BMT WBM

Assessment of Marine Sediments Adjacent to Fisherman Islands 2015

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Synopsis: **This report details the findings of a survey undertaken in July 2015 to determine the grain size composition of marine sediment of intertidal and subtidal banks situated to the south of Fisherman Islands. The survey methodologies were based on those used for previous surveys and the survey results are compared to the historic data to determine any broad-scale shifts in sediments.**

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Executive Summary

The Port of Brisbane Pty Ltd (PBPL) has its main port infrastructure at Fisherman Islands, situated at the mouth of the Brisbane River on reclaimed lands. Previous studies have identified the potential for port reclamation works to cause localised changes to intertidal and subtidal habitats in the vicinity of Fisherman Islands. Such changes included modification of bed sediment characteristics and sedimentation processes through potential alterations to tidal current dynamics and the direction of freshwater flow from the Brisbane River.

The specific objectives of the present study were to:

- Identify and describe broad-scale spatial patterns in sediment grain size composition within the Fisherman Islands area;
- Describe temporal changes to sediment grain size composition within each site, based on data collected in the present study and previous studies in the Fisherman Islands area (WBM 1992, WBM 1998, BMT WBM 2010); and
- Discuss any evidence of changes to sediment grain size that may have resulted from Port of Brisbane activities.

A total of 37 sites were sampled in the present survey. The sampling methodology and site locations of the 2015 survey are consistent with methodologies used in previous studies undertaken by BMT WBM within the study area. Surface samples were collected using a van Veen grab, and analysed for particle size distribution (PSD) by sieve analysis (minimum sieve size = 0.075mm).

There was great variation in sediment particle size distribution among sites in 2015, but spatial patterns were generally consistent with the findings of previous studies. Areas with high mud content (>25%) were predominantly found in the deeper channel area west of St. Helena and Green Islands, at the mouth of the Boat Passage south of Fisherman Islands, within seagrass meadows east of Fisherman Islands, and an area adjacent to Fisherman Islands and south of the Future Port Expansion (FPE) seawall. The areas with higher mud content were located in quiescent areas and seagrass meadows, which provide conditions that promote the deposition and trapping of muds.

Sites located on the shoal extending east-west between the eastern margin of the FPE and St Helena Island consisted of well sorted fine to medium sands. This shoal is the remnant Brisbane River mouth. The shoals are exposed to prevailing north-easterly wind waves and currents, which operate together to prevent the settlement of muds.

Most sites displayed an overall trend of increasing mud proportion since 1992, but both the magnitude of change and timing of such changes varied in different parts of the study area. Areas located offshore of the Boat Passage entrance and the nearshore zone of Fisherman Islands have experienced increasing mud content over time. Major increases were observed at some sites between 2009 and 2014, and are highly likely due to fluvial mud inputs from major flooding in 2011 and minor flooding in 2013.

Many sites also displayed a long-term trend of increasing mud content. The more quiescent nearshore areas of Fisherman Islands represent a depositional environment, and will tend to slowly accumulate muds over long timeframes.

WBM (2000) predicted that the degree of impact on the patterns of flow around the FPE would be generally slight and confined predominantly to the truncation area outside the Moreton Bay Marine Park. The truncation and rounding of the southeastern corner was predicted to allow smooth unimpeded tidal flow to and from northern Waterloo Bay. Sampling undertaken at the north-east tip of Fisherman Islands (site 2) confirms that there have been no major temporal changes in sediment particle grain size at this location.

No consistent, major changes in mud content were observed over time on the sand bank extending between the FPE and St Helena Island. These shallow areas are exposed to local waves from the north east and tidal currents, which do not favour the settlement and/or trapping of muds.

Modelling results presented in WBM (2000) suggest the area around the southeast edge of the FPE seawall would experience a reduction in current velocities. Mud accumulation was observed at this location, however inter-annual changes in prevailing wind and wave climate will influence sediment patterns here in space and time.

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1 Introduction

1.1 Background

The Port of Brisbane Pty Ltd (PBPL) has its main port infrastructure at Fisherman Islands, situated at the mouth of the Brisbane River (Figure 1-1). The port facilities at the river mouth have been established on land reclaimed over a shallow sub-tidal river delta containing a series of low lying mangrove islands, collectively called the Fisherman Islands. Reclamation commenced in the late 1960's, and continued through the mid-1990s ('Superbund') and early 2000s (Future Port Expansion – FPE).

An investigation on the hydrodynamics and sedimentary characteristics (WBM 1992) and Impact Assessment Studies (WBM 2000) had identified the potential for port expansion works to cause localised changes to intertidal and subtidal habitats in the vicinity of Fisherman Islands. Such changes included modification of bed sediment characteristics and sedimentation processes through altering tidal current dynamics and the direction of freshwater flow from the Brisbane River.

An investigation conducted by WBM (1998) found minor shifts in sediment composition post construction of port reclamation works in the mid-1990s. Since completion of the seawall the Port of Brisbane has endeavoured to continue to examine the nature of sediments within the Waterloo Bay/Fisherman Islands area on a broad spatial scale. The most recent study occurred in 2009 (BMT WBM 2010) and showed that between 1992 and 2009, no major changes in broad-scale sediment patterns have occurred but that there have been some smaller scale changes in sediment distribution patterns.

The present study was commissioned by the PBPL and is a continuation of the BMT WBM (2010) study. It aims to catalogue spatial and temporal changes in the characteristics of bed sediments adjacent to Fisherman Islands through ongoing surveys of particle size distribution (PSD) of sediment.

1.2 Study Aims and Objectives

The broad aim of this investigation was to determine any notable changes in marine sediment composition since completion of the FPE seawall of the intertidal and shallow subtidal banks situated south to south west of Fisherman Islands. The specific objectives of this study were to:

- Identify and describe broad-scale spatial patterns in sediment grain size composition within the Fisherman Islands area;
- Describe temporal changes to sediment grain size composition within each site, based on data collected in the present study and previous studies in the Fisherman Islands area (WBM 1992, WBM 1998, BMT WBM 2010); and
- Discuss any evidence of changes to sediment grain size that may have resulted from the Port of Brisbane's activities.

Title:

Sediment sampling sites used for comparison with historic data

Figure: **1-1**

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2 Methodology

2.1 Sampling Design and Collection

The sampling methodology and site locations of the 2015 survey are consistent with methodologies used in previous studies undertaken by BMT WBM within the study area (WBM 1992, WBM 1998, BMT WBM 2010).

A total of 37 sites were sampled within the present survey (refer to Figure 1-1). Some sites previously sampled in 1992 and 1998 were not included within this survey or in the 2009 survey. These were sites 1, 3, and G that are now situated within the FPE reclamation area, and site S on the Brisbane River.

Location and navigation to sites was undertaken using a real time differential Global Positioning System (dGPS) to provide position-fixing accuracy's of ±1m. Precision was maintained among replicate samples at each site by verifying the site position on the dGPS system prior to each grab.

Sediment samples were collected using a stainless steel Van Veen grab with a surface gape of 0.028m^2. Only whole grab samples (i.e. those in which the sampler jaws remained closed following the sample capture) were retained to reduce the loss of finer material. Sediment and any collected overlying waters were placed into a plastic sample tray. BMT WBM (2010) have determined that small-scale variability observed between duplicate samples collected at each site within the study area averaged 3-4% (±3%). To account for this small scale variation within sites at least three grabs were collected at each site. These replicate samples were then homogenised and a subsample of this material (weighing at least 2 kilograms) was transferred into pre-labelled plastic zip locked bags to provide a single representative sample at each site. The van Veen grab, sample trays and utensils were rinsed with seawater between samples to avoid cross contamination of samples.

During collection, samples were photographed, and the following details recorded on a standardised pro-forma (Appendix A):

- Sample weight;
- Sediment colour;
- Sediment odour;
- Plasticity;
- Field texture (i.e. fine sand, coarse sand, silts, shell fragments etc);
- % shell fragments present;
- Presence of organic material or any foreign objects; and
- Presence of any marine flora and fauna.

2.2 Particle Size Distribution (PSD) Analysis

Sediment samples were sent to Advanced Analytical Australia (AAA) for PSD analysis. Sediments were passed through a series of Australian standard sieves identifying particle size down to

0.075mm. A selection of six samples was chosen for further hydrometric analysis to determine particle size down to 1μm. This further analysis was undertaken to allow an estimation of the proportion of material within smaller size categories. Furthermore, sample moisture was also measured at all sites and particle density was measured at the six sites where hydrometric analysis was conducted. Sites for hydrometric analysis were chosen based on results of previous years to allow comparison of this data between sampling campaigns.

2.3 Data Analysis

PSD data from the present study and previous WBM studies were collated. Since PSD data from all studies were determined using the same Australian standard sieves, direct data comparisons can be made between studies.

The PSD results are described hereafter for the percentage composition of the particle size fractions shown in Table 2-1.

Table 2-1 Particle grain size fractions adopted in the present study

Size fraction	Sediment size
Muds	Grain size of less than 0.075 mm
Fine grain sand	Grain size of 0.075 mm to 0.15 mm
Medium grain sand	Grain size of 0.15 mm to 0.60 mm
Coarse grain sand	Grain size of 0.60 mm to 2.36 mm

Note that the fine gravel/shell grit size fraction (>2.36 mm) was only minor in the study area contributing only an average 0.35% of the sediments composition across all study sites. Therefore, the gravel fraction is not further considered within the context of this study.

Data were collated into GIS to illustrate the following spatial and temporal trends:

- Distribution of silt, fine sands, medium sands and coarse sand; and
- % change in proportion of silt and fine sand, medium sand and coarse sand material between each sampling episode.

Previous WBM (1998) study used different criteria to describe the bounds/limits for the various particle size fractions described in Table 2-1. The results presented here conform with more widely accepted methods for defining sediment fractions/classes and are consistent with BMT WBM (2010). Data from all years are based on the same sediment fraction classes to enable direct comparisons among years.

3 Results

Spatial patterns of the particle size fractions are illustrated for the 2015 investigation and temporal patterns are described by comparing the 2015 data to previous investigations at the same sites in 1992 (WBM 1992), 1998 (WBM 1998) and 2009 (BMT WBM 2010). Particle size analysis results and cumulative particle size distribution plots of the 2015, 2009, 1998 and 1992 data are given for all study sites in Appendix B and Appendix C, respectively.

3.1 Spatial Patterns 2015

Table 3-1 is a summary of the dominant sediment types recorded at each site. Based on Folk and Ward method, the mean sediment class at most sites were sands, and most sites were considered to be poorly sorted.

3.1.1 Patterns in Size Fractions

3.1.1.1 Muds

Figure 3-1 shows the distribution of muds (<0.075 mm). Areas with high mud content (>25%) were predominantly found in the deeper channel area west of St. Helena and Green Islands. Furthermore, relatively high mud content sediment was recorded in sediments at the mouth of the Boat Passage south of Fisherman Islands as well as an area adjacent to Fisherman Islands and south of the seawall.

Hydrometer analysis undertaken on samples from sites 6, 11, 16, O and P (refer Figure 3-1 and Appendix C) indicated an average clay content (<0.002 mm) was about 11% ranging between 6% measured at Site P and 20% at Site 6. Hydrometer analysis was not undertaken for Site B due to the relatively low proportion on fines at this location.

3.1.1.2 Fine Sand

The proportion of fine sands ranged between 1.3% and 69.5% across all locations. Similar to spatial patterns in muds, the highest proportion of fine sands was generally found in the deeper channel area west of St. Helena and Green Islands (Figure 3-2). Relatively high contents of fine sands >30% were also found in an area east of Fisherman Islands (sites E, 7, F, and I) within an area of moderate to dense *Zostera* and *Halophila* seagrass cover (BMT WBM 2013).

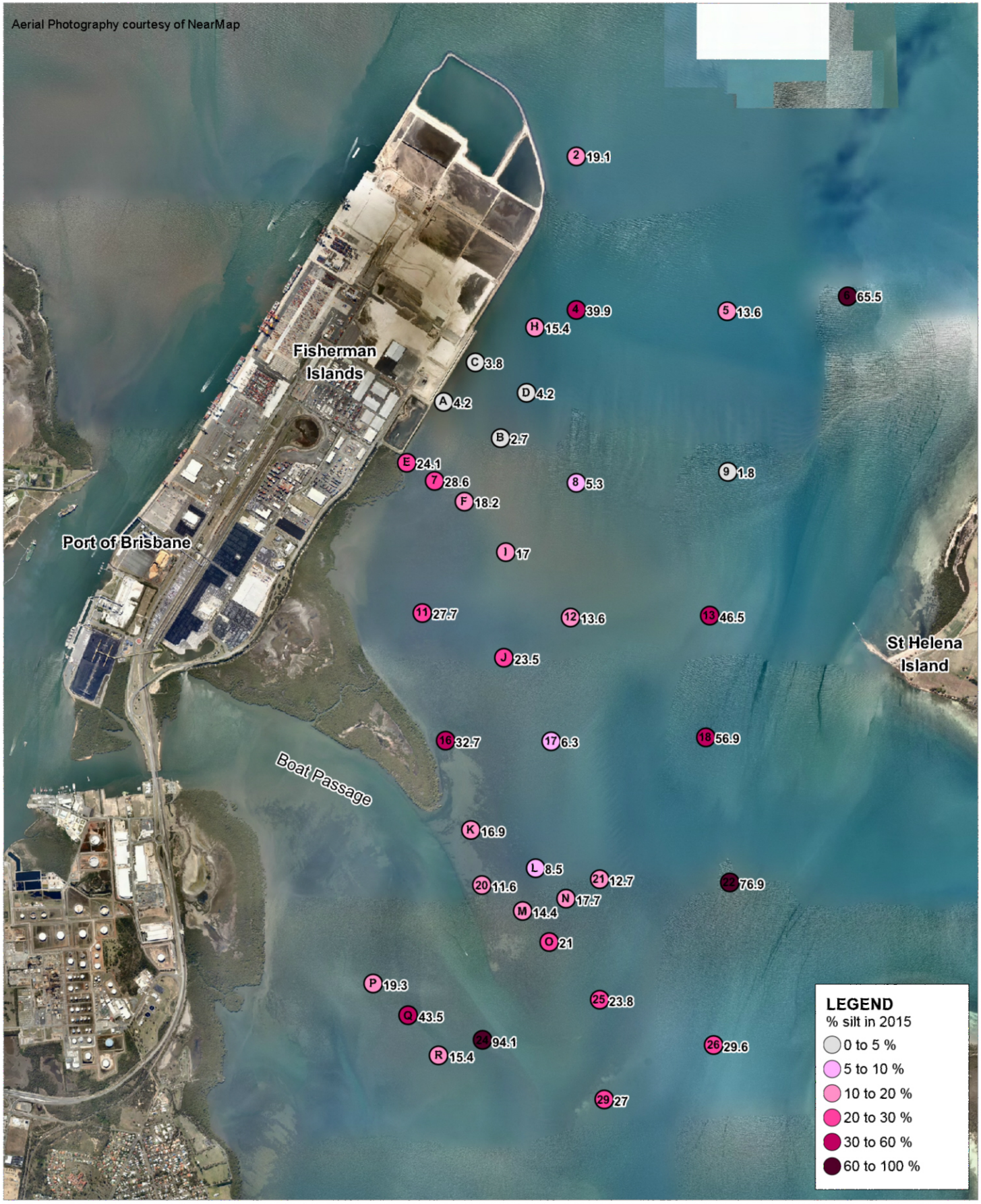
3.1.1.3 Medium and Coarse Sand

Medium sand was the dominant particle fraction within the study area. As noted above, the shoals extending between Fisherman Island, St Helena and Green Islands had the highest high proportion of medium sands (Figure 3-3).

Coarse sand fractions were uncommon in the study area and ranged between <1% to 6% (Figure 3-4). The highest proportion of coarse sand was recorded at Site 2 on near the northeast tip of the seawall, and sites 9 and 22 located on shoals in the eastern sector of the study area.

Table 3-1 Dominant particle size and classification of sediment in 2015 based on Folk and Ward

Site	D_{50}	% Mud	Mean Classification	Sorting
2	242.0	18.3%	Fine Sand	Very Poorly Sorted
4	94.2	38.2%	Very Coarse Silt	Very Poorly Sorted
5	183.6	13.1%	Fine Sand	Poorly Sorted
6	<75	62.8%	Silt	Very Poorly Sorted
7	107.9	27.4%	Very Fine Sand	Very Poorly Sorted
8	181.8	5.0%	Fine Sand	Moderately Sorted
9	274.2	1.7%	Medium Sand	Moderately Well Sorted
11	162.1	26.5%	Very Fine Sand	Very Poorly Sorted
12	199.9	13.0%	Fine Sand	Poorly Sorted
13	79.1	44.6%	Silt	Very Poorly Sorted
16	128.8	31.3%	Very Fine Sand	Very Poorly Sorted
17	225.6	6.0%	Fine Sand	Moderately Sorted
18	44.4	54.5%	Coarse Silt	Very Poorly Sorted
20	186.7	11.1%	Fine Sand	Poorly Sorted
21	170.2	12.1%	Fine Sand	Poorly Sorted
22	<75	73.7%	Silt	Very Poorly Sorted
24	<75	90.1%	Silt	Very Poorly Sorted
25	131.1	22.8%	Very Fine Sand	Very Poorly Sorted
26	182.4	28.3%	Very Fine Sand	Very Poorly Sorted
26	94.3	25.9%	Silt	Poorly Sorted
A	193.6	4.0%	Fine Sand	Moderately Well Sorted
B	199.1	2.6%	Fine Sand	Moderately Well Sorted
C	204.1	3.6%	Fine Sand	Well Sorted
D	225.5	4.0%	Fine Sand	Moderately Well Sorted
E	134.2	23.0%	Very Fine Sand	Very Poorly Sorted
F	119.2	17.5%	Very Fine Sand	Poorly Sorted
H	207.2	14.7%	Fine Sand	Poorly Sorted
I	128.7	16.3%	Fine Sand	Poorly Sorted
J	169.6	22.5%	Very Fine Sand	Very Poorly Sorted
K	184.8	16.2%	Fine Sand	Poorly Sorted
L	207.6	8.1%	Fine Sand	Poorly Sorted
M	195.9	13.8%	Fine Sand	Poorly Sorted
N	135.7	17.0%	Very Fine Sand	Poorly Sorted
O	158.0	20.1%	Very Fine Sand	Poorly Sorted
P	184.5	18.5%	Fine Sand	Poorly Sorted
Q	85.8	41.7%	Silt	Very Poorly Sorted
R	194.6	14.7%	Fine Sand	Poorly Sorted



Title:

Distribution of Silt (<0.075mm) in 2015

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Approx. Scale

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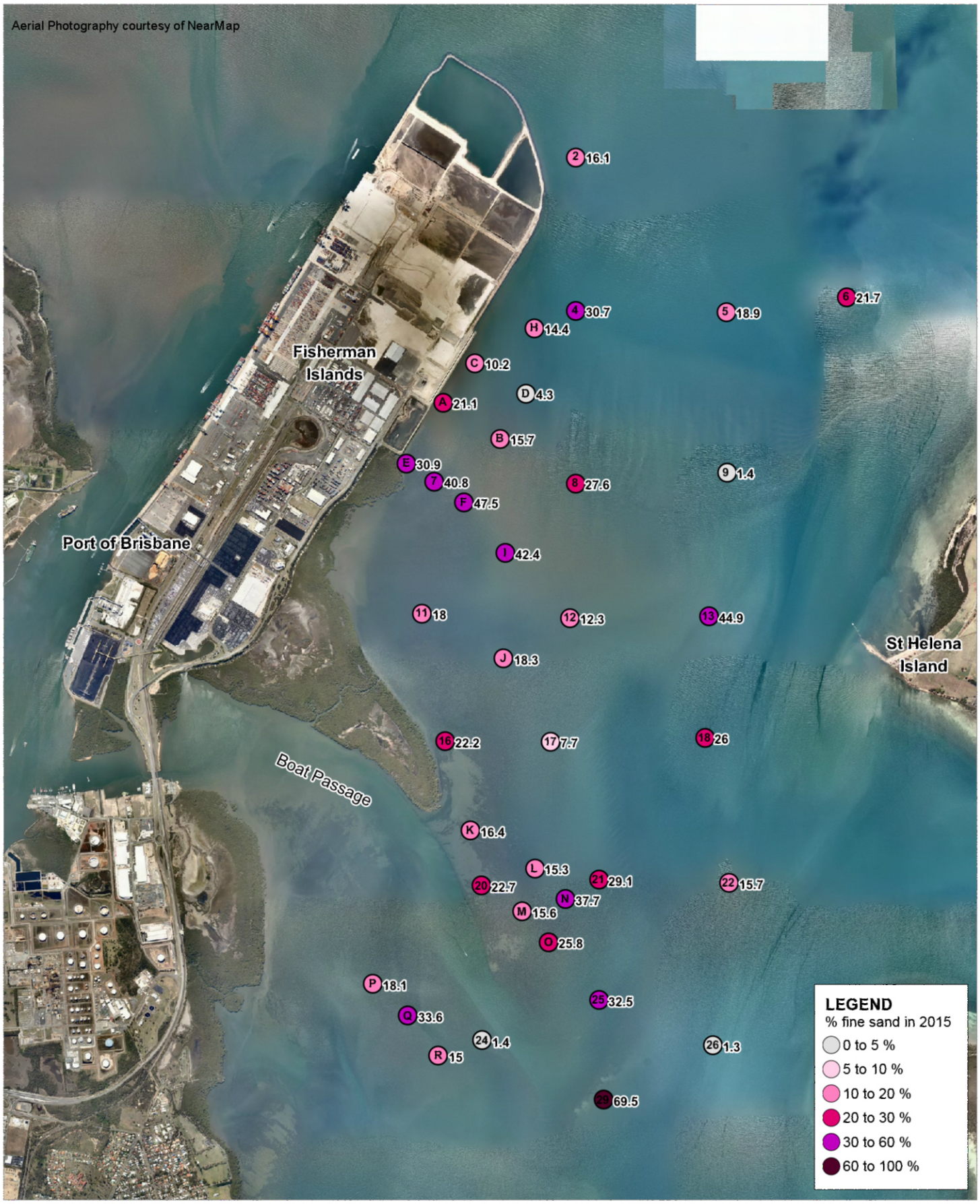

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Distribution of Fine Sand (0.075 to 0.15mm) in 2015

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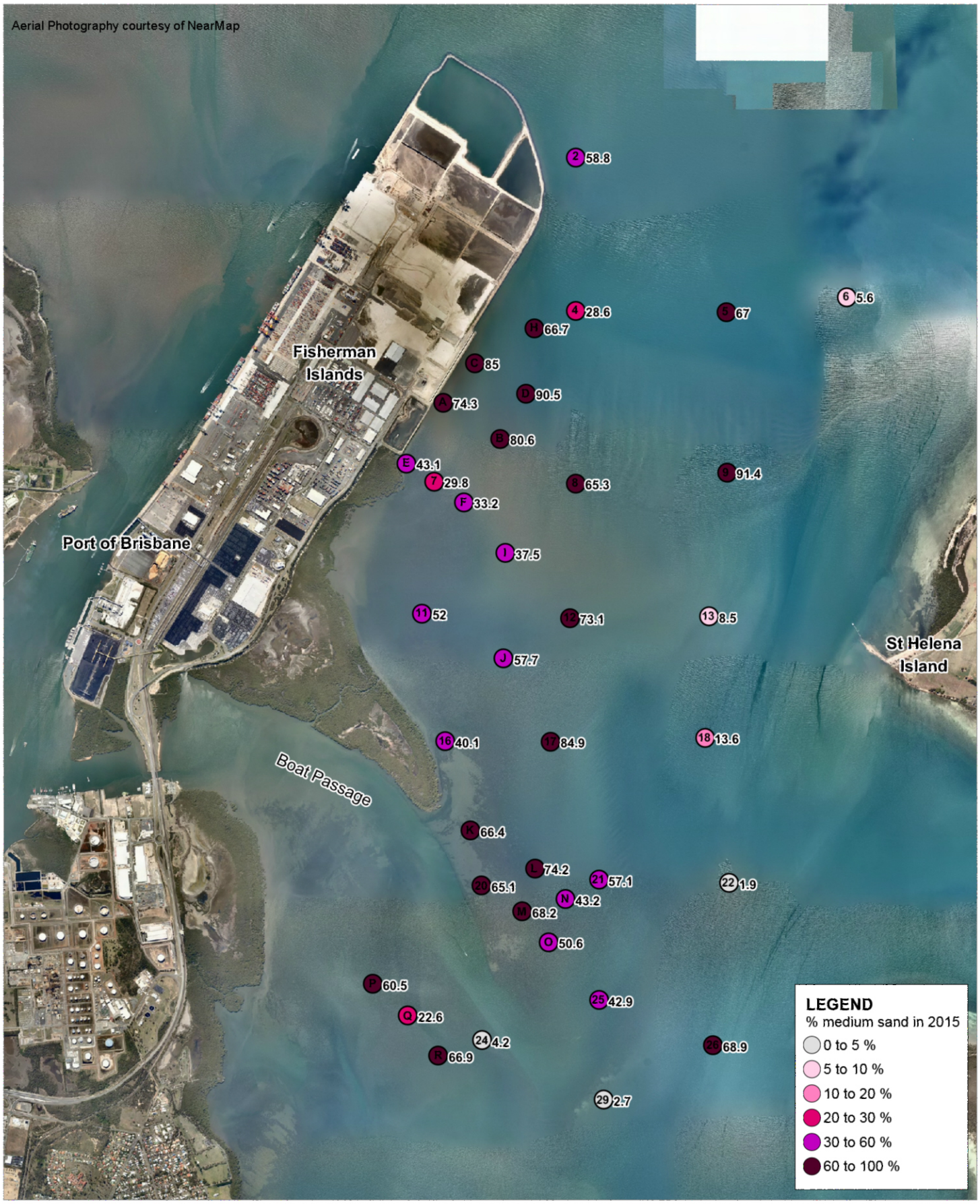

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Distribution of Medium Sand (0.15 to 0.60mm) in 2015

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Title:

Distribution of Coarse Sand (0.60 to 2.36mm) in 2015

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3.1.2 Bulk Density

Bulk density analysed for the six analysed samples ranged from 1.519 t/m^3 to 1.741 t/m^3 (Table 3-2). As expected, lower bulk density values were associated with higher silt content due to the higher proportion in pore space compared to coarser sediments. Correspondingly, samples with high bulk density values also had a higher proportion of sandy sediments.

