA and the Department of Environment and Heritage Protection (DEHP). Each TUMRA operates for a set time after which it is renegotiated. There are currently five TUMRA regions in the Great Barrier Reef Marine Park. None of these agreements cover the current study area as the land reclamation and shipping channels lie largely outside the GBRMP. |
| *Traditional cultural and spiritual values - 'connection to country'. Includes heritage values defined in the GBRMPA Heritage Strategy (2005).* | No impact is evident | No impact is evident | There are enduring (complex and integrated) cultural and spiritual values along this section of Cleveland Bay coastline. Ross Creek and Ross River are integral components of the local Aboriginal creation story.<br>Reclamation works for the port have been undertaken periodically since European settlement in Townsville in the 1860's. Despite these significant alterations to the landscape Aboriginal people maintain their 'connections to country' although the proposed development is unlikely to impact this association with the GBR marine park, the world heritage area and national heritage place. | Further development of the port by coastal development, Cleveland Bay, the Townville coastline and major waterways such as Ross Creek, Ross River and the GBRMP will continue to be fundamental and significant places.<br>The project will have no greater impact on cultural values than the many previous development projects which have resulted in distinct alterations to the original coastline at Cleveland Bay. |

| Cultural and Social Values | Potential Impact of PEP and regional projects to GBR values in Cleveland Bay | | | Potential Cumulative Effects |
|---|---|---|---|---|
| | Fabric<br>Environmental factors (such as noise, air, light, vibration) may affect the integrity of heritage built fabric. | Setting<br>Direct or indirect impacts that would compromise the visual settings that contributes to the place's cultural heritage significance. | Associations<br>Direct or indirect impacts that would affect the community's enjoyment or use of these places or restrict the opportunity for the interpretation, commemoration and celebration of the community's links with the places. | |
| *Native Title rights and interests* | No impact is evident. Although there is no current native title claim over the development area, PEP will change an area of seabed used by traditional owners. | No impact is evident | No impact is evident | There are currently no registered Native Title claims within the Townsville region. POTL will continue to liaise with traditional owners. Future liaison/actions will be consistent with the provisions of the Native Title Act. |
| *Vessel mooring* | Short term moorings and exclusion zones for vessels used in and around the Outer Harbour during construction will have an impact on the natural heritage fabric of a small inshore area of Cleveland Bay.<br>Currently, there is no offshore designated anchorage area for visiting ships, although an area east of Magnetic Island is used informally as an anchorage. | Vessel mooring, in the short term for PEP construction, and offshore ship anchorage (when used) would have small-scale effects on the visual setting of natural aesthetic appreciation and natural values of parts of Cleveland Bay. | Alteration of mooring patterns would not affect opportunity for community appreciation or enjoyment of GBRWHA natural heritage values of Cleveland Bay or the region. | A designated anchorage area (DAA) is being proposed east of Magnetic Island outside of the POTL port limits and within the Commonwealth marine area and GBRMP (General use Zone). |
| *Commercial Marine Tourism* | No Impact | No Impact | No Impact | The regional population base and its wealth may grow tourism activity and interest.<br>Tourism operators will focus, as they do now, on natural experiences away from built up or functional port locations. |


# Port Expansion Project EIS

## Appendix X1

## Oil Spill Risk and Exposure Study to the Townsville PEP

AECOM BMT WBM

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# OIL SPILL RISK AND EXPOSURE MODELLING STUDY FOR THE TOWNSVILLE PORT EXPANSION PROJECT

**Prepared for:**
**Port of Townsville Ltd., AECOM and BMT WBM.**

# Document control form

| *Document draft* | *Originated by* | *Edit & review* | *Authorized for release by* | *Date* |
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**DISCLAIMER:**

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# EXECUTIVE SUMMARY

The Port of Townsville Ltd (POTL), as part of planning for the Port Expansion Project, commissioned an oil spill risk assessment to quantify and aid in managing oil spill risks associated with the planned expansion of the port. A Hazard Identification Assessment of the new operations associated with the expansion was undertaken and revealed a range of oil spill risks and potential incident scenarios related to 3 areas within Port Limits, being the offshore Anchorage Area, the Sea Channel and the new Outer Harbour entrance. For these sites, a range of spill scenarios were developed to: (1) quantify seasonal influences on spill fates; (2) include Maximum Credible and Most Likely Spill Scenarios and (3) cover a range of locations within the Port Limits. Specifically, 6 scenarios were selected as follows:

1. Winter Spill Risk Assessment of a collision with a Panamax ship while at the offshore anchorage resulting in a Maximum Credible Spill of 100% of the volume of the largest tank (300 cubic meters) of Bunker Fuel over 1 hour.
2. Summer Risk Assessment of a collision of a Panamax ship while at the offshore anchorage resulting in a Maximum Credible Spill of 100% of the volume of the largest tank (300 cubic meters) of Bunker Fuel over 1 hour.
3. Winter Risk Assessment of a collision of a Panamax ship in the Sea Channel (between a site close to Magnetic Island 146º 52’ 55.2”E 19º 9’ 26.3”S and the harbour) resulting in a Maximum Credible Spill of 100% of the volume of a wing tank (300 cubic meters) of Bunker Fuel over 1 hour, from a collision with an Island Ferry/Barge or Fishing Vessel.
4. Winter Risk Assessment of a collision of a Panamax ship in the Sea Channel (between a site close to Magnetic Island 146º 52’ 55.2”E 19º 9’ 26.3”S and the harbour) resulting in a Most Likely Spill of 20% of the volume of a wing tank (60 cubic meters) of Bunker Fuel over 6 hours, from a collision with an Island Ferry/Barge or Fishing Vessel.
5. Winter Risk Assessment of a collision of a Panamax ship with the breakwater at the Harbour Entrance – 146º 50’ 17.9”E 19º 14’ 16.4”S resulting in a Maximum Credible loss of 300 cubic meters of Bunker Fuel over 1 hour.
6. Winter Risk Assessment of a collision of a Panamax ship with the breakwater at the Harbour Entrance – 146º 50’ 17.9”E 19º 14’ 16.4”S resulting in a Most Likely Spill of 60 cubic meters of Bunker Fuel over 6 hours.

The oil spill modelling was performed using a purpose built oil spill trajectory and weathering model (OILMAP) with stochastic ability, to analyse and summarize hundreds of spill simulations. Using high resolution modelled currents of the region and measured winds from coastal wind stations, OILMAP simulated the transport, spreading and weathering of the specific oil types under the influence of the changing meteorological and oceanographic conditions of the study region. For each spill scenario, the OILMAP stochastic model analysed the multitude of predictions to assess the probability of oil exposure to surrounding regions, including any shoreline exposure, as well as the minimum time and weathered state that exposure to a certain location could potentially be. The stochastic modelling approach involves simulating each of the hypothetical incidents many times (e.g. 100) using the same spill information (i.e. release location, spill volume, duration and oil type) but randomly varying the start time and in turn the prevailing wind and current conditions. This approach ensured that the predicted transport and weathering of an oil slick was subjected to a range of varying weather conditions for a given period and hence objectively quantified risk to surrounding resources. The extents of risk were defined using two thickness thresholds being 10 µm (0.01 mm) as the minimum thickness that would potentially produce an ecological impact to sensitive species and 0.5 µm (0.0005 mm) as the minimum thickness extent of visible oil as observed from an aircraft.

Collectively, 100 spill simulations were conducted for the 6 scenarios above, making 600 simulations in total for spills within the Port Limits. The results from these scenarios were reviewed and reported herein. Collectively, the findings of the oil spill risk assessment can be summarized as follows:

1. The fate of HFO spills in Cleveland Bay is significantly wind driven.
2. The predominant wind direction over Cleveland Bay is from the Southeast direction, hence spills mostly always drifted north-westward, frequently moved into Halifax Bay and generally oscillated backwards and forwards with the tide until they encountered a shoreline in Cleveland Bay, including Magnetic Island or Halifax Bay. The modelling indicated that typically multiple shoreline impacts occurred with any given spill incident.
3. Shorelines within this region are populated, and shoreline impacts occurred in less than one hour of release in some simulations, particularly related to an incident in the outer harbour or along the Sea Channel. Shoreline trapped Bunker Fuels will evaporate, albeit slowly, creating a hydrocarbon vapour plume that may blow onshore with the wind that brought the oil ashore. The modelling indicated that the vapours may persist for up to 10 days for the Maximum Credible Spill Volume.
4. A comparison of the seasonal influences (that is, summer and winter conditions) on spill fate within the region revealed little variance in spill outcomes between summer and winter conditions.
5. Spills reaching beaches with breaking wave action along the shore were predicted to potential emulsify, incorporate suspended sediment and sink after a period of days if not recovered and collected before that time.
6. From the 600 simulations undertaken for this study, no spills were predicted to reach the mid shelf reefs of the Great Barrier Reef, indicating a very low to insignificant risk to the offshore reefs from spills within the Port Limits of Cleveland Bay. Also, the furthest excursion from any spill was typically alongshore, where small volumes of spilt oil could reach the Hinchinbrook Island region as highly weathered and potentially semi solid tar balls and paddies.

# 1 INTRODUCTION

The Port of Townsville Ltd (POTL), as part of planning for the Port Expansion Project, commissioned an oil spill risk assessment as part of their initial due diligence of the project and for the purposes of their draft EIS for the project. The oil spill risk assessment was undertaken in parts and included a Hazard Identification Assessment and an Oil Spill Modelling study to quantify and aid in managing oil spill risks associated with the planned expansion of the port.

This report describes the outcomes of the Hazard Identification Assessment and details the new and/or increased oil spill risks within the Port Limits that are associated with the planned port expansion. The report also describes the oil spill modelling component which simulated credible spill scenarios using the expected layout of the new offshore breakwater and its modification of water flows within Cleveland Bay as shown in Figure 1.

Please note that the OILMAP system, the methods and analysis presented herein use modelling algorithms which have been anonymously peered reviewed and published in international journals. Further, Asia-Pacific ASA warrants that this work meets and exceeds the ASTM Standard F2067-07 “Standard Practice for Development and Use of Oil Spill Models”.

Note that the modelling does not take into consideration any of the spill prevention, mitigation and response capabilities and arrangements that POTL have in place. The modelling makes no allowance for intervention following a spill to reduce volumes and/or prevent hydrocarbons from reaching sensitive areas.


*Figure 1: Map showing Port of Townsville and surrounds.*

# 2 HAZARD IDENTIFICATION ASSESSMENT

Port of Townsville Limited, AECOM and BMTWBM undertook a workshop to assess additional risks associated with the expected increase in shipping numbers and ship sizes. Specifically, the expected change in the shipping risk profile associated with the planned Townsville Port Expansion Project is detailed in Section B18.1 “Ship Management Planning” of the Draft EIS. This section outlines that the proposed new outer harbour allows for larger dry bulk carrier vessels and possibly liquid bulk carrier vessels initially up to 75,000 DWT Panamax size with 13m maximum draught, but in the long term capable of berthing Panamax vessels up to 85,000 DWT with 14.6m maximum draught.

The workshop reviewed the Queensland Coastal Contingency Action Plan 2011 (QCCAP 2011) that identified that the oil spill risks associated with 75,000-85,000 DWT Panamax Size Bulk Carriers to be related to collision and grounding risks and typically accounted for incidents that released bunkers or heavy fuel oils (HFO) from ruptured fuel tanks to the marine environment.

Given the shallow and wide spread soft muddy benthos of Cleveland Bay, POTL advised that the collision risk was significantly higher than the grounding risk, since a vessel would typically stick in the soft benthic muds preventing any grounding on rock or fringing coral reefs within Port Limits.

Hence ship traffic routes were reviewed to examine sites that might be associated with a collision (see Figure 2). From the ship traffic routes, 3 areas or intersections were noted and these were agreed as significant hazards for collisions. Firstly, the offshore anchorage area was identified as a collision risk due to the increased shipping numbers associated with an anchorage. While the Sea Channel is limited to one ship at a time, Figure 2 demonstrated that commercial fishing vessels and Island Ferries merge into and out of the channel hence pose a collision risk at these parts of the channel. Finally, the harbour entrance was also identified as area where multiple ships can transverse simultaneously and given the presence of rock breakwaters, was also a significant collision risk area.

QCCAP 2011 also identified that the 75,000-85,000 DWT Panamax size Bulk Carriers fuel tank capacity to be 3,000 Cubic Meters as worst-case estimates. Hence a worst-case outcome would be the total loss of a vessel laden with fuel. However, the new AMSA 2012 guidelines suggested a Maximum Credible Spill to be the loss of the largest tank. Panamax size Bulk Carrier typically have about 8 tanks spread around the vessel, hence the loss of an entire tank would be 300 cubic metres or less that could be lost if a collision ruptured an entire tank. However, a most likely scenario would be either a partial rupture of a tank that allowed oil to remain trapped within the tank or a slower leak that allowed internal transfer of fuel oil to other tanks to prevent loss to the environment. Hence a most probable spill estimate would by 20% of the largest tank volume lost or 60 cubic metres.

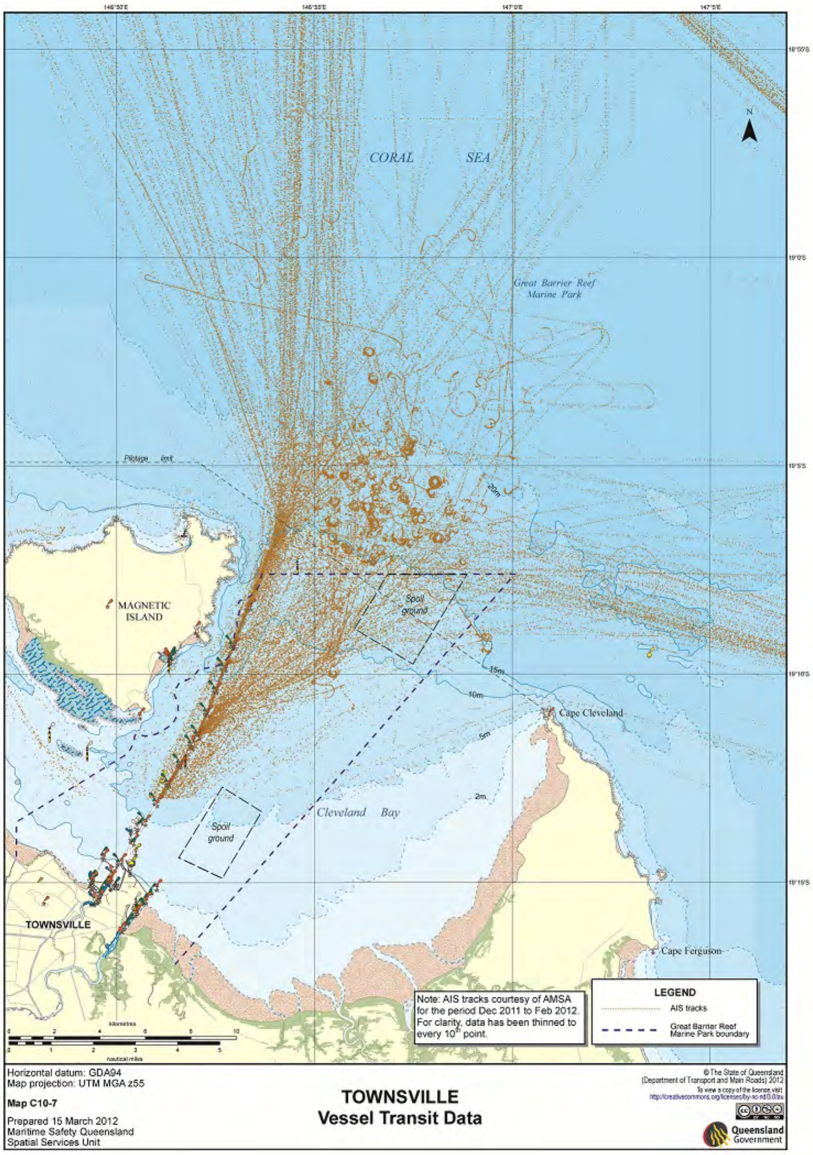


*Figure 2: Maritime Safety Queensland map showing vessel transit data for the Port of Townsville.*

The AMSA 2012 guidelines suggest that stochastic spill modelling be used to quantify the risk of related impacts associated with the risk scenarios developed through the Hazard Identification Assessment workshop. From the 3 sites selected above, a range of spill scenarios where developed to: (1) quantify seasonal influences on spill fates; (2) include Maximum Credible and Most Likely Spill Scenarios and (3) cover a range of locations within the port Limits. Specifically, 6 were selected as follows:

1. Winter Spill Risk Assessment of a collision with a Panamax ship while at the offshore anchorage resulting in a Maximum Credible Spill of 100% of the volume of the largest tank (300 cubic meters) of Bunker Fuel over 1 hour.
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The stochastic oil spill modelling selected for the risk assessment was OILMAP, which is designed to simulate the transport, spreading and weathering of specific oil types under the influence of changing meteorological and oceanographic forces. It is also the OSTM for the National Plan. The findings from this assessment will assist POTL managers to assess the potential risks and to develop appropriate oil spill contingency plans.

# 3 SCOPE OF WORK

The modelling scope of work included:

1. Incorporate the high resolution currents developed by BMTWBM that included the new outer harbour development influence on flow fields for the winter months, when currents were typically strongest. Beyond that high resolution grid, incorporate regional currents (for example, HYCOM with tides) from the APASA COASTMAP Environmental Data Server (EDS) as used by SAR agencies for the Great Barrier Reef and Coral Sea for the period 2007 to 2011. These broader scale datasets are modelled from observations of ocean state from ongoing Global Satellite Ocean Altimetry and Temperature measurements over 25 years. They are also the same used for notable spill events (Montara, AMSA, SEWPAC Studies and MSQ for Pacific Adventurer and Sheng Neng Grounding on the Great Barrier Reef);
2. Use ambient wind data, current data and detailed oil characteristics as input into the OILMAP Stochastic Model to undertake 100s of spill simulations to predict the range

of potential movement and weathering of spilt oil originating from each of the spill scenarios;

3. For each spill scenario, analyse the multitude of predictions to assess the probability of oil exposure to surrounding regions, including any shoreline exposure, as well as the minimum time and weathered state that exposure to a certain location could potentially be; and
4. Report on the single trajectories, (identified from the stochastic results) which resulted in the maximum volume of oil to reach the shore where possible.

# 4 REGIONAL CURRENTS

Cleveland Bay adjoins Halifax Bay to the north and they are separated partly by Magnetic Island and collectively define the inshore coastal region between the Port of Townsville and the Central Section of the Great Barrier Reef. The flows within these two bays are tidal and wind driven.

The tides flood into Cleveland Bay and Halifax Bay from the Coral Sea in a southwest movement typically and ebb to the northeast in a semi diurnal cycle (12 hours) with a diurnal inequality. The tides also demonstrate a Spring/Neap cycle, resulting in greater tidal height ranges and stronger currents during the springs.

Wind forcing on surface flows is typically from the Southeast direction which pushes inshore waters northward from Cleveland Bay into Halifax Bay during strong winds events. This in turn draws waters from offshore Cape Cleveland into Cleveland Bay and creates significant drift currents within the region.

Depending on the state of the spring/neap cycle and the wind strength, it is possible for the ebb tides to reverse the wind driven flows during spring tides and weak winds, but potentially wind driven currents can overpower tidal flows when winds are moderate to strong.

It is important to note, that while there is considerable influence on shelf waters in general from the offshore deepwater East Australian Current, none of this exists within the sheltered Cleveland Bay, due to the blocking influences of Magnetic Island and Cape Cleveland.

# 5 REGIONAL WINDS

To account for the wind influence, local wind data was sourced from the Bureau of Met station at the Townsville Airport (given its proximity to the coast) and at a broader scale from the National Centers for Environmental Predictions (NCEP) reanalysis global model, known as GFS, which is made available by NOAA's (National Oceanic and Atmospheric Administration) Climate Diagnostics Center. The GFS wind data is the integration of extensive historic and observed atmospheric data into a state-of-the-art atmospheric model, with global coverage predictions at hourly intervals.

GFS wind data for the years 2007 to 2011 (inclusive) was extracted across the entire model domain for input into the oil spill model. Figure 3 shows a snapshot of the winds during the winter months). Figure 4 shows the monthly wind rose distributions for Cleveland Bay. Note that the atmospheric convention for defining wind direction, that is, the direction the wind blows **from**, is used to reference wind direction throughout this report. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Twelve directions are used. The branches are divided into segments of different length and thickness which is proportional to the frequency of winds from that direction and colour coded to indicate the relative wind seeds that have occurred from that direction.

Figure 4 shows that winds are typically from the southeast direction, being stronger during winter than summer.

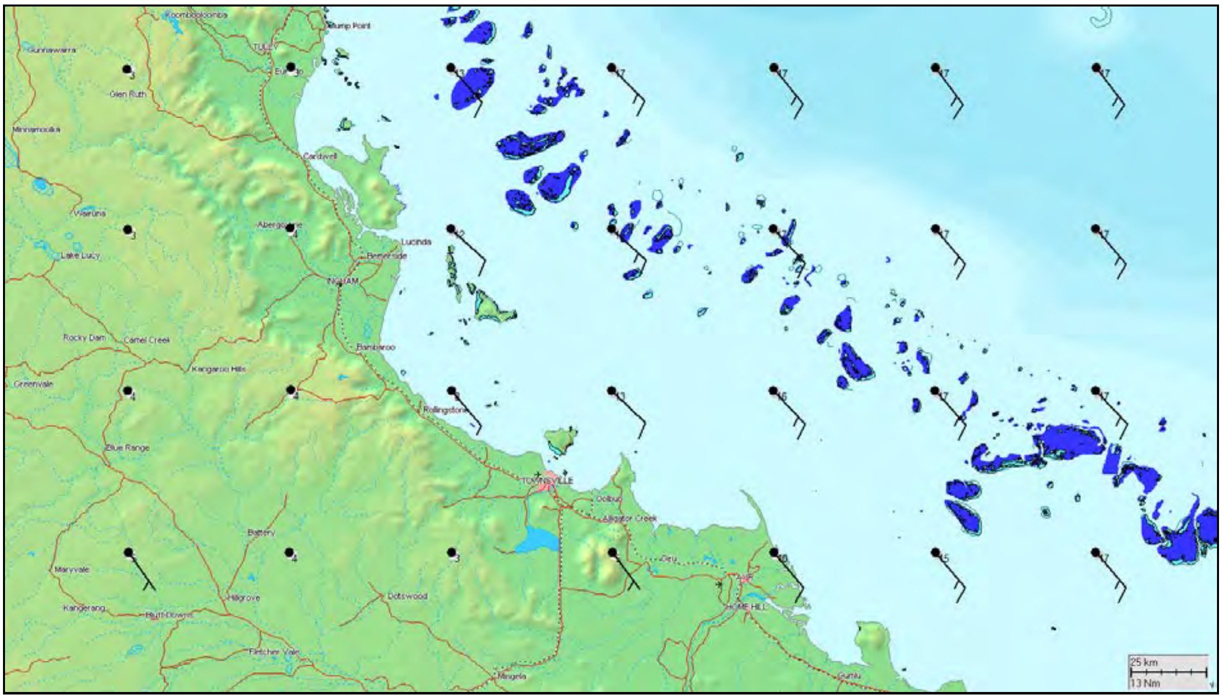


*Figure 3: Map showing wind barbs (speed and direction) for moderate southeast winds over the Central Great Barrier Reef.*

# 6 WATER TEMPERATURE

Average sea surface water temperature according to the National Oceanographic Data Centre – World Ocean Atlas (www.metoc.gov.au) was found to vary seasonally from a minimum of 24 ºC in Winter to a maximum of 29 ºC in summer.

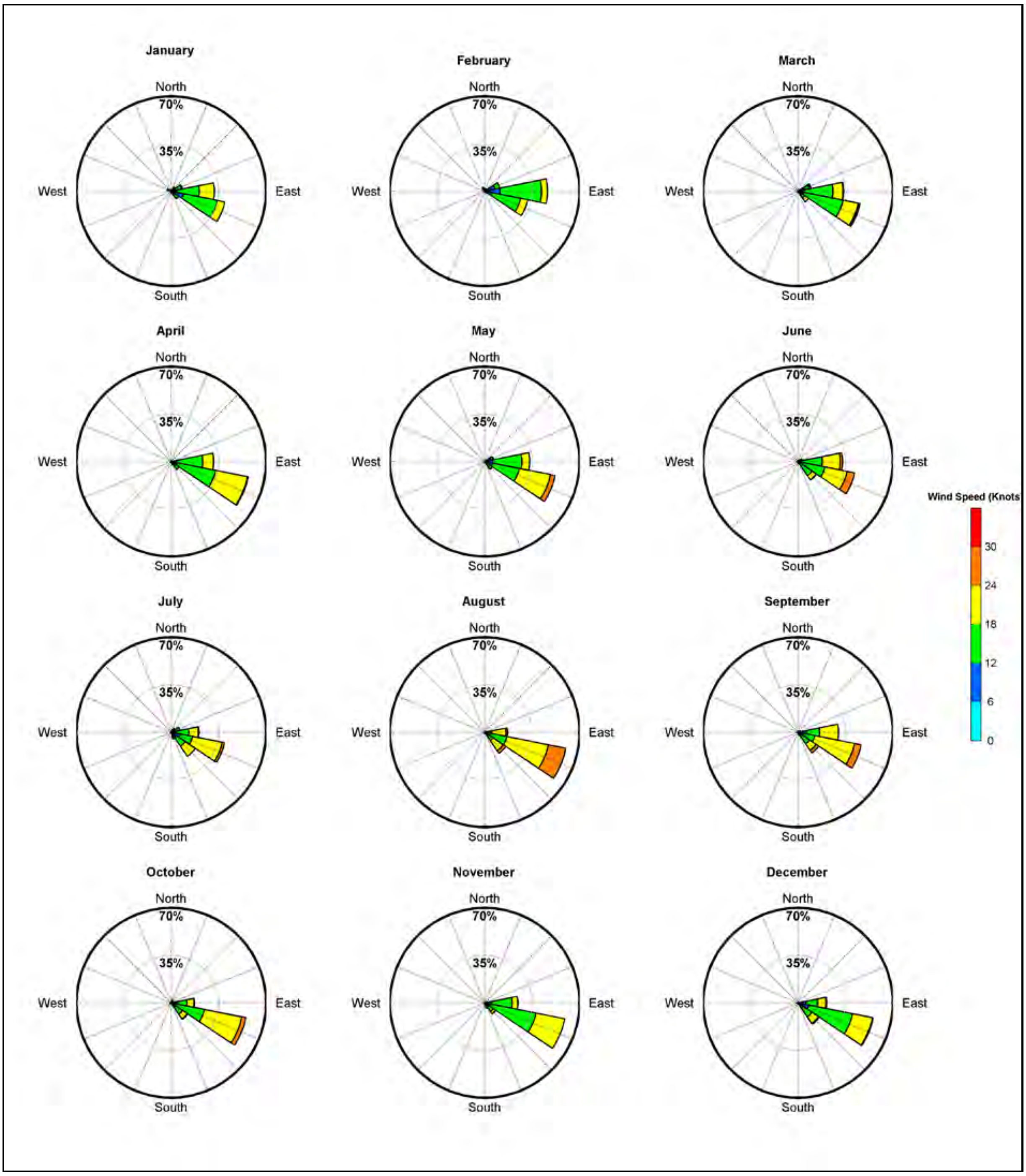



*Figure 4: Monthly wind rose distribution for the winds over Cleveland Bay during 2007 to 2011, inclusive.*

# 7 OIL SPILL MODEL - OILMAP

The spill modelling was carried out using a purpose-developed trajectory and fates model, OILMAP. The OILMAP physical fates model calculates the transport, spreading, entrainment and evaporation of spilled oil over time, based on the prevailing metocean conditions and the physical properties of the oil type.