Table 3-2 Bulk Density Measurements and Corresponding Sediment Type

Sample	Bulk Density (t/m^3)	Silt (%)	Sands (%)	Gravel (%)
6	1.519	65.5	30.5	4
11	1.669	27.7	70.7	1.6
16	1.563	32.7	63.5	3.8
B	1.712	2.7	96.8	0.5
O	1.684	21	77.4	1.6
P	1.741	19.3	79.4	1.3

3.2 Temporal Patterns

Cumulative frequency plots showing changes in particle grain size over time at each site are presented in Figure 3-5 to Figure 3-8. In terms of sites displaying major temporal changes in sediment grain size:

- Sites 22 (Figure 3-9) and 4 changed from fine sand dominated in 2009 to mud dominated in 2015
  - there was a 40.4% increase in mud at site 22
  - there was a 12.9% increase in mud at site 4
- Site 24 (Figure 3-10) was dominated by mud in both 2009 and 2015 however there was a 48.6% increase in mud between these years
- Site 29 (Figure 3-11), F, 7 and I changed from medium sand dominated in 2009 to fine sand dominated in 2015, with:
  - a 62.5% increase in fine sand at site 29
  - a 22.5% increase in fine sand at site F
  - a 9.8% increase in fine sand at site 7
  - site I shifting to dominance of fine sand although there was only a small change in the proportion of this size fraction (7.9%) and the decrease in medium sand was minimal (-2%)
- Site 26 shifted to dominance by a more coarse sediment type, from fine sand in 2009 to medium sand in 2015.

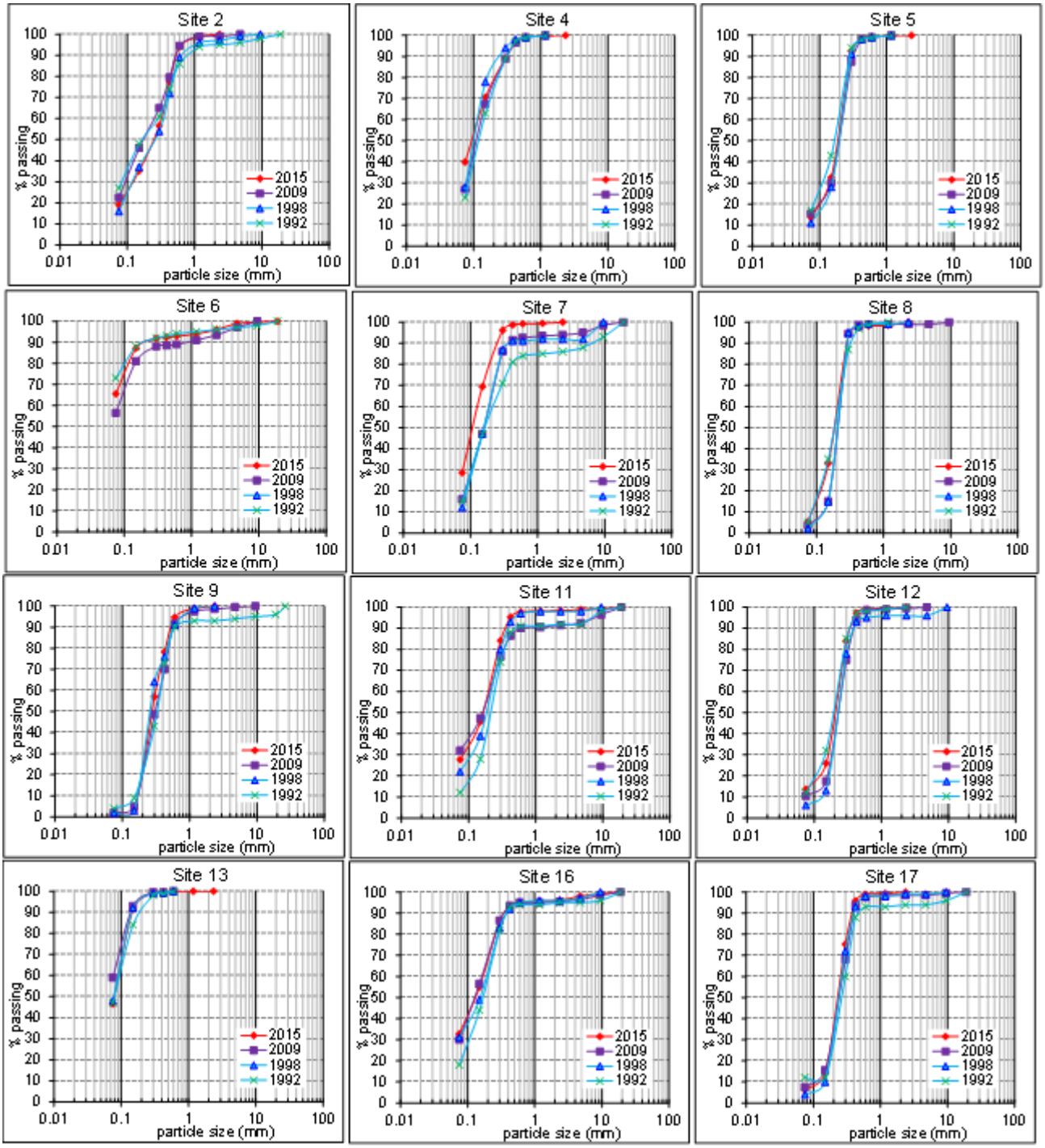


Figure 3-5 Cumulative sediment mass passing each sieve size – sites 2 to 17

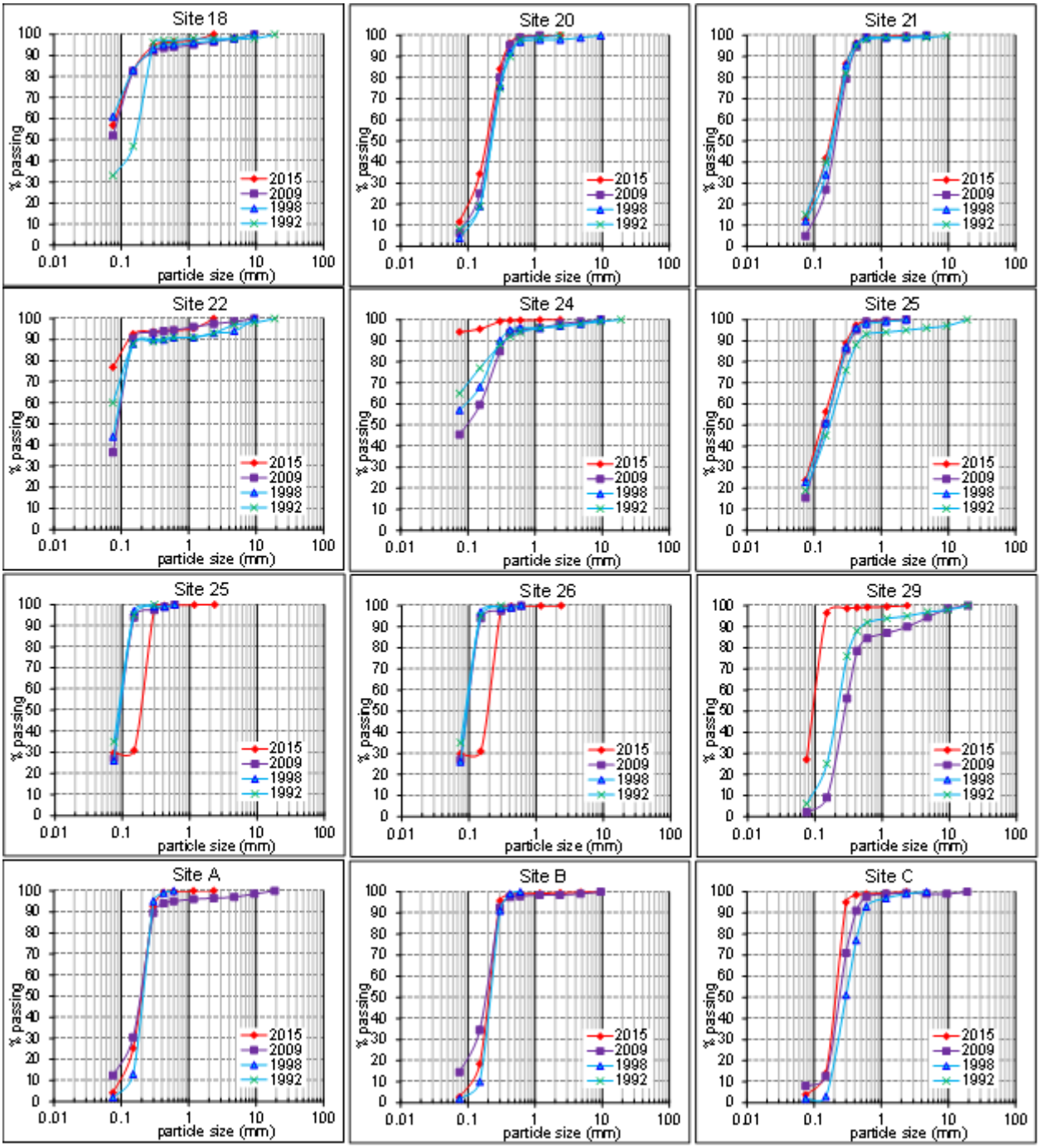


Figure 3-6 Cumulative sediment mass passing each sieve size – sites 18 to C

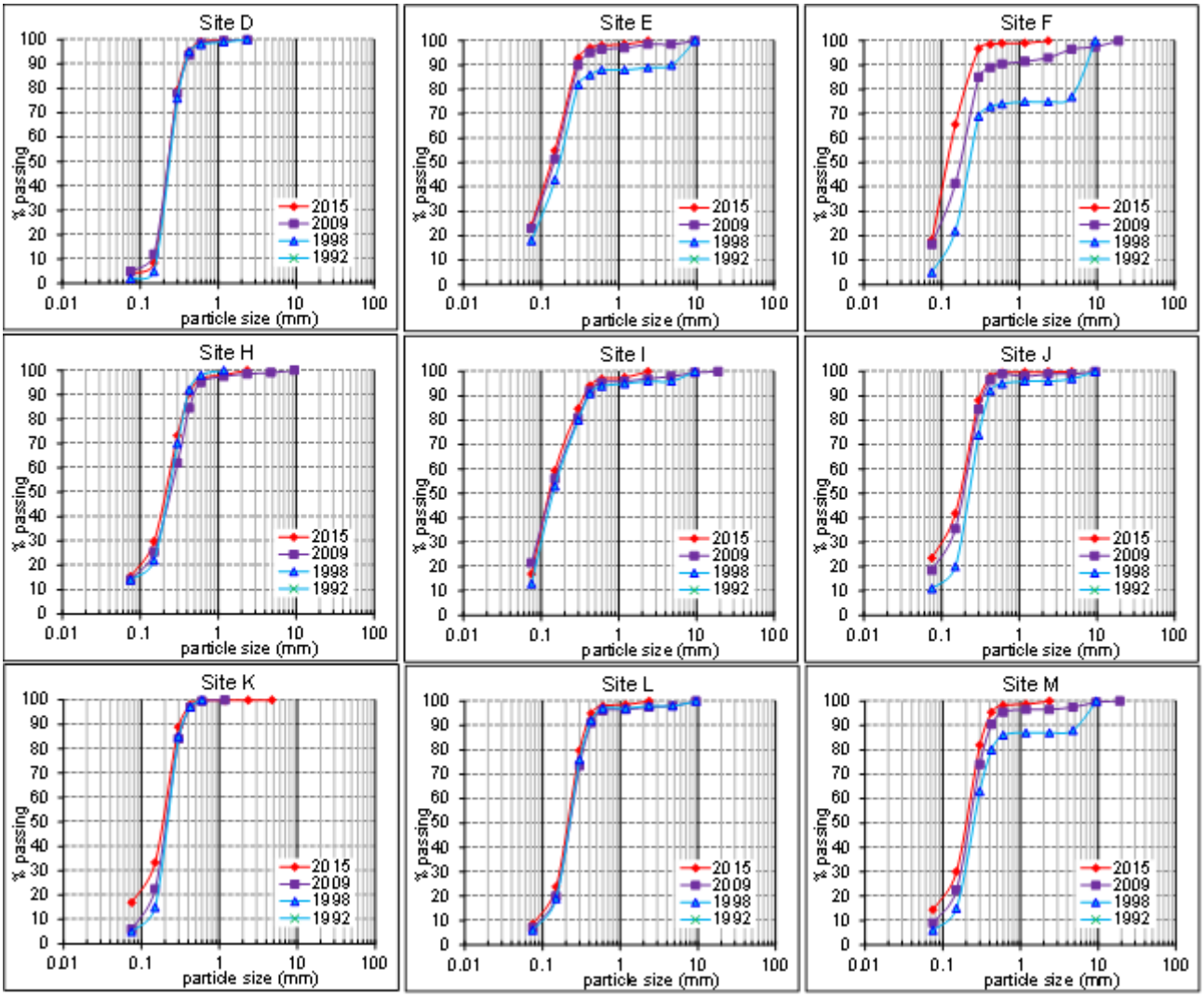


Figure 3-7 Cumulative sediment mass passing each sieve size – sites D to M

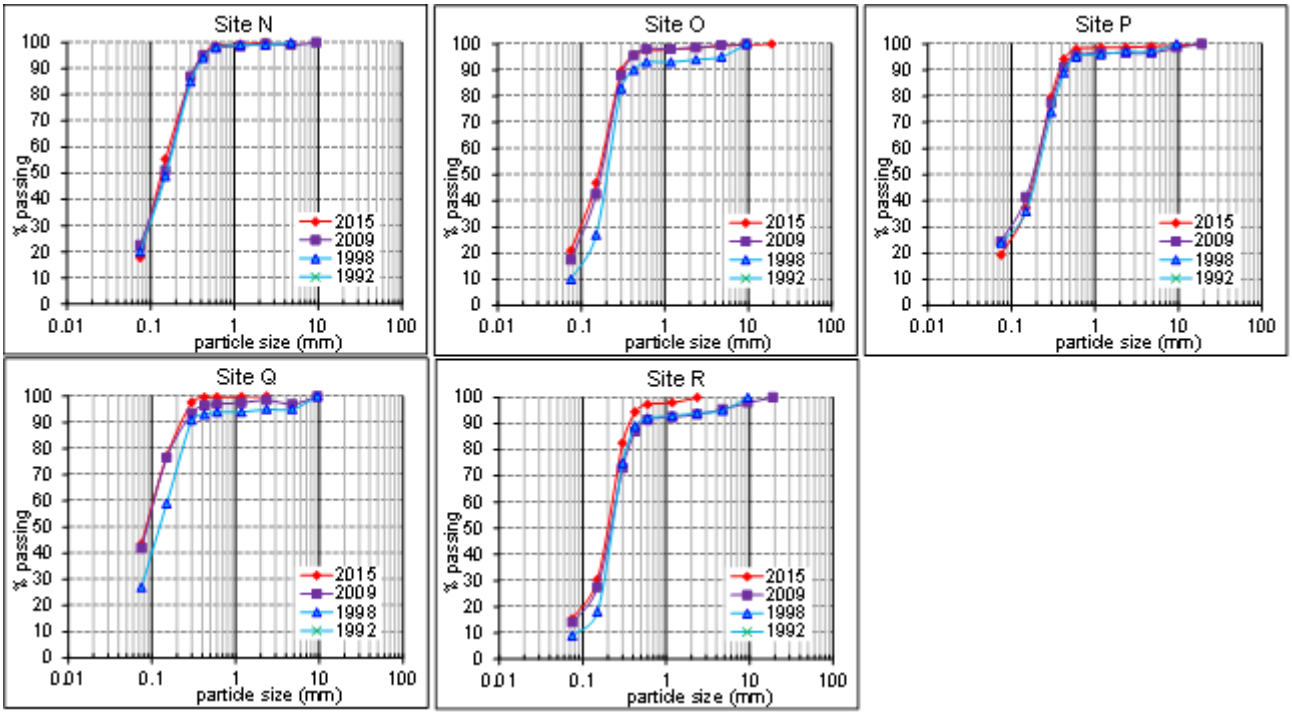


Figure 3-8 Cumulative sediment mass passing each sieve size – sites N to R

Figure 3-9 40.4% increase in the silt fraction at site 22 between 2009 and 2015

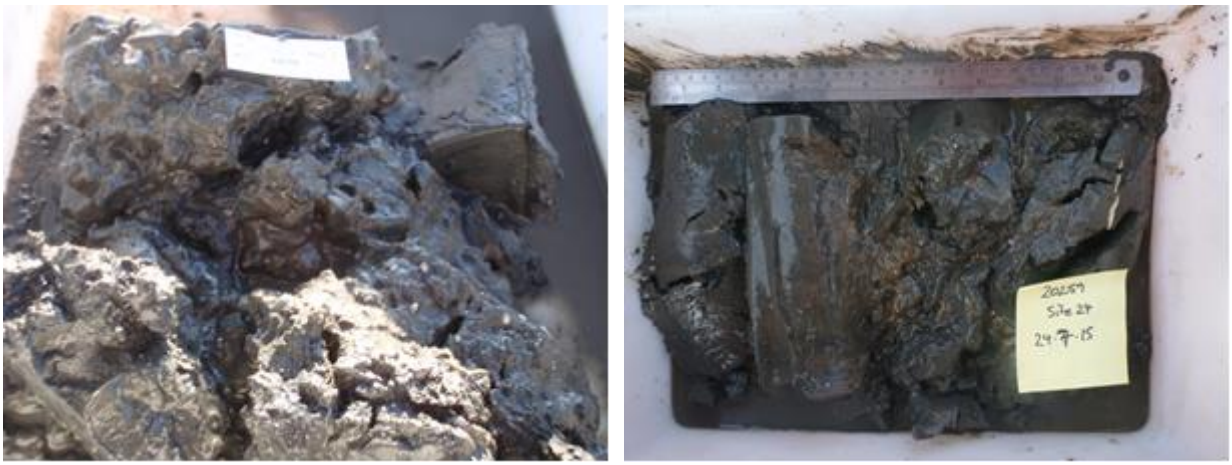


Figure 3-10 48.6% increase in the silt fraction at site 24 between 2009 and 2015

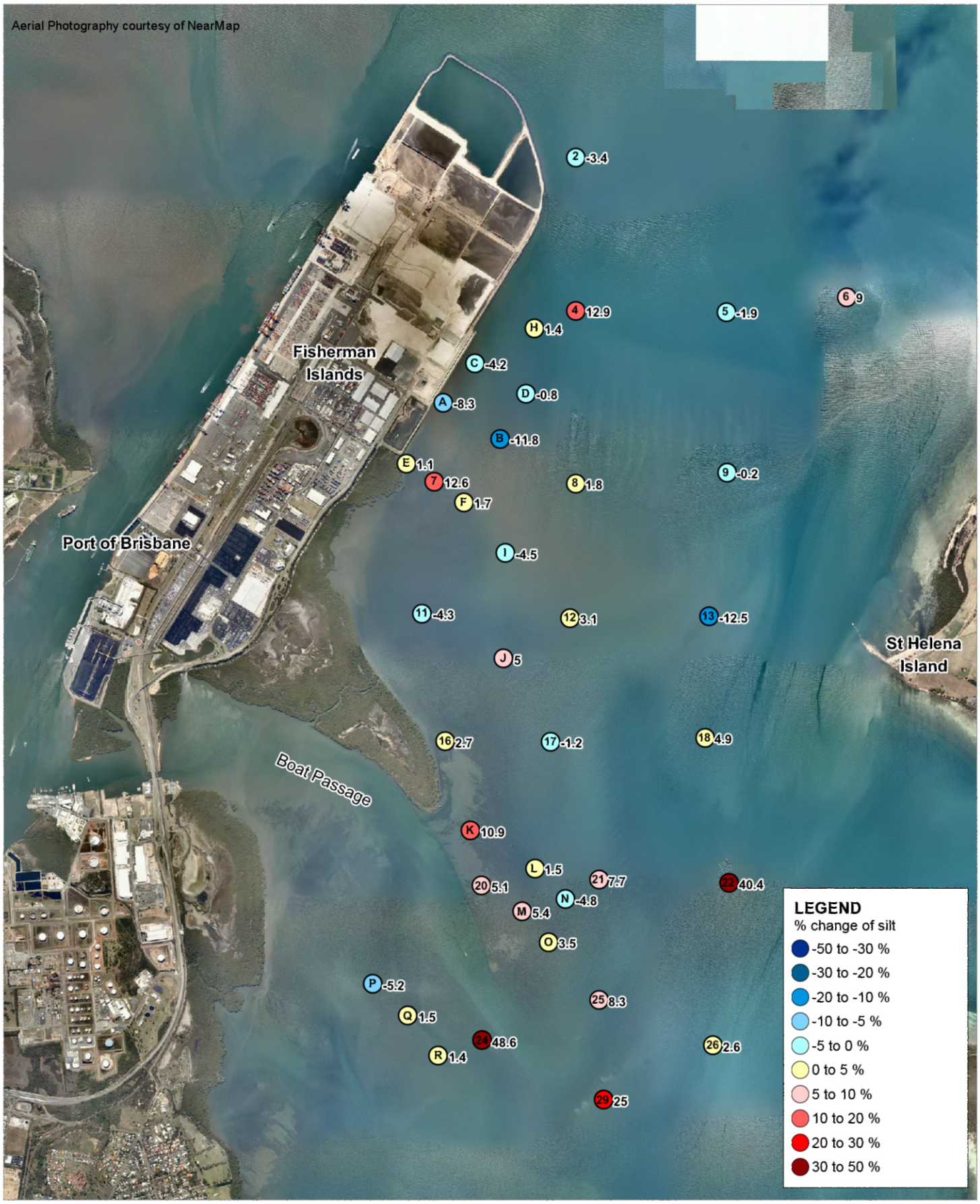
Figure 3-11 62.5% increase in the fine sand fraction at site 29 between 2009 and 2015

Figure 3-12 shows changes in mud content between 2009 and 2015, and Figure 3-13 shows trends in mud content within sites over time. Several sites showed notable changes in mud content over time, which can be classified as follows (Figure 3-13):

- Increase in mud between 2009 and 2015, but stable over time prior to 2009. This includes sites 4 (1992 = 23%; 1998 = 28%; 2009 = 27%; 2015 = 40%); 7 (1992 = 15%; 1998 = 12%; 2009 = 16%, 2015 = 29%), 29 (1992 = 6%; 2009 = 2%, 2015 = 27%), K (1998 = 5%; 2009 = 6%, 2015 = 17%), and 20 (1992 = 8%; 1998 = 4%; 2009 = 6%, 2015 = 12%).
- Higher mud content 2015 than other years, reversing the trend in previous years. This group of sites had a trend of decreasing mud content between 1992 and 2009, but in 2015 the trend reversed, with mud content higher in 2015. This includes sites 6 (1992 = 73%; 1998 = 56%; 2015 = 65%), 21 (1992 = 15%; 1998 = 12%; 2009 = 5%, 2015 = 13%), site 22 (1992 = 60%; 1998 = 44%; 2009 = 36%, 2015 = 77%), and site 24 (1992 = 65%; 1998 = 57%; 2009 = 45%, 2015 = 94%).
- Increase in mud between 2009 and 2015, continuing the trend observed in previous years. This group of sites experienced large increases in mud since monitoring commenced in 1992/1998, with moderate (≤5% increase) changes observed between 2009 and 2015 sampling episodes. This category includes sites 11 (1992 = 12%; 1998 = 22%; 2009 = 32%; 2015 = 28%), 16 (1992 = 18%; 1998 = 31%; 2009 = 30%; 2015 = 33%), 18 (1992 = 33%; 1998 = 61%; 2009 = 52%; 2015 = 57%), F (1998 = 5%; 2009 = 16%, 2015 = 18%), J (1998 = 11%; 2009 = 18%, 2015 = 23%), M (1998 = 6%; 2009 = 9%, 2015 = 14%), O (1998 = 10%; 2009 = 17%, 2015 = 21%), Q (1998 = 27%; 2009 = 42%, 2015 = 43%), R (1998 = 9%; 2009 = 14%, 2015 = 15%), H (1992 = 2%; 1998 = 14%; 2009 = 14%; 2015 = 15%).
- Decrease in mud between 2009 and 2015. This includes sites A (1992 = 1, 1998 = 2%; 2009 = 14%, 2015 = 4%), site B (1992 = 1, 1998 = 2%; 2009 = 14%, 2015 = 3%), site C (1998 = 2%; 2009 = 8%, 2015 = 4%), I (1998 = 13%; 2009 = 21%, 2015 = 17%).
- Progressive decrease in muds over time, but no major changes between 2009 and 2015. This includes site 17 (1992 = 12%; 1998 = 4%; 2009 = 7%; 2015 = 6%).