The model uses the specific properties of each oil type to predict weathering under different conditions. These specific properties include the density, viscosity, surface tension and the slope of the distillation curve. These properties are used to determine the oil's spreading, evaporation, entrainment and shoreline interactions. If oil reaches the shorelines (as defined in the OILMAP GIS), details are recorded on the quantity, travel time to contact the shore, and habitat resources at the stranding location. It also incorporates a geographic information system (GIS) for defining the location and nature of natural resources, which is often helpful in analysing and interpreting model predictions. Predictions of the OILMAP model have been validated worldwide (Spaulding *et. al.* 1992, 1994) and in Australia (King *et. al.* 1999).

## 7.1 Stochastic Modelling

OILMAP may be used to simulate the fate of a single oil spill at a specified time and therefore under a given set of time-varying wind and current. This is generally the approach for an exercise or known spill event.

As spills can occur during any set of wind and current conditions, OILMAP's stochastic module is required to quantify the risks for a given period (e.g. season), as has been done in this study. The stochastic modelling approach involves running multiple single simulations (e.g. 100) using the same spill information (i.e. release location, spill volume, duration and oil type) but varying the start time and in turn the prevailing wind and current conditions. This approach ensures that the predicted transport and weathering of an oil slick is subjected to a range of varying weather conditions for a given period.

During each simulation, the model records the areas exposed to oil, as well as the time elapsed prior to contact or exposure. Once the stochastic modelling is complete, the model output and statistical descriptors for each of the individual simulations are combined to determine:

- Probability that a region (or grid cell) may be exposed to oil slicks;
- Minimum time before exposure and
- Probability of shoreline exposure.

The model output estimators (probability and time) are calculated independently for each location in the grid and the stochastic model output does not represent the extent of any one spill event (which would be significantly smaller) but rather provides a summary of the individual simulations for a given period/season. For this assessment, 100 simulations were performed for each scenario and combined into a single stochastic output for each scenario. This equated to 1,200 individual simulations for the entire assessment.

## 7.2 Oil Thickness Threshold

The OILMAP model is able to track oil on the water surface to thicknesses that are lower than biologically significant levels, or that can be physically cleaned up. Therefore the threshold for the oil on the seas surface was set to a minimum thickness of 0.5 µm (0.0005 mm) based on the AMSA 2012 guideline being the extent of visible oil as observed from an aircraft. A minimum thickness for ecological impact of 10 µm (0.01 mm) based on the AMSA 2012 guideline is also helpful for response planning. Oil at these threshold thicknesses are described as a rainbow sheen in appearance for the lower threshold to a metallic sheen appearance for the higher threshold, according to the Bonn Agreement Oil Appearance Code (BAOAC) 2006 (see Table 1). Figure 5 demonstrates the difference in appearance between a silvery sheen, rainbow sheen and metallic sheen on the water's surface.

*Table 1: The Bonn Agreement Oil Appearance Code.*

| Code | Description Appearance | Layer Thickness Interval (µm) | Litres per km$^2$ |
|---|---|---|---|
| 1 | Sheen (silvery/grey) | 0.04 – 0.30 | 40 – 300 |
| 2 | Rainbow | 0.30 – 5.0 | 300 – 5,000 |
| 3 | Metallic | 5.0 – 50 | 5,000 – 50,000 |
| 4 | Discontinuous True Oil Colour | 50 – 200 | 50,000 – 200,000 |
| 5 | Continuous True Oil Colour | 200 – >200 | 200,000 – >200,000 |

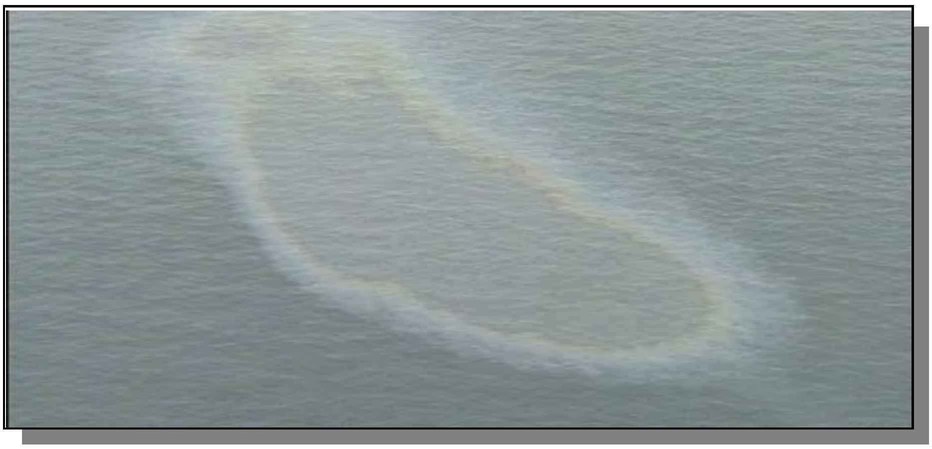


*Figure 5: A photograph showing the difference between metallic appearance in the centre and the silvery and rainbow sheen oil around the edges. The thickness of the metallic is between 5 µm - 50 µm; rainbow sheen is between 0.3 µm – 5.0 µm; and silvery sheen is between 0.04 µm – 0.3 µm. The thickness of the (source: Bonn Agreement Aerial Surveillance Handbook, 2004 – Part 3, Annex A).*

## 7.3 Model Settings and Assumptions

Oil spill modelling was carried out for six scenarios being:

1. Winter Spill Risk Assessment of a collision with a Panamax ship while at the offshore anchorage resulting in a Maximum Credible Spill of 100% of the volume of the largest tank (300 cubic meters) of Bunker Fuel over 1 hour.
2. Summer Risk Assessment of a collision of a Panamax ship while at the offshore anchorage resulting in a Maximum Credible Spill of 100% of the volume of the largest tank (300 cubic meters) of Bunker Fuel over 1 hour.
3. Winter Risk Assessment of a collision of a Panamax ship in the Sea Channel (between a site close to Magnetic Island 146º 52’ 55.2”E 19º 9’ 26.3”S and the harbour) resulting in a Maximum Credible Spill of 100% of the volume of a wing tank (300 cubic meters) of Bunker Fuel over 1 hour, from a collision with an Island Ferry/Barge or Fishing Vessel.
4. Winter Risk Assessment of a collision of a Panamax ship in the Sea Channel (between a site close to Magnetic Island 146º 52’ 55.2”E 19º 9’ 26.3”S and the harbour) resulting in a Most Likely Spill of 20% of the volume of a wing tank (60 cubic meters) of Bunker Fuel over 6 hours, from a collision with an Island Ferry/Barge or Fishing Vessel.
5. Winter Risk Assessment of a collision of a Panamax ship with the breakwater at the Harbour Entrance – 146º 50’ 17.9”E 19º 14’ 16.4”S resulting in a Maximum Credible loss of 300 cubic meters of Bunker Fuel over 1 hour.
6. Winter Risk Assessment of a collision of a Panamax ship with the breakwater at the Harbour Entrance – 146º 50’ 17.9”E 19º 14’ 16.4”S resulting in a Most Likely Spill of 60 cubic meters of Bunker Fuel over 6 hours.

Each scenario was tracked to a threshold thickness as suggested by the AMSA 2012 guidelines, being 0.5 micron being the extent of visible oil and 10 microns, being the lowest thickness for which there exists a risk of an ecological impact (smothering for example) to sensitive species.

# 8 MODELLING RESULTS

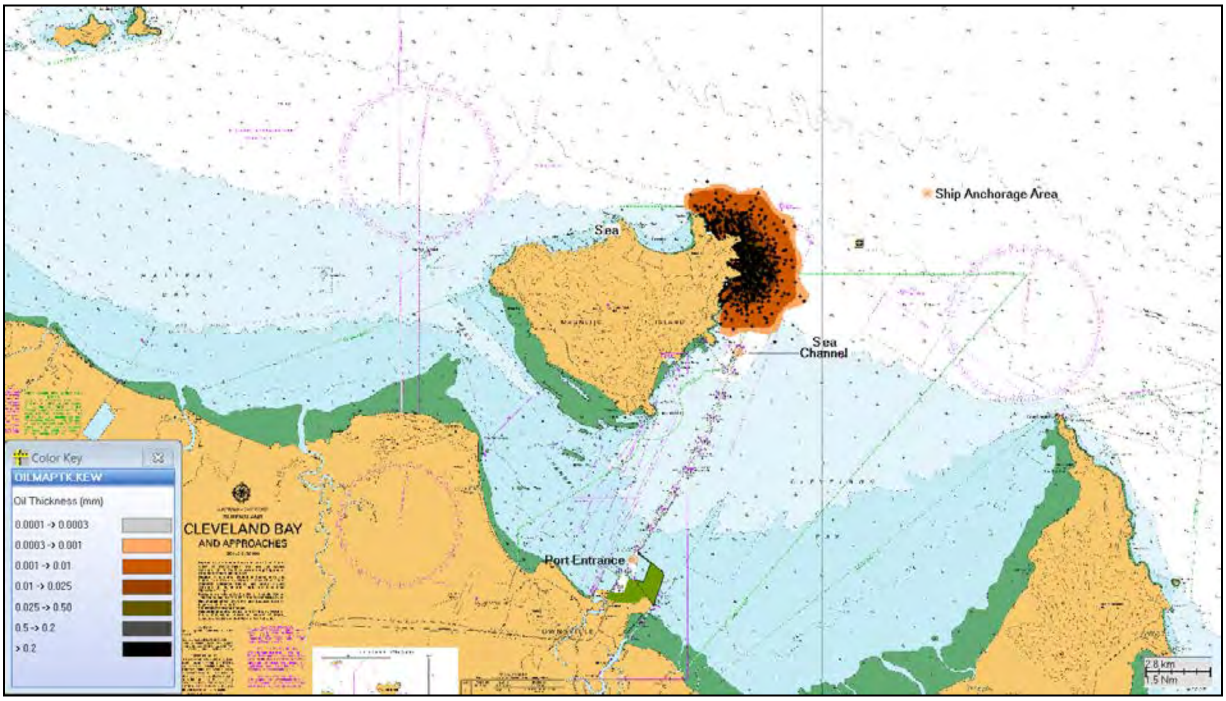
## 8.1 Scenario 1: Winter Risk from Maximum Credible Spill at Anchorage

Stochastic spill modeling was used for the Risk Assessment for the winter period for a maximum credible spill from a collision with a Panamax Bulk Carrier while at anchorage. Using the AMSA 2012 guidelines, it was determined that a collision would result in a Maximum Credible Spill of 100% of the volume of the largest tank (300 cubic meters) of Heavy Fuel Oil (HFO) over a 1 hour period.

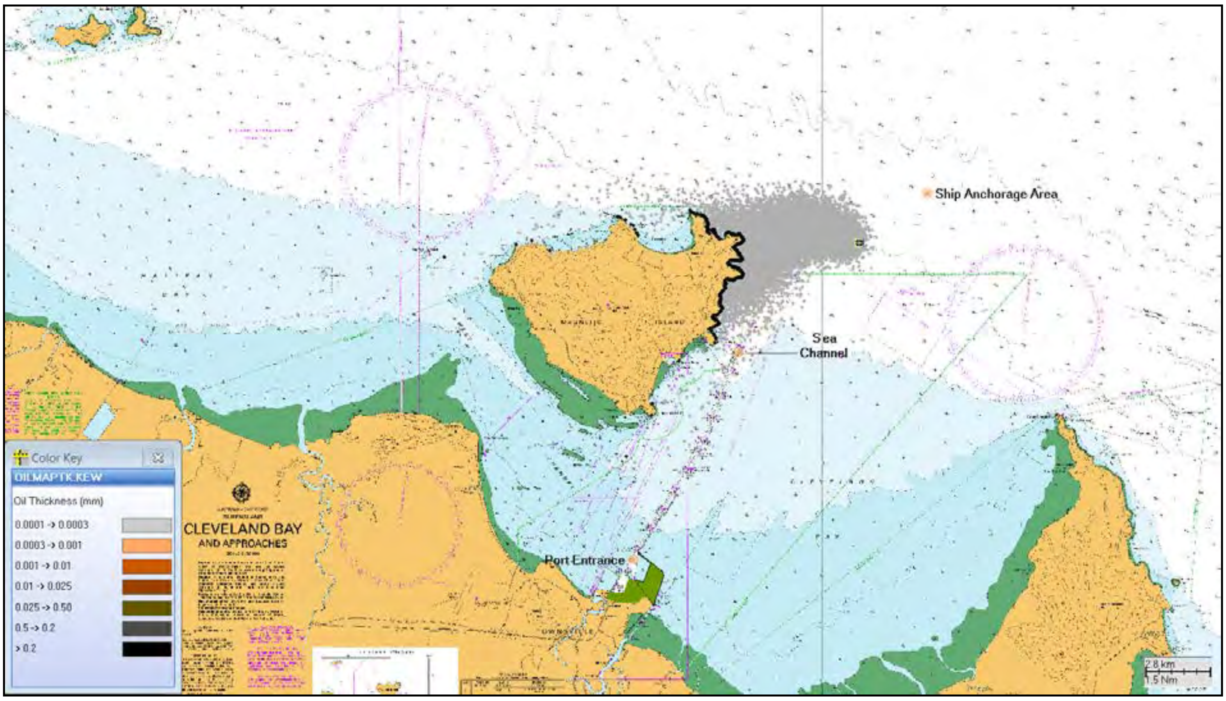
Worst-case single spill simulations were selected from the large number of simulations carried out for each scenario and period. The basis of selection was typically to demonstrate how the largest volume ashore occurred from the many simulations (100 for each scenario).

### *8.1.1 Worst-Case Single Spill Results*

From all 100 simulations, the worst-case volume on shore from a 300 cubic metres spill of HFO was 270 cubic metres, all ashore within 24 hours of release. That scenario and the wind and current conditions that forced that outcome is shown in the sequence of maps below.




For this example, the above map shows oil position and thickness 12 hours after a collision with a Panamax bulk carrier within the anchorage area. Winds at the time were moderate to strong from the northeast and tide was outgoing. For this worst-case scenario, oil was calculated to arrive at the north-eastern tip of Magnetic Island (Gowrie Bay) and Orchard Rocks after 7 hours to then engulf the bays from Horseshoe Bay to Alma Bay by 12 hours.




The above map shows the final oil position 24 hours after a collision with a Panamax sized bulk carrier vessel within the anchorage area. Stranded oil positions are shown as black dots along the coastline. The grey shaded region shows the swept area that oil on the water's surface took over the 24 hour period.

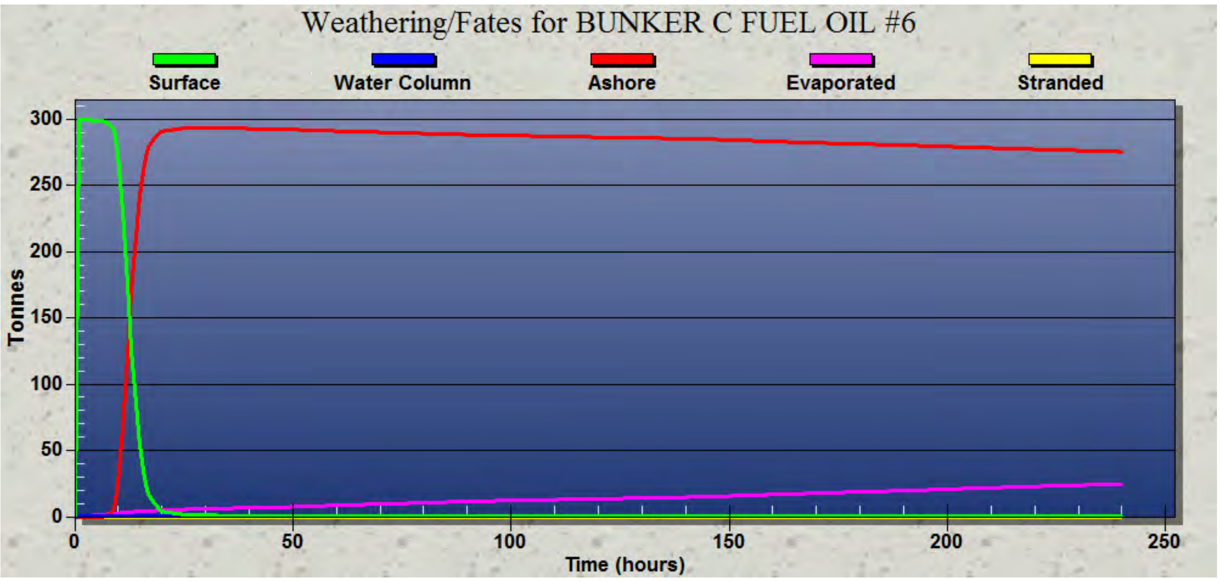



Figure showing the time history of the above spill in terms of weathering. The graph indicated that the spilt fuel oil would not evaporate significantly and would lose mass from surface oil to stranded oil over time.

### 8.1.2 Stochastic Results

The stochastic modelling of 100 spill simulations of this scenario was collectively analysed which quantified the probability of sea surface exposure and minimum time before exposure. Note the probability figures shown in this report summarised the likely exposure for each grid cell as a colour coding. For example, the grid cells with a 10% probability were exposed to 10 of the 100 trajectories and the cells with a higher probability of oiling were exposed during a greater number of spill trajectories, up to 100% at the release site.

Figure 6 to Figure 7 show the probability of sea surface exposure to heavy oiling and heavy sheens (being the 10 micron threshold), and any visible sheens (0.5 micron threshold) and the calculated minimum time before exposure. These results demonstrate that excusion away from the spill site is typically wind driven in this region. These figures demonstrate that a spill anywhere within the anchorage would put Magnetic Island and Acheron Island in Halifax Bay at a 30% risk overall of being hit by passing oil slicks. Other islands in Halifax Bay such as Rattlesnake, Herald Island would be at a 20% risk of shoreline impacts from a significant spill of oil at the Anchorage area. Spills would most likely come ashore along the coast between Balgal Beach and Halifax. There was only a small risk that the Palm Group of Islands and Hinchinbrook Island could be impacted. Given the time required to reach the coast from this location, being at least 2 or 3 days, oil coming ashore was predicted to have emulsified (incorporated seawater within the oil to form a mousse) if strong winds prevailed at the time of or following a spill event. The modelling estimated that the emulsified oil may account for a significant increase of recoverable volumes (up to 1,000 cubic metres as a worst case estimate).

Table 2 summaries the shoreline statistics which demonstrates that 100 out of 100 simulations made shoreline contact predominantly due to the prevelence of onshore winds in this region. The results also demonstrate that this type of oil is highly persistent without significant volumes of volatile components and hence remains adhesive over time and does not readily evaporate.

*Table 2: Summary of shoreline contact from this scenario tracked to the 0.5 µm threshold being the extent of visible oil as per AMSA Guidelines (2012).*

| Risk from Maximum Credible Spill in the Anchorage Area | | | | |
|---|---|---|---|---|
| **Release** | **Probability of contact to any shoreline (%)** | **Time to any shoreline (hours)** | **Average volume of oil to reach shore for single trajectory ($m^3$)** | **Largest volume of oil to reach shore for single trajectory ($m^3$)** |
| **Anchorage Area** | 100 | 8 to 102 | 257 | 270 |

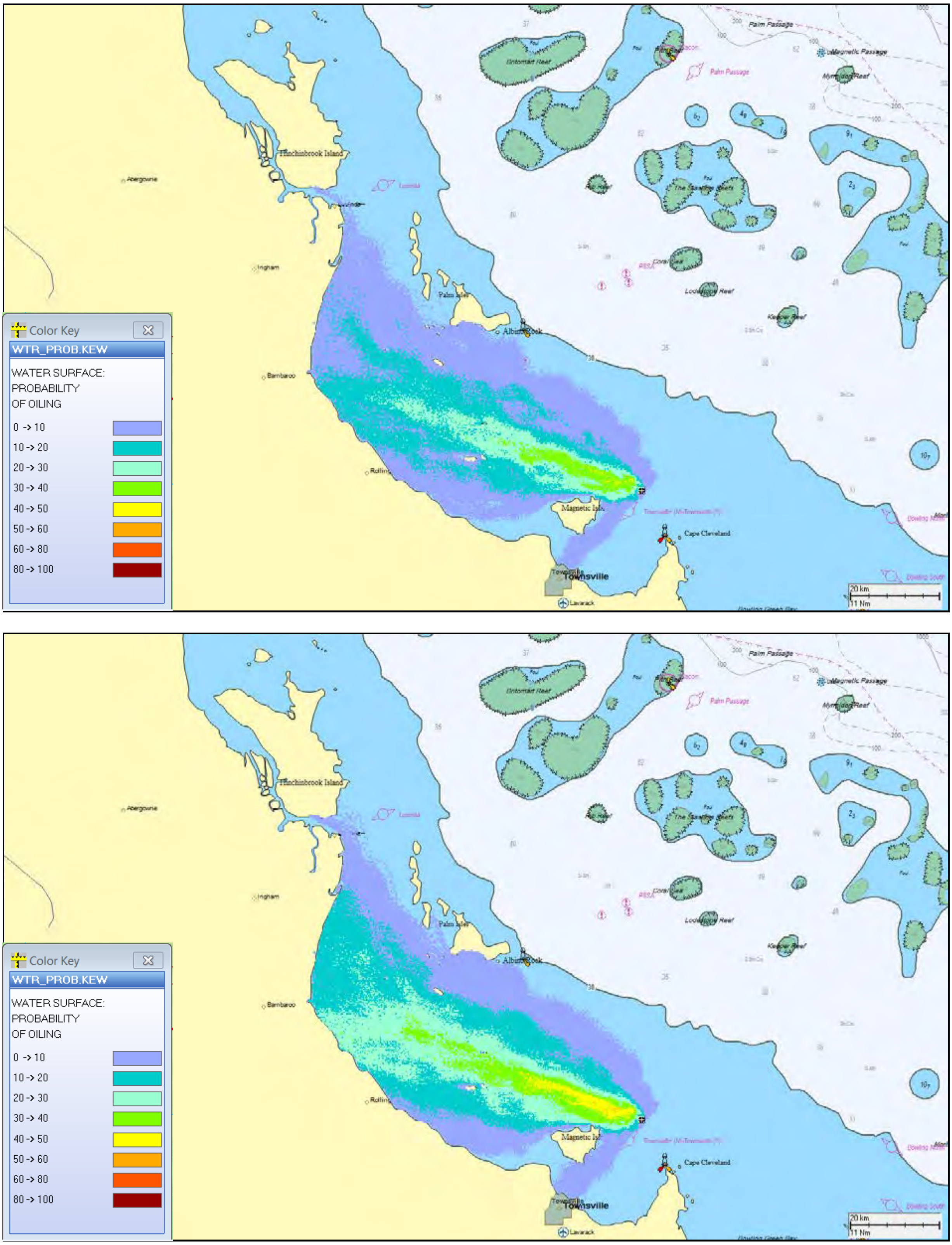



*Figure 6: Map showing the model calculated probability or risk of sea surface and shoreline exposure to heavy oiling and heavy sheens above 10 µm (top), and any visible oil above 0.5 µm (lower) by combining 100 simulations of a 300 cubic meter spill anywhere over the offshore anchorage area.*

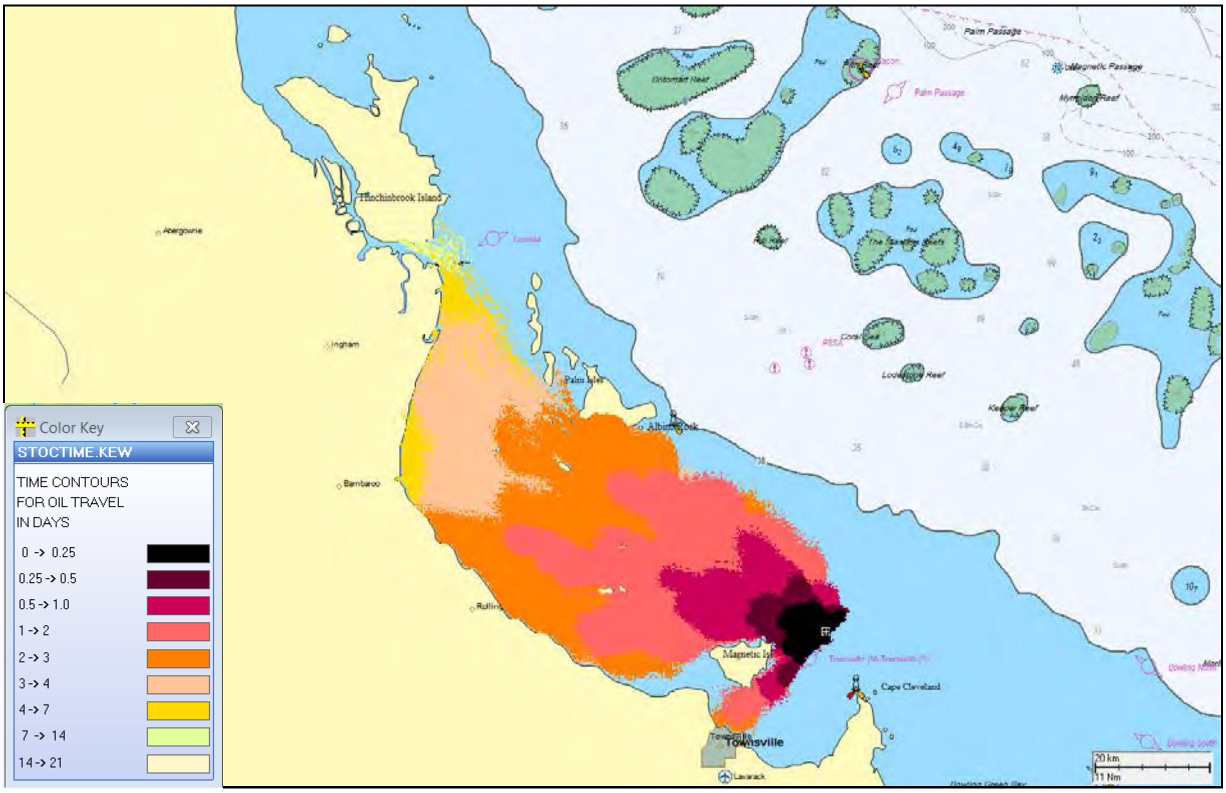



*Figure 7: Map showing the model calculated minimum time required before sea surface and shoreline exposure from the combination of 100 simulations of a 300 cubic meter spill of HFO anywhere over the offshore anchorage area.*