Most other sites showed little change in mud content over time. The exception to this was site 13, which had 59% mud in 2009 but 46-48% in all other years.

Figure 3-15 is a scatter-plot showing the relationship between the proportions of mud at each site in 2015 and the amount of variation over time in percentage of mud (as expressed by coefficient of variation – CoE). The scatter plot shows that sites with the highest degree of temporal variation in muds (i.e. CoE value >40%) tended to have a low proportion of muds (i.e. mud content <30%). Muddy sediments, therefore, tended to remain muddy over time, whereas some (but not all) sites with a higher proportion of sands tended to display a high degree of temporal variability in mud content.



Title:

Percentage change in proportion of silt (<0.075mm) between 2009 and 2015

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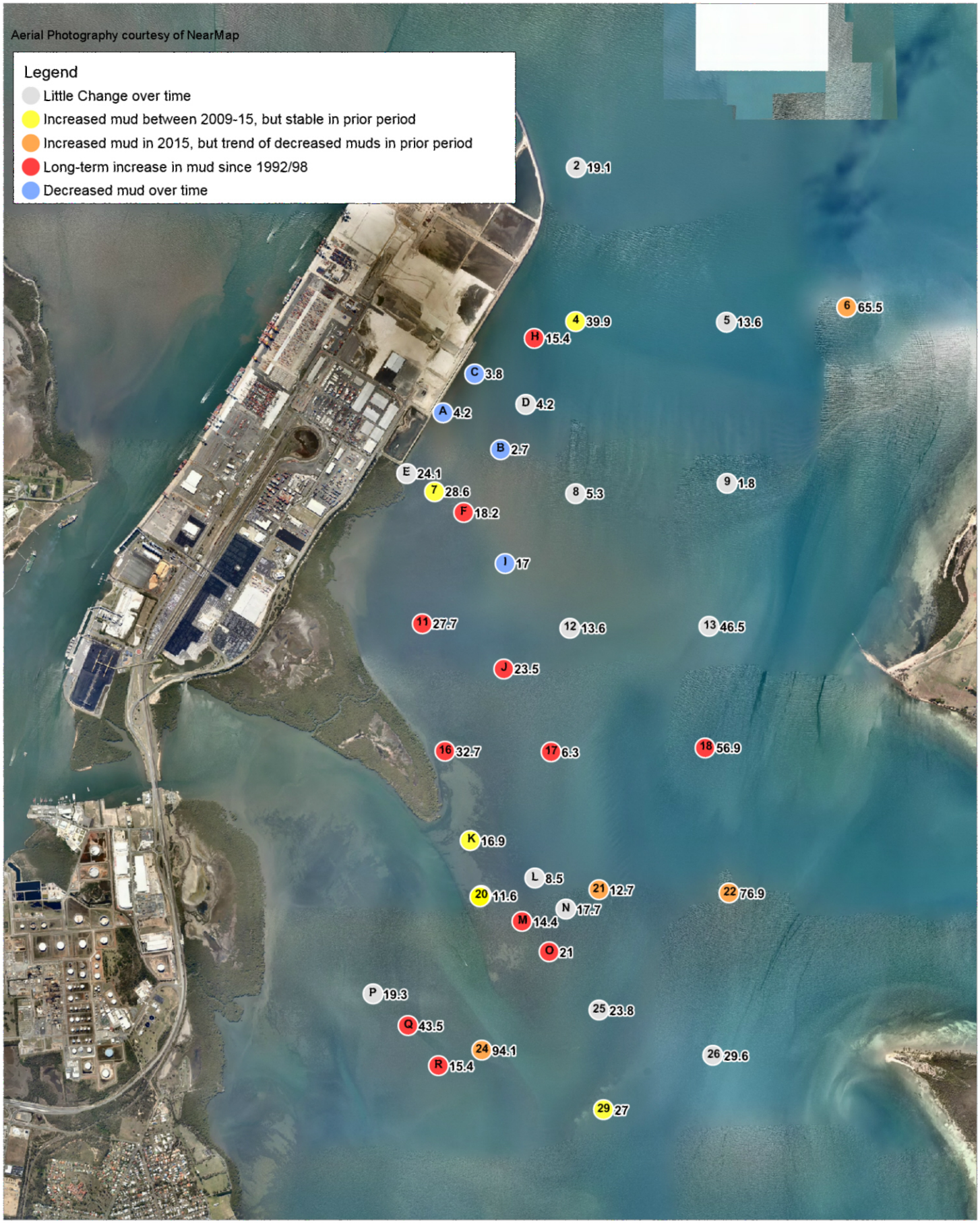

Title:

Temporal trends in muds - 1992 to 2015

Figure: **3-13**

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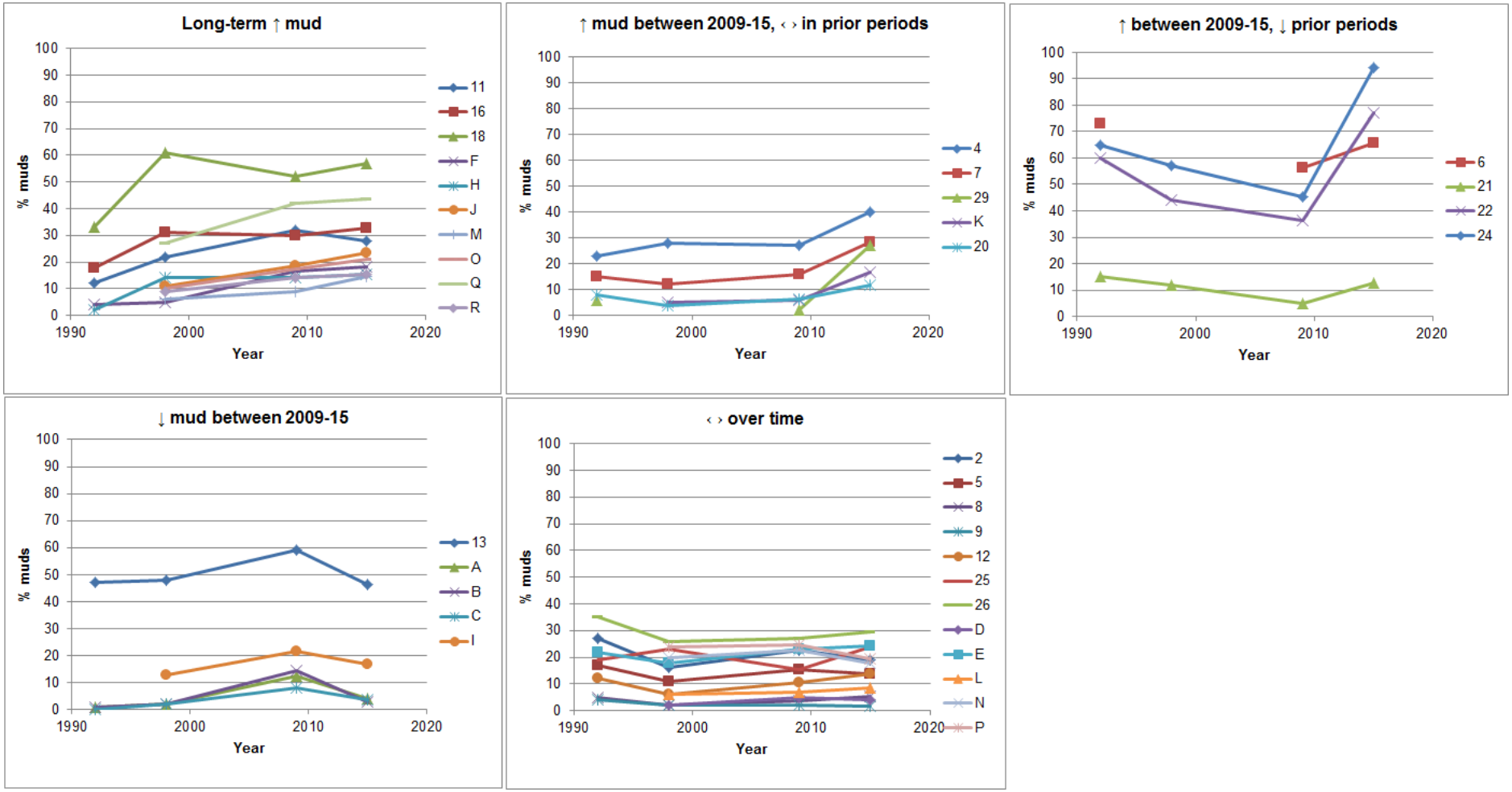

Figure 3-14 Time-series plots of % muds in each category

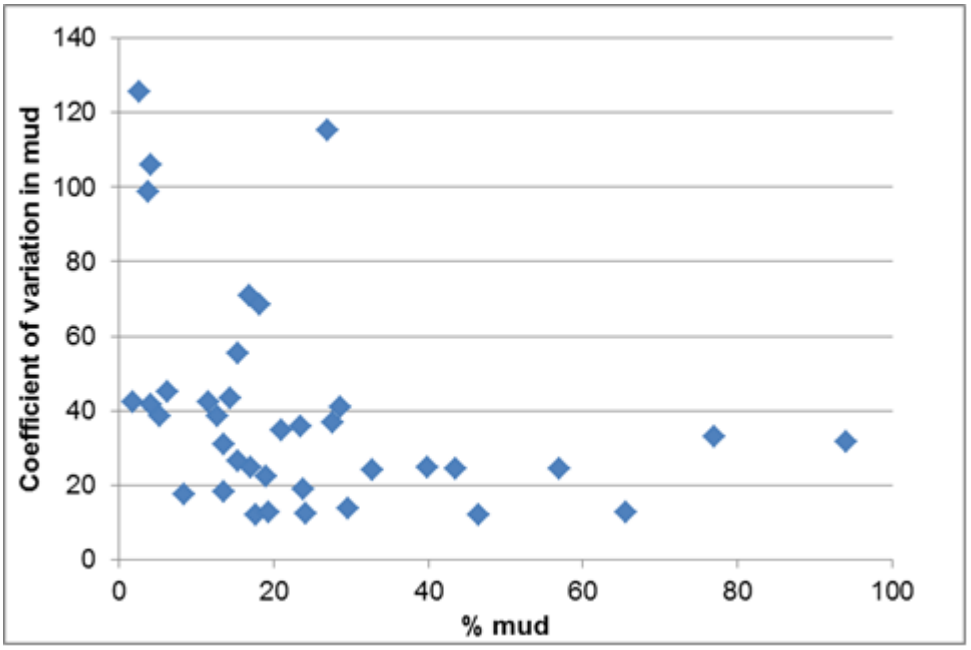

Figure 3-15 Relationship between percentage mud (2015) and degree of temporal variability in percentage of mud (as expressed by coefficient of variation) at each site

4 Discussion

4.1 Spatial Patterns

There was great variation in sediment particle size distribution among sites in 2015, but spatial patterns were generally consistent with the findings of previous studies conducted for the Port of Brisbane by WBM (1992, 1998, 2000) and BMT WBM (2010), as well as O'Brien *et al*. (2011) (Figure 4-1) and unpublished data from Dr Alastair Grinham (University of Queensland).

Sedimentation processes in the vicinity of Fisherman Islands are determined by a range of interacting hydrodynamic processes and the physical characteristics of the sediments involved. Key factors and considerations include (WBM 2000):

- Supply of sediment to the area, historically a mixture of sand and silt but now predominantly fine fluvial material brought during floods (primarily from the Brisbane River)
- The pattern of deposition of the fluvial supply at the river mouth, being direct deposition on the bar of any sand material and widespread dispersion of flood-borne fine silts
- Resuspension of the deposited sediments from time to time by the prevailing waves and currents, to be re-distributed to other areas
- Progressive accumulation of sediment in places where the supply is active but removal by resuspension and further dispersion is relatively less.

Sedimentation patterns and net movement of sediments in the Fisherman Islands area are dictated by the prevailing waves and currents. The study area is relatively sheltered from waves from the southeast to east by Green, St Helena and Mud Islands. Generally, the wave climate along the southern side of the study area is low (less than 0.5 metre) with corresponding low capacity for sediment resuspension from the bed. This is conducive to settling of fine silty material characteristic of that area. Areas with high mud content (>25%) were predominantly found in the following areas:

- The deeper channel area west of St. Helena and Green Islands – WBM (2000) also found that this area had mixed and variable sediments, depending on tidal conditions, sediment supply and relict sub-surface sediments, which can be highly variable over time and space. Low rates of sand supply is thought be important in maintaining mud sediments in this area.
- Nearshore sheltered areas directly adjacent to Fisherman Islands – WBM (2000) found that this area was significantly sheltered from waves by St Helena and Green Islands, and had low bed sheer stress. The sheltering effect results in low bed sheer stress, allowing fine sediments to settle onto the seafloor. Furthermore, accretion of fine sediments in this area may be facilitated by dense seagrass cover in this area, which can lead to a reduction of near-bed current velocities (WBM 1998, Orth *et al*. 2006). The FPE also provides partial protection of nearshore environments from dominant north-east winds and fluvial outflows from the Brisbane River, promoting suitable conditions for mud accumulation in these areas.

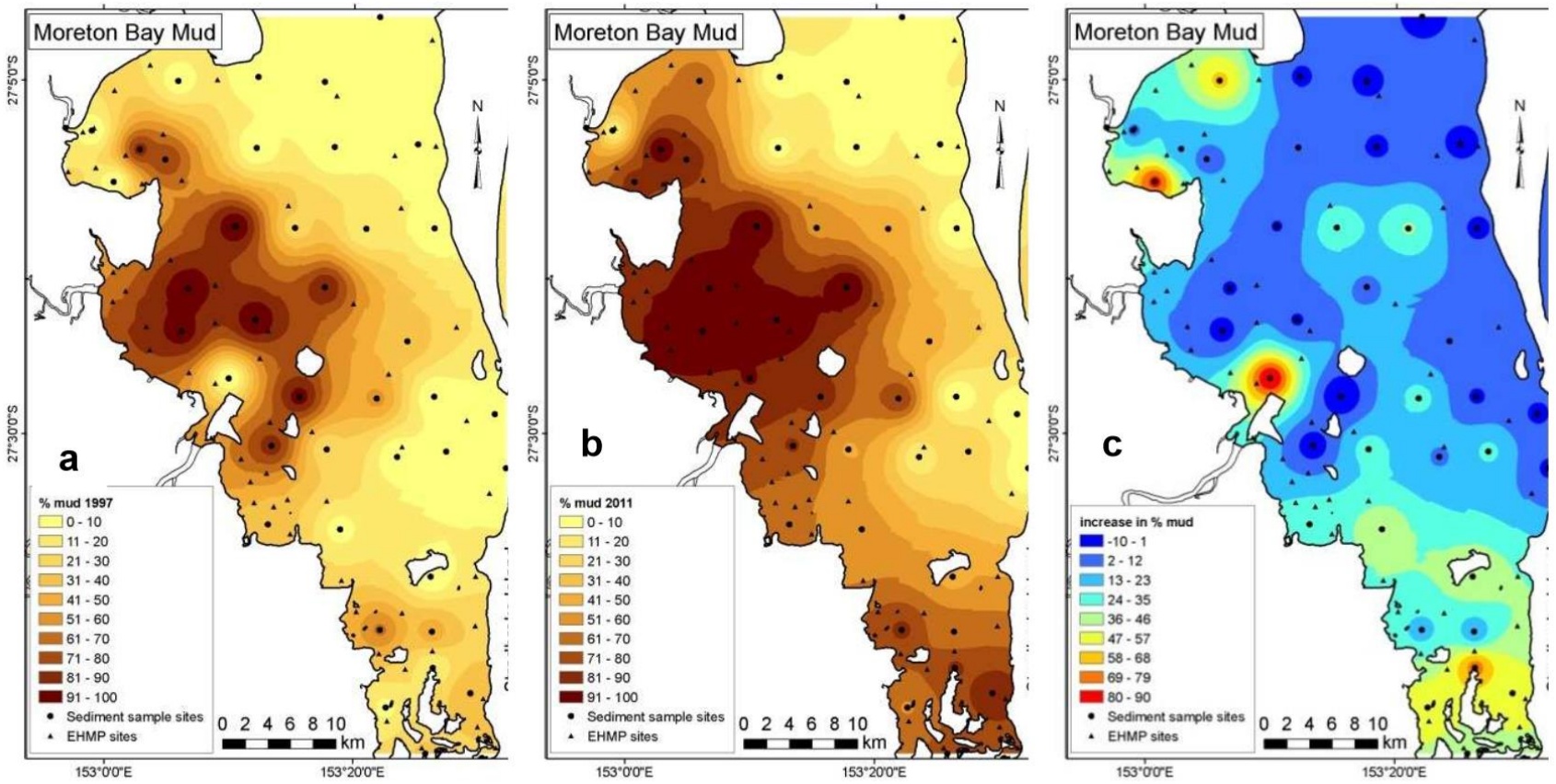

Figure 4-1 Percentage of mud in Moreton Bay during 1997 and 2011, and percentage change over time (Reproduced from O'Brien *et al*. 2012)

- Mouth of the Boat Passage south of Fisherman Islands – this area was found by WBM (2000) to experience moderate bed sheer stress, representing the principal flowpath to and from Boat Passage. While bed sheer would result in re-mobilisation of fine sediments, the high mud content recorded in this area in 2015 suggests that a significant mud source is currently present in this area (see further discussion below). The spatial patterns documented in the present study also suggest that fluvial outflows (flows) from the Brisbane River via Boat Passage have a strong influence on mud distribution in this area.

Sites located on the shoal extending east-west between the eastern margin of the FPE and St Helena Island (i.e. sites A, C, B, D, 8 and 9) had the lowest low mud content (<6%), and consisted of well sorted fine to medium sands. WBM (1998, 2000), citing Stephens (1992), suggested that the sandy deposits in this area were remnants of the original river mouth delta. The shoal experiences high current velocities and is exposed to wind waves from the north-east (WBM 2000). During high wind and wave events (including storms), fine sediment is resuspended and ultimately transported to more quiescent (i.e. sheltered and/or deeper) areas. This reworking of sediments prevents the permanent settlement of muds on the shoal, leaving higher sand content sediments (with occasional shell fragments) on the bed (WBM 1992).

Coarse sand and gravel does not represent a significant proportion of sediments at the sampling sites, reflecting both a lack of a significant supply of coarse material to this area, together with low bed sheer stress in more quiescent sections of the study area.

4.2 Temporal Patterns

Sediment particle size distribution displayed complex spatio-temporal patterns within the study area. Most sites displayed an overall trend of increasing proportion of muds since 1992, but both the magnitude of change and timing of such changes varied in different parts of the study area. In this regard (see Figure 3-13 and Figure 3-14):

- Eight sites (4, 6, 7, 29, K, 20, 21, 22 and 24) had relatively consistent proportion of mud between 1992 and 2009, but experienced an 8-49% increase in mud content (and lower sand content) between 2009 and 2015. Most of these sites were located offshore of the Boat Passage entrance, which is the area that experienced the largest change in muds between 2009 and 2015 (40-49% increase in mud content at sites 22 and 24).
- Ten sites (11, 16, 18, F, H, J, M, O, Q, R) displayed a long-term trend of increasing mud content since 1992/1998. These sites had a progressive accumulation of mud over time, including between 2009 and 2015 sampling episodes. The magnitude of change in muds between 2009 and 2015 (≤5%) was not as high as experienced at the sites listed in the paragraph above. All of these sites were also located offshore of Boat Passage entrance (including the channel south-west of St Helena Island), as well as the nearshore zone of Fisherman Islands.

These results are consistent with the findings of O'Brien *et al*. (2012), who documented large increases in proportion of muds in western and central Moreton Bay between 1997 and 2011 (Figure 4-1). They found that the largest changes occurred at the mouth of Brisbane River, as well as nearshore environments in southern Moreton Bay and Deception Bay. Only a small number of

sites were sampled by O'Brien *et al*. (2012) in the study area, but results were broadly consistent with the present study.

O'Brien *et al.* (2012) suggested that the January 2011 floods were a key driver of observed changes in muds between 1997 and 2011. As shown in Figure 4-2, the 2011 flood event was the largest by far in the period 1992-2015, although freshes and smaller flood events (e.g. 2013) during this period may also to sediment loading in the study area. Similar findings were reported for the 1974 flood, when five million tonnes of fluvial mud were washed downstream, producing a five metre thick blanket of pro-delta mud in sub-tidal areas (to about 10-15 m depth) of western Moreton Bay (Heckel *et al*. 1979; Jones and Stephens 1981).

The results described above (for sites 11, 16, 18, F, H, J, M, O, Q, R) suggest that there was also a long term increase in muds at many sites in the study area prior to the 2011 flood event. For these sites, the magnitude of change in the six year period between 2009 and 2015 (≤5%) was generally less than or similar to the magnitude of change between 1992 and 1998 sampling episodes (1-27% change, mean = 12.7%). WBM (2000) suggested that the net long term pattern in the quiescent nearshore environments of Fisherman Islands was one of slow progressive fluvial mud accretion, leading to the slow progression of the mangrove shoreline. The general patterns observed in the present study conform to this hypothesis.

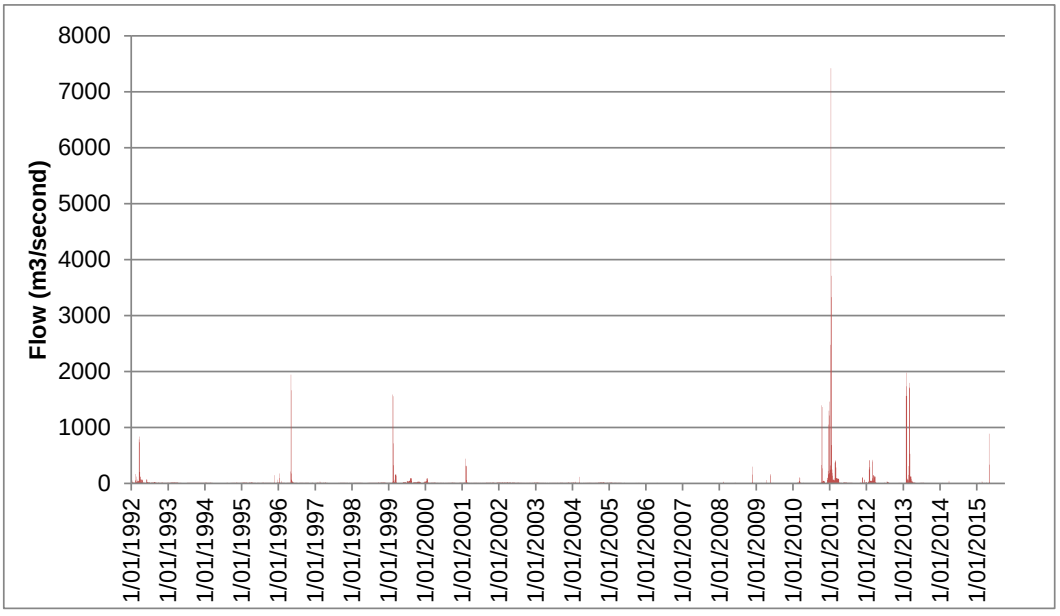

Figure 4-2 Daily flow (cumecs) at Brisbane River (Savages Crossing) between 1992 and 2015 (Source: Bureau of Meteorology unpublished data).

No consistent, major changes in mud content were observed over time at the north-eastern tip of the FPE (site 2) or sites located on the sand bank extending between the FPE and St Helena Island (sites D, 8, 12, 5, 9, 13, 6). These shallow areas are exposed to local waves from the north east and tidal currents, and the presence of sand waves and large ripples indicate that these are active hydrodynamic environments. These areas also have no or sparse seagrass cover (BMT WBM 2014). Such conditions do not favour the settlement and/or trapping of fine sediment.

Sites A, B, C, I and 13 mud content declined between 2009 and 2015, but in the periods prior most of these sites experienced an increase in muds. All these sites were located on or adjacent to the sand shoal extending between Fisherman Islands and St Helena Island, or in deep waters immediately west of St Helena Island. A group of sites located offshore of Boat Passage also displayed a trend of decreasing mud content between 1992 and 2009, but in 2015 the trend reversed, with mud content higher in 2015 (sites 20, 21, 22 and 24). Site 17 (located east of the southern tip of Fisherman Islands) also displayed a trend of decreasing mud content over time, including in 2015. These sites are located on a broad shoal containing seagrass meadows, which vary in cover from year to year.

Inter-annual changes in prevailing wind and environmental conditions will have a strong influence on sediment deposition processes. For example, WBM (2000) found that in years when strong south-east winds prevailed, the tidal flats of Fisherman Islands can have sandier sediments due to remobilisation of silts. Other environmental processes, such as changes in seagrass cover (and associated sediment trapping), may also influence changes in sediment grain size over time.

4.3 Influence of the Port Operations

The FPE influences hydrodynamic conditions (and therefore the sedimentary environment) in the study area. The FPE has an effect of (i) diverting flood flows in a northerly direction into Moreton Bay, and (ii) partially sheltering nearshore areas from north-easterly winds prevailing in spring and summer (WBM 2000). BMT WBM (2014) suggested that these alterations to hydrodynamic conditions have favoured the expansion of seagrass meadows in northern sections of the study area.

WBM (2000) predicted that the degree of impact on the patterns of tidal currents around the FPE would be generally slight and localised. The truncation and rounding of the northeastern corner was predicted to allow smooth unimpeded tidal flow to and from northern Waterloo Bay, thereby minimising effects of currents, flushing and sedimentation. Sampling undertaken at the north-east tip of Fisherman Islands (site 2) confirms that there have been no major temporal changes in sediment particle grain size at this location.

Modelling results presented in WBM (2000) suggest the area around the southeast edge of the FPE seawall would experience a reduction in current velocities. Reduced current velocities were predicted to occur during ebbing and flooding tides during northerly wind/wave conditions, and under such conditions, deposition of silty material could be expected to occur. BMT WBM (2008) found that localised accumulation of muds near the south-eastern edge of the FPE seawall between 1992/98 and 2009 (i.e. sites A, B and F), consistent with these predictions. The present study found that Site F had similar mud content between 2009 and 2015, indicating a longer term trend of increasing fine sediment in this area. By contrast, the present study found that there was a reduction in mud content at sites A and B between 2009 and 2015, and had now returned to baseline (pre-2009) conditions. The different temporal patterns observed among sites in this area likely reflect differences in water depth and exposure to north-east waves. It is also possible that sampling error due to small-scale variability in sediments may be a factor here (and elsewhere in the study area (BMT WBM 2008).

5 Conclusions

- The results of the present study demonstrate that patterns in sediment grain size are dynamic, varying over time and space.
- There was great variation in sediment particle size distribution among sites in 2015, but spatial patterns were generally consistent with the findings of previous studies and previous modelling.
- Areas with high mud content (>25%) were predominantly found in the deeper channel area west of St. Helena and Green Islands, at the mouth of the Boat Passage south of Fisherman Islands, within seagrass meadows east of Fisherman Islands, and an area adjacent to Fisherman Islands and south of the FPE seawall.
- The areas with higher mud content were located in quiescent areas and within seagrass meadows, which provide conditions that promote the accretion of muds.
- Sites located on the shoal extending east-west between the eastern margin of the FPE and St Helena Island consisted of well sorted fine to medium sands. High bed shear stress is common in these shallow, exposed areas and wave action is expected to prevent the settlement of muds on these shoals.
- Most sites displayed an overall trend of increasing proportion of muds since monitoring commenced in 1992, but both the magnitude of change and timing of such changes varied in different parts of the study area.
- Areas located offshore of the Boat Passage entrance and the nearshore zone of Fisherman Islands have experienced increasing mud content over time.
- Major increases were observed at many sites between 2009 and 2014, and are highly likely due to fluvial mud inputs resulting from flooding in 2011.
- Many sites also displayed a long-term trend of increasing mud content. The more quiescent nearshore areas of Fisherman Islands represent a depositional environment, and will tend to slowly accumulate muds over long timeframes.
- No consistent, major changes in mud content were observed over time at the north-eastern tip of the FPE (i.e. the seawall truncation) or sites located on the sand bank extending between the FPE and St Helena Island. These areas are exposed to local waves from the north east and strong tidal currents, which do not favour the settlement and/or trapping of muds.
- Modelling results presented in WBM (2000) suggest the area around the southeast edge of the FPE seawall would experience a reduction in current velocities. Mud accumulation was observed in this area, however inter-annual changes in prevailing wind and wave climate will influence sediment patterns here in space and time.

6 References

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Appendix A Sediment Log and Photographs

Table A-1 Sediment log

Site No.	Date	Time	Colour	Odour	Palasticity	Field Texture	% Shell	% Seagrass	% Macroalgae	% Organics/biota
2	23/07/15	9:19	Dark grey	Normal	Low	Coarse sand	5	0	0	0
6	23/07/15	9:42	Dark grey	Normal	Low with some moderate globs (clay)	Soft muddy sand	2	0	0	0
5	23/07/15	9:54	Dark grey	Normal	None-low	Fine sand	2	0	0	1
4	23/07/15	10:11	Dark grey	Normal	Low-moderate	Fine sand	5	0	1	0
H	23/07/15	10:22	Dark grey	Normal	None-low	Fine sand	3	0	0	6
D	23/07/15	10:37	Dark grey	Normal	None	Stiff fine sand	2	3	0	0
9	23/07/15	11:01	Yellow/grey	Norma	None	Sand	4	0	0	0
13	23/07/15	11:15	Dark grey	Normal	Moderate with some high globs	mud	0	0	5	3
18	23/07/15	11:28	Dark grey	Normal	Moderate with some high globs	Soft mud	7	0	0	5
22	23/07/15	11:38	Dark grey	Normal	Low-moderate with some high globs	Soft mud	5	0	0	0
26	23/07/15	12:02	Brown/grey	Normal	Low-moderate	Soft mud	5	0	0	0
29	23/07/15	12:19	Dark grey	Normal	low with some moderate-high globs	Muddy sand	5	0	0	0
25	23/07/15	12:38	Dark grey	Normal	None	Sandy mud	2	5	0	0
21	23/07/15	12:56	Dark grey	Normal	None	Sandy mud	2	2	0	0
17	23/07/15	13:12	Dark grey	Normal	None	Fine sand	5	30	0	5
12	23/07/15	13:26	Dark grey	Normal	None	Moderate-firm sand	3	7	0	1
I	23/07/15	13:42	Dark grey	Normal	None	Firm sand	2	15	0	23
F	23/07/15	13:52	Dark grey	Normal	None	Firm sand	7	30	0	4
7	23/07/15	14:02	Dark grey	Normal	None	Firm sand with globs	2	40	0	1

Sediment Log and Photographs

Site No.	Date	Time	Colour	Odour	Palasticity	Field Texture	% Shell	% Seagrass	% Macroalgae	% Organics/biota
						of soft mud				
E	23/07/15	14:09	Dark grey	Normal	Low	Soft muddy sand	0	60	0	2
A	23/07/15	14:12	Yellow/brown	Normal	None	Firm sand	3	3	1	0
B	23/07/15	14:23	Brown/grey	Normal	None	Firm sand	7	10	1	2
8	23/07/15	14:33	Dark grey	Normal	None	Firm sand	9	25	2	0
C	23/07/015	14:48	Dark grey	Normal	None	Firm sand	5	3	1	2
24	24/07/15	9:30	Dark grey	Normal	High	Soft mud	1	0	0	0
R	24/07/15	10:30	Dark grey	Normal	None	Soft sand held together by seagrass roots	15	20	0	7
O	24/07/15	11:20	Dark grey	Slight anoxic	None	Soft muddy sand	5	25	0	0
M	24/07/15	11:32	Dark grey	Slight anoxic	None	Muddy sand	5	30	0	5
N	24/07/15	11:43	Dark grey	Normal	Low	Sandy mud	3	2	0	8
L	24/07/15	11:55	Dark grey	Slight anoxic	None	Sandy mud	4	15	3	5
J	24/07/2015	12:06	Dark grey	Normal	None	Sandy mud	1	20	0	5
11	24/07/2015	12:20	Dark grey	Slight anoxic	None	Sandy mud	2	20	0	5
16	24/07/15	12:41	Dark grey	Slight anoxic	Low	Soft muddy sand	12	25	0	5
K	24/07/15	12:57	Dark grey	Anoxic	None	Sandy mud	0	30	0	10
20	24/07/15	13:11	Dark grey	Anoxic	None	Sandy mud	3	25	0	10
Q	24/07/15	13:28	Dark grey/brown	Normal	Low	soft mud	0	15	0	3
P	24/07/15	13:37	Dark grey/brown	Slight anoxic	None	sandy mud	2	20	0	5

Figure A-1 Sample photos – sites 2, 4, 5, 6, 7, 8, 9 and 11

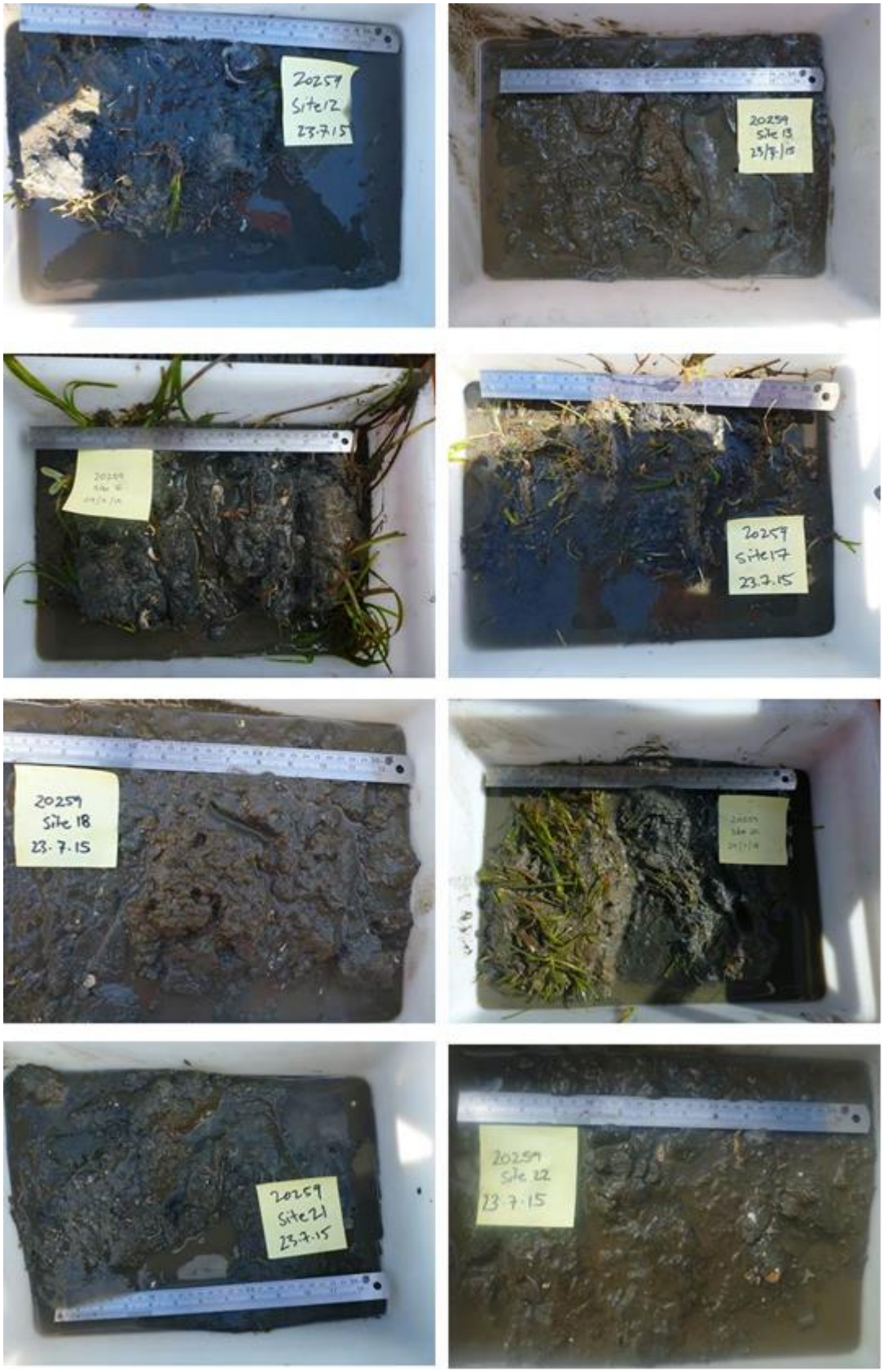


Figure A-2 Sample photos (cont) – 12, 13, 16, 17, 18, 20, 21 and 22

Figure A-3 Sample photos (cont.) – 24, 26, 29, A, B, C, D and E

Figure A-4 Sample photos (cont.) – F, H, I, J, K, L, M and N

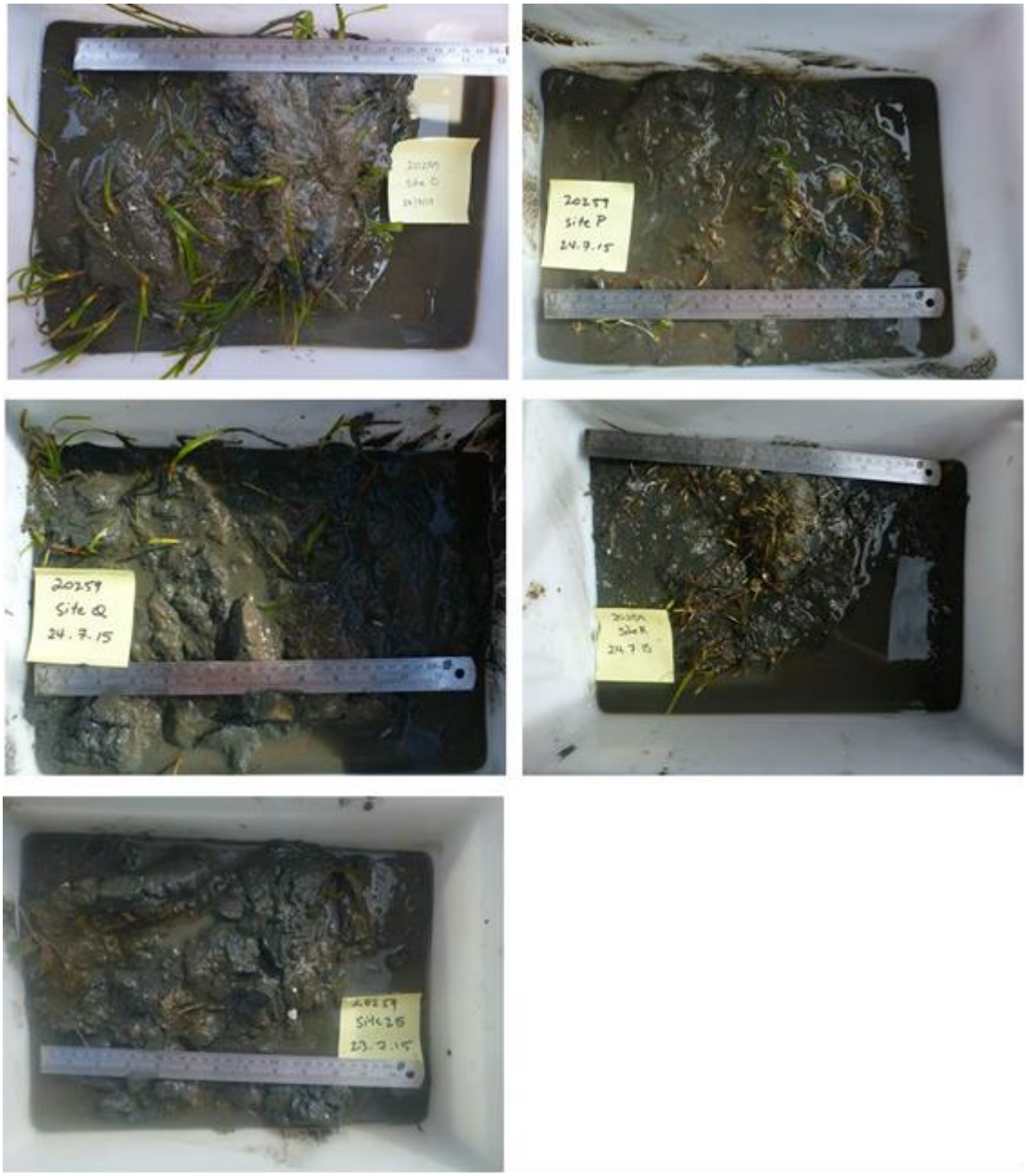
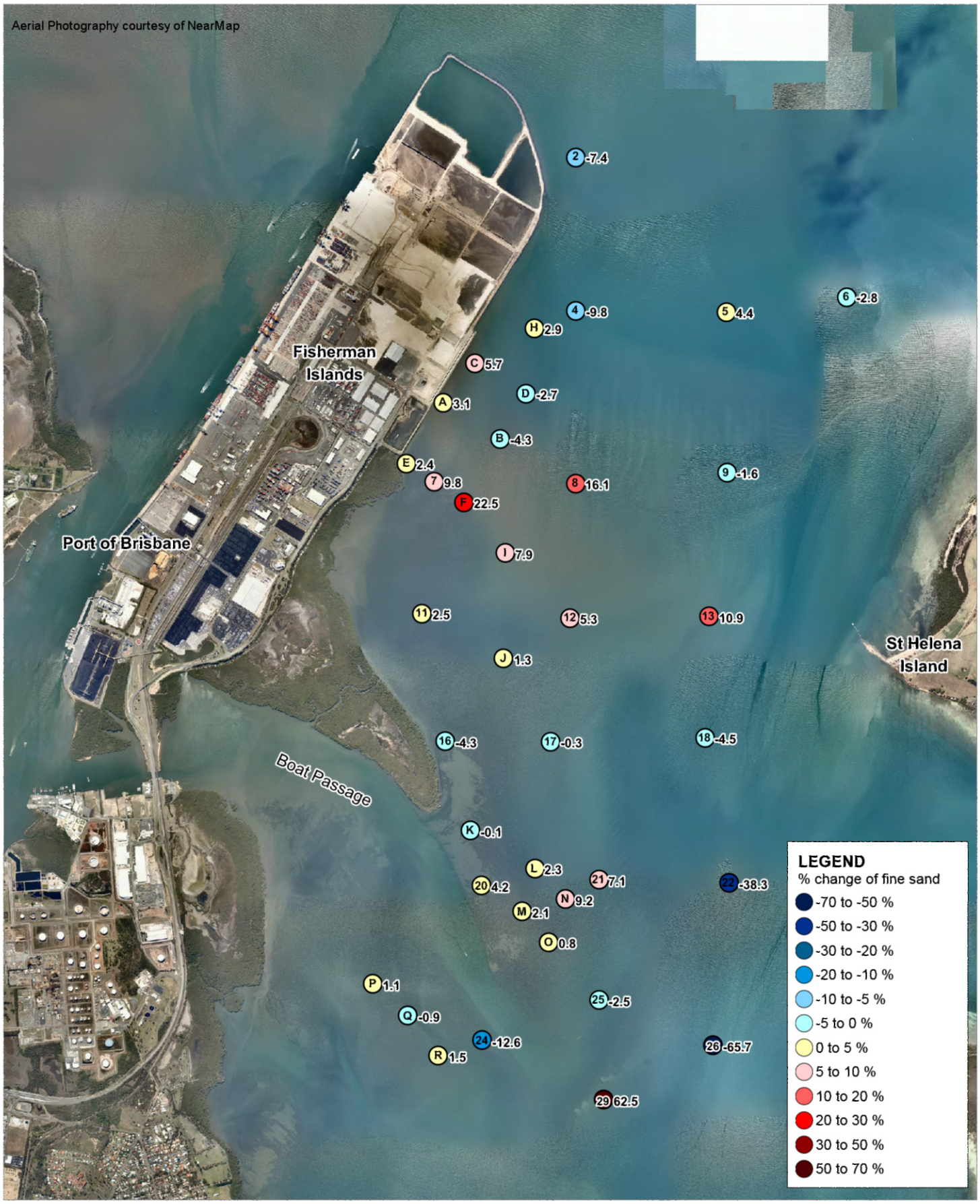


Figure A-5 Sample photos (cont.) – O, P, Q, R and 25

Appendix B Temporal Patterns 1992-2015



Title:

Percentage change in proportion of fine sand (0.075 to 0.15 mm) between 2009 and 2015