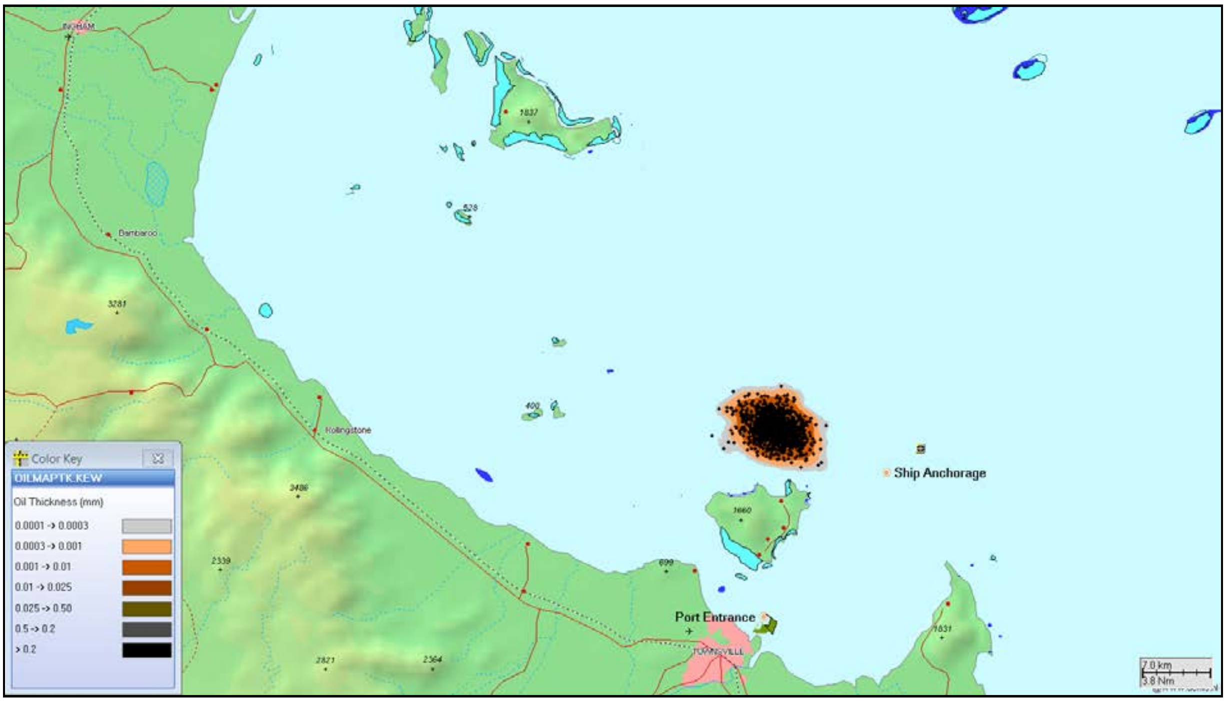
## 8.2 Scenario 2: Summer Risk from Maximum Credible Spill at Anchorage

Stochastic spill modeling was used for the Risk Assessment for the summer period for a maximum credible spill from a collision with a Panamax Bulk Carrier while at anchorage. Using the AMSA 2012 guidelines, it was determined that a collision would result in a Maximum Credible Spill of 100% of the volume of the largest tank (300 cubic meters) of Heavy Fuel Oil (HFO) over a 1 hour period.

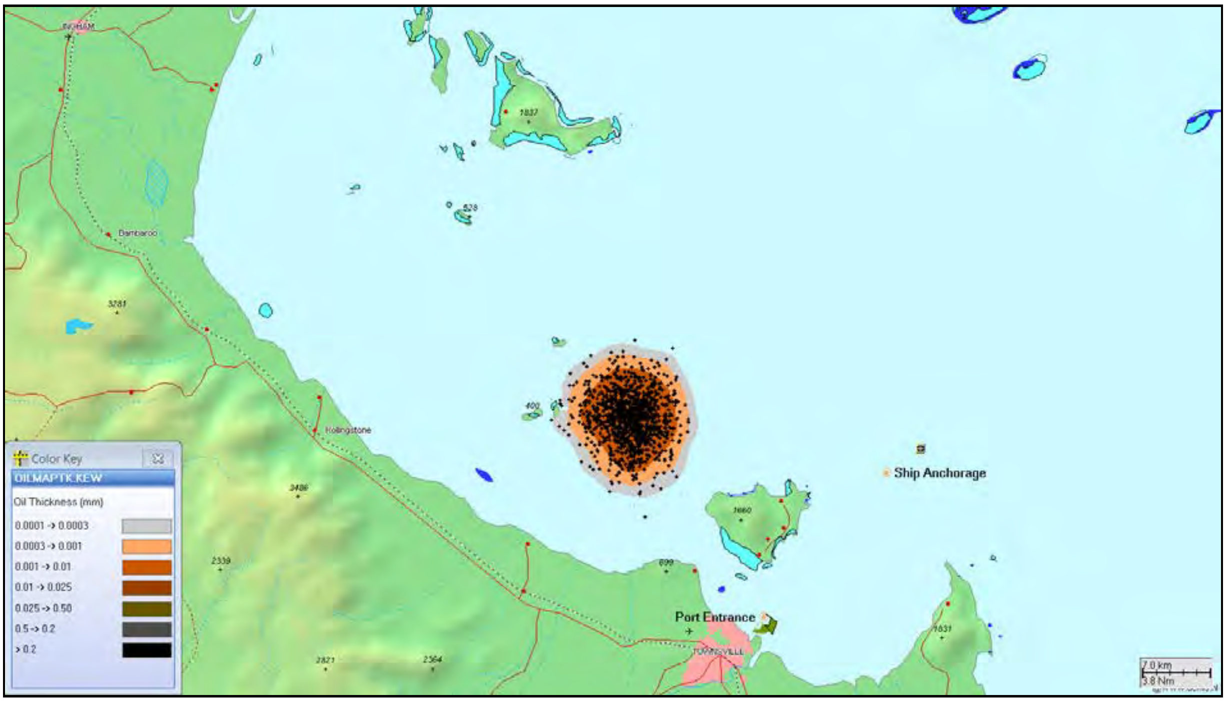
Worst-case single spill simulations were selected from the large number of simulations carried out for each scenario and period. The basis of selection was typically to demonstrate how the largest volume ashore occurred from the many simulations (100 for each scenario).

### *8.2.1 Worst-Case Single Spill Results*

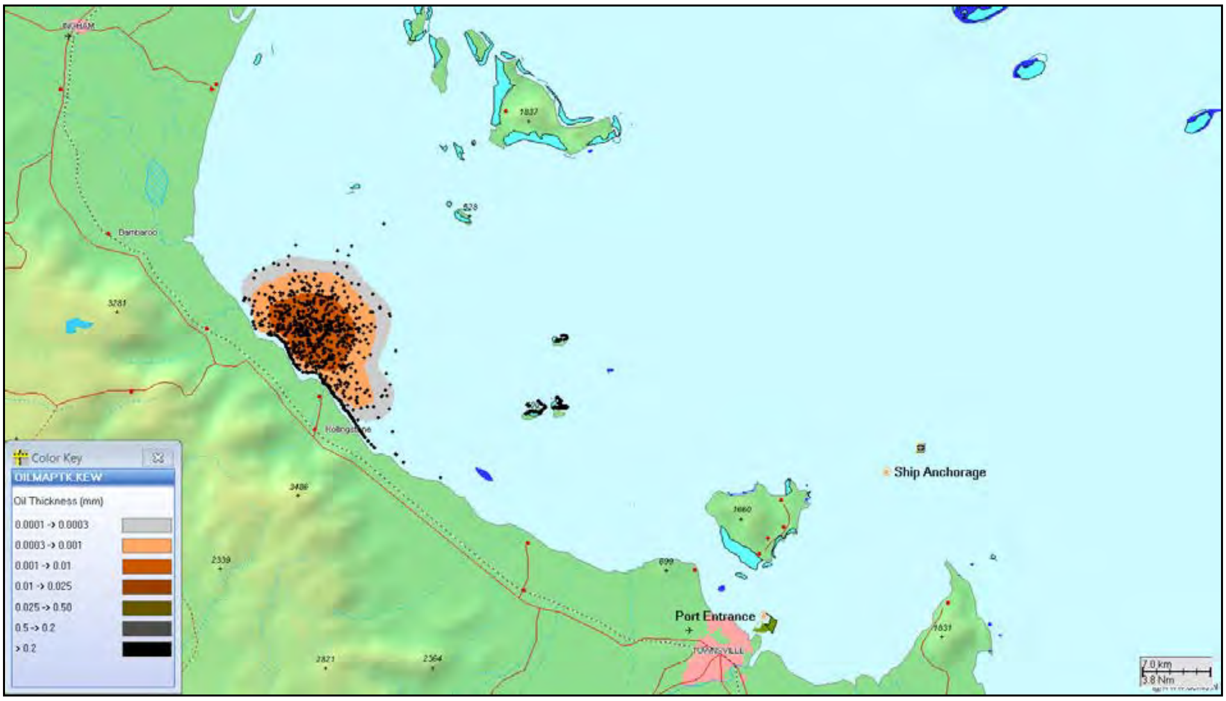
Given that tropical cyclones can be a feature of the summers in this region, the selected simulation for summer was based on the conditions of Cyclone Yasi. Hence, it was assumed that the collision occurred at the anchorage during high winds at 10pm 2nd February, 2011 being a few hours prior to it crossing the coast to the north. From this simulation, the worst-case volume on shore from a significant 300 cubic metres spill of HFO at a location within the anchorage area was 450 cubic metres of emulsified oil and water. That scenario and the wind and current conditions that forced that outcome is shown in the sequence of maps below.



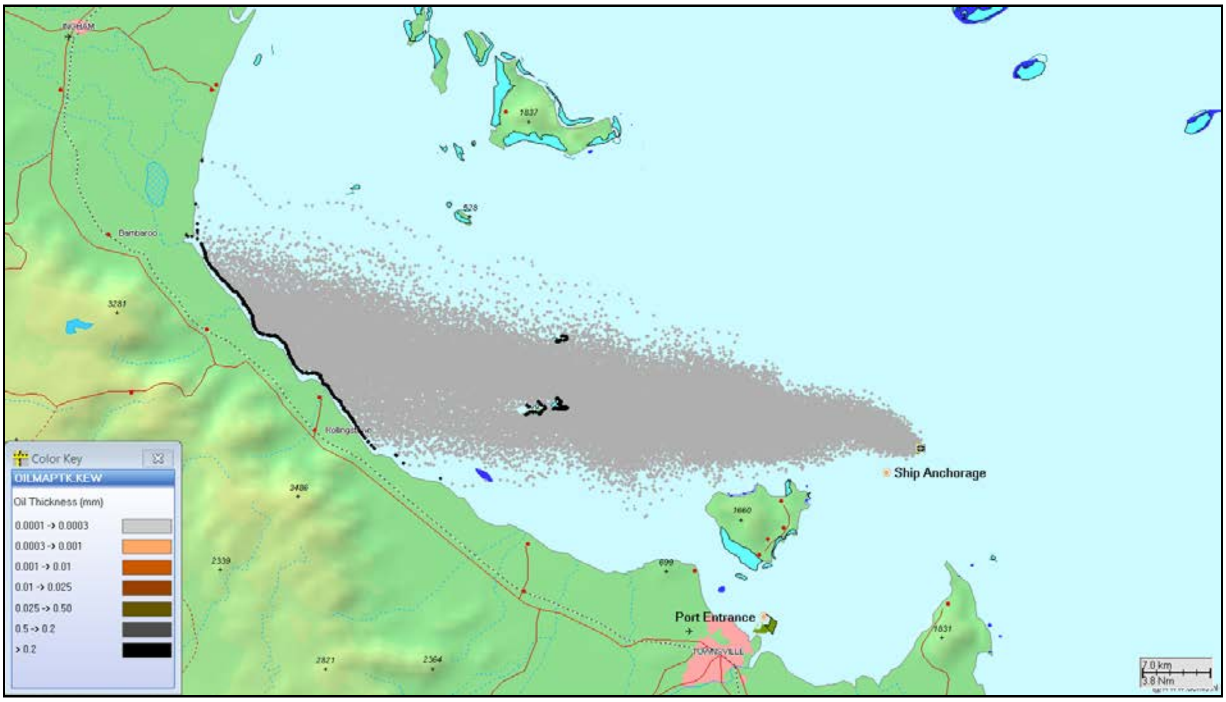

For this example, the above map shows oil position and thickness 12 hours after a collision with a Panamax vessel within the anchorage area while cyclonic conditions prevailed. Under these conditions, the spill would be difficult to detect since it would partially entrain in the near surface waters due to extensive breaking wave action.




The above map shows oil position and thickness 36 hours after a collision of a Panamax Bulk Carrier within the anchorage area while cyclonic conditions prevailed. Moderate to strong onshore winds persisted following the passage of Yasi. At this time, the spill was 16 km wide and was starting to loose oil to the shorelines of Herald Island in Halifax Bay.




The above map shows oil position and thickness 3 days after a collision of a Panamax Bulk Carrier within the anchorage area while cyclonic conditions prevailed. Moderate to strong onshore winds persisted following the passage of Yasi. At this time, the spill was 16 km wide and was starting to loose oil to the shorelines of Herald Island in Halifax Bay.




The above map shows the final oil position 4 days after a collision with a Panamax sized bulk carrier vessel within the anchorage area while cyclonic conditions prevailed. Stranded oil positions shown as black dots along the coastline an offshore islands (Rattlesnake, Herald and Acheron Islands in Halifax Bay). The grey shaded region shows the swept area that oil on the water's surface took over the 4 day period.

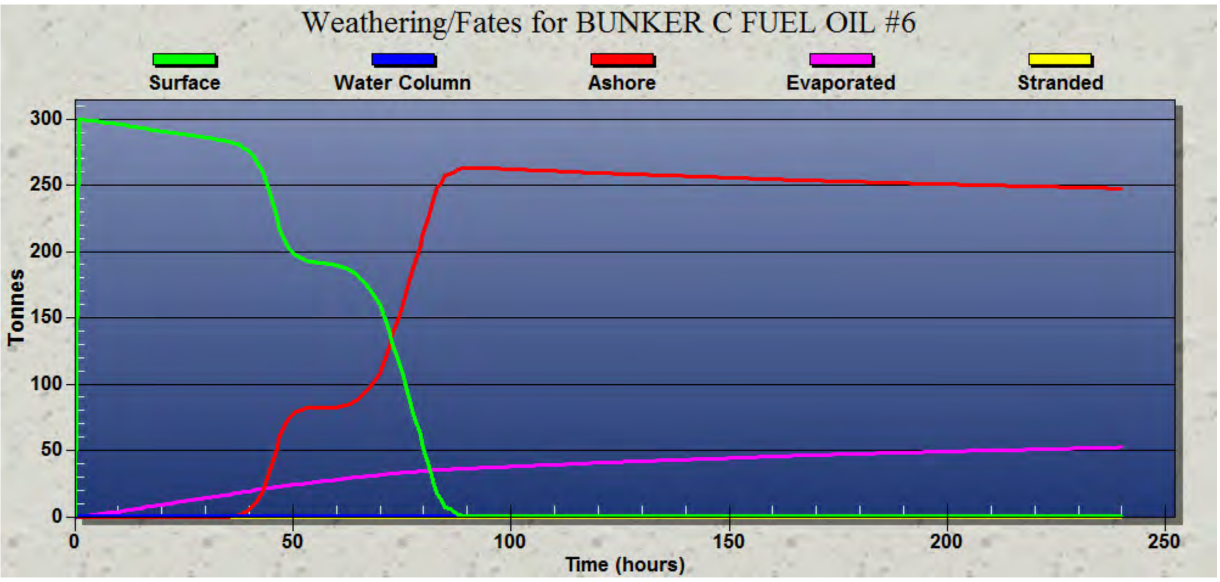



Figure showing the time history of the hypothetical cyclone "Yasi" spill in terms of weathering. The graph indicated that the spilt fuel oil would not evaporate significantly, would entrain on occasions and would lose mass from surface oil to stranded oil over time. Emulsification was also predicted for this spill event due to the strong wind conditions adding an additional 50% to the spill volume from water being incorporated into the emulsion.

### 8.2.2 Stochastic Results

The stochastic modelling of 100 spill simulations of this scenario was collectively analysed which quantified the probability of sea surface exposure and minimum time before exposure. Note the probability figures shown in this report summarised the likely exposure for each grid cell as a colour coding. For example, the grid cells with a 10% probability were exposed to 10 of the 100 trajectories and the cells with a higher probability of oiling were exposed during a greater number of spill trajectories, up to 100% at the release site.

Figure 8 to Figure 9 show the probability of sea surface exposure to heavy oiling and heavy sheens (being the 10 micron threshold), and any visible sheens (0.5 micron threshold) and the calculated minimum time before exposure. These results demonstrate that excusion away from the spill site is typically wind driven in this region. These figures demonstrate that a spill anywhere within the anchorage would put Magnetic Island at a 30% risk overall of being hit by passing oil slicks. Islands in Halifax Bay such as Rattlesnake, Herald Island and Acheron Island would be at a 20% risk of shoreline impacts from a significant spill of oil at the Anchorage area. Spills would most likely come ashore between Balgal Beach and Halifax. There was only a small risk that the Palm Group of Islands and Hinchinbrook Island could be impacted. Given the time required to reach the coast from this location, being at least 2 or 3 days, oil coming ashore was predicted to have emulsified (incorporated seawater within the oil to form a mousse) if strong winds prevailed at the time of or following a spill event. The modelling estimated that the emulsified oil may account for a significant increase of recoverable volumes (up to 1,000 cubic metres as a worst case estimate).

Table 3 summaries the shoreline statistics which demonstrates that 100 out of 100 simulations made shoreline contact predominantly due to the prevelence of onshore winds in this region. The results also demonstrate that this type of oil is highly persistent without significant volumes of volatile components and hence remains adhesive over time and does not readily evaporate.

*Table 3: Summary of shoreline contact from this scenario tracked to the 0.5 μm threshold being the extent of visible oil as per AMSA Guidelines (2012).*

| Risk from Maximum Credible Spill in the Anchorage Area | | | | |
|---|---|---|---|---|
| **Release** | **Probability of contact to any shoreline (%)** | **Time to any shoreline (hours)** | **Average volume of oil to reach shore for single trajectory ($m^3$)** | **Largest volume of oil to reach shore for single trajectory ($m^3$)** |
| **Anchorage Area** | 100 | 9 to 88 | 259 | 289 |

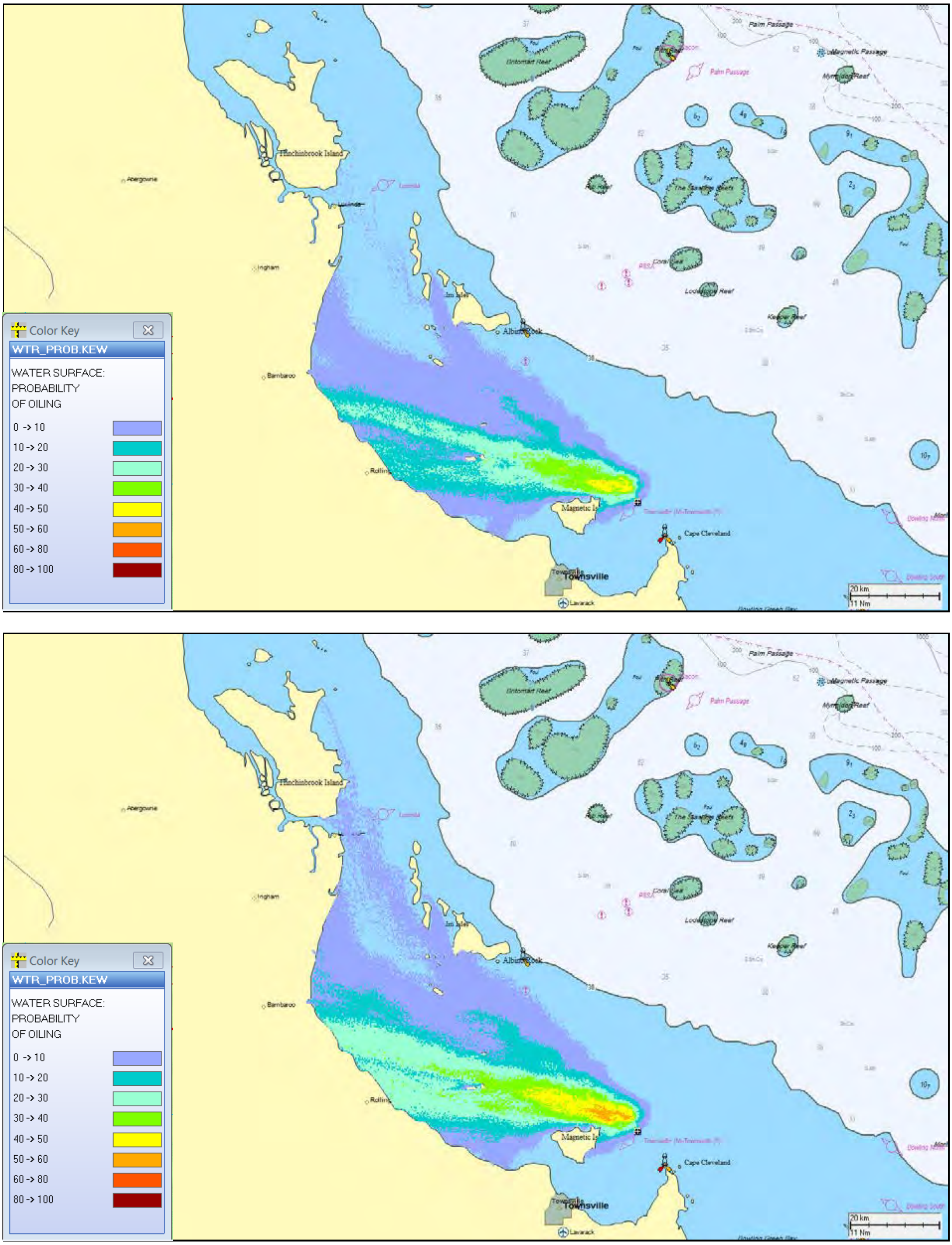



*Figure 8: Map showing the model calculated probability or risk of sea surface and shoreline exposure to heavy oiling and heavy sheens above 10 µm (top), and any visible oil above 0.5 µm (lower) by combining 100 simulations of a 300 cubic meter spill anywhere over the offshore anchorage area.*

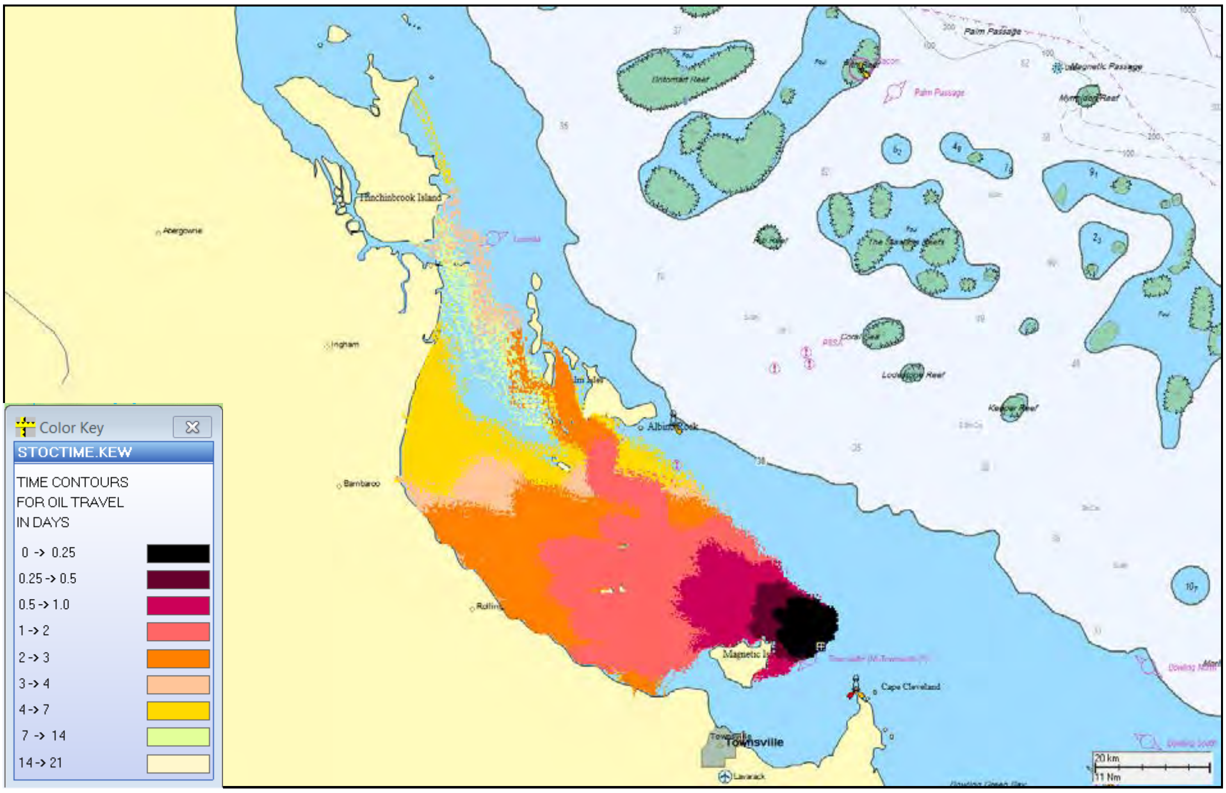



*Figure 9: Map showing the model calculated minimum time required before sea surface and shoreline exposure from the combination of 100 simulations of a 300 cubic meter spill of HFO anywhere over the offshore anchorage area.*