Figure: **B-1**

Rev: **A**

N

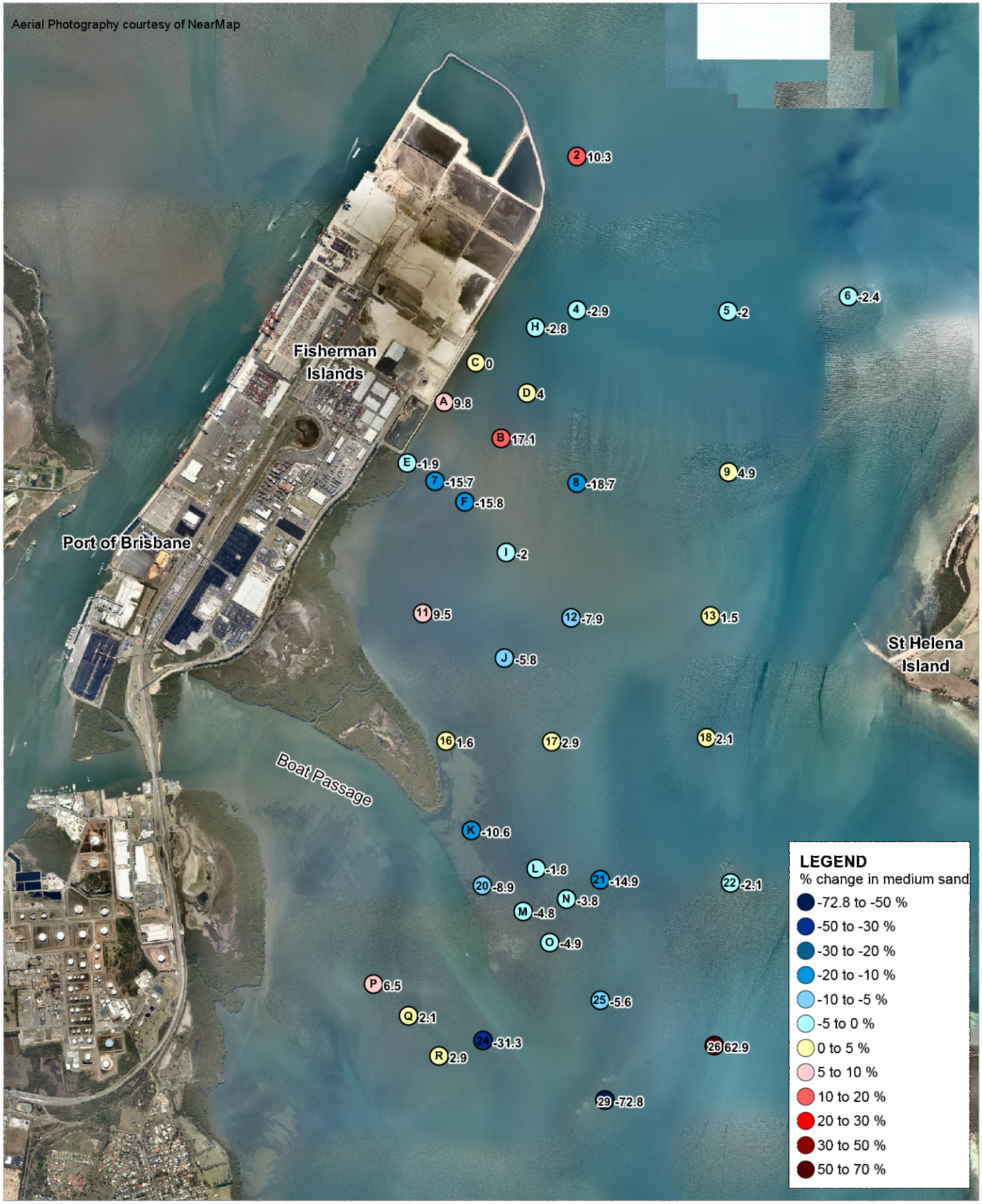
0 1 2km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B20259_I_BRH Port of Brisbane DLR\DRG\Marine Sediments 2015\ECO_007_150901_FineSand_Change_2015.wor



Title:

Percentage change in proportion of medium sand (0.15 to 0.60 mm) between 2009 and 2015

Figure: **B-2**

Rev: **A**

N

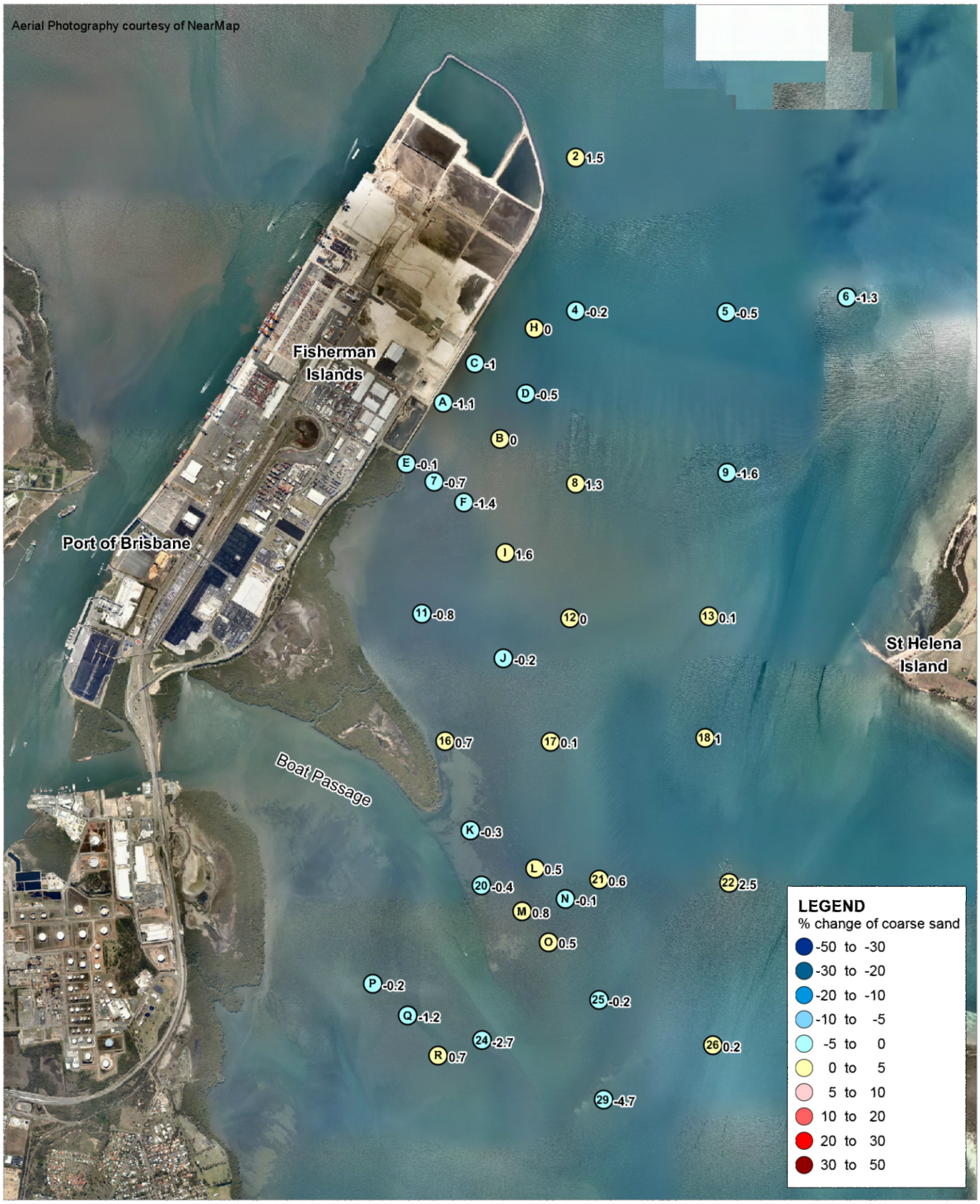
0 1 2km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B20259_I_BRH Port of Brisbane DLR\DRG\Marine Sediments 2015\ECO_008_150901_MedSand_Change_2015.wor



Title:

Percentage change in proportion of coarse sand (0.60 to 2.36 mm) between 2009 and 2015

Figure: **B-3**

Rev: **A**

N

0 1 2km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B20259_I_BRH Port of Brisbane DLR\DRG\Marine Sediments 2015\ECO_009_150901_CoarseSand_Change_2015.wor

Appendix C PSD Data 2015

C.1 PSD Plots (Sieve)

Golder Associates

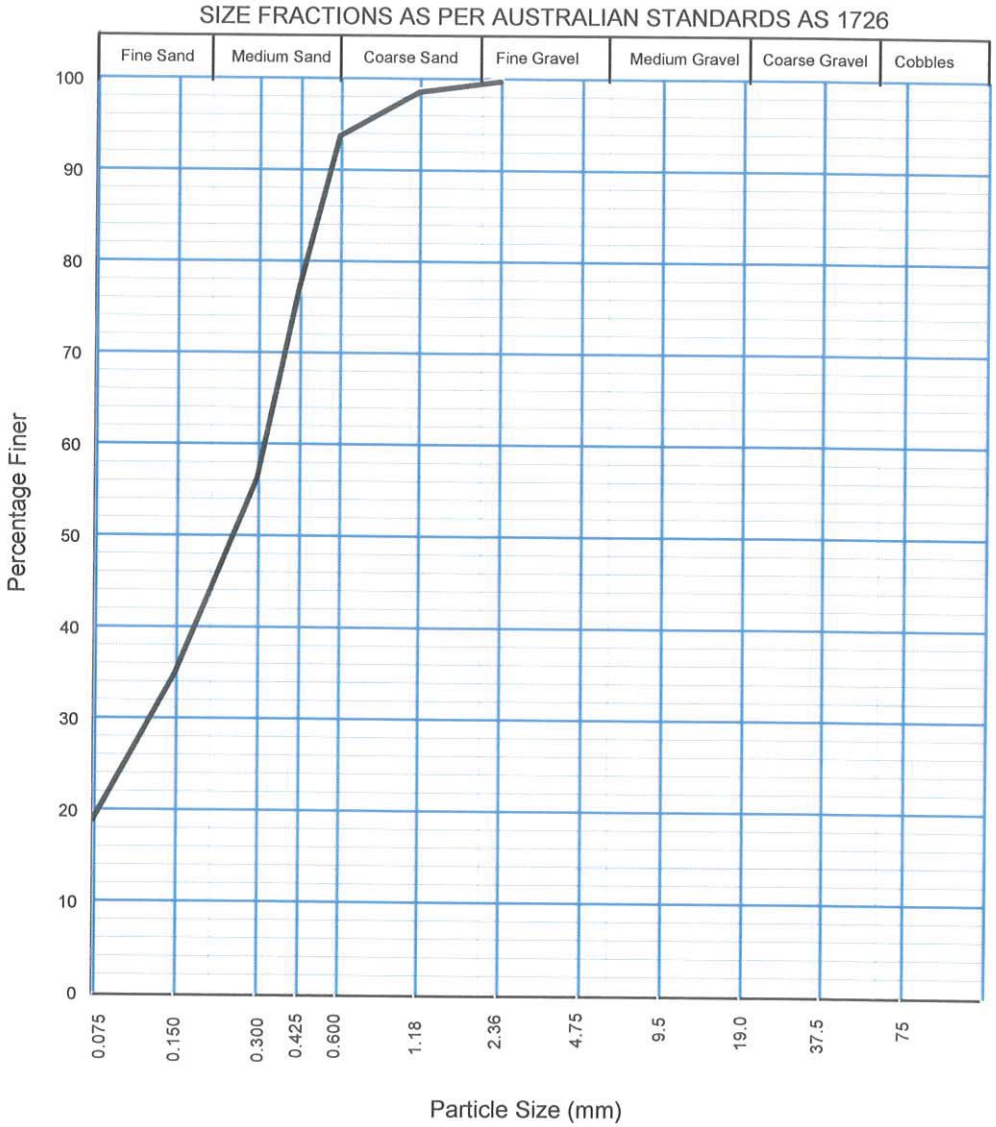
BRISBANE LABORATORY

ABN 64 006 107 857
28 Bank Street, West End QLD 4101
PO Box 3427 Sth Brisbane BC QLD 4101
Phone : (07) 3840 9500
Email : bnelab@golder.com.au

PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18217
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301895
AAA Lab. ID :	2 23/07/2015	Project Ref. :	A15/3936/1
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	98.8
0.600	94.0
0.425	77.3
0.300	56.6
0.150	35.2
0.075	19.1



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by : DJ

NATA WORLD RECOGNISED ACCREDITATION

10/8/15

Nick Farrer
Approved Signatory

Senior Technical Officer
NATA Accred. No. : 1961

Golder Associates

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PO Box 3427 Sth Brisbane BC QLD 4101
Phone : (07) 3840 9500
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PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18218
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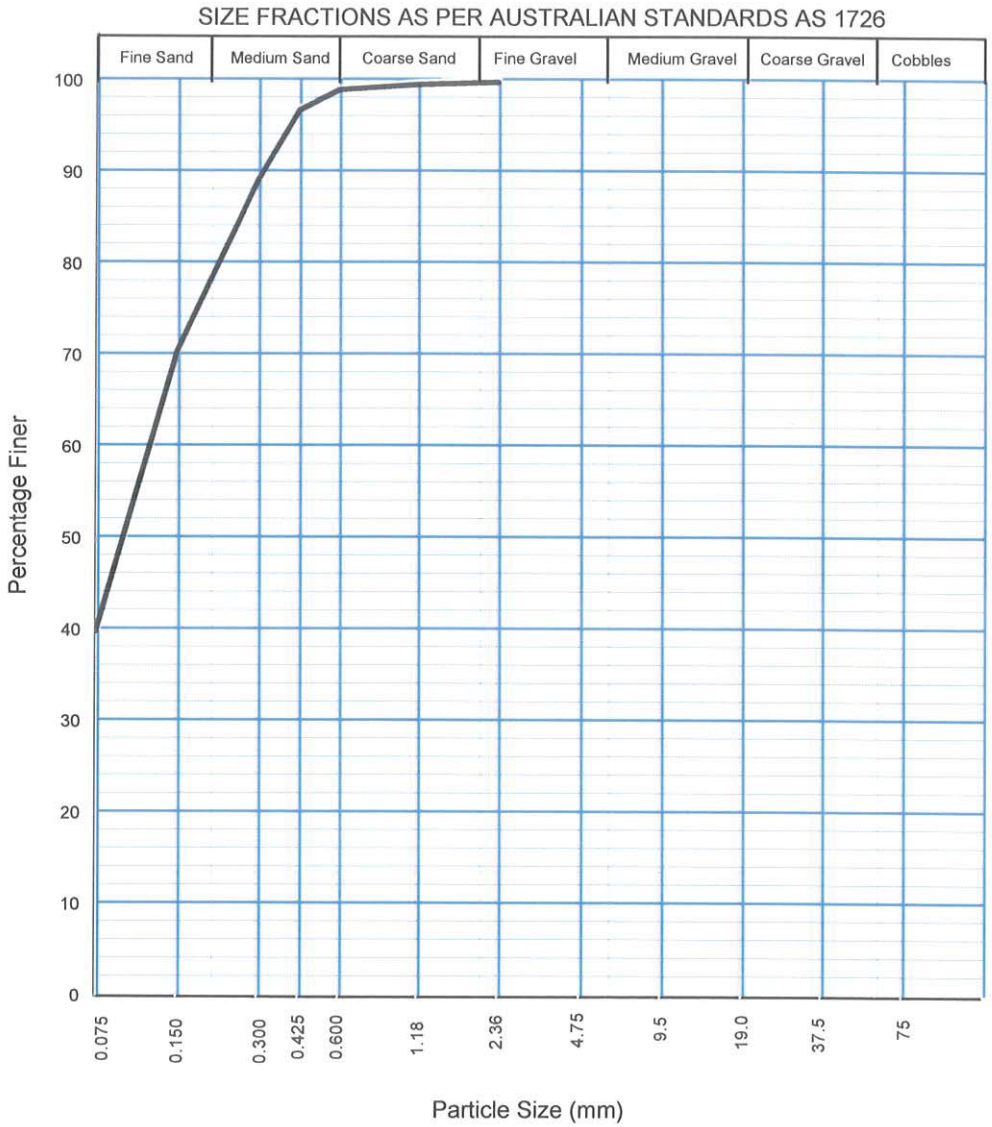
Project :	Delivered Samples	Reg'n No. :	15301896
AAA Lab. ID :	4 23/07/2015	Project Ref. :	A15/3936/2
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.7
0.600	99.2
0.425	96.9
0.300	89.3
0.150	70.6
0.075	39.9



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MK

Checked by : DJS

Accredited for compliance with ISO/IEC 17025.
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

NATA

10/8/15

Nick Farrer
Approved Signatory

Senior Technical Officer
NATA Accred. No. : 1961

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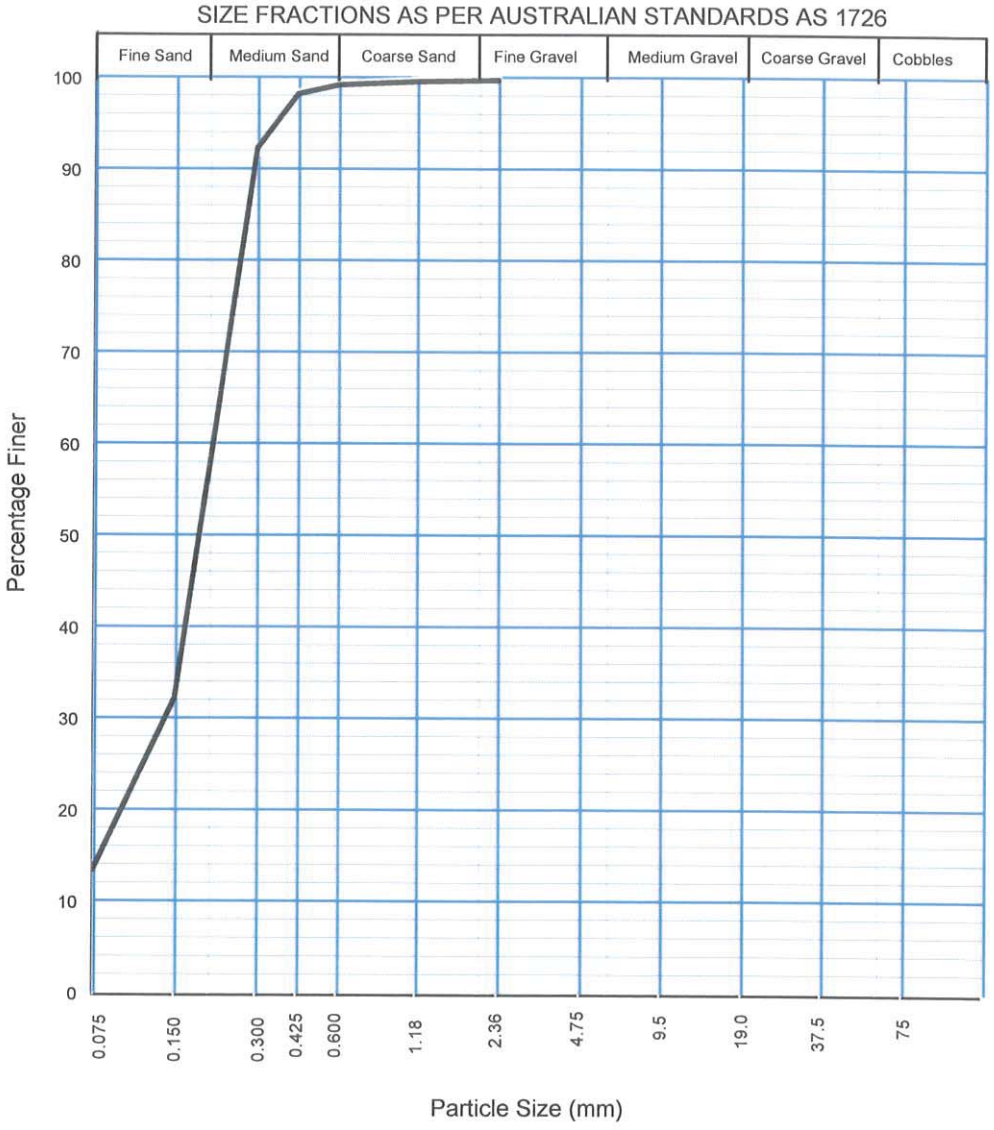
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18219
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301897
AAA Lab. ID :	5 23/07/2015	Project Ref. :	A15/3936/3
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.8
0.600	99.5
0.425	98.5
0.300	92.6
0.150	32.5
0.075	13.6



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : NF

Checked by :

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Nick Farrer
Approved Signatory

Senior Technical Officer
NATA Accred. No. : 1961

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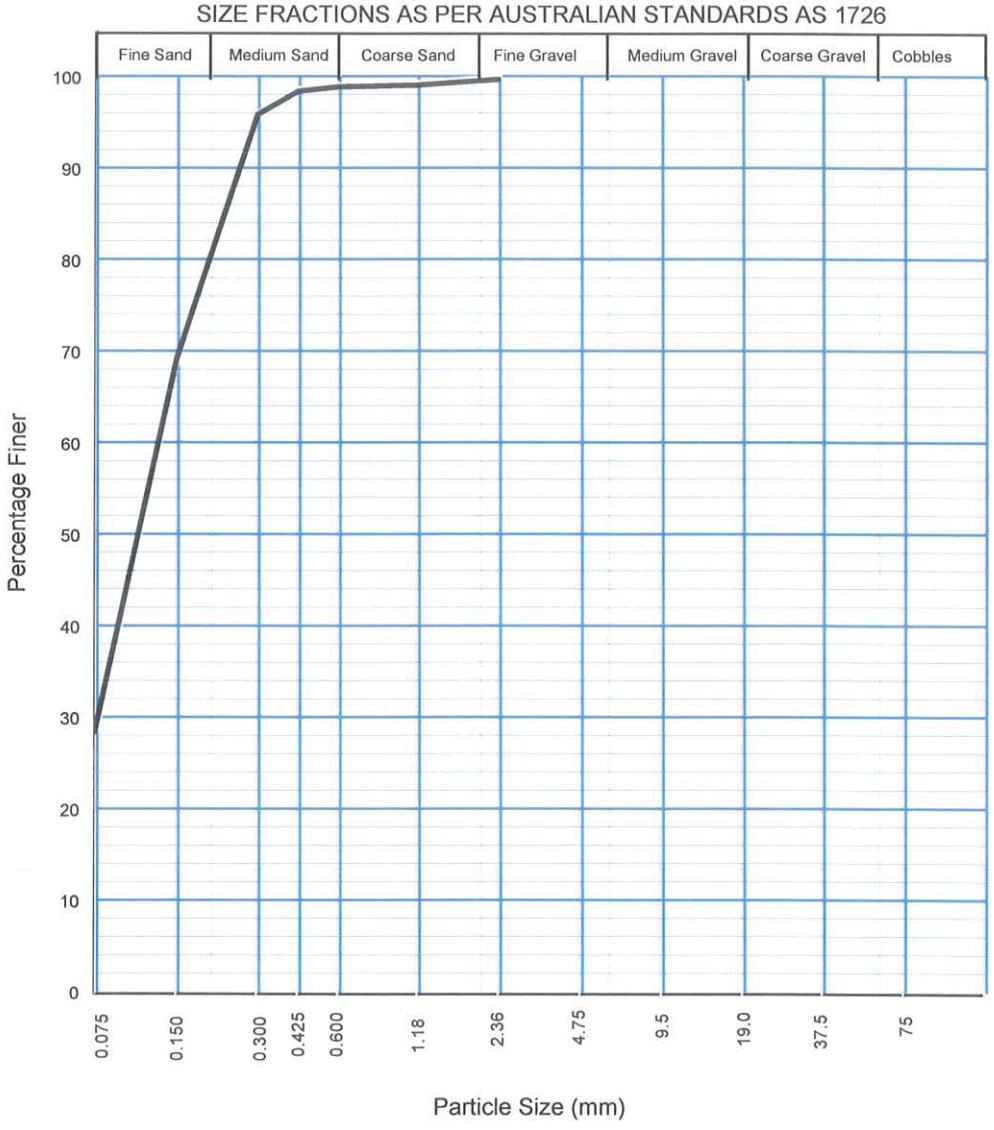
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18221
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301899
AAA Lab. ID :	7 23/07/2015	Project Ref. :	A15/3936/5
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.4
0.600	99.2
0.425	98.7
0.300	96.1
0.150	69.4
0.075	28.6



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : NF

Checked by :

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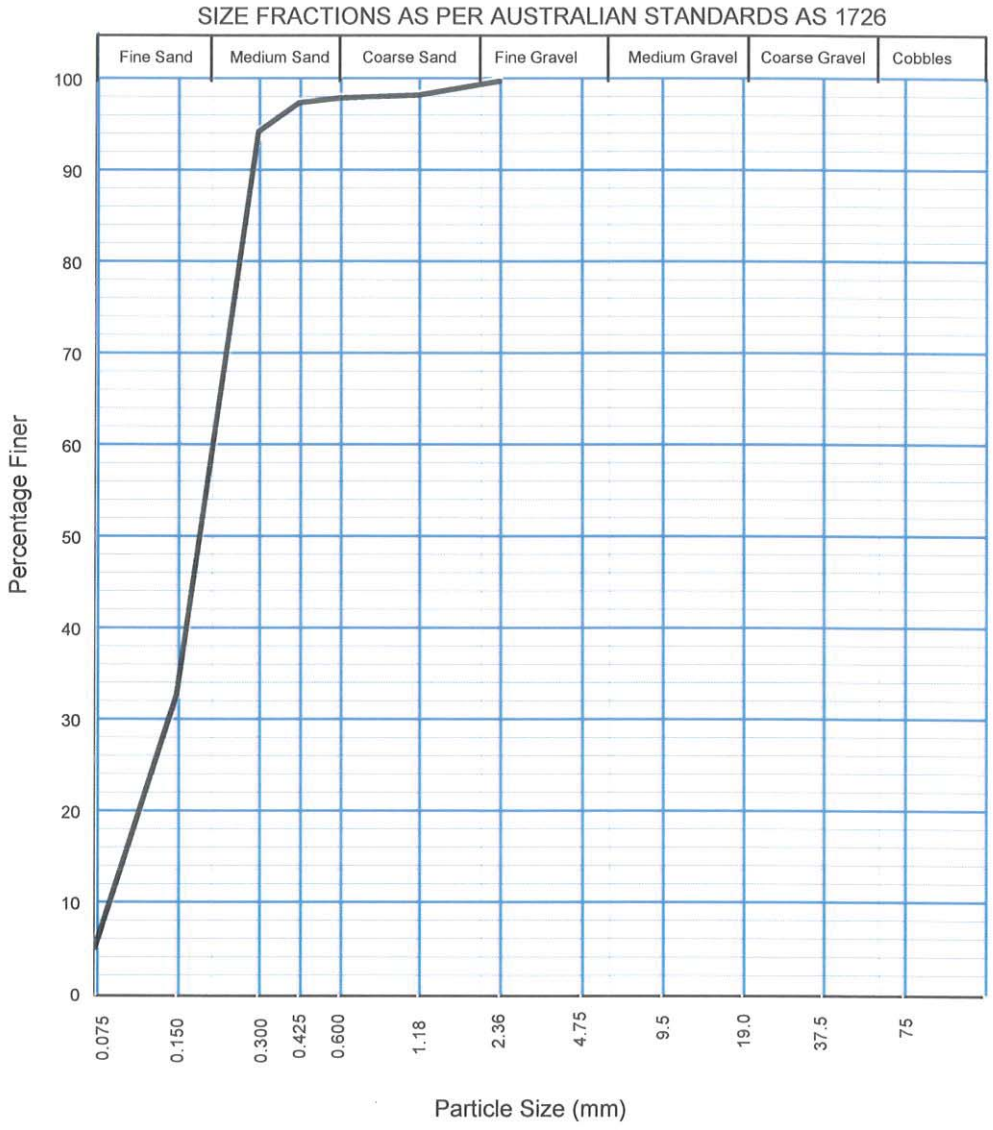
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18222
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301900
AAA Lab. ID :	8 23/07/2015	Project Ref. :	A15/3936/6
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	98.5
0.600	98.2
0.425	97.6
0.300	94.5
0.150	32.9
0.075	5.3



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : NF

Checked by : DP

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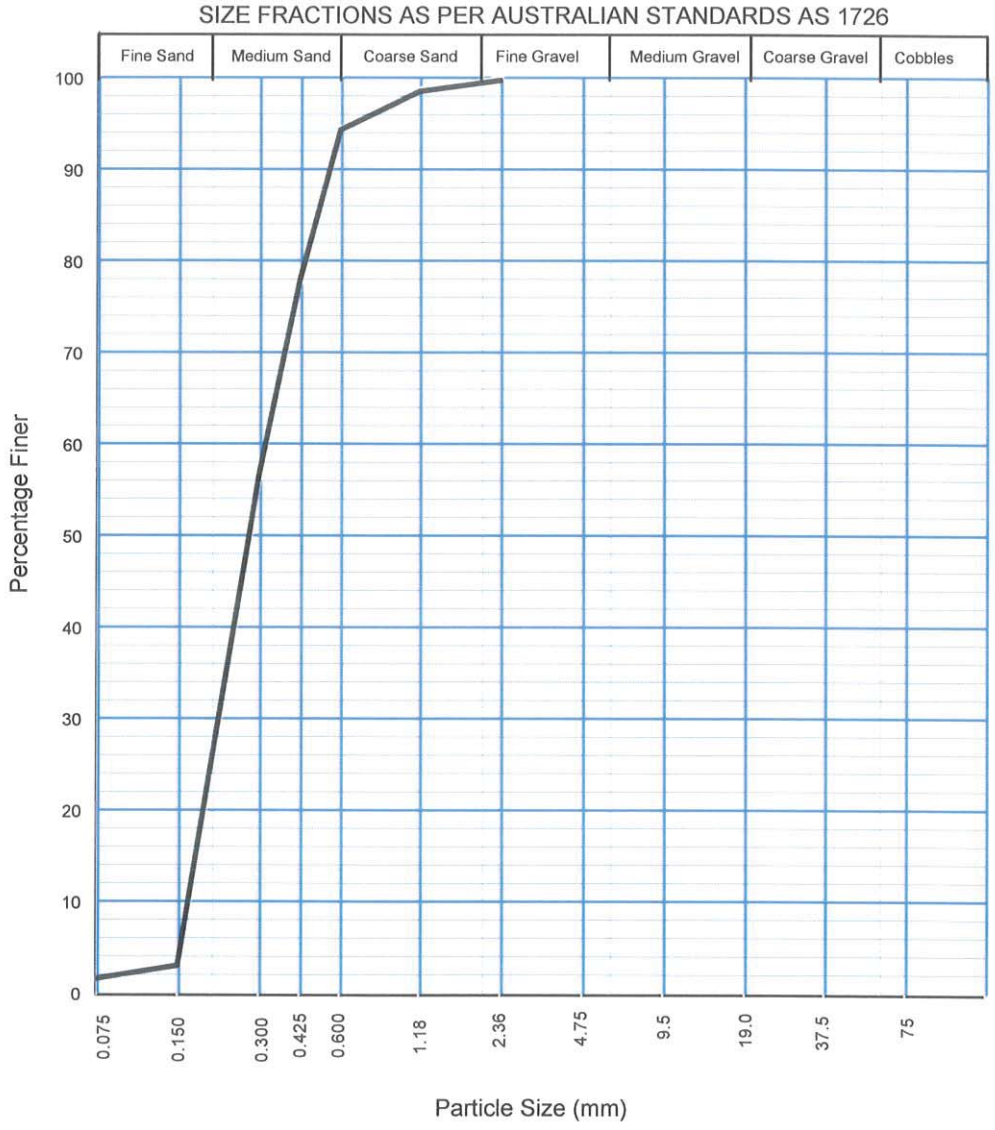
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18223
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301901
AAA Lab. ID :	9 23/07/2015	Project Ref.:	A15/3936/7
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	98.8
0.600	94.6
0.425	78.3
0.300	57.0
0.150	3.2
0.075	1.8



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by : DJP

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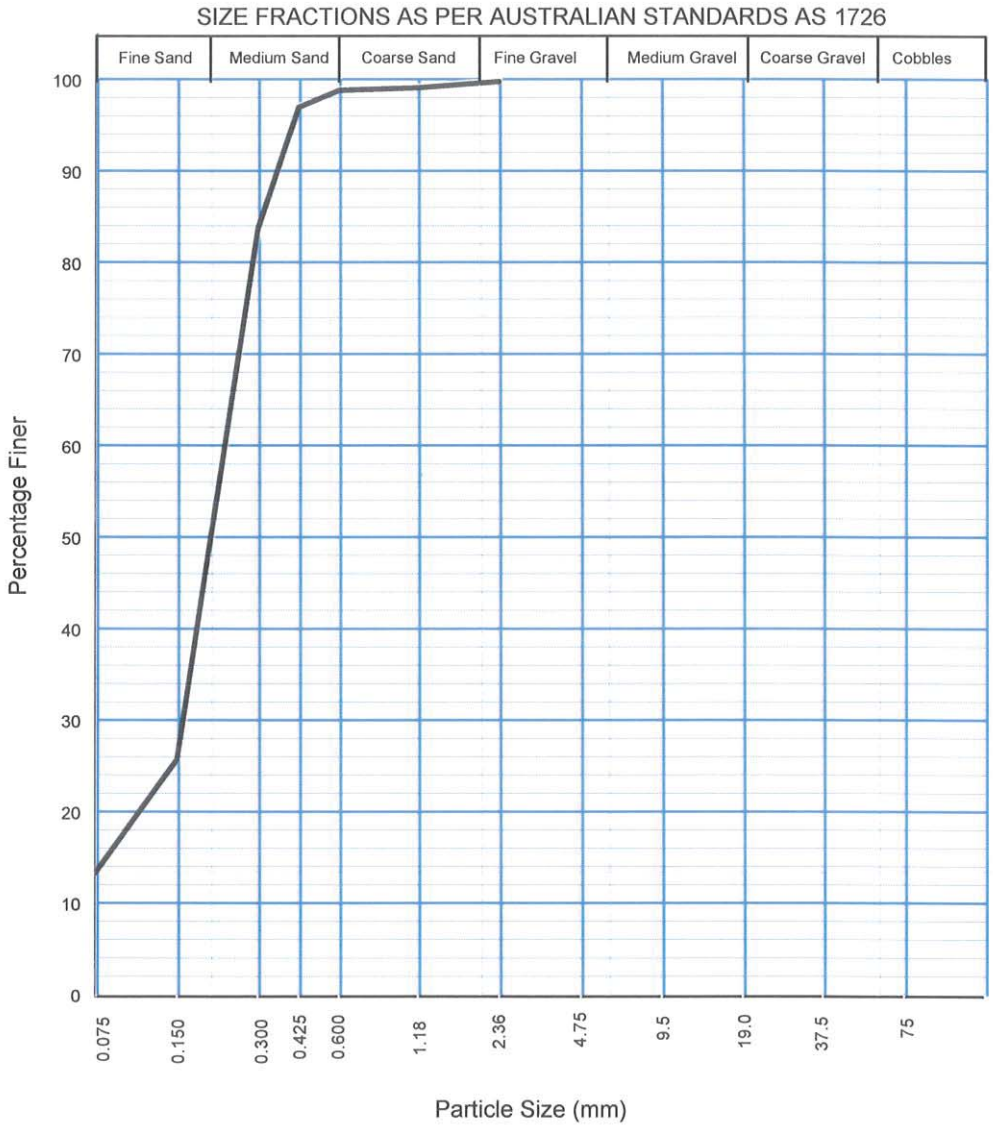
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18225
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301903
AAA Lab. ID :	12 23/07/2015	Project Ref.:	A15/3936/9
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.3
0.600	99.0
0.425	97.2
0.300	84.0
0.150	25.9
0.075	13.6



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MC

Checked by : DJ

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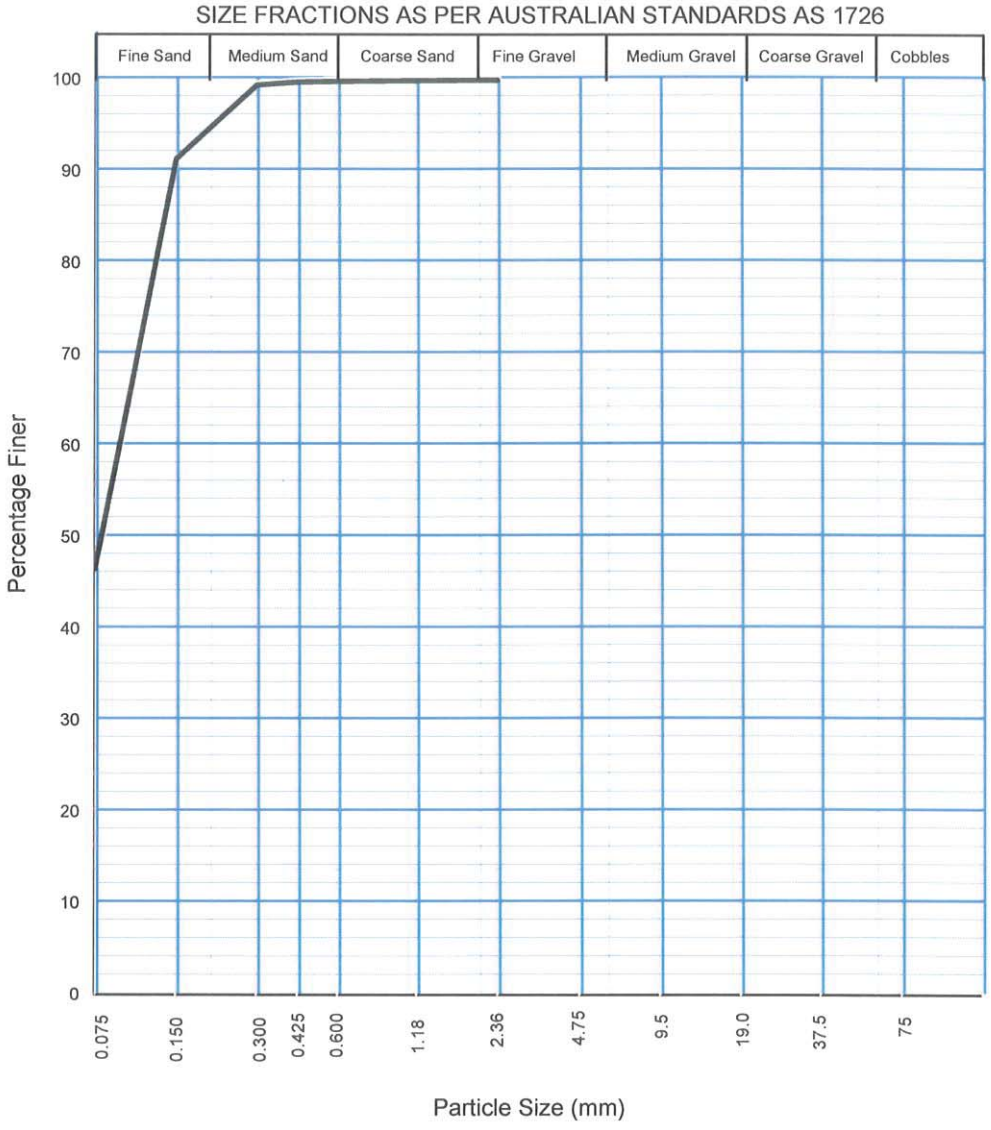
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18226
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301904
AAA Lab. ID :	13 23/07/2015	Project Ref.:	A15/3936/10
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.9
0.600	99.9
0.425	99.8
0.300	99.4
0.150	91.4
0.075	46.5



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : NF

Checked by : DJ

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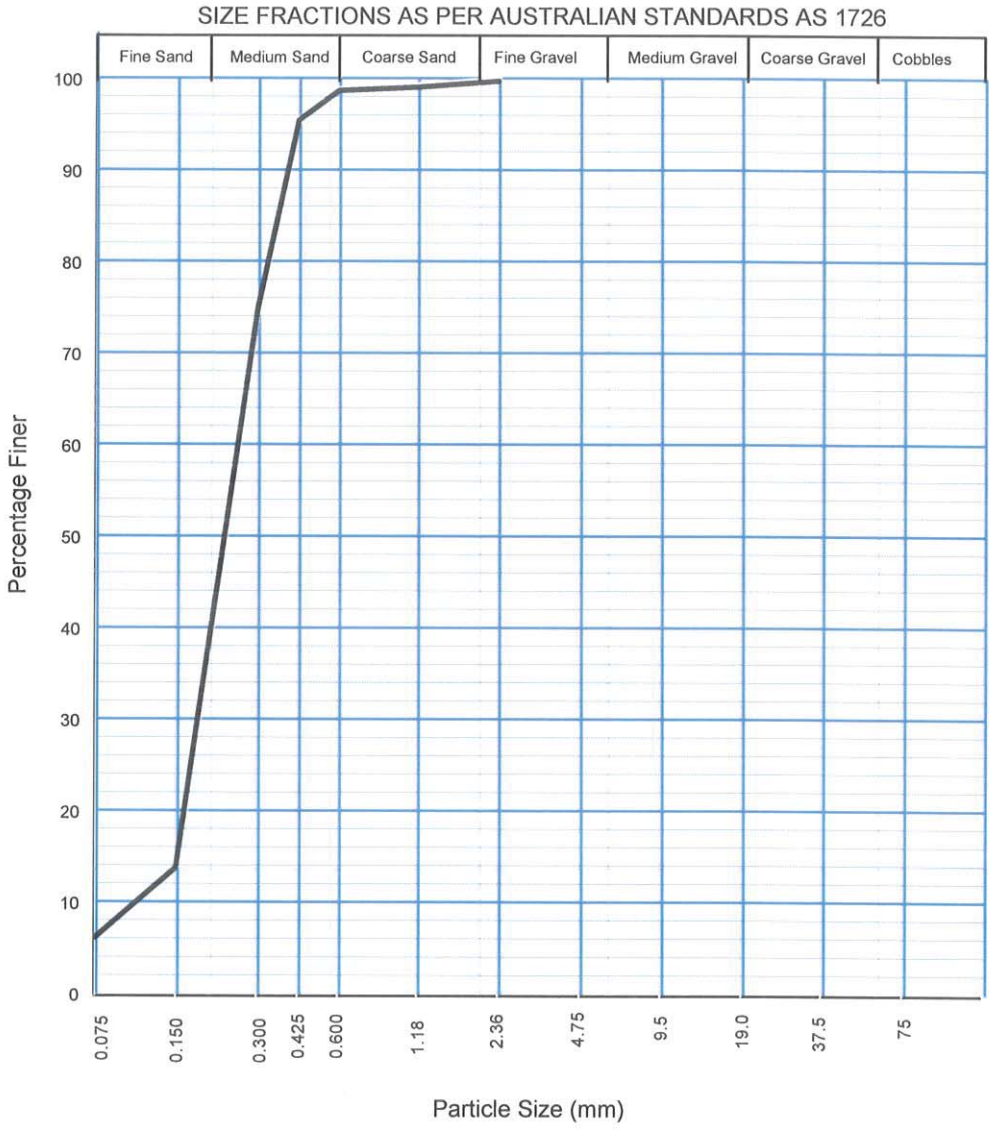
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18228
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301906
AAA Lab. ID :	17 23/07/2015	Project Ref.:	A15/3936/12
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.3
0.600	98.9
0.425	95.7
0.300	75.2
0.150	14.0
0.075	6.3



Remarks :

Test Procedure : AS 1289 3.6.1

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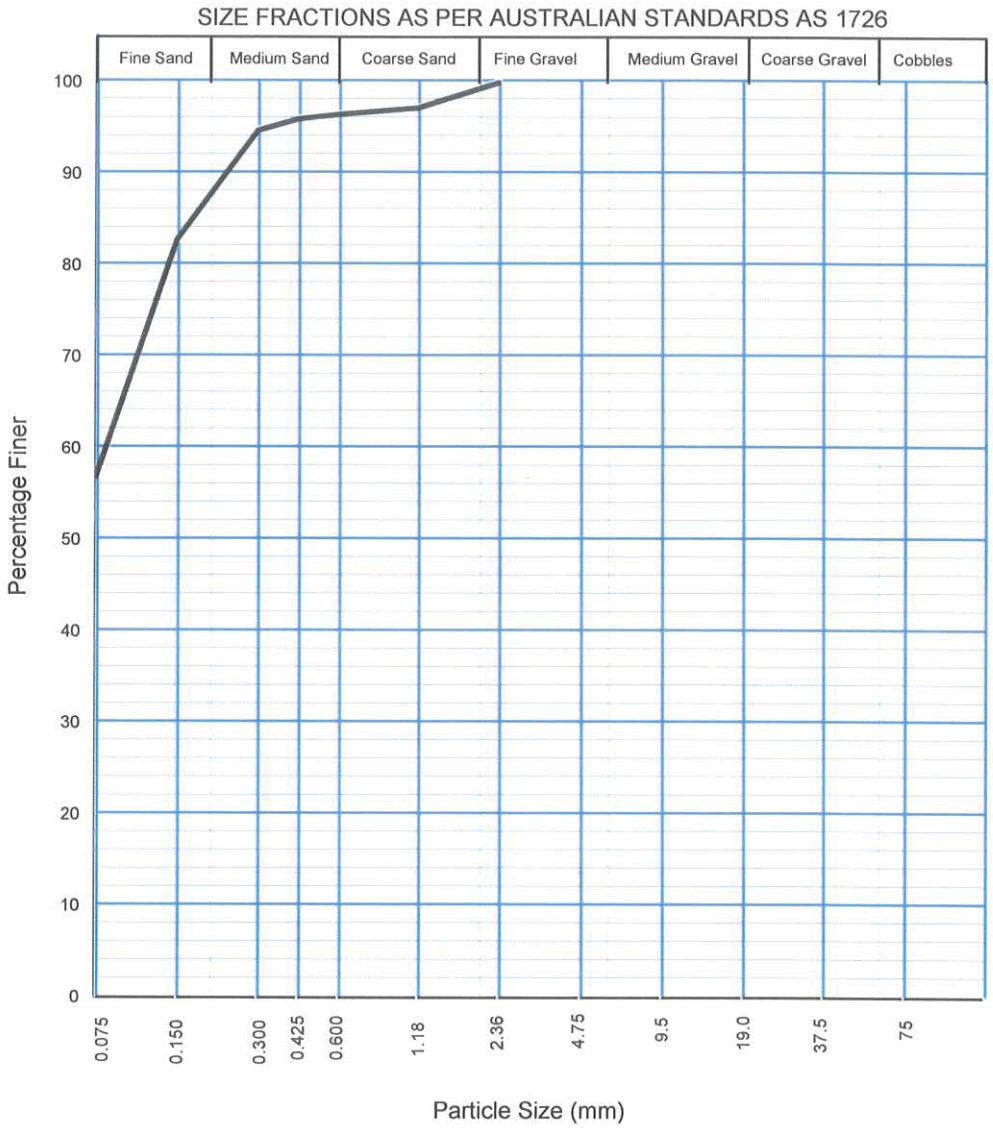
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18229
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301907
AAA Lab. ID :	18 23/07/2015	Project Ref.:	A15/3936/13
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	97.2
0.600	96.5
0.425	96.0
0.300	94.8
0.150	82.9
0.075	56.9



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by : DJP

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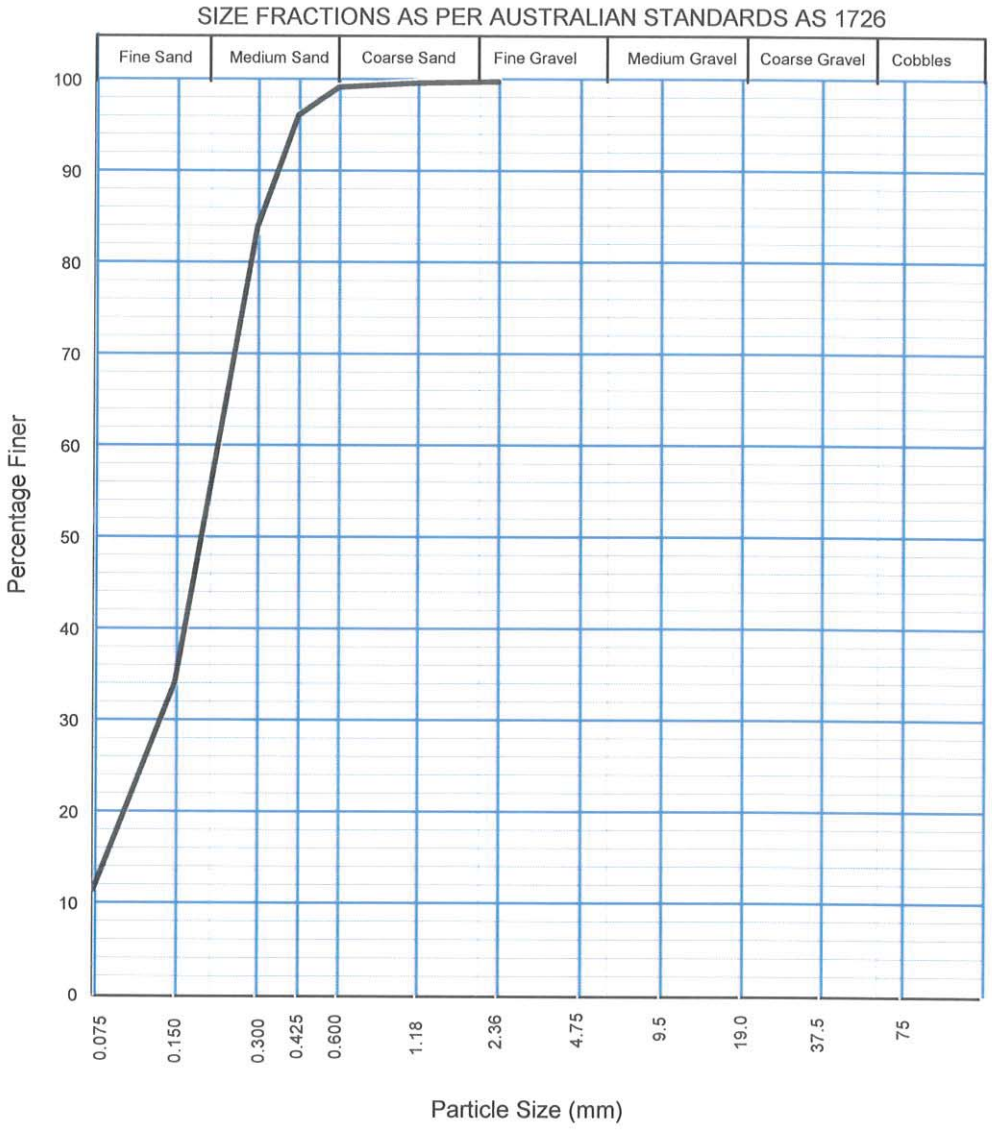
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18230
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301908
AAA Lab. ID :	20 24/07/2015	Project Ref.:	A15/3936/14
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.8
0.600	99.4
0.425	96.3
0.300	84.1
0.150	34.3
0.075	11.6