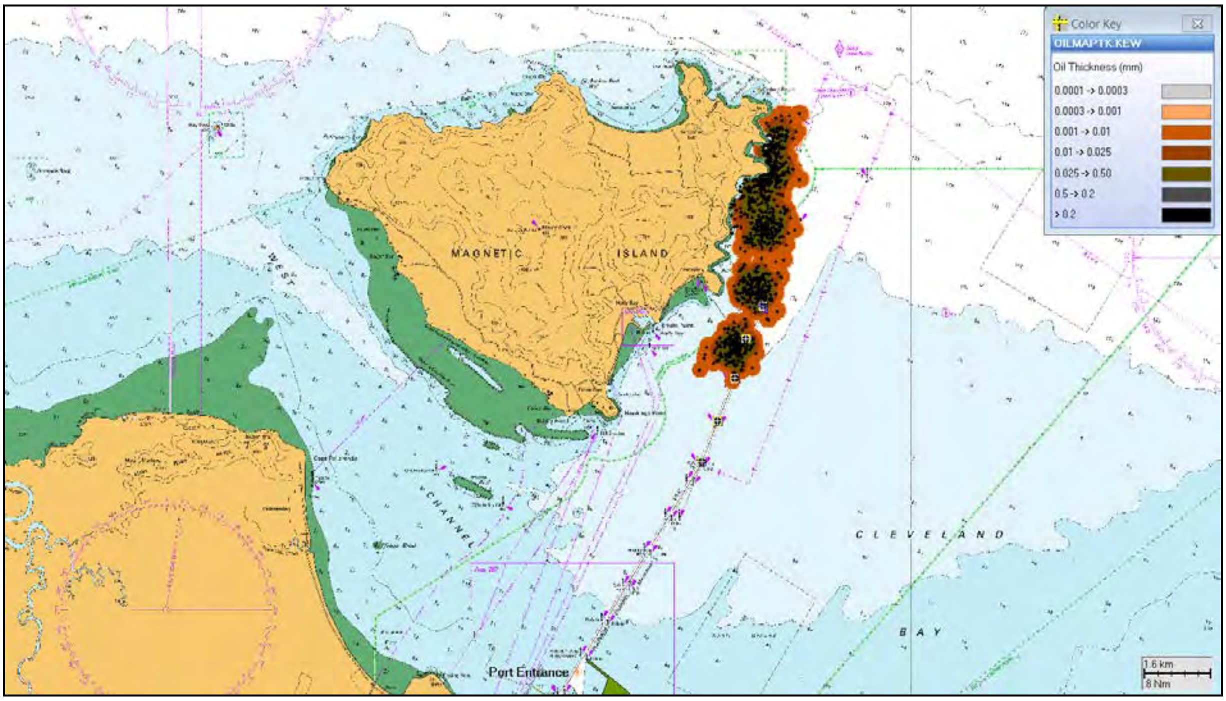
## 8.3 Scenario 3: Winter Risk from Maximum Credible Spill in the Channel

Stochastic spill modeling was used for the Risk Assessment for the winter period for a maximum credible spill from a collision with a Panamax Bulk Carrier while transversing the Sea Channel. Using the AMSA 2012 guidelines, it was determined that a collision would result in a Maximum Credible Spill of 100% of the volume of the largest tank (300 cubic meters) of Heavy Fuel Oil (HFO) over a 1 hour period.

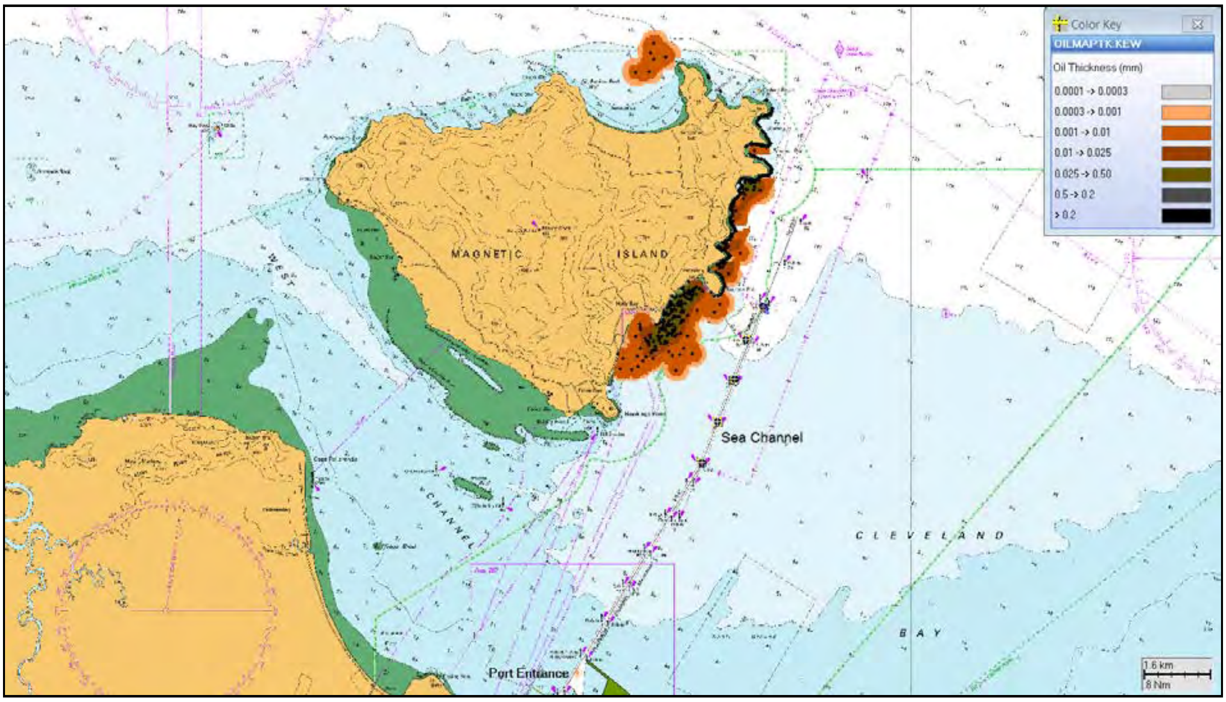
Worst-case single spill simulations were selected from the large number of simulations carried out for each scenario and period. The basis of selection was typically to demonstrate how the largest volume ashore occurred from the many simulations (100 for each scenario).

### *8.3.1 Worst-Case Single Spill Results*

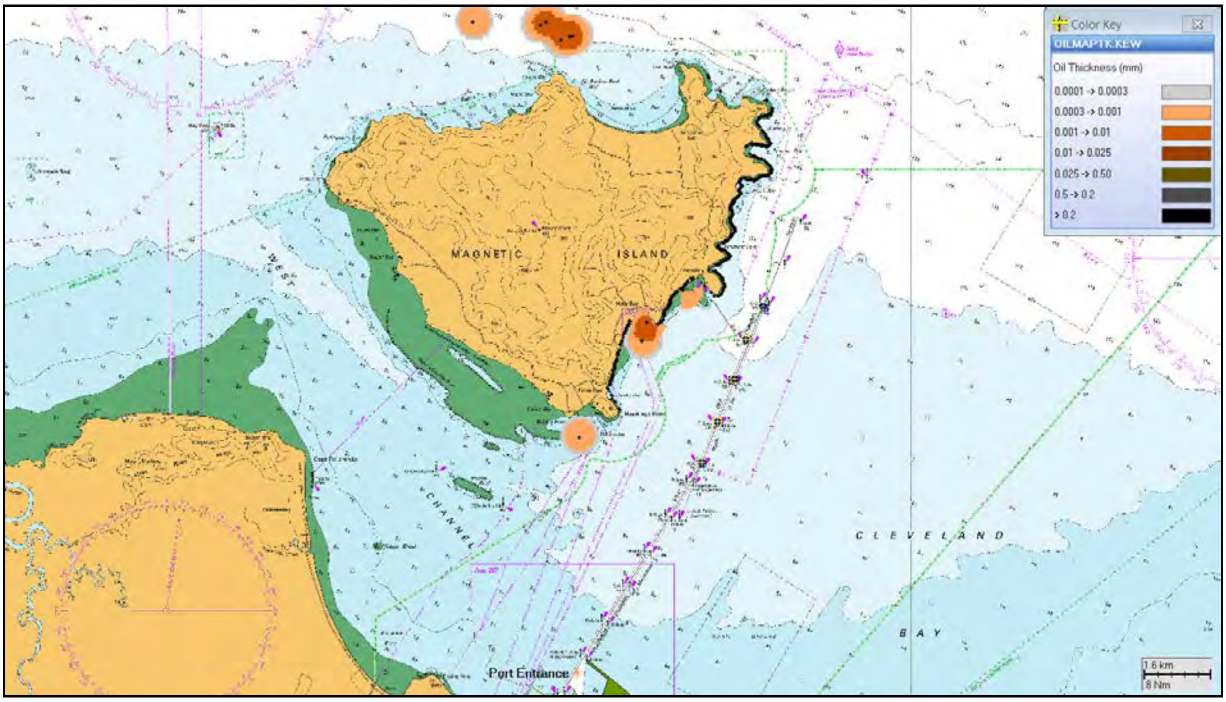
From all 100 simulations, the worst-case volume on shore from a significant 300 cubic metres spill of HFO from a moving Panamax vessel was 289 cubic metres, almost all ashore within 10 hours of release. That scenario and the wind and current conditions that forced that outcome is shown in the sequence of maps below.



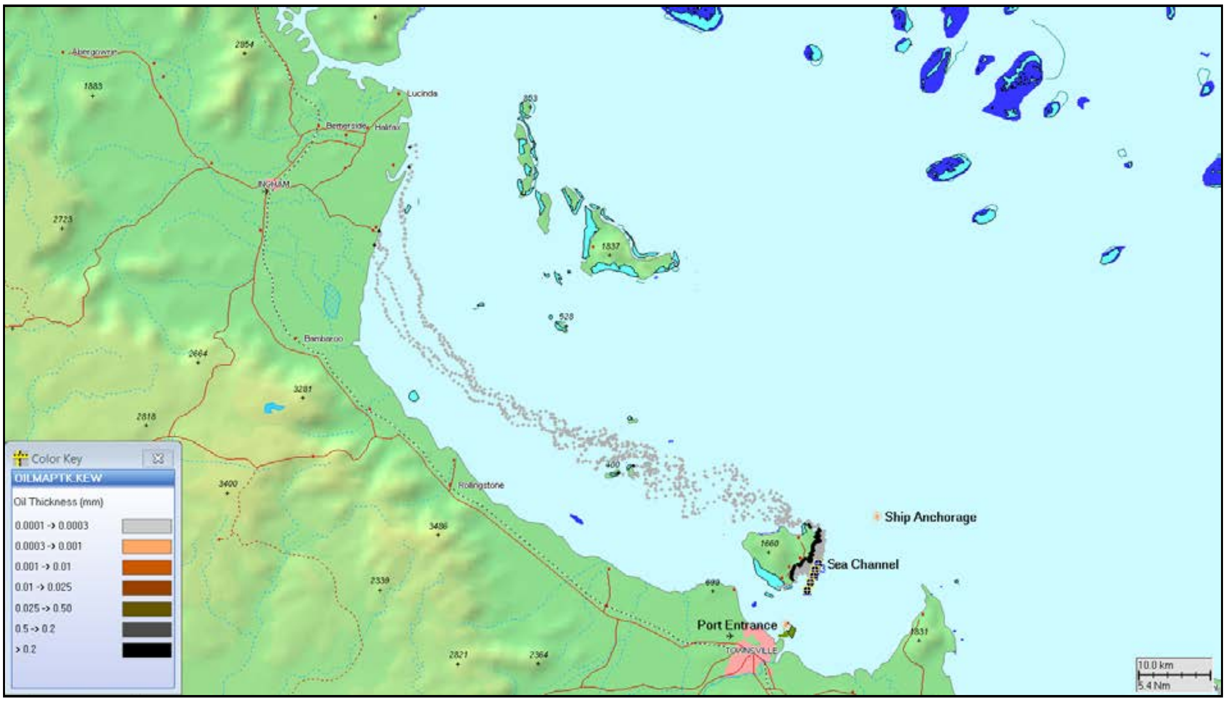

For this example, the above map shows oil position and thickness 3 hours after a collision with a moving Panamax vessel along the Sea Channel. Winds at the time were light from the southeast and tide was outgoing.




The above map shows oil position and thickness 6 hours after a collision with a moving Panamax vessel along the Sea Channel. Winds at the time were light from the southeast and tide was incoming. The length of the impact was attributable to the moving nature of the leaking source as the vessel continued to make its way to the Port with a substantial break to one fuel tank.




The above map shows oil position and thickness 12 hours after a collision with a moving Panamax vessel along the Sea Channel. Winds at the time were light from the southeast. Substantially, all spilt oil was ashore by this time, trapped along the southeast face of Magnetic Island.




The above map shows the final outcome of this scenario. Only a few cubic meters escaped the shorelines of Magnetic Island and continued for 9 days, striking Herald and Rattlesnake Island on route to Halifax as highly weathered and semi-solid residues.

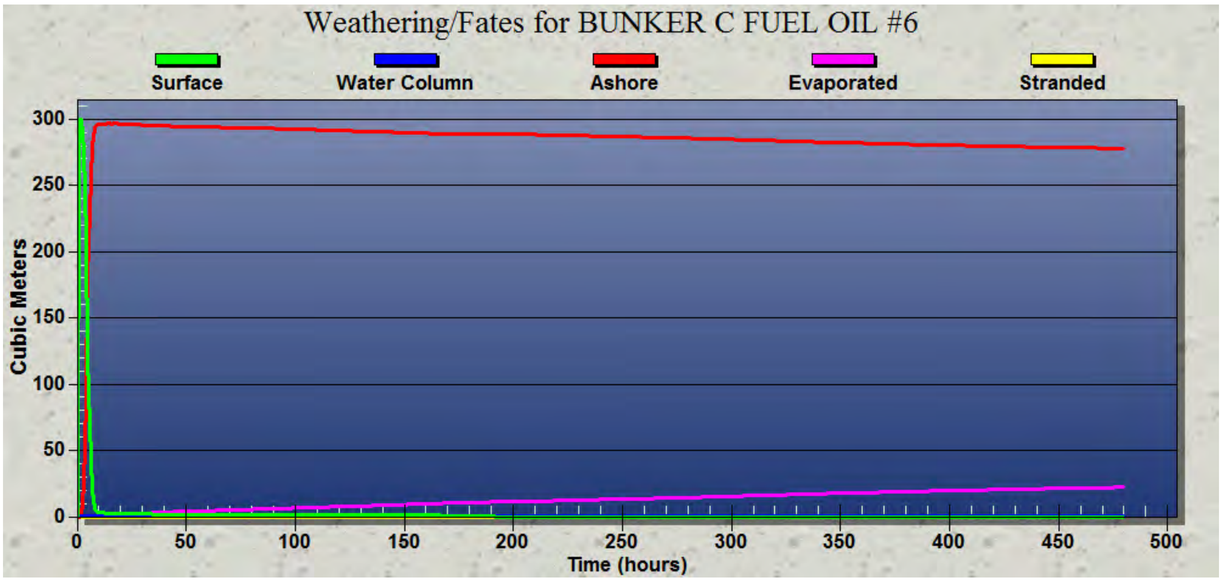



Figure showing the time history of the above spill in terms of weathering. The graph indicated that the HFO would strand on the shorelines quickly and would not evaporate significantly over time.

### 8.3.2 Stochastic Results

The stochastic modelling of 100 spill simulations of this scenario was collectively analysed which quantified the probability of sea surface exposure and minimum time before exposure. Note the probability figures shown in this report summarised the likely exposure for each grid cell as a colour coding. For example, the grid cells with a 10% probability were exposed to 10 of the 100 trajectories and the cells with a higher probability of oiling were exposed during a greater number of spill trajectories, up to 100% at the release site.

Figure 10 to Figure 11 show the probability of sea surface exposure to heavy oiling and heavy sheens (being the 10 micron threshold), and any visible sheens (0.5 micron threshold) and the calculated minimum time before exposure. These results demonstrate that excusion away from the spill site is typically wind driven in this region. These figures demonstrate that almost 100% of spills hit Magnetic island and about 60% of spills remained trapped by Magnetic Island, particularly from Picnic Bay to Florence Bay and typically within 9 hours and as quickly as 1 hour under strong southeast winds. The results demonstrate that oil can be trapped within Magnetic Island's inlets and beaches facing the Channel under southeast wind conditions to the point of significantly saturating shorelines and near shore waters. Oil on water near these shorelines remain within the surf zone of these inlets, potentially mixing with sediments, entraining under breaking waves and potentially sinking after a few days.

Table 4 summaries the shoreline statistics which demonstrates that 100 out of 100 simulations made shoreline contact predominantly due to the prevelence of onshore winds in this region. The results also demonstrate that this type of oil is highly persistent without significant volumes of volatile components and hence remains adhesive over time and does not readily evaporate.

*Table 4: Summary of shoreline contact from this scenario tracked to the 0.5 μm threshold being the extent of visible oil as per AMSA Guidelines (2012).*

| **Risk from Maximum Credible Spill in the Sea Channel** | | | | |
|---|---|---|---|---|
| **Release** | **Probability of contact to any shoreline (%)** | **Time to any shoreline (hours)** | **Average volume of oil to reach shore for single trajectory ($m^3$)** | **Largest volume of oil to reach shore for single trajectory ($m^3$)** |
| **The Sea Channel** | 100 | 1 to 23 | 279 | 289 |

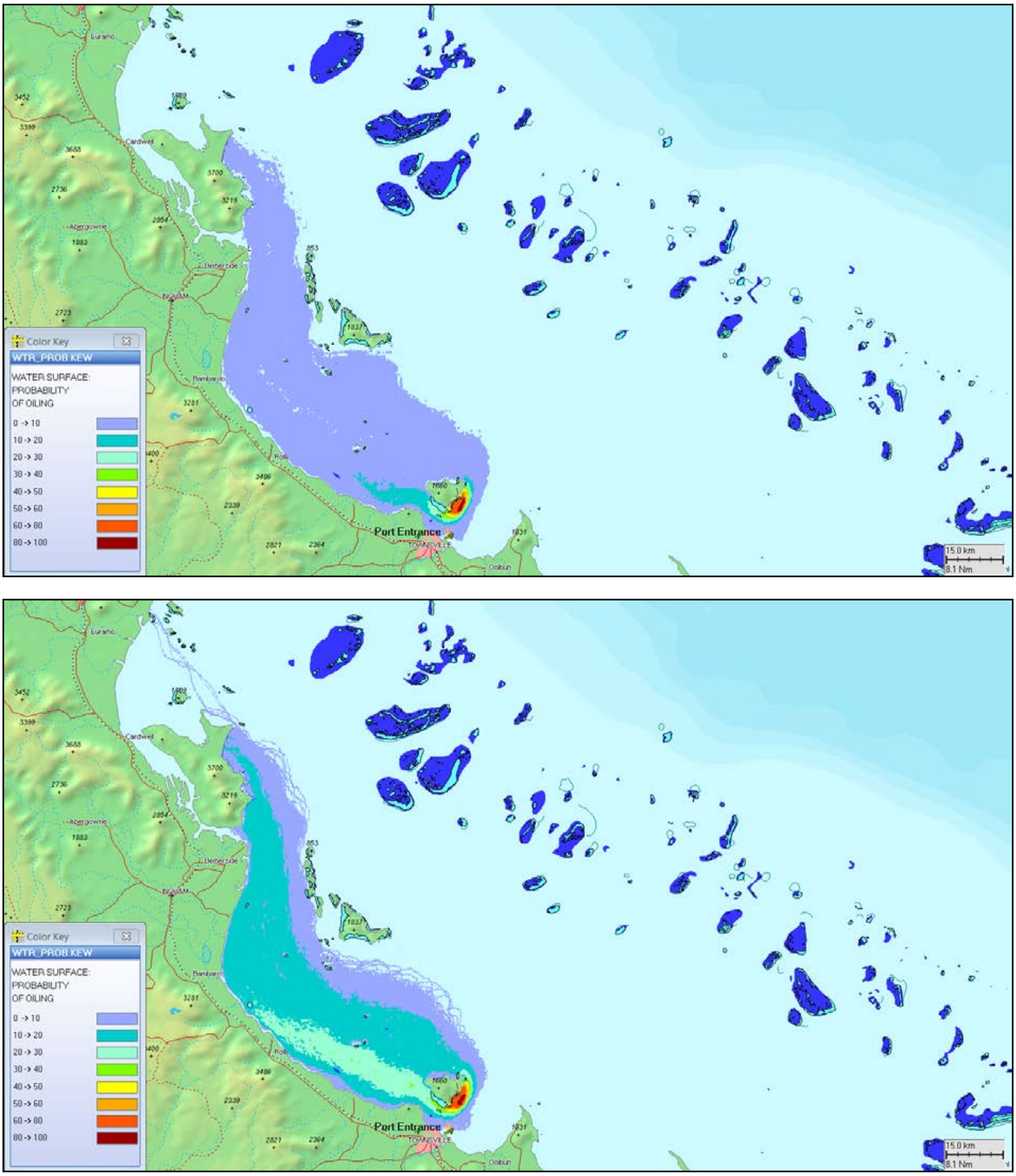



*Figure 10: Map showing the model calculated probability or risk of sea surface and shoreline exposure to heavy oiling and heavy sheens above 10 µm (top), and any visible oil above 0.5 µm (lower) by combining 100 simulations of a 300 cubic meter spill of HFO along the Sea Channel.*

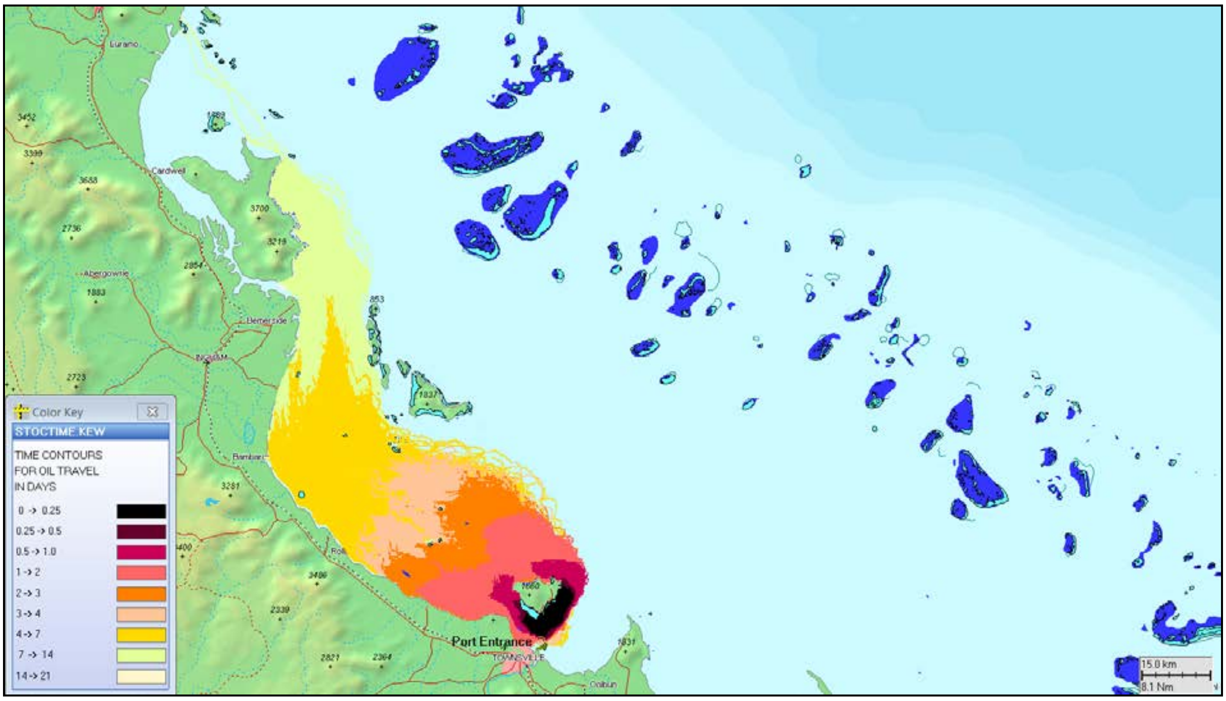



*Figure 11: Map showing the model calculated minimum time required before sea surface and shoreline exposure from the combination of 100 simulations of a 300 cubic meter spill of HFO along the Sea Channel.*

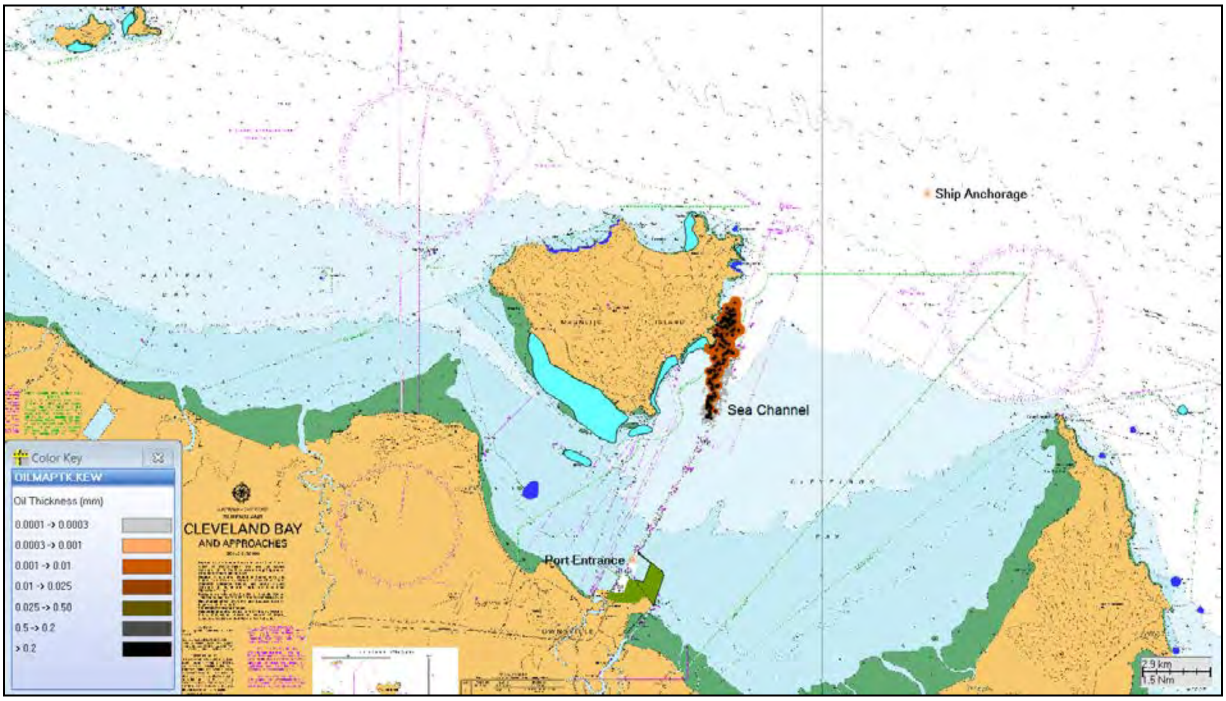
## 8.4 Scenario 4: Winter Risk from Most Likely Spill in the Channel

Stochastic spill modeling was used for the Risk Assessment for the winter period for a most likely spill from a collision with a Panamax Bulk Carrier while transversing the Sea Channel. Using the AMSA 2012 guidelines, it was determined that a collision would result in a probably spill of 20% of the volume of the largest tank (60 cubic meters) of Heavy Fuel Oil (HFO) over a 6 hour period.