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by : [signature]

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Approved Signatory

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Senior Technical Officer
NATA Accred. No. : 1961

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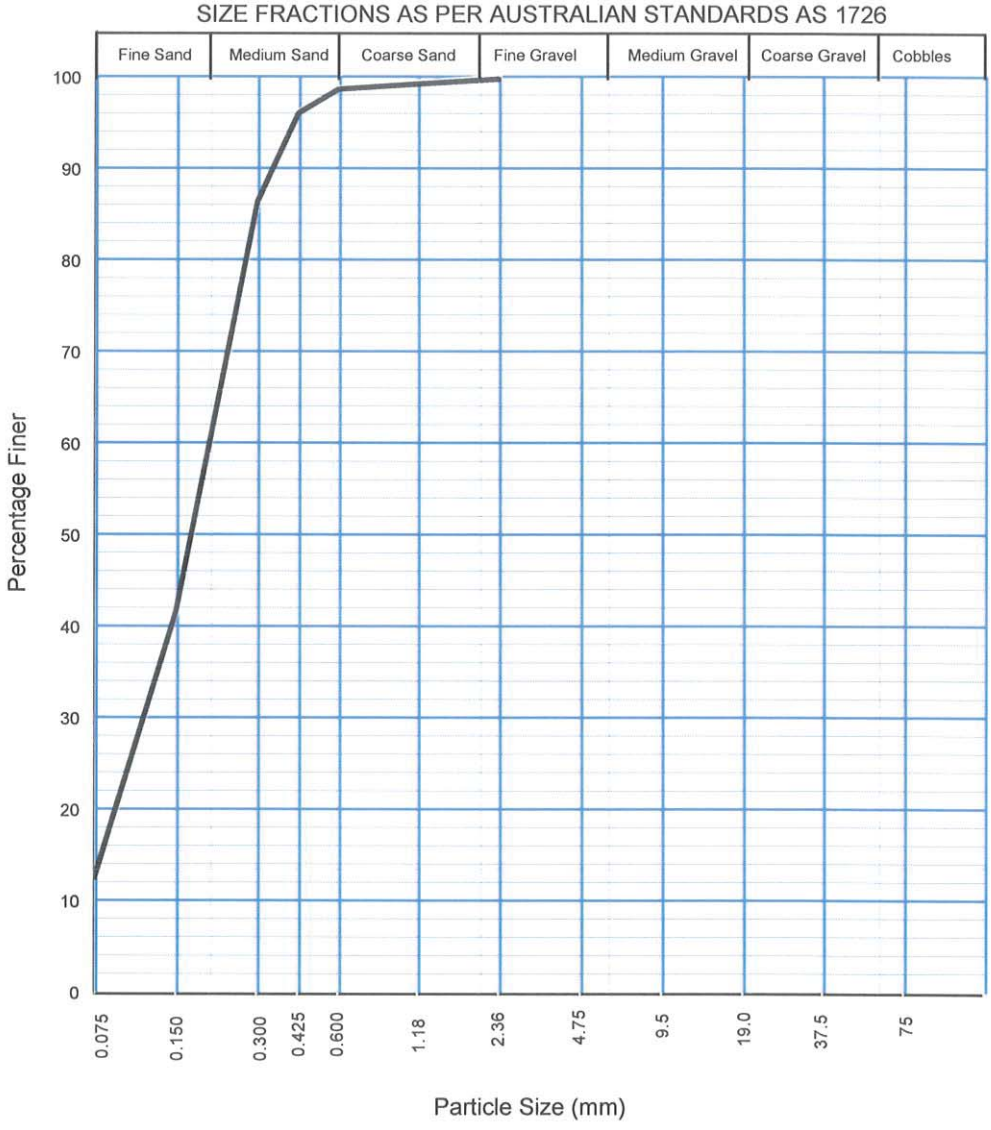
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18231
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301909
AAA Lab. ID :	21 23/07/2015	Project Ref.:	A15/3936/15
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.5
0.600	98.9
0.425	96.3
0.300	86.6
0.150	41.8
0.075	12.7



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by : NJF

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Phone : (07) 3840 9500
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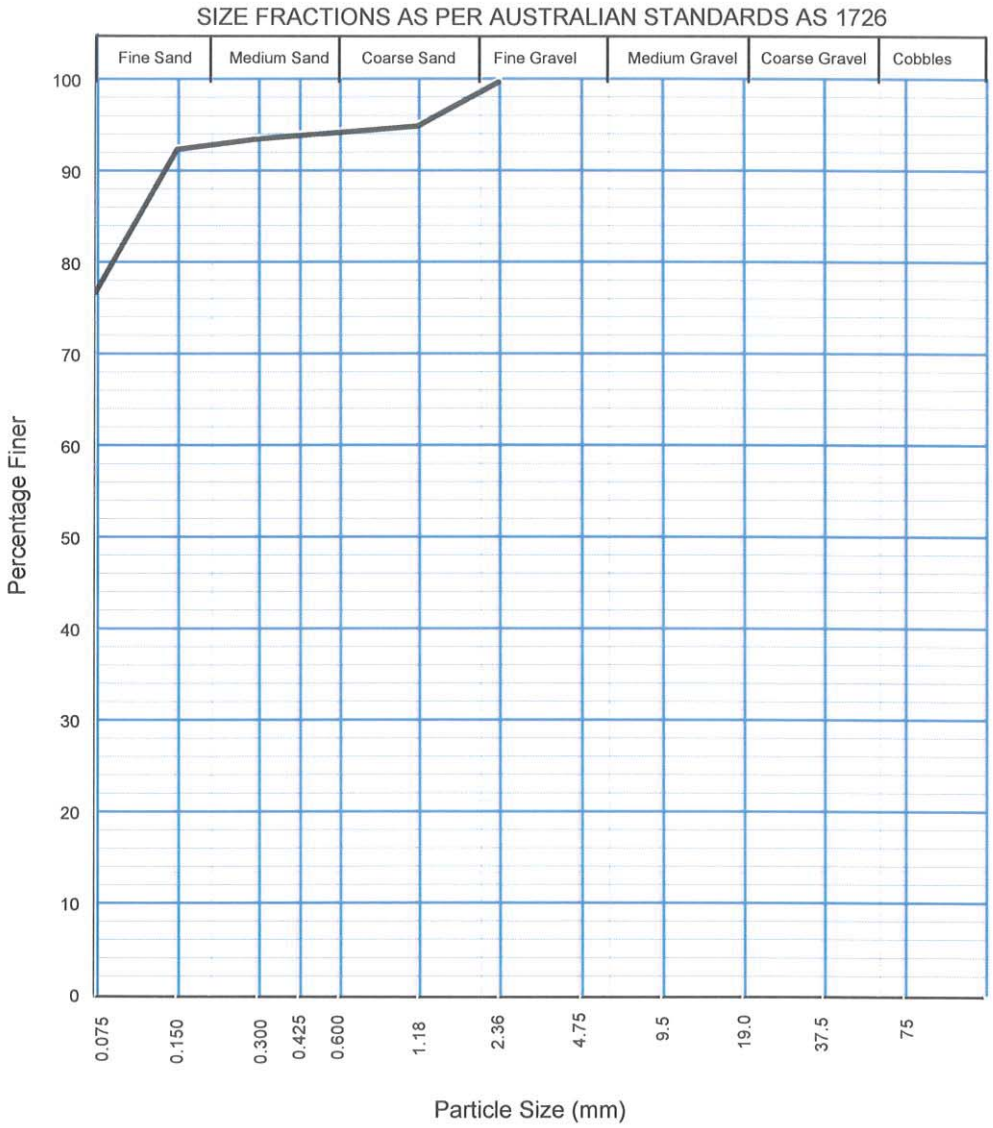
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18232
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301910
AAA Lab. ID :	22 23/07/2015	Project Ref.:	A15/3936/16
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	95.2
0.600	94.5
0.425	94.1
0.300	93.7
0.150	92.6
0.075	76.9



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by :

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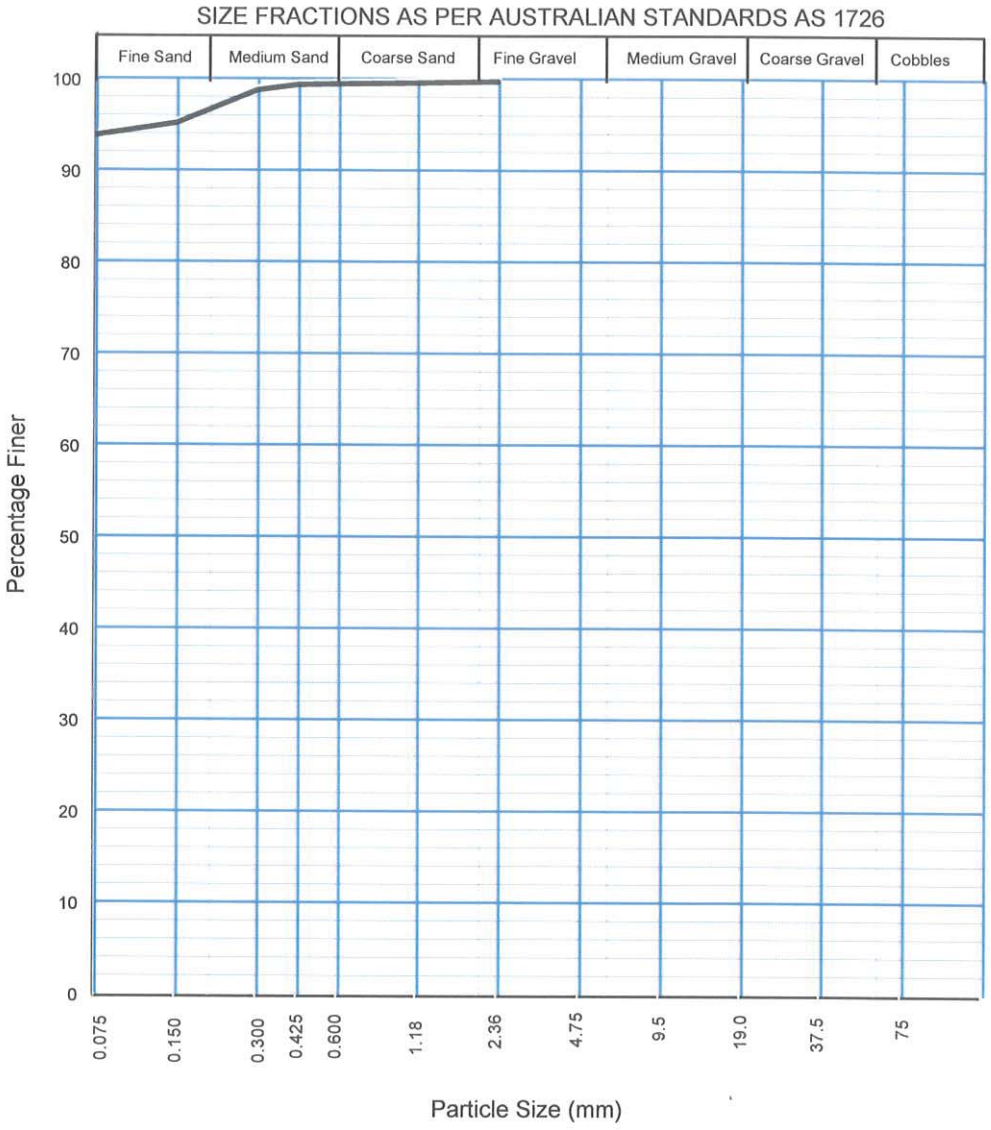
Email : bnelab@golder.com.au

PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18233
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301911
AAA Lab. ID :	24 24/07/2015	Project Ref.:	A15/3936/17
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.9
0.600	99.7
0.425	99.6
0.300	99.1
0.150	95.5
0.075	94.1



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : NF

Checked by : DJP

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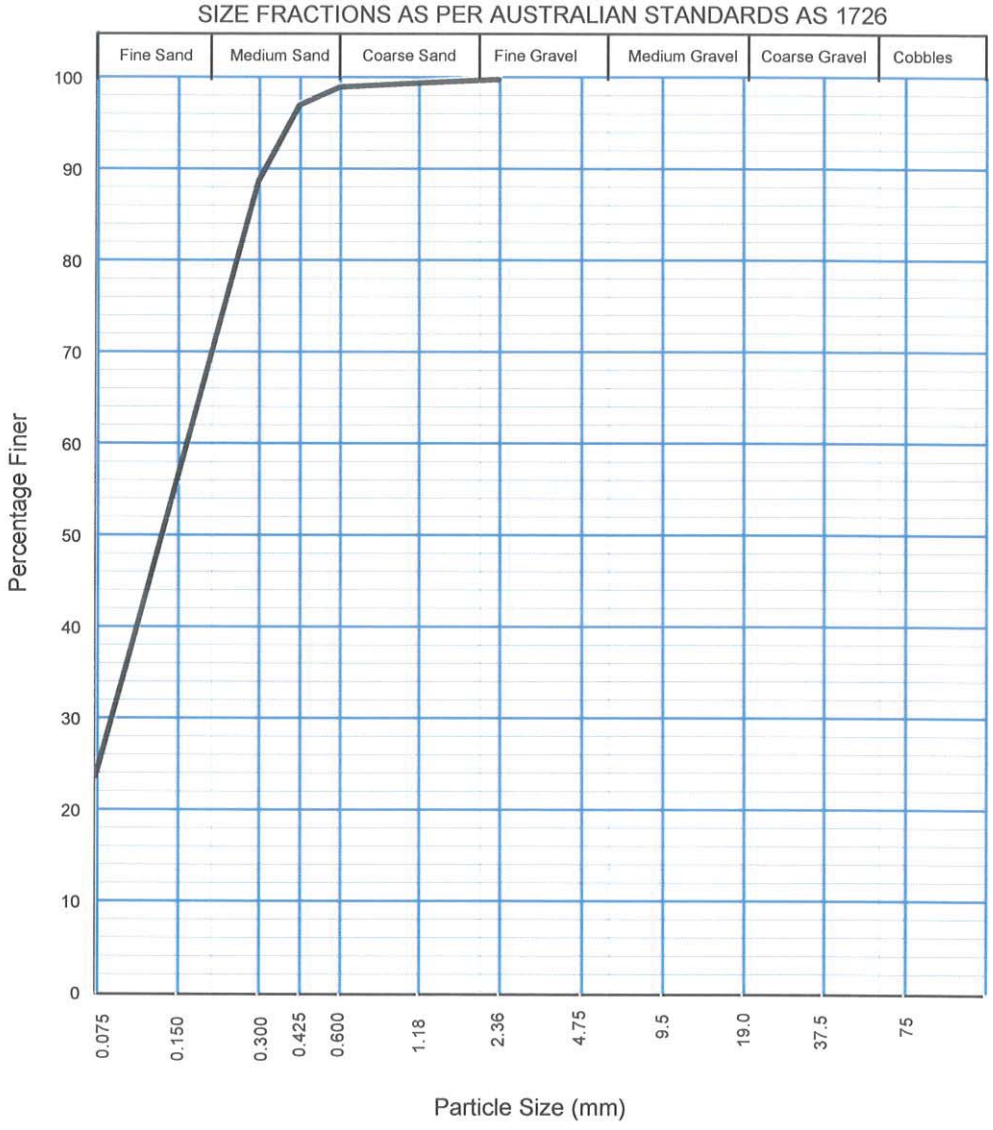
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18234
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301912
AAA Lab. ID :	25 23/07/2015	Project Ref.:	A15/3936/18
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.6
0.600	99.2
0.425	97.2
0.300	88.9
0.150	56.3
0.075	23.8



Remarks :

Test Procedure : AS 1289 3.6.1

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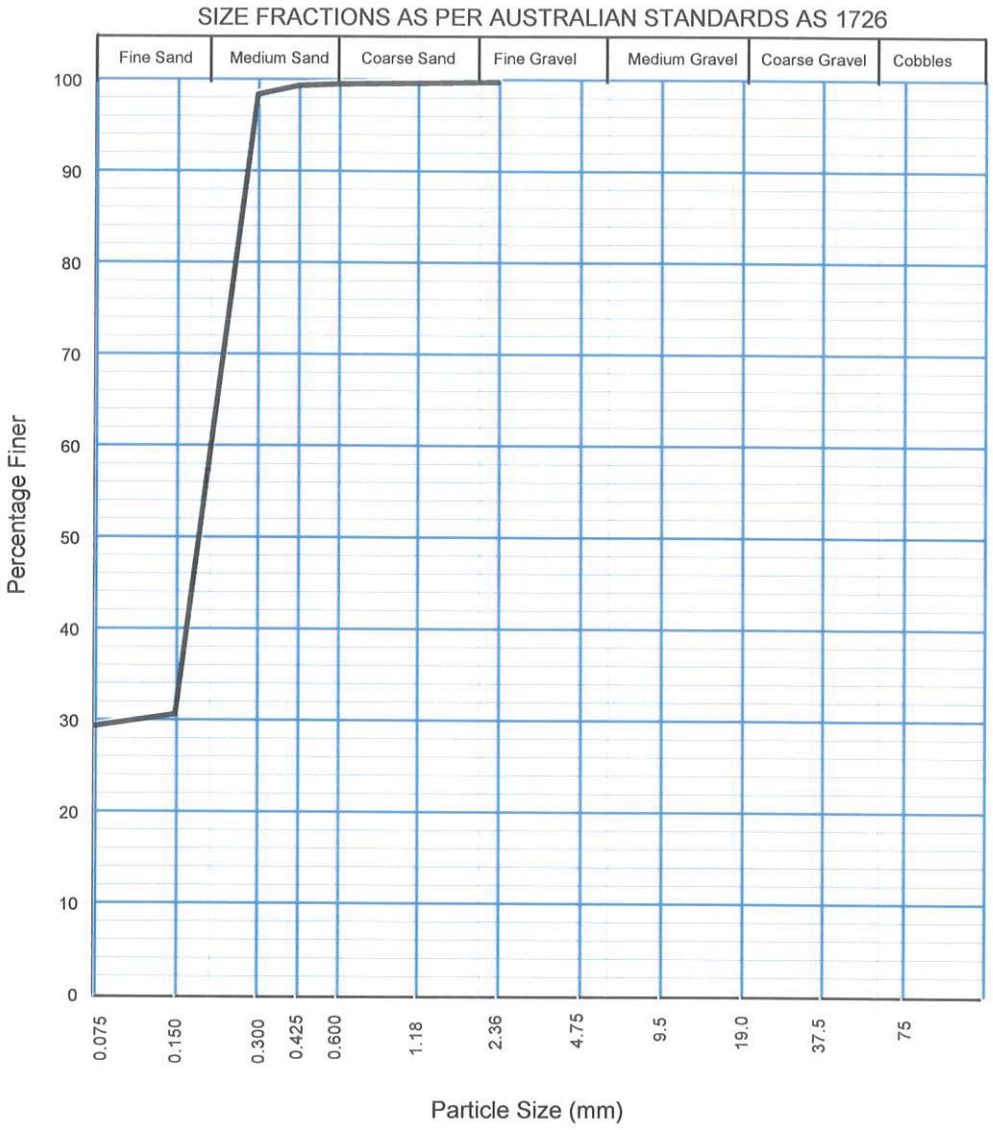
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18235
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301913
AAA Lab. ID :	26 23/07/2015	Project Ref.:	A15/3936/19
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.9
0.600	99.8
0.425	99.6
0.300	98.6
0.150	30.9
0.075	29.6



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by : [signature]

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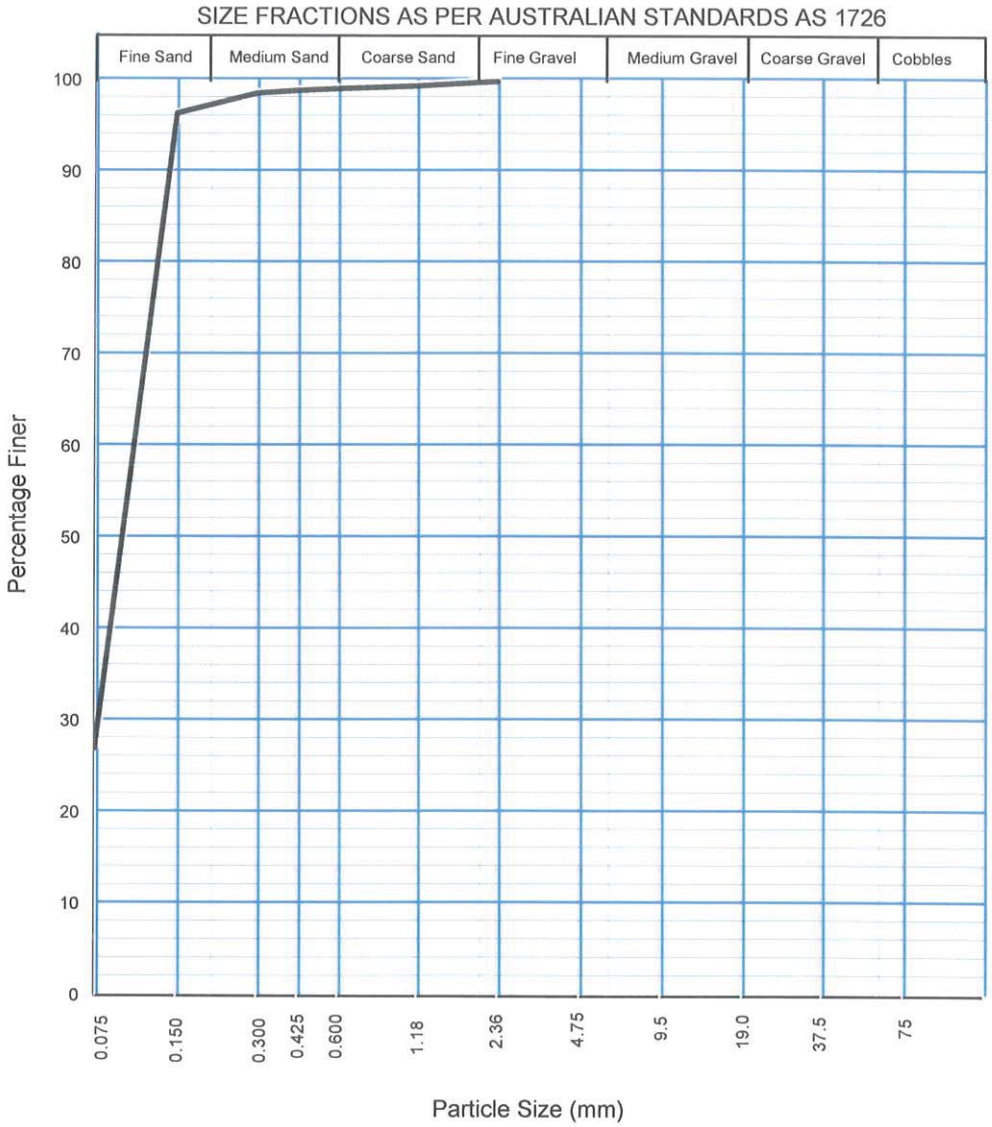
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18236
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301914
AAA Lab. ID :	29 23/07/2015	Project Ref.:	A15/3936/20
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.5
0.600	99.2
0.425	99.0
0.300	98.7
0.150	96.5
0.075	27.0