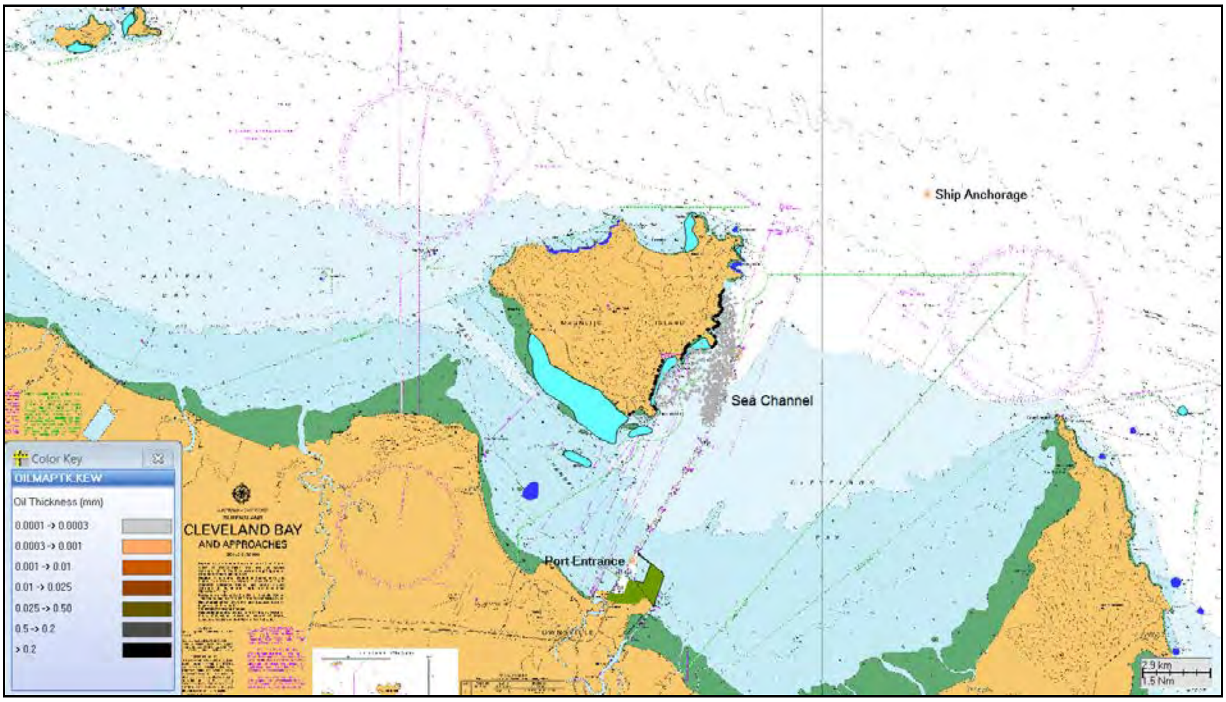
Worst-case single spill simulations were selected from the large number of simulations carried out for each scenario and period. The basis of selection was typically to demonstrate how the largest volume ashore occurred from the many simulations (100 for each scenario).

### *8.4.1 Worst-Case Single Spill Results*

From all 100 simulations, the worst-case volume on shore from a 60 cubic metres spill of HFO was 57.6 cubic metres, all ashore within 12 hours of release. That scenario and the wind and current conditions that forced that outcome is shown in the sequence of maps below.




For this example, the above map shows oil position and thickness 6 hours after a collision with a Panamax vessel along the Sea Channel. Winds at the time were moderate to strong from the southeast and tide was outgoing.




The above map shows the final oil position and thickness 12 hours after a collision with a Panamax vessel along the Sea Channel. Stranded oil positions shown as black dots along the coastline represent 57.6 cubic metres of fresh HFO. The grey region shows the swept area that oil on the water's surface took over the 12 hour period.

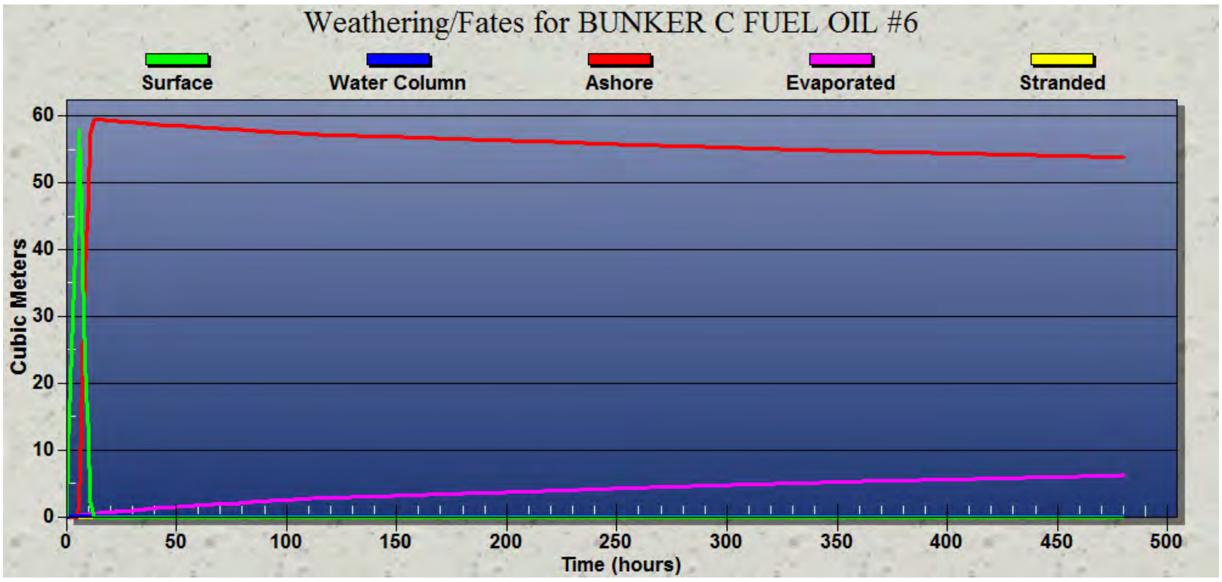



Figure showing the time history of the spill in terms of weathering. The graph indicated that the HFO would not evaporate significantly and would lose mass from surface oil to stranded oil over time.

### 8.4.2 Stochastic Results

The stochastic modelling of 100 spill simulations of this scenario was collectively analysed which quantified the probability of sea surface exposure and minimum time before exposure. Note the probability figures shown in this report summarised the likely exposure for each grid cell as a colour coding. For example, the grid cells with a 10% probability were exposed to 10 of the 100 trajectories and the cells with a higher probability of oiling were exposed during a greater number of spill trajectories, up to 100% at the release site.

Figure 12 to Figure 13 show the probability of sea surface exposure to heavy oiling and heavy sheens (being the 10 micron threshold), and any visible sheens (0.5 micron threshold) and the calculated minimum time before exposure. These results demonstrate that excusion away from the spill site is typically wind driven in this region. These figures demonstrate that almost 80% of spills along the channel will be trapped by Magnetic island, particularly from Picnic Bay to Florence Bay and typically within 12 hours and as quickly as 1 to 3 hours under strong southeast winds. The results demonstrate that oil can be trapped within the Bay facing the Channel under southeast wind conditions to the point of saturating shorelines. Oil on water then will not stay ashore and remain within the surf zone of these inlets, potentially mixing with shoreline and intertidal sediments and sinking over time.

Table 5 summaries the shoreline statistics which demonstrates that 100 out of 100 simulations made shoreline contact predominantly due to the prevelence of onshore winds in this region. The results also demonstrate that this type of oil is highly persistent without significant volumes of volatile components and hence remains adhesive over time and does not readily evaporate.

*Table 5: Summary of shoreline contact from this scenario tracked to the 0.5 μm threshold being the extent of visible oil as per AMSA Guidelines (2012).*

| Risk from Most Likely Spill in the Sea Channel | | | | |
|---|---|---|---|---|
| **Release** | **Probability of contact to any shoreline (%)** | **Time to any shoreline (hours)** | **Average volume of oil to reach shore for single trajectory ($m^3$)** | **Largest volume of oil to reach shore for single trajectory ($m^3$)** |
| **The Sea Channel** | 100 | 1 to 75 | 55.7 | 57.6 |

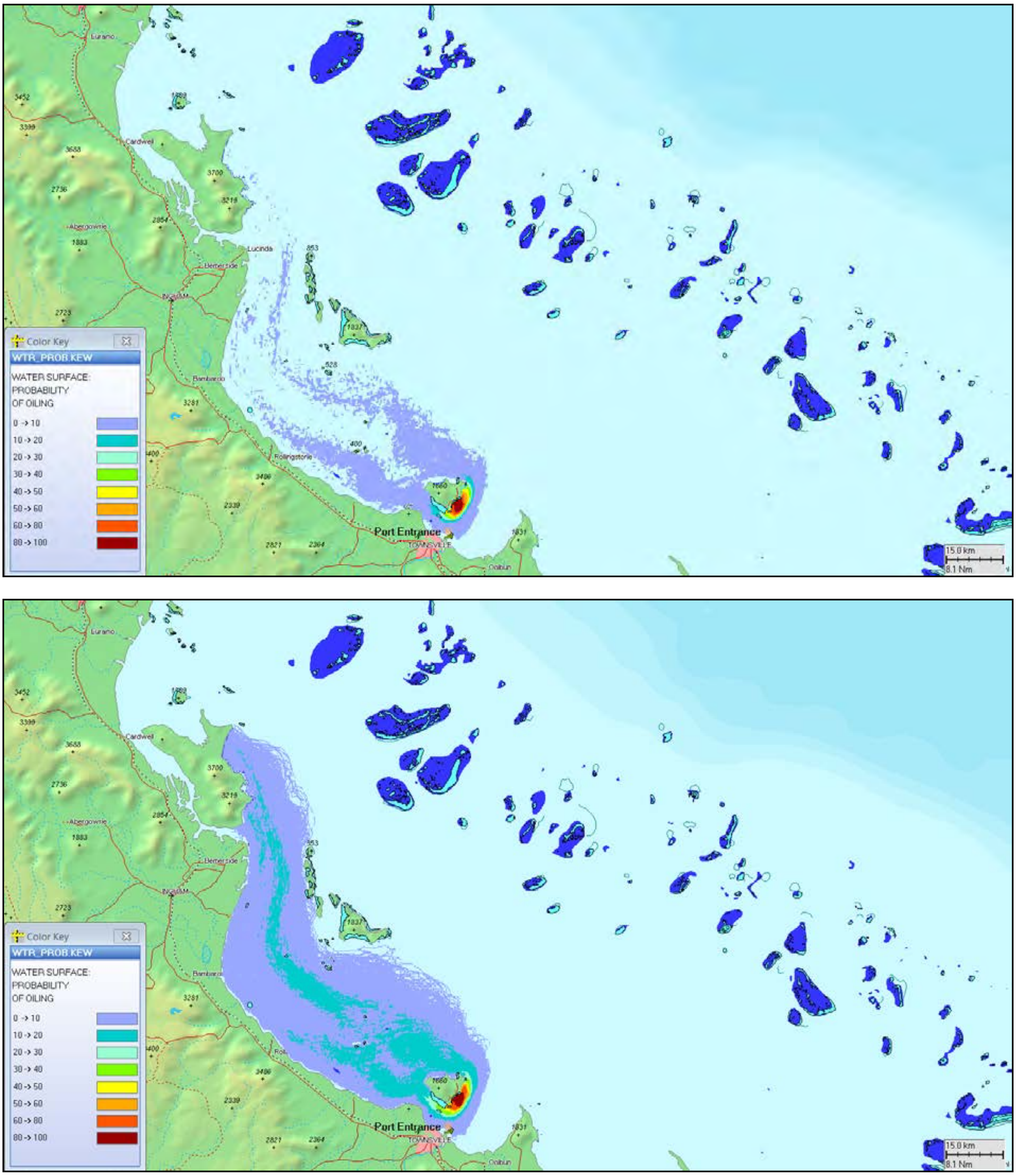



*Figure 12: Map showing the model calculated probability or risk of sea surface and shoreline exposure to heavy oiling and heavy sheens above 10 µm (top), and any visible oil above 0.5 µm (lower) by combining 100 simulations of a 60 cubic meter spill of HFO along the Sea Channel.*

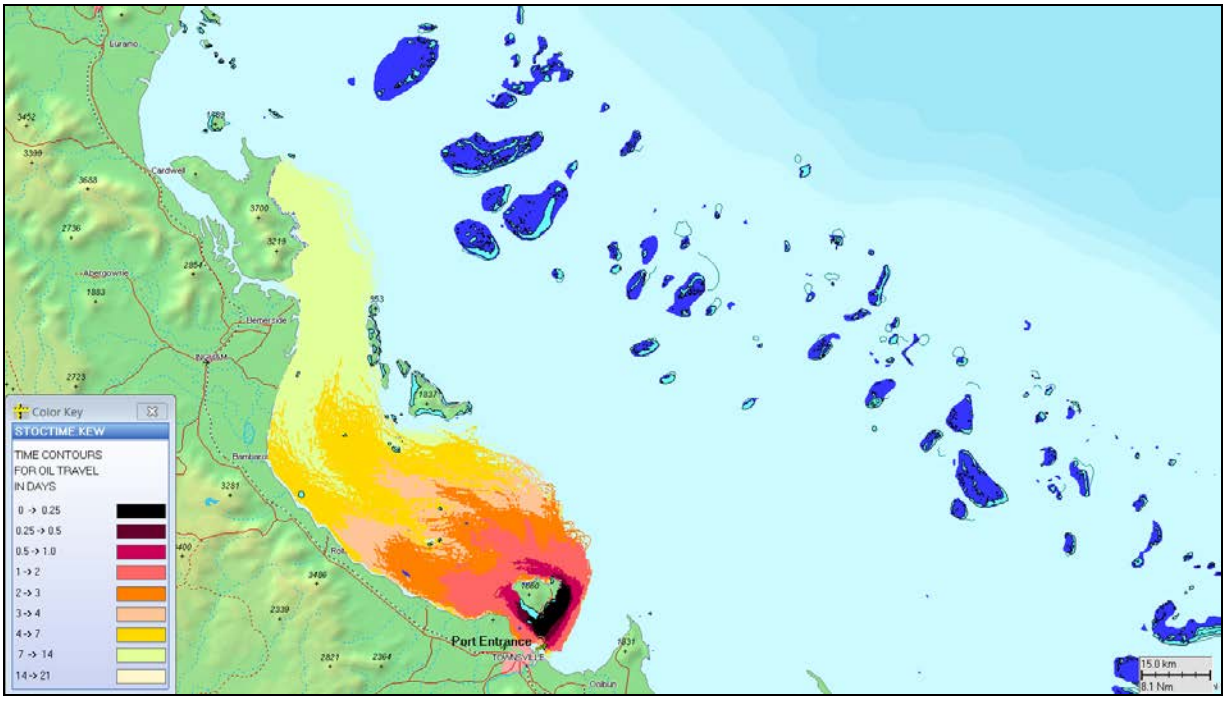



*Figure 13: Map showing the model calculated minimum time required before sea surface and shoreline exposure from the combination of 100 simulations of a 60 cubic meter spill of HFO along the Sea Channel.*

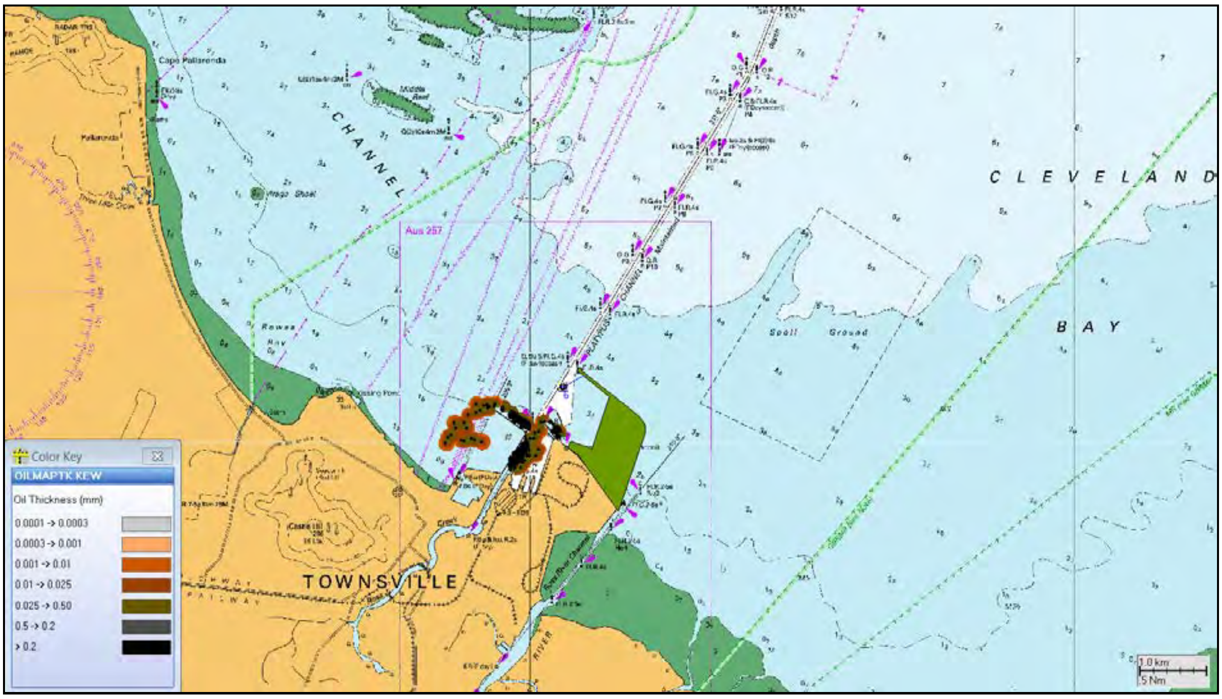
## 8.5 Scenario 5: Winter Risk from Maximum Credible Spill in the New Harbour

Stochastic spill modeling was used for the Risk Assessment for the winter period for a maximum credible spill from a collision with a Panamax Bulk Carrier while entering the new outer harbor proposed as part of the Townsville Port Expansion project. Using the AMSA 2012 guidelines, it was determined that a collision would result in a Maximum Credible Spill of 100% of the volume of the largest tank (300 cubic meters) of Heavy Fuel Oil (HFO) over a 1 hour period.

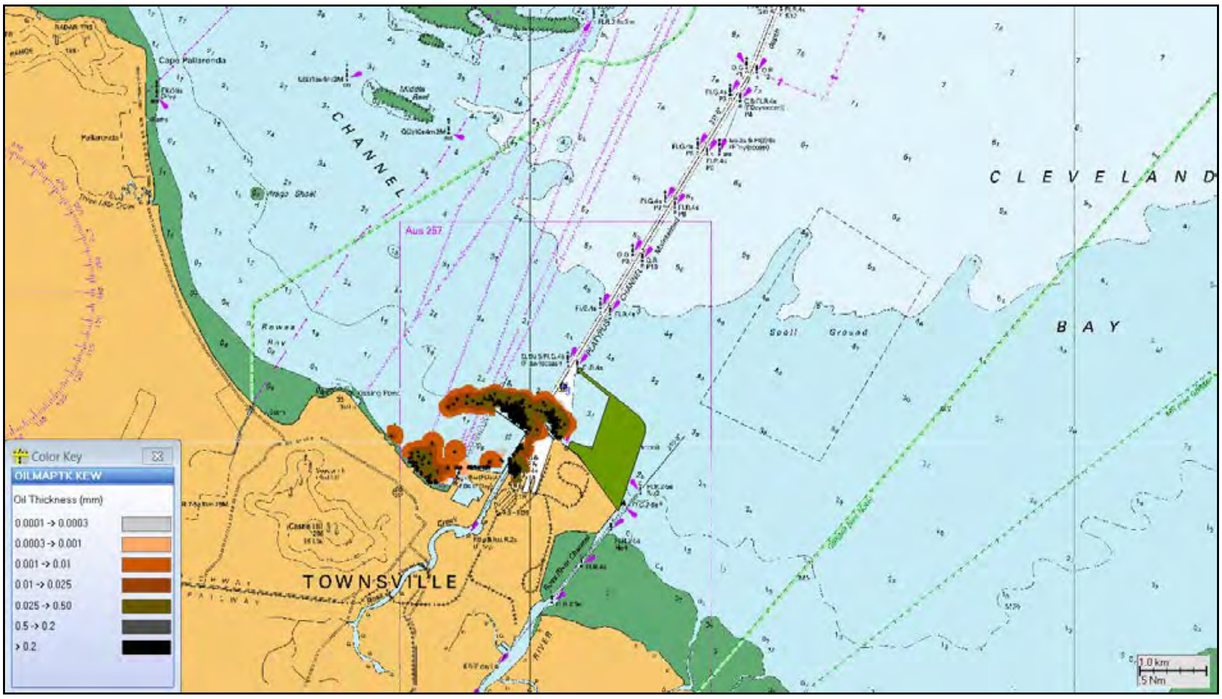
Worst-case single spill simulations were selected from the large number of simulations carried out for each scenario and period. The basis of selection was typically to demonstrate how the largest volume ashore occurred from the many simulations (100 for each scenario).

### *8.5.1 Worst-Case Single Spill Results*

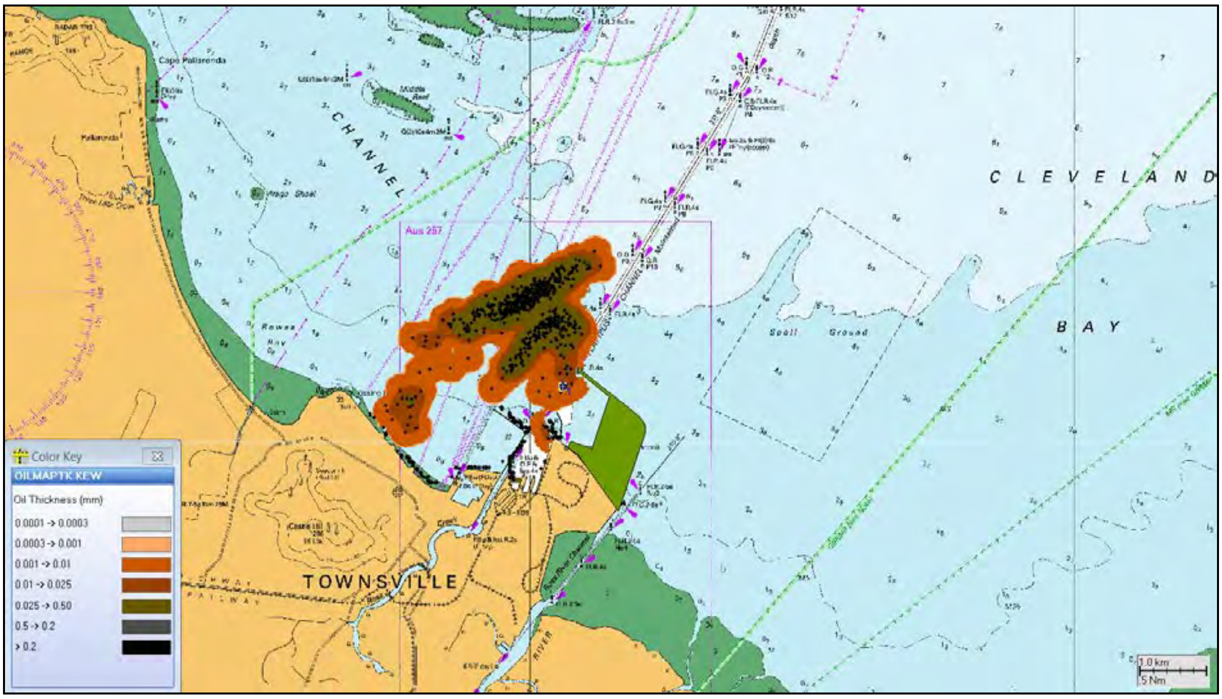
From all 100 simulations, the worst-case volume on shore from a significant 300 cubic metres spill of HFO was 289 cubic metres, all ashore over an 11 day period. That scenario and the wind and current conditions that forced that outcome is shown in the sequence of maps below.



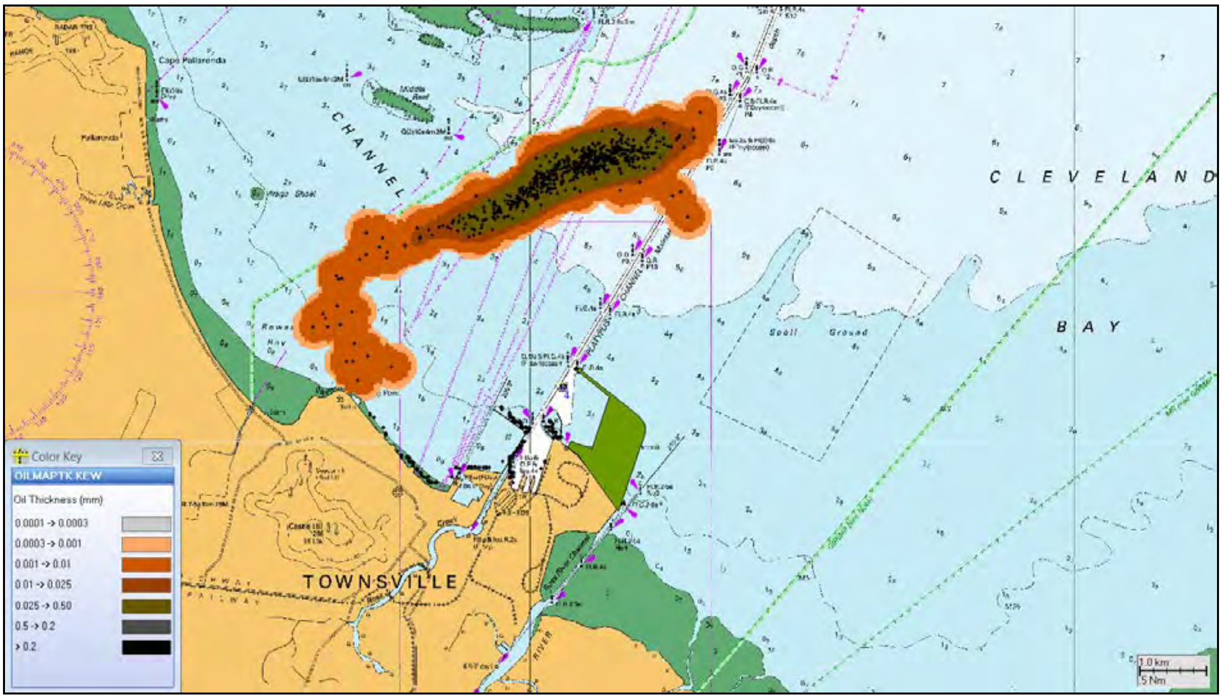

For this example, the above map shows oil position and thickness 3 hours after a significant collision at the harbour entrance. Winds at the time were slight from the northeast (afternoon seabreeze) and tide was incoming.



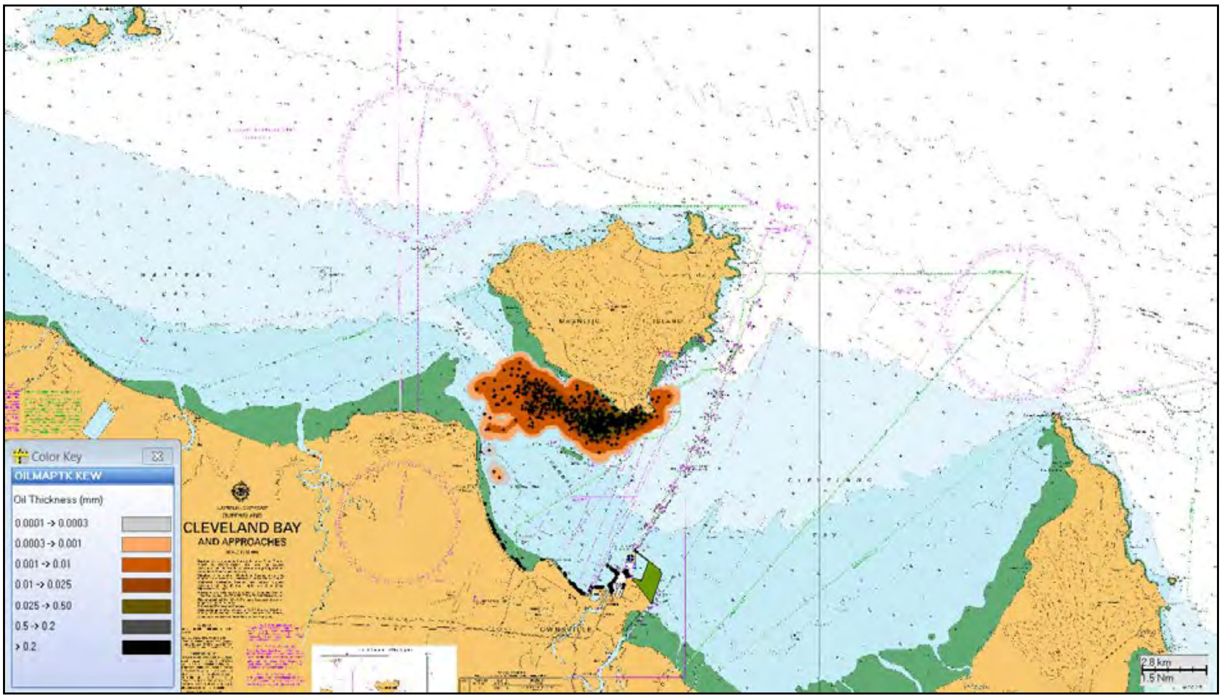

Map showing oil position and thickness 6 hours after a significant collision at the harbour entrance. Winds at the time were from the NE winds pushing oil onto The Strand shoreline against an outgoing tide. Stronger ebb currents within the harbour brought oil out of the inner berths and Ross Creek, leaving stranded residues along the rock walls within the Port of Townsville.



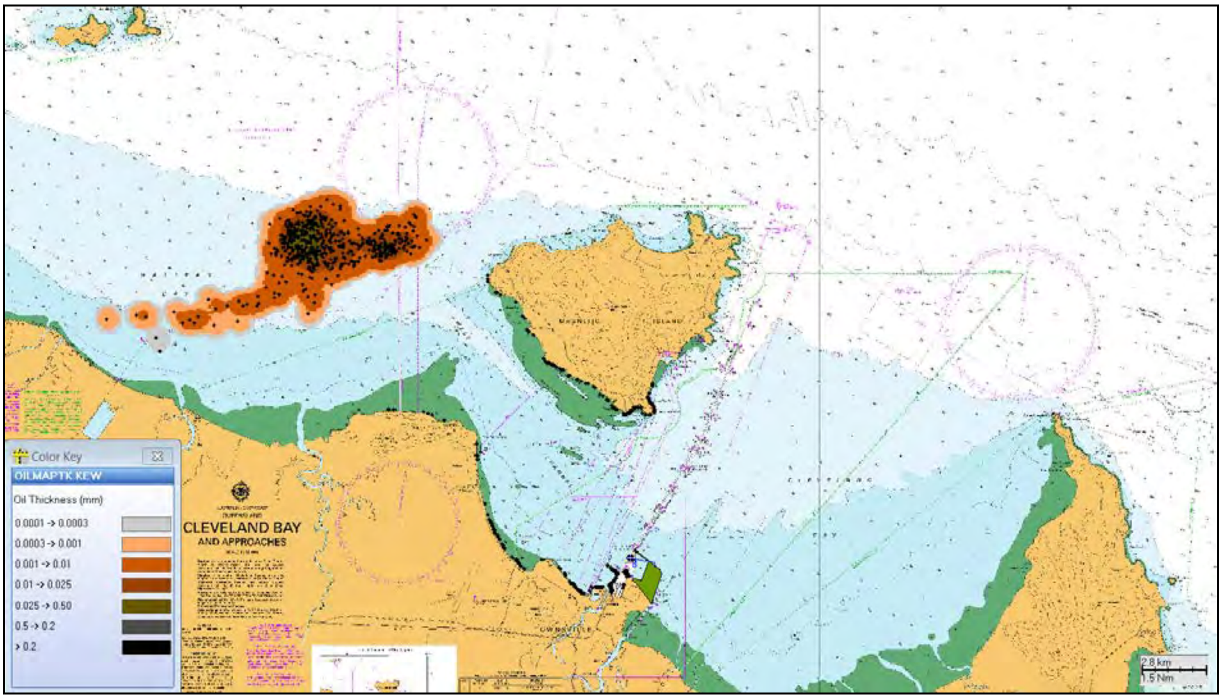

Map showing oil position and thickness 12 hours after a significant collision at the harbour entrance. Winds at the time were calm and the slick oscillated back and forth with the tides, while continuing to spread.



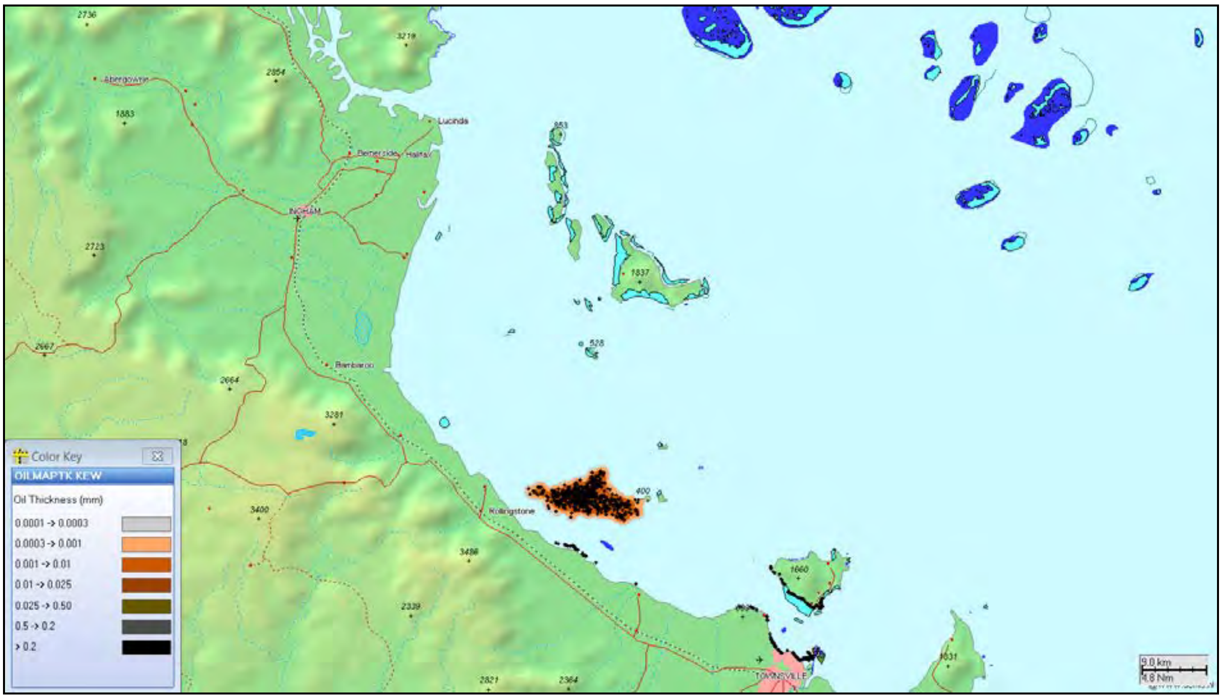

Map showing oil position and thickness 24 hours after a significant collision at the harbour entrance. Winds at the time were calm and the slick oscillated back and forth with the tides, while continuing to spread, now almost 8 km long. During the following day the slick moved into and out of Rowes Bay.



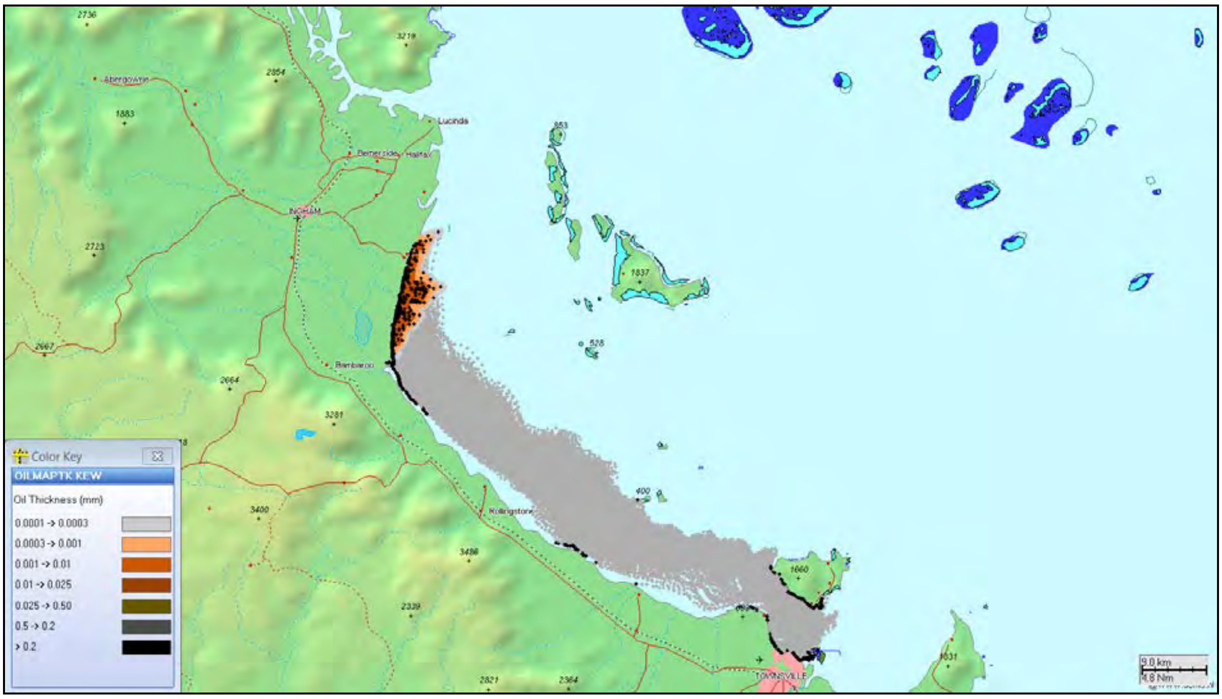

Map showing oil position and thickness 48 hours after a significant collision at the harbour entrance. Winds at the time were light from the SE, slowly pushing the slick northward parallel to the coast and into Picnic Bay, Nelly Bay and the Southwest Side of Magnetic Island.




Map showing oil position and thickness 72 hours or 3 days after a significant collision at the harbour entrance. Winds at the time were light from the SE, slowly pushing the slick northward parallel to the coast, side swiping shorelines along Shelley Beach, Bay Rock and the southwest side of Magnetic Island.




Map showing oil position and thickness 7 days after a significant collision at the harbour entrance. Winds at the time were light from the SE, slowly pushing the slick northward parallel to the coast, side swiping shorelines of Rattlesnake Island and the shorelines south of Balgal.




Map showing oil position and thickness 10 days after a significant collision at the harbour entrance. Winds at the time were predominantly light from the SE, slowly pushing the slick northward parallel to the coast, making shore on a number of occasions, as shown by the swept path (grey shading).

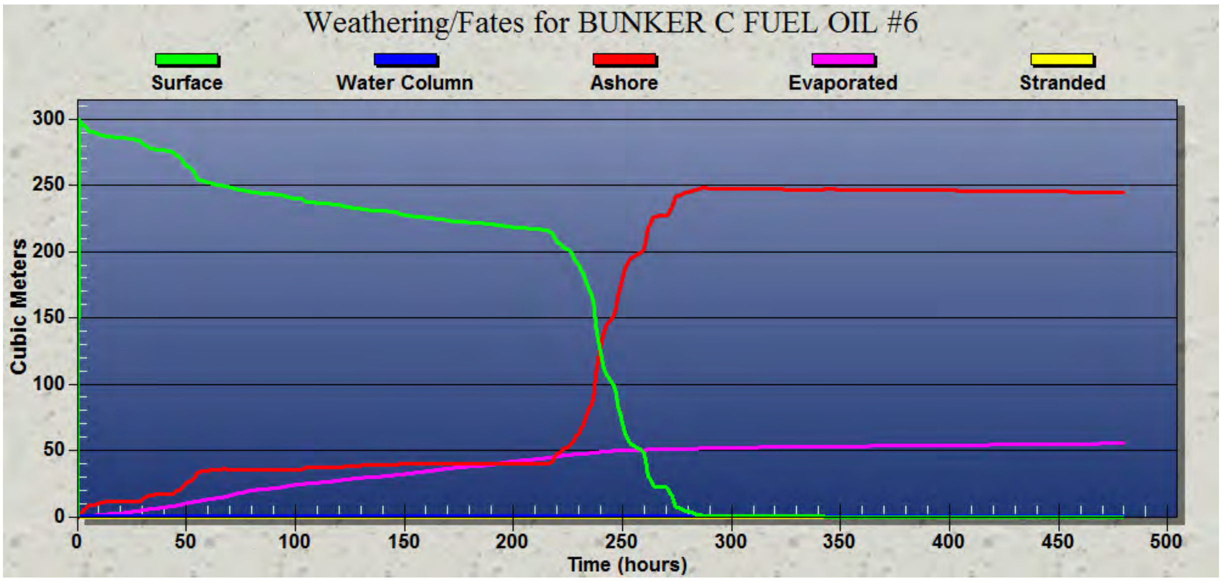



Figure showing the time history of the spill in terms of weathering. The graph indicated that the HFO would not evaporate significantly and would lose mass from surface oil to stranded oil over time.

### 8.5.2 Stochastic Results

The stochastic modelling of 100 spill simulations of this scenario was collectively analysed which quantified the probability of sea surface exposure and minimum time before exposure. Note the probability figures shown in this report summarised the likely exposure for each grid cell as a colour coding. For example, the grid cells with a 10% probability were exposed to 10 of the 100 trajectories and the cells with a higher probability of oiling were exposed during a greater number of spill trajectories, up to 100% at the release site.

Figure 14 to Figure 15 show the probability of sea surface exposure to heavy oiling and heavy sheens (being the 10 micron threshold), and any visible sheens (0.5 micron threshold) and the calculated minimum time before exposure. These results demonstrate that excusion away from the spill site is typically wind driven in this region. These figures demonstrate that almost 50% of spills can reach Saunders Beach in as little as 2 days and as far as Hinchinbrook Island under some extreme conditions.

Table 6: Summary of shoreline contact from this scenario tracked to the 0.5 μm threshold being the extent of visible oil as per AMSA Guidelines (2012). summaries the shoreline statistics which demonstrates that 100 out of 100 simulations made shoreline contact predominantly due to the prevelence of onshore winds in this region. The results also demonstrate that this type of oil is highly persistent without significant volumes of volatile components and hence remains adhesive over time and does not readily evaporate.

*Table 6: Summary of shoreline contact from this scenario tracked to the 0.5 μm threshold being the extent of visible oil as per AMSA Guidelines (2012).*

| Risk from Maximum Credible Spill in the New Harbour | | | | |
|---|---|---|---|---|
| **Release** | **Probability of contact to any shoreline (%)** | **Time to any shoreline (hours)** | **Average volume of oil to reach shore for single trajectory ($m^3$)** | **Total volume of oil to reach shore for single trajectory ($m^3$)** |
| **Harbour Entrance** | 100 | 0 to 46 | 275 | 289 |

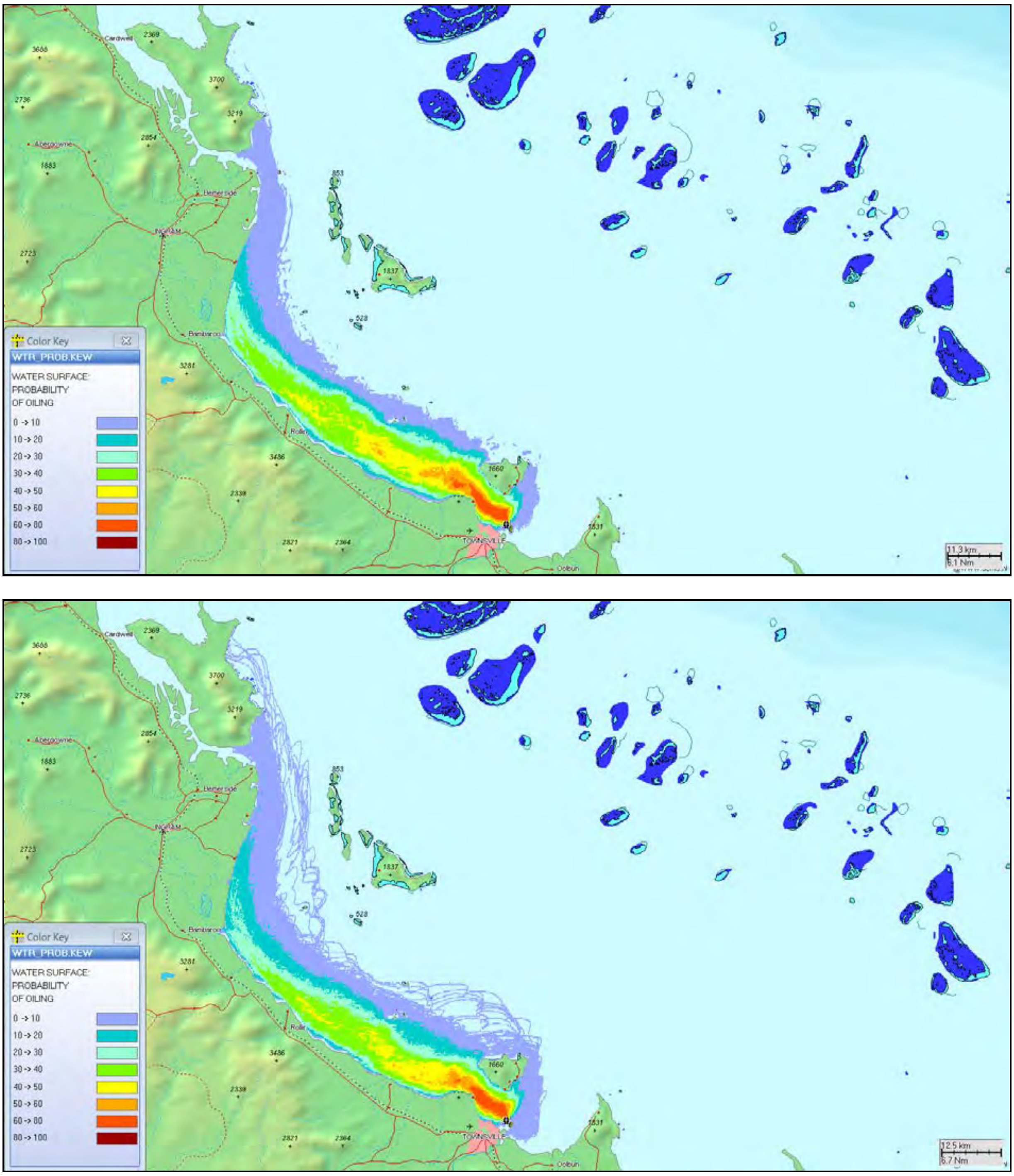



*Figure 14: Map showing the model calculated probability or risk of sea surface and shoreline exposure to heavy oiling and heavy sheens above 10 µm (top), and any visible oil above 0.5 µm (lower) by combining 100 simulations of a 300 cubic meter spill of HFO at the Harbour Entrance under winter conditions.*

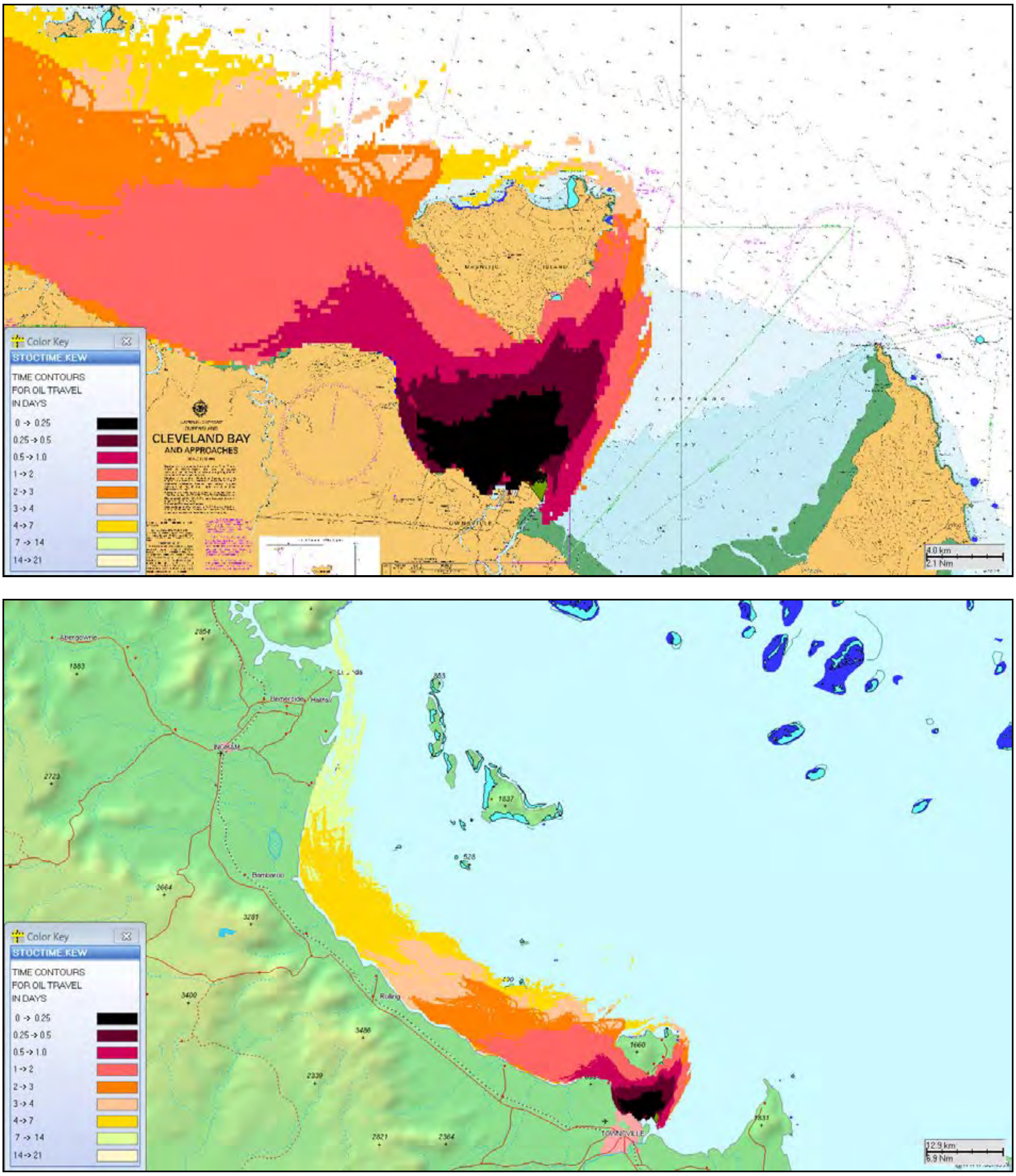



*Figure 15: (Top) Zoomed in and (lower) Zoomed out map showing the model calculated minimum time required before sea surface and shoreline exposure from the combination of 100 simulations of a 60 cubic meter spill of HFO at the Harbour Entrance under winter conditions.*

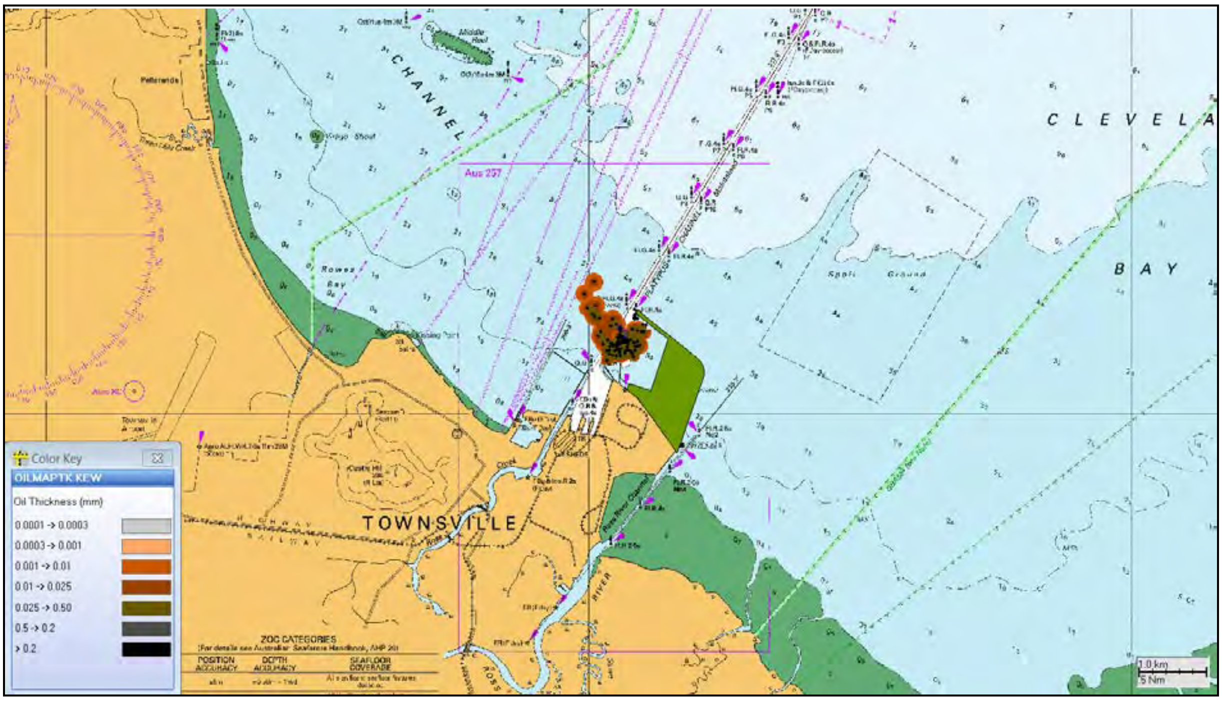
## 8.6 Scenario 6: Winter Risk from Most Likely Spill in the New Harbour

Stochastic spill modeling was used for the Risk Assessment for the winter period for the most likely spill volume from a collision with a Panamax Bulk Carrier while entering the new outer harbor proposed as part of the Townsville Port Expansion project. Using the AMSA 2012 guidelines, it was determined that a collision would typically result in a Most Like Spill of 20% of the volume of the largest fuel tank, that is, 60 cubic meters of Heavy Fuel Oil (HFO) over a 1 hour period.

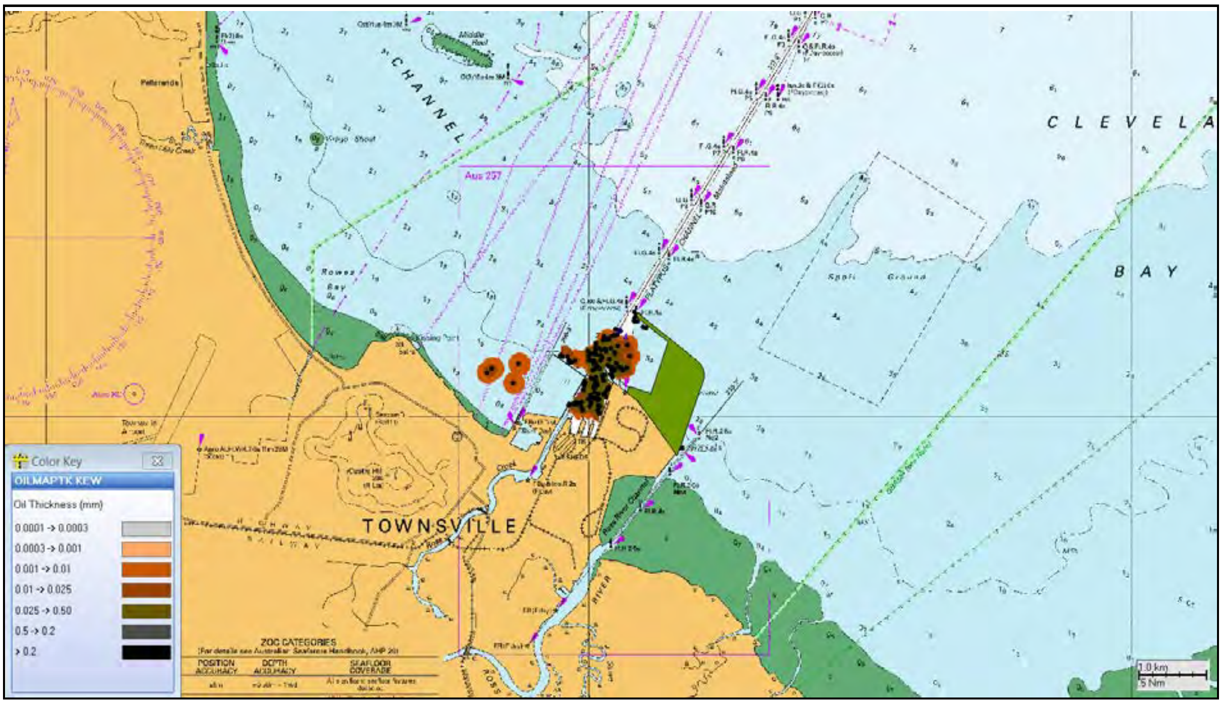
Worst-case single spill simulations were selected from the large number of simulations carried out for each scenario and period. The basis of selection was typically to demonstrate how the largest volume ashore occurred from the many simulations (100 for each scenario).

### *8.6.1 Worst-Case Single Spill Results*

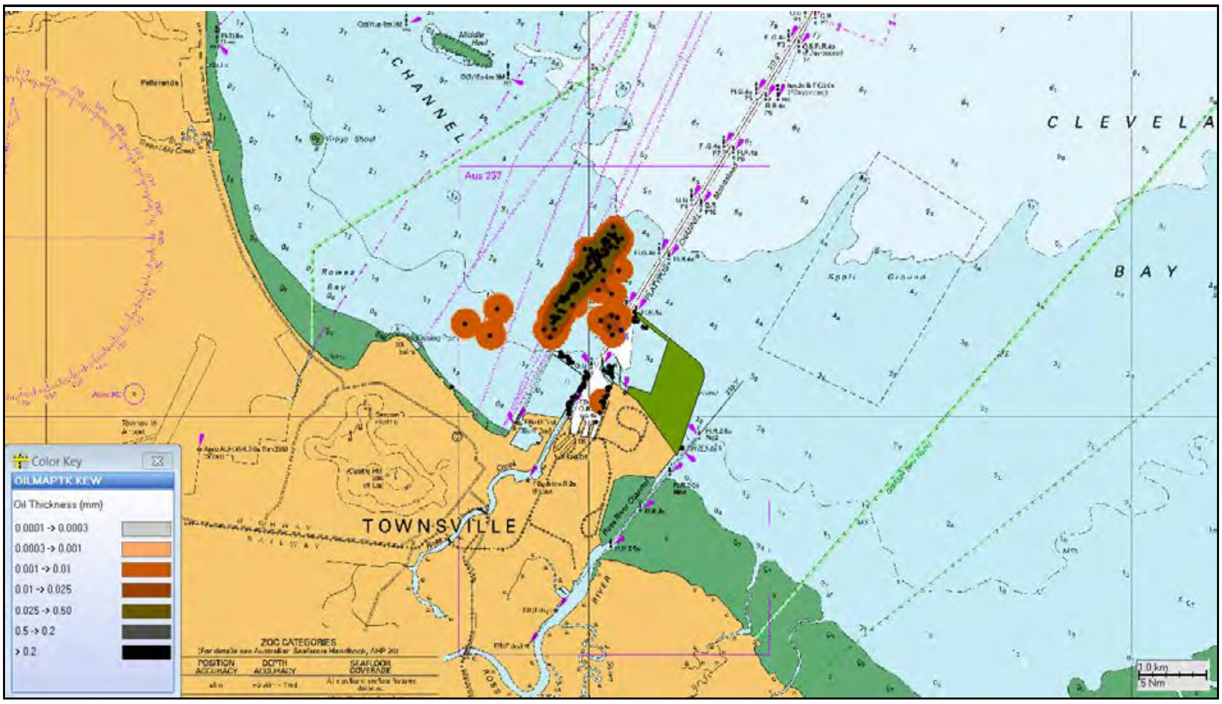
From all 100 simulations, the worst-case volume on shore from a 60 cubic metres spill of HFO was 57 Tonnes, all ashore within 5 days of release. That scenario and the wind and current conditions that forced that outcome is shown in the sequence of maps below.



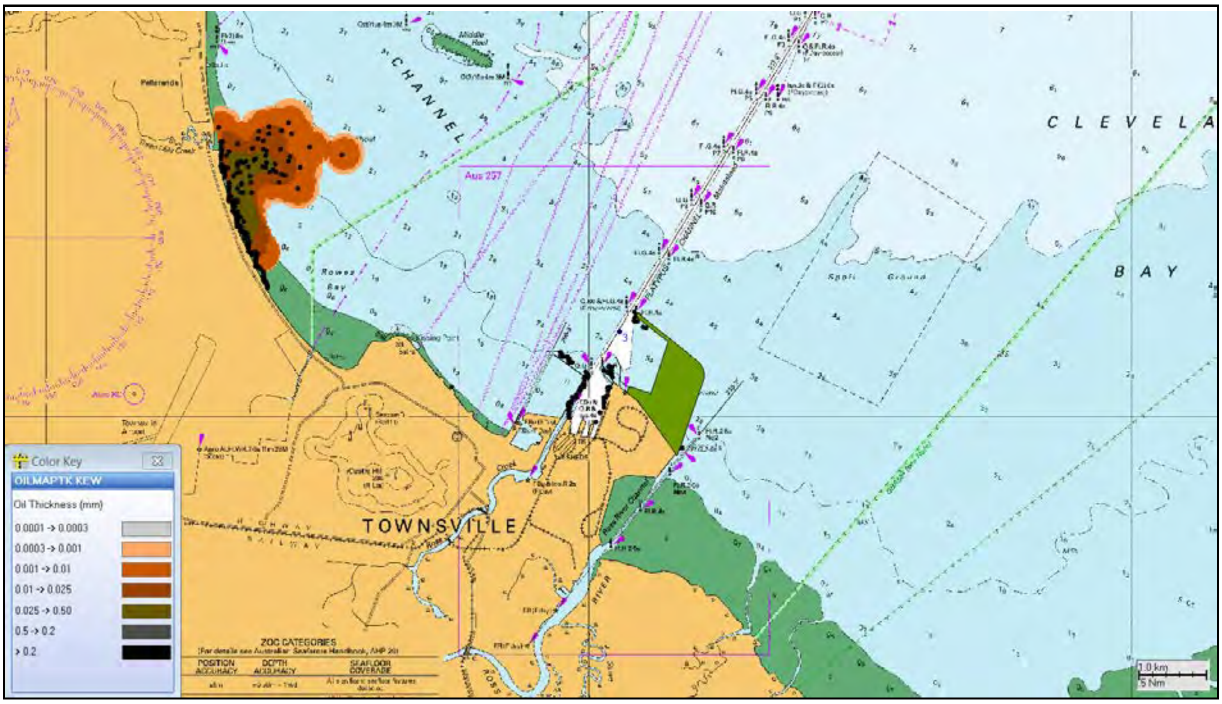

For this example, the above map shows oil position and thickness 3 hours after collision at the harbour entrance. Winds at the time were calm and the tide was near its low.



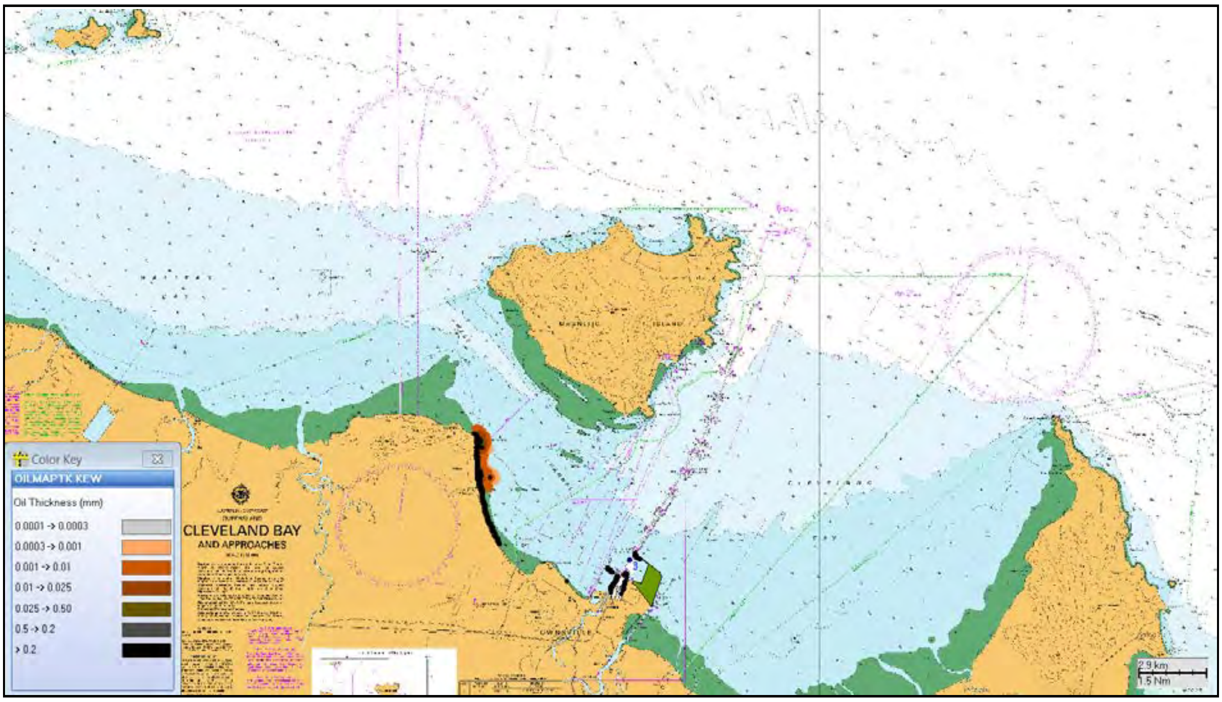

Map showing oil position and thickness 6 hours after collision at the harbour entrance. Winds at the time were calm and the incoming tide brought oil into the inner berths and Ross Creek.



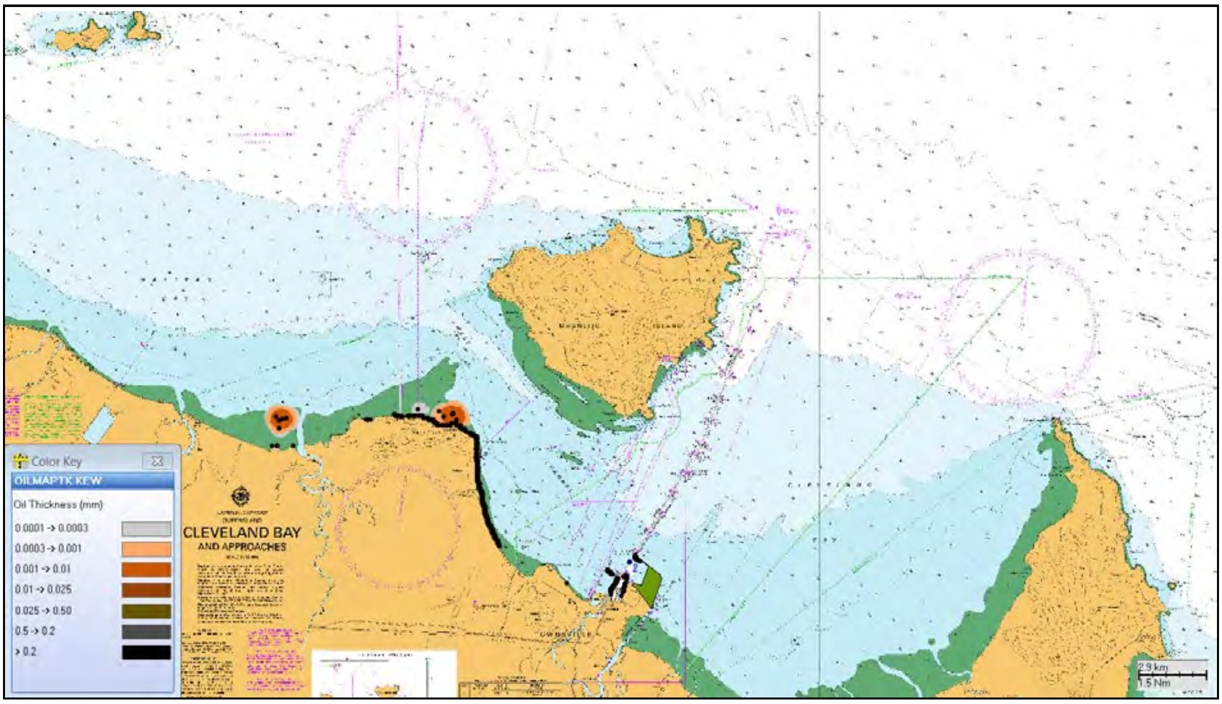

Map showing oil position and thickness 12 hours after collision at the harbour entrance. Winds at the time were light SE winds and the outgoing tide brought oil out of the inner berths and Ross Creek, leaving stranded residues along the rock walls, wharf faces and piers within the Port of Townsville.



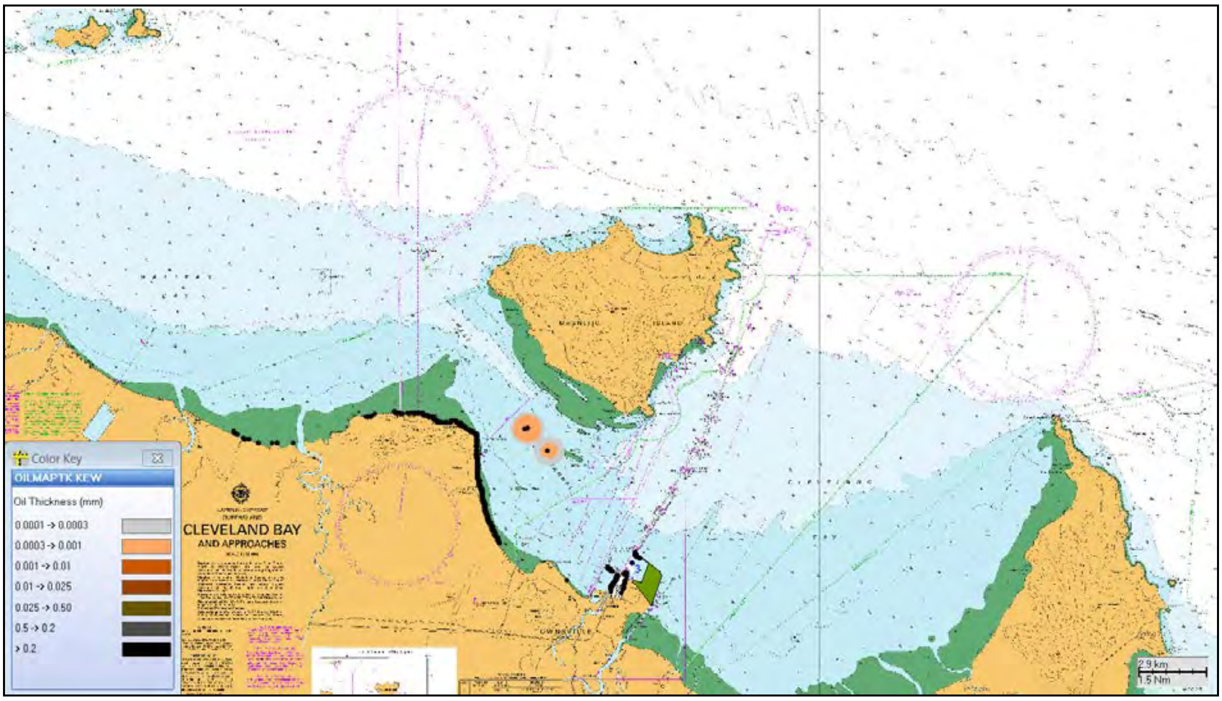

Map showing oil position and thickness 24 hours after collision at the harbour entrance. Winds at the time were light SE winds and pushed the spill towards the beaches of Rowes Bay and Pallarenda making significant shoreline contact. Once the stranded oil saturated the shoreline, oil still on water remained free to slip on and off the coated shore.



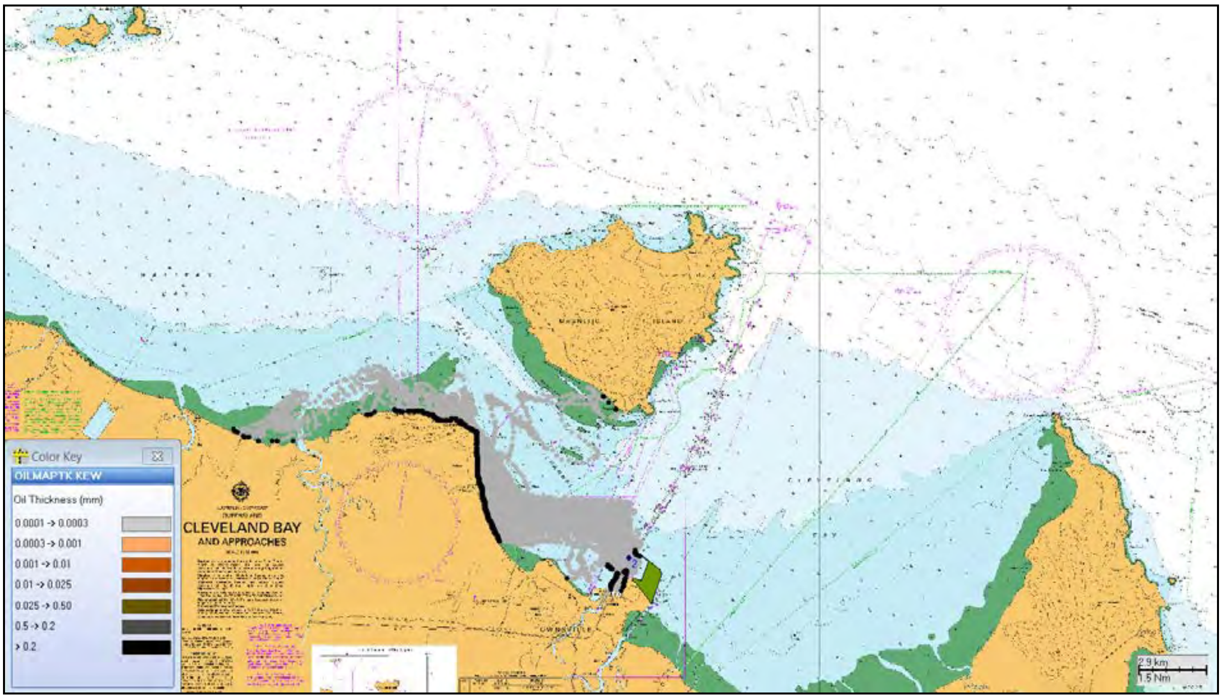

Map showing oil position and thickness 36 hours after collision at the harbour entrance. Winds at the time were light SE winds and held the oil against the coast, oiling more shorelines in this location as it slowly migrated out of Cleveland Bay with the wind and changing tides.




Map showing oil position and thickness 60 hours after collision at the harbour entrance. Winds at the time were calm and variable and held the oil against the coast, oiling more shorelines in this location as it slowly migrated around to Shelley Beach with the wind and changing tides. By this time considerable amount of oil adhered to the beach, slowly depleting surface oil, such that by this time, most of the oil had saturated on the beaches and headlands of Cape Pallarenda.




Map showing oil position and thickness 4 days (96 hours) after collision at the harbour entrance. Winds at the time were more southerly pushing non stranded oil patches out into West Channel and eventually to the southwestern shore of Magnetic Island.




Map showing stranded oil positions shown as black dots along the coastline being 57 tonnes of partially weathered and congealed HFO. The grey region shows the swept area that oil on the water's surface took over the 5 day period.

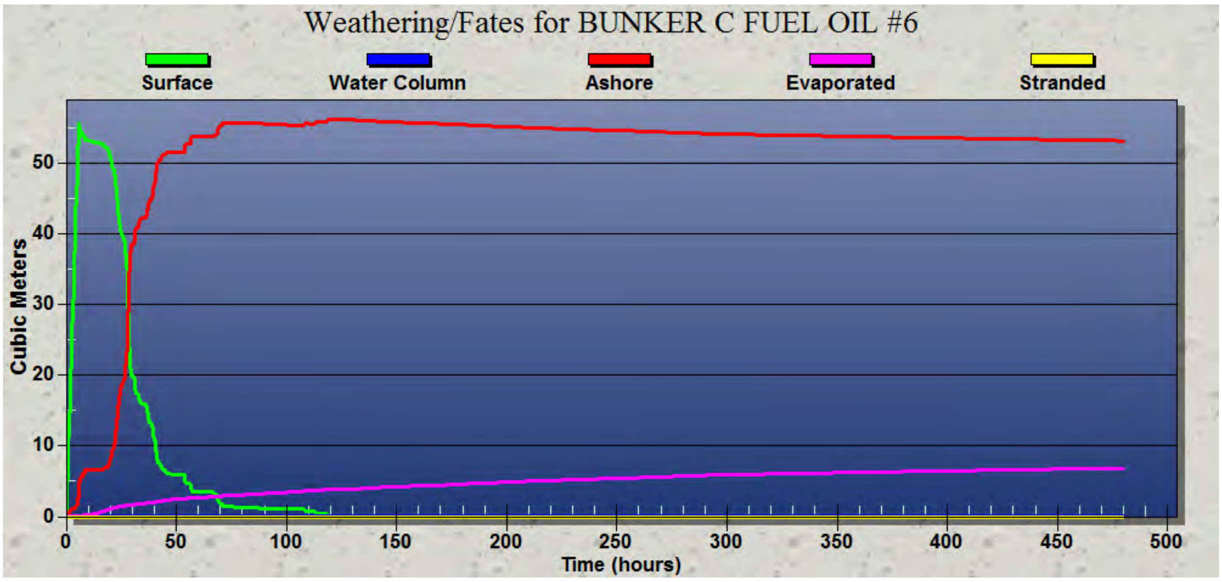



Figure showing the time history of the spill in terms of weathering. The graph indicated that the HFO would not evaporate significantly and would lose mass from surface oil to stranded oil over time.

### 8.6.2 Stochastic Results

The stochastic modelling of 100 spill simulations of this scenario was collectively analysed which quantified the probability of sea surface exposure and minimum time before exposure. Note the probability figures shown in this report summarised the likely exposure for each grid cell as a colour coding. For example, the grid cells with a 10% probability were exposed to 10 of the 100 trajectories and the cells with a higher probability of oiling were exposed during a greater number of spill trajectories, up to 100% at the release site.

Figure 16 to Figure 17 show the probability of sea surface exposure to heavy oiling and heavy sheens (being the 10 micron threshold), and any visible sheens (0.5 micron threshold) and the calculated minimum time before exposure. These results demonstrate that excusion away from the spill site is typically wind driven in this region. These figures demonstrate that almost 50% of spills can reach Shelley Beach in as little as 24 hours and as far as Hinchinbrook Island under some extreme conditions.

Table 7: Summary of shoreline contact from this scenario tracked to the 0.5 µm threshold being the extent of visible oil as per AMSA Guidelines (2012). summaries the shoreline statistics which demonstrates that 100 out of 100 simulations made shoreline contact predominantly due to the prevelence of onshore winds in this region. The results also demonstrate that this type of oil is highly persistent without significant volumes of volatile components and hence remains adhesive over time and does not readily evaporate.

*Table 7: Summary of shoreline contact from this scenario tracked to the 0.5 µm threshold being the extent of visible oil as per AMSA Guidelines (2012).*

| Risk from Most Likely Spill in the New Harbour | | | | |
|---|---|---|---|---|
| **Release** | **Probability of contact to any shoreline (%)** | **Time to any shoreline (hours)** | **Average volume of oil to reach shore for single trajectory ($m^3$)** | **Total volume of oil to reach shore for single trajectory ($m^3$)** |
| **Harbour Entrance** | 100 | 0 to 51 | 53.9 | 57.7 |

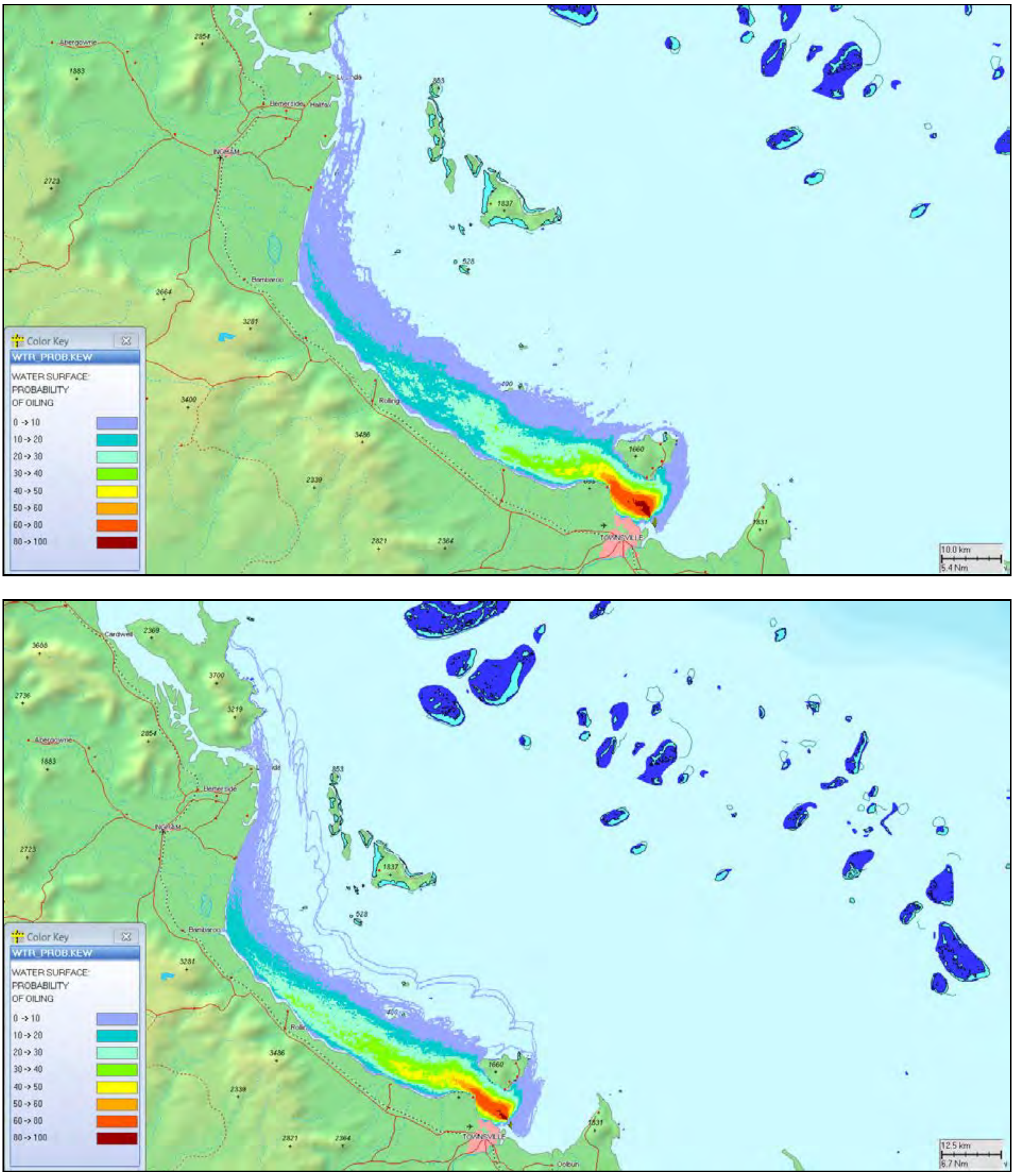



*Figure 16: Map showing the model calculated probability or risk of sea surface and shoreline exposure to heavy oiling and heavy sheens above 10 µm (top), and any visible oil above 0.5 µm (lower) by combining 100 simulations of a 60 cubic meter spill of HFO at the Harbour Entrance under winter conditions.*

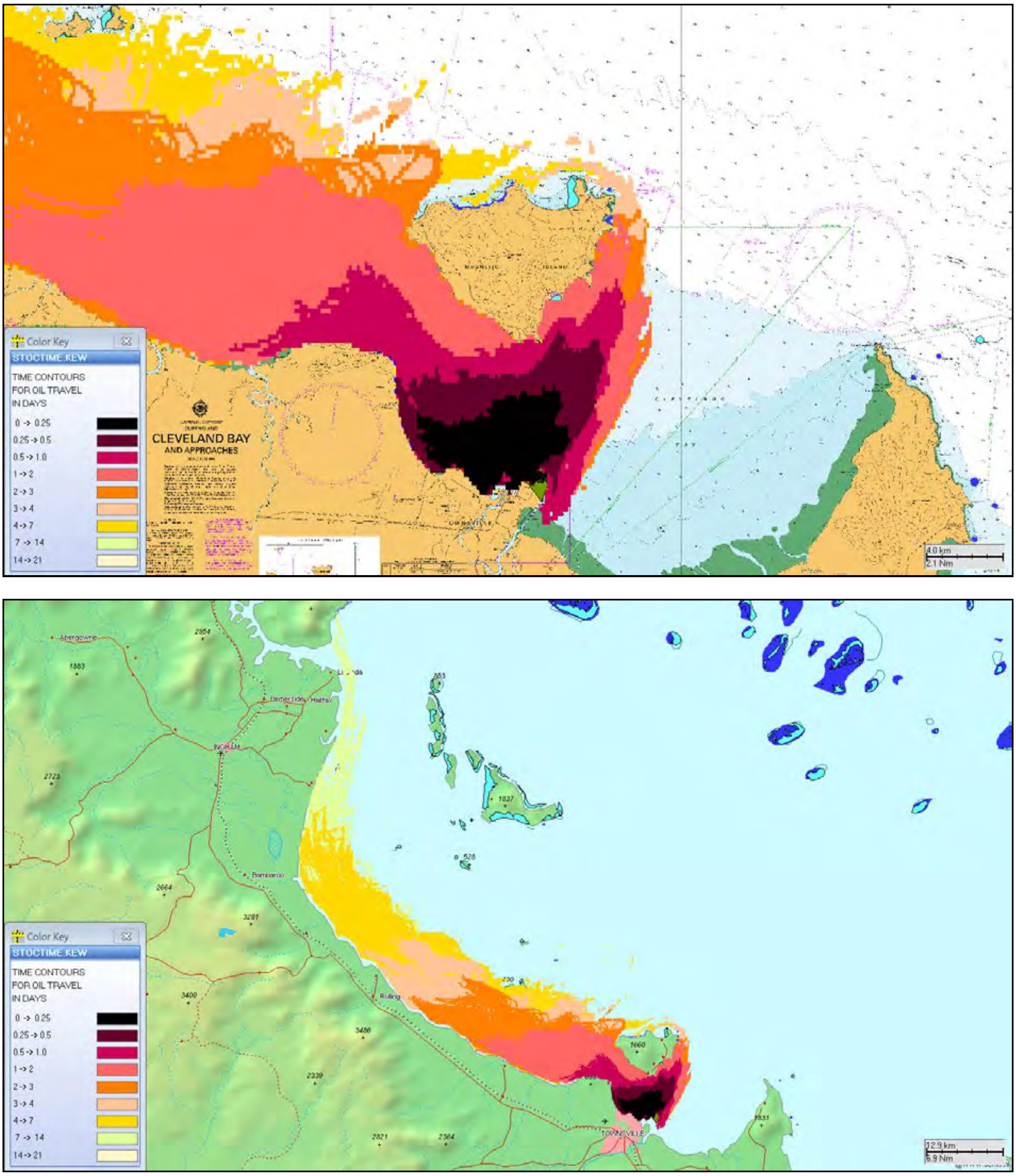



*Figure 17: (Top) Zoomed in and (lower) Zoomed out map showing the model calculated minimum time required before sea surface and shoreline exposure from the combination of 100 simulations of a 60 cubic meter spill of HFO at the Harbour Entrance under winter conditions.*

# 9 DISCUSSION

Collectively, this study undertook 100 spill simulations for the 6 scenarios above, making 600 simulations in total for spills within the Port Limits. Some general observations from the oil spill risk assessment can be summarized as follows:

1. The fate of HFO spills in Cleveland Bay is significantly wind driven.

2. The predominant wind direction over Cleveland Bay is from the Southeast direction, hence spills mostly always drifted north-westward, frequently moved into Halifax Bay and generally oscillated backwards and forwards with the tide until they encountered a shoreline in Cleveland Bay, including Magnetic Island or Halifax Bay. The modelling indicated that typically multiple shoreline impacts occurred with any given spill incident.

3. Shorelines within this region are populated, and shoreline impacts occurred in less than one hour of release in some simulations, particularly related to an incident in the outer harbour or along anywhere along the Sea Channel. Shoreline trapped Bunker Fuels will evaporate, albeit slowly, creating a hydrocarbon vapour plume that may blow onshore with the wind that brought the oil ashore. The modelling indicated that the vapours may persist for up to 10 days for Maximum Credible Spill Volume.

4. A comparison of the seasonal influences (that is, summer and winter conditions) on spill fate within the region revealed little variance in spill outcomes between summer and winter conditions.

5. Spills reaching beaches with breaking wave action along the shore were predicted to potential emulsify, incorporate suspended sediment and sink after a period of days if not recovered and collected before that time.

6. From the 600 simulations undertaken for this study, no spills were predicted to reach the mid shelf reefs of the Great Barrier Reef, indicating a very low to insignificant risk to the offshore reefs from spills within the Port Limits of Cleveland Bay. Also, the furthest excursion from any spill was typically alongshore, where small volumes of spilt oil could reach the Hinchinbrook Island region as highly weathered and potentially semi solid tar balls and paddies.

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# Port Expansion Project EIS

**Appendix X2**

**MARPOL Discharge Standards and Annexures**

AECOM BMT WBM

Table A.1 Summary of MARPOL discharge standards of relevance to the release of waste

| Annex | Vessel/Voyage Type/Area | Sub-Category | Discharge Conditions |
|---|---|---|---|
| Annex IV - Sewage | Vessels on international voyages | Ground and disinfected sewage using an approved system. | >3 nm from nearest land |
| | | Sewage stored in holding tanks (untreated and treated sewage) | >12 nm from nearest land; and<br>Discharged at a moderate rate*; and<br>Ship proceeding en route at a speed of at least 4 knots.<br>* The rate of discharge must be approved by the Administration. |
| | | Treated sewage effluent discharged through an IMO approved sewage treatment plant (STP).<br>Also integrated system where the STP includes:<br>grey water input<br>food processing input. | Effluent not to produce visible floating solids nor cause discolouration of the surrounding water.<br>When in port limits, check with port authority as permission may be required<br>All vessels should ensure that the STP is operating at optimum performance when in Australian waters<br>Food or biological waste removed from filtration unit is prohibited from discharge in 12nm from land (Australian Quarantine requirements) |
| | Vessels on domestic voyages (all sizes | | Recommended to comply with MARPOL Annex IV<br>Local laws may prohibit discharges in ports |
| | Great Barrier Reef Marine Park<br>Vessels on International voyages to and continuing in Australian waters | All sewage discharges | In accordance with Annex IV requirements and where applicable with any additional restrictions imposed as conditions of a GBRMP permit |
| | Great Barrier Reef Marine Park Vessels on domestic voyages | All sewage discharges | Recommended to comply with MARPOL Annex IV<br>Or In accordance with requirements of Part 3A of the GBRMPA Regulations (93A-93G) for both treated and untreated sewage<br>AND, where applicable, in accordance with any additional restrictions imposed as conditions of a GBRMP permit |
| | Queensland State Waters (small vessels/State | If vessel does not have a sewage treatment system on board, options include:<br>using onshore toilet facilities | If a vessel has 16 or more persons on board, no discharge of untreated sewage is permitted anywhere in Queensland waters. |

| Annex | Vessel/Voyage Type/Area | Sub-Category | Discharge Conditions |
|---|---|---|---|
| | registered and recreational) | whenever possible<br>using a portable toilet to be later emptied to a sewerage/septic system<br>retain sewage in onboard holding tank for pumping out to shore facilities. | If a vessel has 7 to 15 persons on board, no discharge of untreated sewage is permitted in 1 nautical mile (1852 m) of a reef or the mean low water mark of an island or the mainland. |
| Annex V - Garbage<br>(Applies to all vessels) | All vessels<br>All waters | Mixed garbage with different discharge requirements<br>(for example  food waste mixed with plastic – prohibited) | The most stringent requirement applies |
| | | Plastics<br>This may include:<br>▪ synthetic ropes,<br>▪ synthetic fishing nets and line,<br>▪ plastic garbage bags and incinerator ashes from plastic products,<br>▪ cigarette filters,<br>▪ fibreglass/laminated structures piping,<br>▪ insulation,<br>▪ carpets paints and finishes,<br>▪ electrical components,<br>▪ sheeting,<br>▪ floats. | Prohibited |
| | | Dunnage, lining and packing materials which will float (for example pallets, cardboard, plywood) | > 25 nm from nearest land |
| | | Food wastes and all other garbage.<br>▪ This may include:<br>▪ domestic waste,<br>▪ cargo residues,<br>▪ maintenance and operational waste and incinerator ashes (except from plastic products),<br>▪ soot machinery deposits,<br>▪ scraped paint, and<br>▪ deck sweepings, etc.<br>This category includes cargo hold washing water | > 12 nm from nearest land |
| | | Garbage that has been ground or crushed to particles < 25mm | > 3 nm from nearest land. |
| | All vessels in the Nearest Land (MARPOL definition) | All garbage types (including food waste) in the Great Barrier Reef Marine Park and part of the Torres Strait (see MARPOL definition of 'from the nearest | Prohibited |

| Annex | Vessel/Voyage Type/Area | Sub-Category | Discharge Conditions |
|---|---|---|---|
| | | land'). Note: exception for small amounts of food waste associated with tourist and fishing activities. See Annex V Guidelines. | |
| | All Vessels when alongside or in 500 metres of a fixed or floating platform that is located more than 12 nm from Nearest Land. | All garbage types (except food waste passed through a crusher or grinder) | Prohibited |
| | All vessels | Grey water (from showers, laundry, dishwater) and swimming/spa pool waters | Discharge allowed at sea; When in port, check with port authority as permission may be required |
| | Vessels at anchorages or stationary while waiting for a berth. All waters | Food waste and other garbage | Comply with all Annex V requirements If the vessel is anchored or stationary more than 12nm from the nearest land, it is recommended that only food waste is discharged and all other garbage is retained for offloading when alongside. |
| | Bulk Cargo vessels operating in the 12nm from nearest land limitation (including the Great Barrier Reef Marine Park) | Wash down of cargo residues on deck areas. Entry should be recorded in the Garbage Record Book (item 4.1(d)) for verification of a discharge under these specific circumstances. | Only for safety purposes wash down discharge allowed for: safe operation of a helicopter in the landing area and its immediate vicinity to avoid dust being raised by the down-draft of the rotors; where there is a need to avoid navigational hazards such as dust being blown onto the wheelhouse or bridge wings; and where residues may cause a serious safety hazard to personnel if spillages are not cleaned from deck areas, adjacent walkways and working areas. |
| | | Cargo bilge water Entry should be recorded in the Garbage Record Book (item 4.1(d)) for verification of a discharge under these specific circumstances | Only for safety purposes where the cargo hold bilge water generated through a loaded hold is required to be discharged through the vessel's fixed piping bilge drainage system provided that the cargo material is not classified as a marine pollutant in the IMDG Code. Vessels at anchorage for a period of time with empty holds may discharge hold bilge water as long as the water is not directly related |

| Annex | Vessel/Voyage Type/Area | Sub-Category | Discharge Conditions |
| --- | --- | --- | --- |
| | | | to a hold washing/cleaning operation. |
| | All vessels operating in Australian Antarctic Territory (sea area south latitude 60°S) | All Plastics | Prohibited |
| | | All other garbage (except food waste) | Prohibited |
| | | Food waste | >12 nm from nearest land |
| | All vessels on International voyages to and continuing in Australian waters<br>(Australian Quarantine requirements) | All Food waste including ground, crushed or extracted from a filtration system | >12 nm from land (baselines)<br>Offload to port facilities for Australian Quarantine approved contractor for autoclave/steam sterilization processing |
| | | Recycled waste (for example aluminium tins, glass) | Offload to port facilities if the vessel has processed recycled waste onboard through a steam sterilizer.<br>OR<br>Offload to port facilities for Australian Quarantine approved contractor for autoclave/steam sterilization processing. |
| | | Ashes from type approved incinerator (IMO Resolution MEPC.76(40)<br>Ashes from an incinerator (not type approved | Accepted by port reception facilities.<br>Offload to Australian Quarantine approved contractor but only acceptable for deep burial treatment. |

Table A.2 Summary of MARPOL discharge standards of relevance to the release of chemical contaminants

| Annex | Vessel/Voyage Type/Area | Sub-Category | Discharge Conditions |
| --- | --- | --- | --- |
| Annex I<br>(Applies to all vessels) | Oil tankers<br>All waters | Oily waste from cargo tanks | ▪ More than 50 nautical miles from the nearest land; and<br>▪ Tanker is proceeding en route; and<br>▪ Instantaneous rate of discharge < 30 litres per nautical mile; and<br>▪ Total quantity discharge does not exceed 1/15,000 or 1/30,000 of the total cargo (depending on the age of the vessel); and<br>▪ Oil discharge monitoring and control system and slop tank arrangement to be operating. |
| | All vessels ≥ 400 gross tons<br>All waters | Machinery space bilges | ▪ Oil and all oily mixtures retain onboard for on shore disposal;<br>OR<br>▪ Proceeding en route; and<br>▪ Oil content less than 15 parts per million; and<br>▪ Oil discharge monitoring and control system and oil filtering equipment to be operating. |

| Annex | Vessel/Voyage Type/Area | Sub-Category | Discharge Conditions |
|---|---|---|---|
| | | | Note: 15ppm discharges can be anywhere at sea (not in port limits) including the Great Barrier Reef Marine Park and Marine Protected Areas. Vessel must not be stationary when undertaking discharge. |
| | All vessels <400 gross tons<br>All waters | Machinery space bilges | ▪ Oil and all oily mixtures retain onboard for on shore disposal;<br>OR<br>▪ Proceeding en route; and<br>▪ Has in operation equipment of a design approved by the administration that ensures oil content less than 15 parts per million.<br>Note: 15ppm discharges can be anywhere at sea (not in port limits) including the Great Barrier Reef Marine Park and Marine Protected Areas. Vessel must not be stationary when undertaking discharge. |
| | Vessels operating in the Great Barrier Reef Marine Park | Bunkering utilising ship-to-ship transfers | A permit is required from the Great Barrier Reef Marine Park Authority (GBRMPA), under which certain conditions may be imposed. |
| Annex II | Chemical and Product Tankers | Category X | Tanks to be prewashed before leaving unloading port, residues to be pumped ashore until the concentration of the substance in the effluent is 0.1% by weight or less, as indicated by analysis of samples of the effluent taken by an AMSA marine surveyor. When the required concentration level has been achieved, remaining tank washings to be discharged to the reception facility until the tank is empty. Appropriate entries to be made in the Cargo Record Book and endorsed by the AMSA marine surveyor. Any water subsequently added may be discharged if:<br>Ship is proceeding en route at a speed of at least 7 knots; and<br>Discharge below the waterline; and<br>Ship is > 12 nm from nearest land and depth of water is >25m |
| | | High-viscosity or solidifying Category Y | Prewash in accordance with Convention, residues to be pumped ashore until tank is empty. Any water subsequently added may be discharged if:<br>Ship is proceeding en route at a speed of at least 7 knots; and<br>Discharge below the waterline; and<br>Ship is > 12 nm from nearest land and depth of water is >25m. |
| | | Category Y<br>Category Z | Ship is proceeding en route at a speed of at least 7 knots; and<br>Concentration of substance in wake of ship < 1 part per million; and |

| Annex | Vessel/Voyage Type/Area | Sub-Category | Discharge Conditions |
|---|---|---|---|
| | | | Amount not to exceed 1m$^3$ or 1/3,000 of tank capacity, whichever is greater; and<br>Discharge below the waterline; and<br>Ship is > 12 nm from nearest land and depth of water is >25m. |
| Annex III | Vessels carrying Harmful Packaged Substances Labelling requirements | N/A | Jettisoning is prohibited. |

## MARPOL Annexes

Table B.1 Summary of MARPOL annexes of relevance to the release of waste into the marine environment

| Annex | Title | Summary of Content |
|---|---|---|
| Annex IV | Regulations for the Prevention of Pollution by Sewage from Ships | Annex IV deals with the discharge of sewage into the sea, ships' equipment and systems for the control of sewage discharge, the provision of facilities at ports and terminals for the reception of sewage, and requirements for survey and certification.<br>It is generally considered that on the high seas, the oceans are capable of assimilating and dealing with raw sewage through natural bacterial action and therefore the regulations in Annex IV of MARPOL prohibit ships from discharging sewage in a specified distance of the nearest land, unless they have in operation an approved treatment plant.<br>Annex IV originally entered into force in Australia on 27 May 2004. |
| Annex V | Regulations for the Prevention of Pollution by Garbage from Ships | Annex V deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of. The requirements are much stricter in a number of special areas. The Annex imposes a complete ban on the dumping into the sea of all forms of plastic.<br>Annex V originally entered into force in Australia on 14 November 1900. |
| Annex VI | Regulations for the Prevention of Air Pollution from Ships | Annex VI sets limits on the emissions of nitrogen oxides (NOx) from marine diesel engines, requires ships to avoid using fuel with sulphur content exceeding 3.5% by mass, prohibits deliberate emissions of ozone depleting substances, and prohibits the incineration of certain products on board ships. Furthermore, if a ship is in a sulphur oxides (SOx) Emission Control Area, it has to use a fuel with a sulphur content not exceeding 1.0% by mass, or an exhaust gas cleaning system or any other approved apparatus to limit SOx emissions.<br>From 1 January 2020, the global sulphur cap shall decrease to 0.5%. However, the 2020 decrease is subject to a feasibility review to be completed by the IMO no later than 2018, which shall consider among other issues, the availability of compliant fuel. The sulphur limit in SOx Emission Control Areas shall decrease to 0.1% from 1 January 2015. |