Remarks :

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Checked by :

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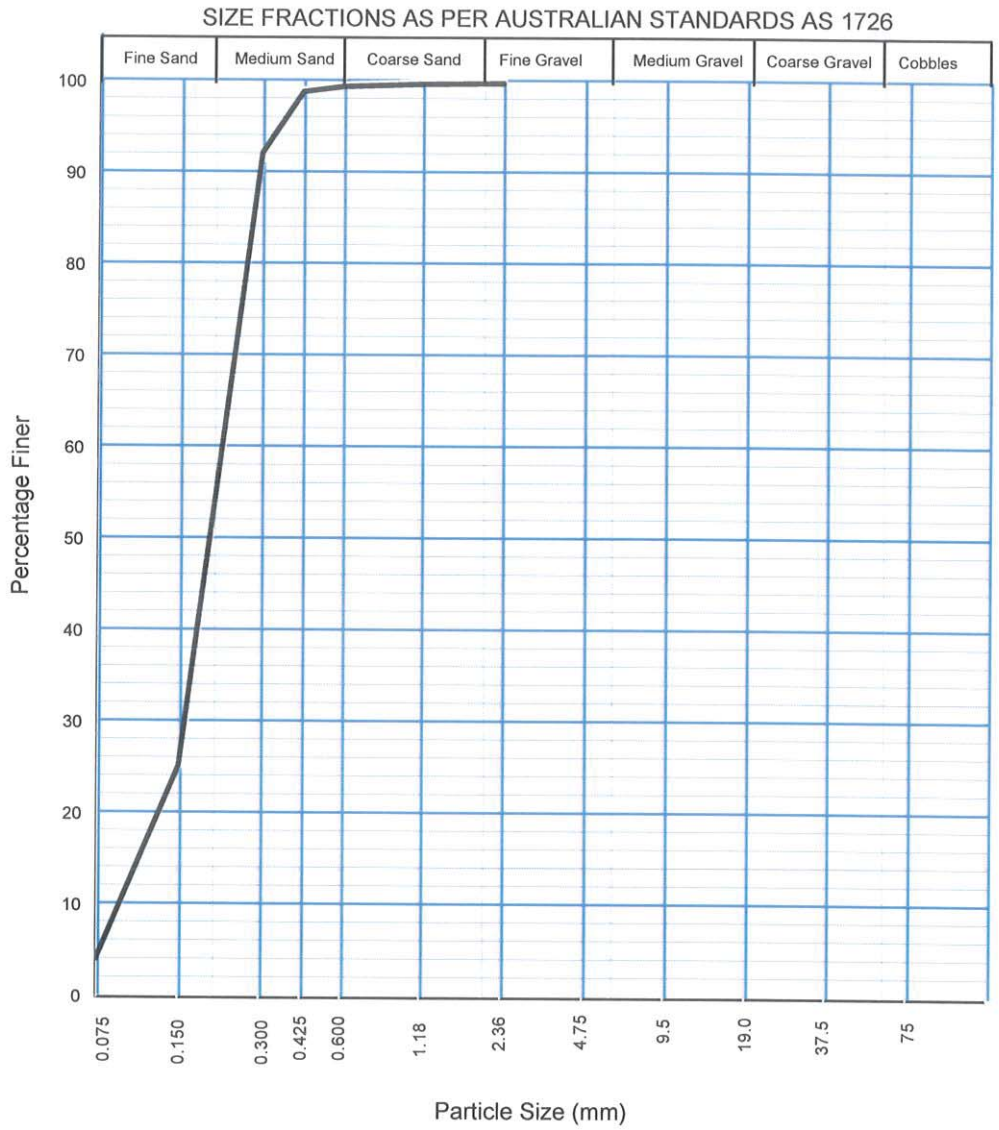
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18237
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301915
AAA Lab. ID :	A 23/07/2015	Project Ref.:	A15/3936/21
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.9
0.600	99.6
0.425	99.1
0.300	92.4
0.150	25.3
0.075	4.2



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by :

NATA
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13/8/15

Nick Farrer
Approved Signatory

Senior Technical Officer
NATA Accred. No. : 1961

Golder Associates

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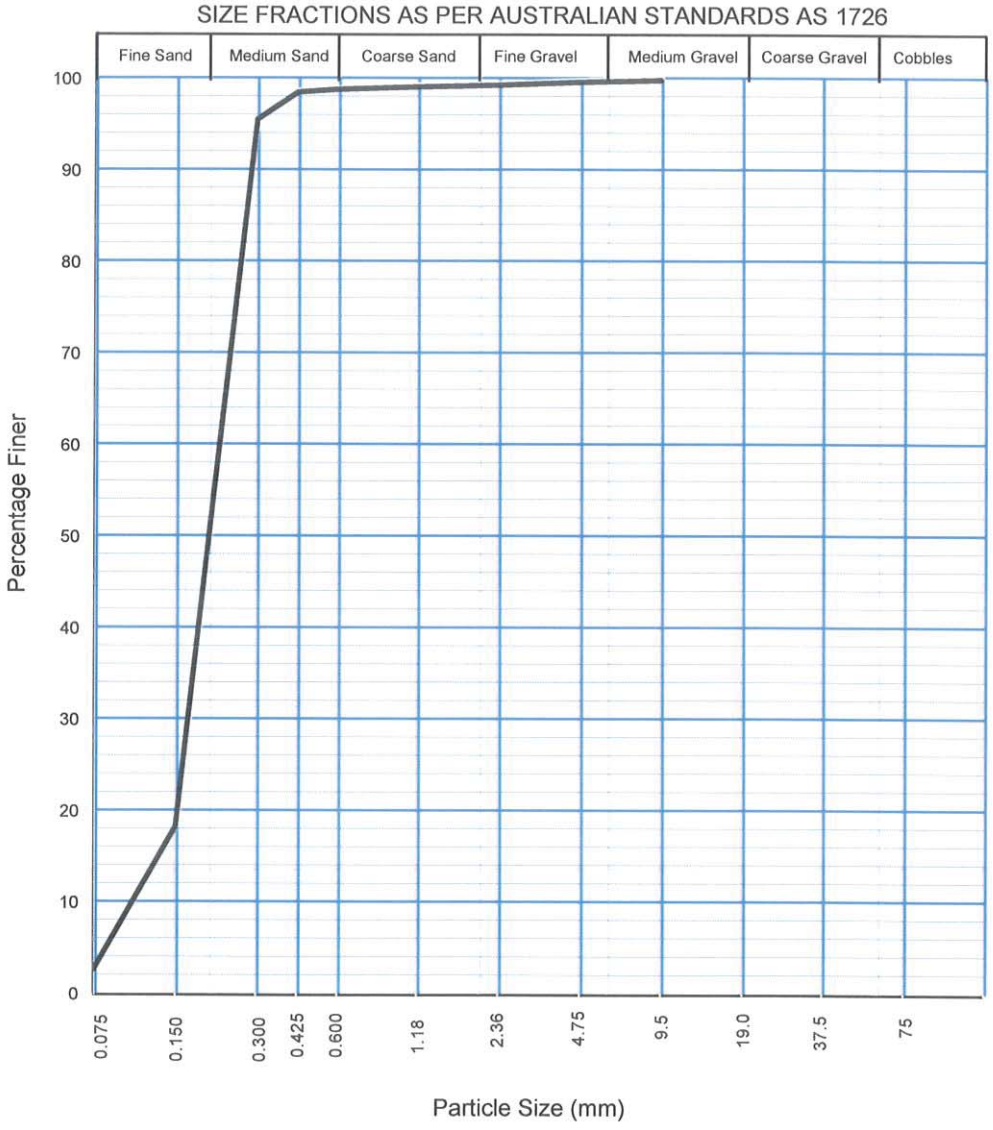
28 Bank Street, West End QLD 4101
PO Box 3427 Sth Brisbane BC QLD 4101
Phone : (07) 3840 9500
Email : bnelab@golder.com.au

PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18238
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301916
AAA Lab. ID :	B 23/07/2015	Project Ref.:	A15/3936/22
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	100.0
4.75	99.8
2.36	99.5
1.18	99.3
0.600	99.0
0.425	98.7
0.300	95.7
0.150	18.4
0.075	2.7



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF | Checked by : DJF

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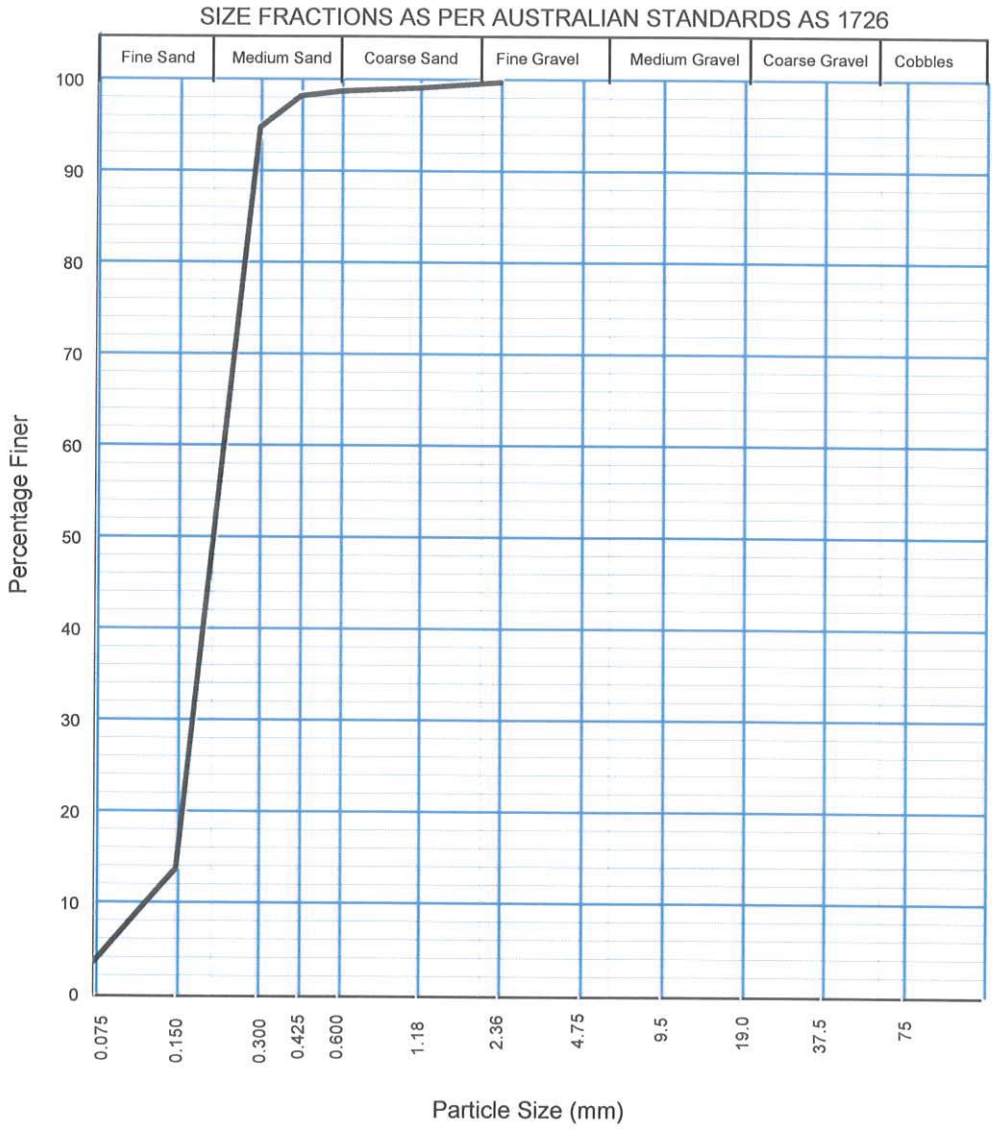
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18239
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301917
AAA Lab. ID :	C 23/07/2015	Project Ref.:	A15/3936/23
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.4
0.600	99.0
0.425	98.5
0.300	95.0
0.150	14.0
0.075	3.8



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by :

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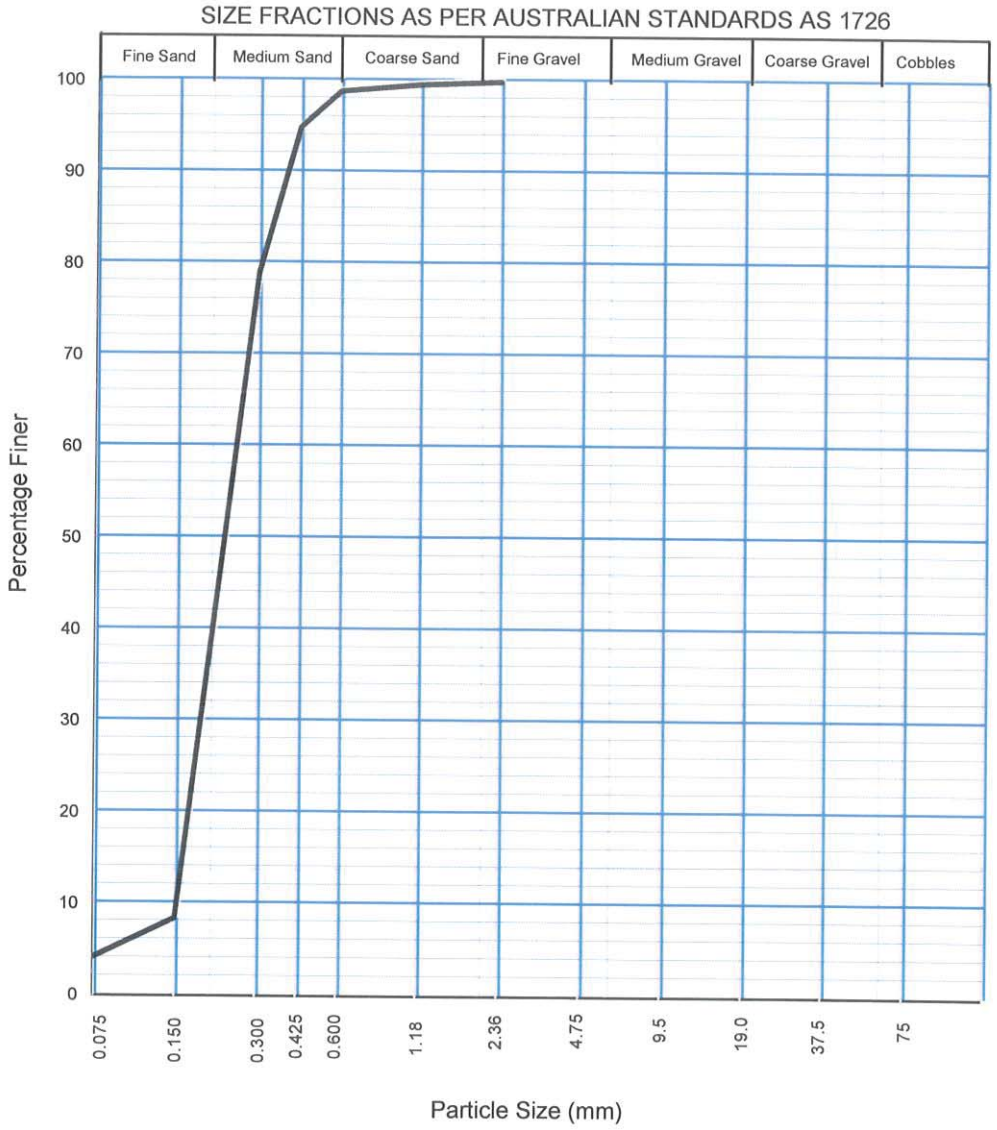
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18240
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301918
AAA Lab. ID :	D 23/07/2015	Project Ref.:	A15/3936/24
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.7
0.600	99.0
0.425	95.0
0.300	79.1
0.150	8.5
0.075	4.2



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : NK

Checked by : DJP

NATA

Nick Farrer
Approved Signatory

10/8/15

Senior Technical Officer
NATA Accred. No. : 1961

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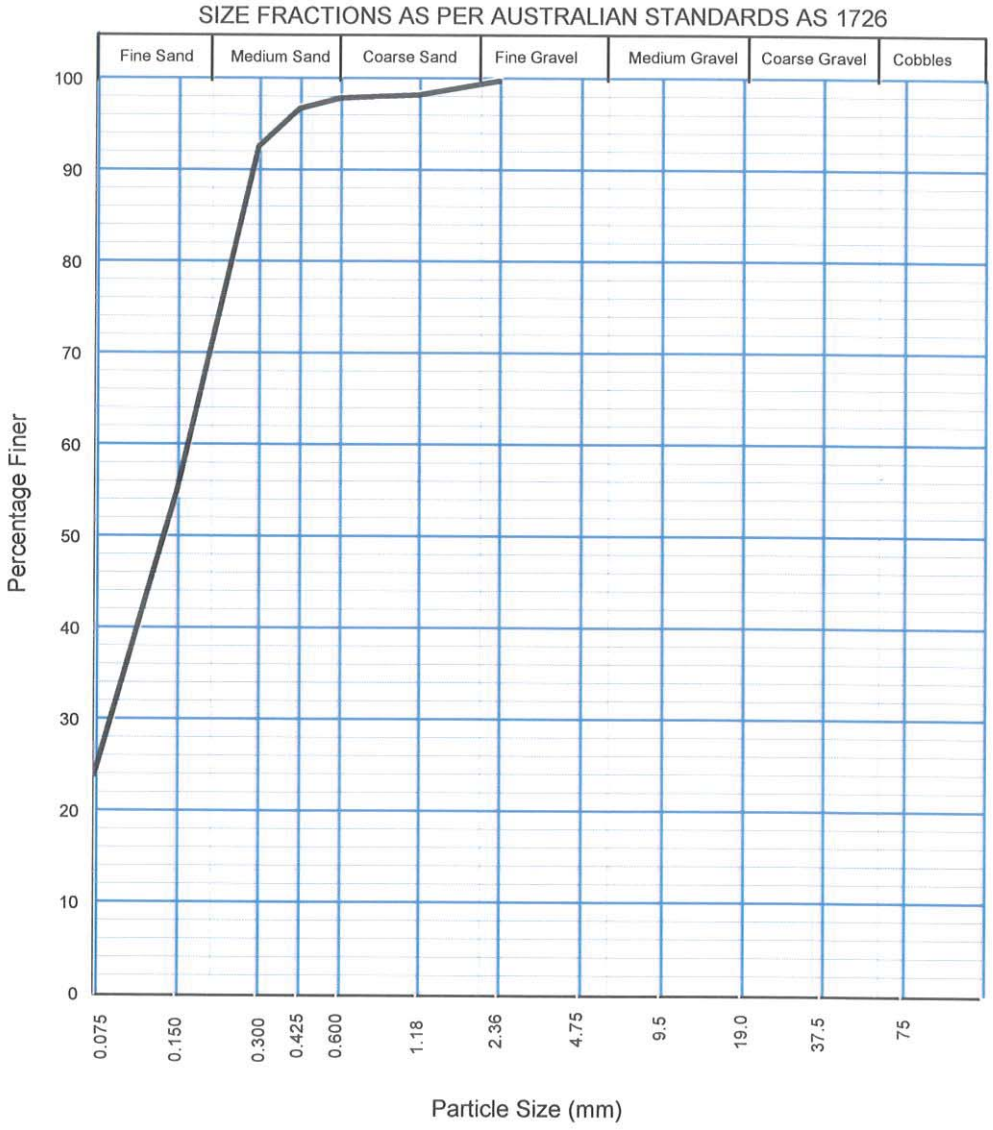
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18241
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301919
AAA Lab. ID :	E 23/07/2015	Project Ref.:	A15/3936/25
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	98.5
0.600	98.1
0.425	97.0
0.300	92.8
0.150	55.0
0.075	24.1



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : nt

Checked by : [signature]

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[signature] 10/8/15

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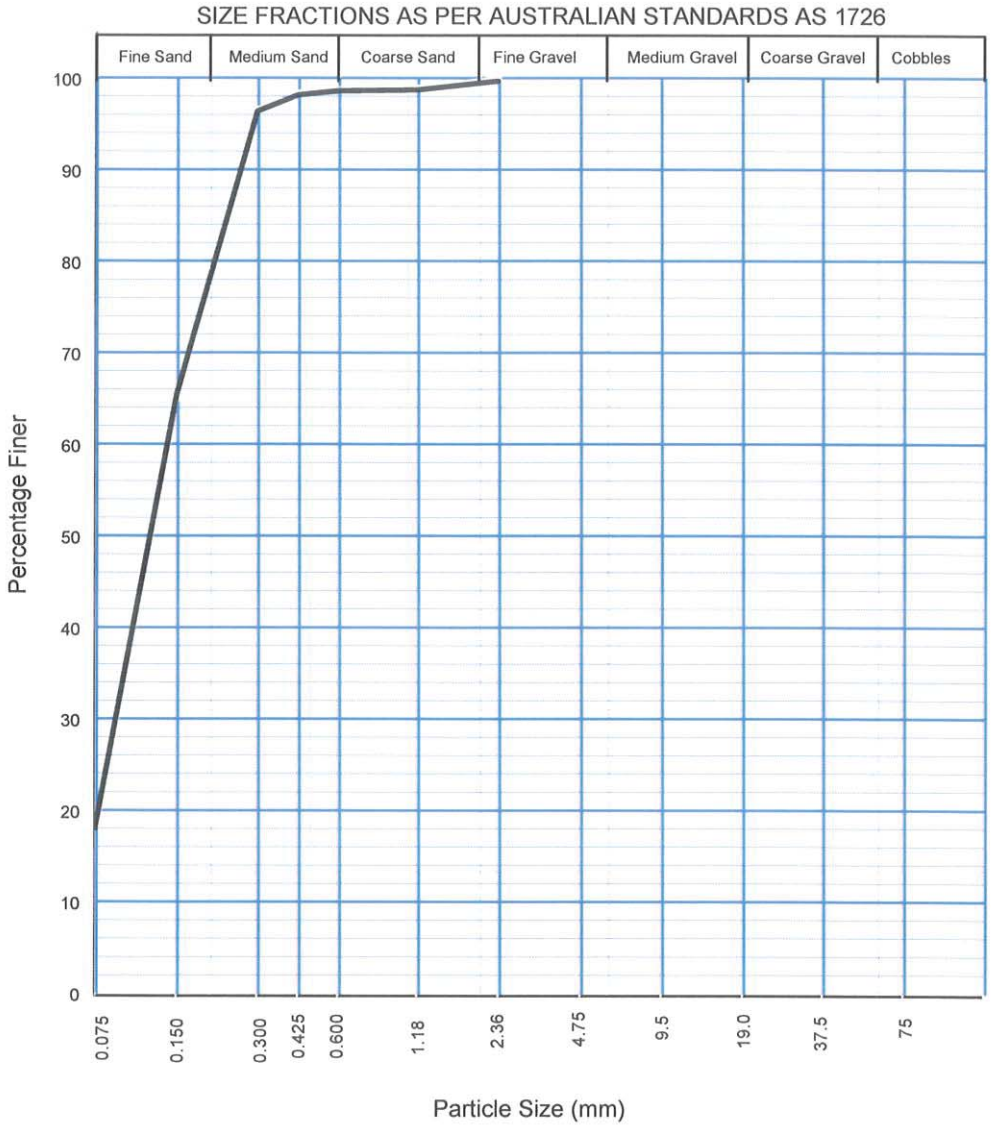
Client :	Advanced Analytical Australia	Report No. :	R18242
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301920
AAA Lab. ID :	F 23/07/2015	Project Ref.:	A15/3936/26
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.0
0.600	98.9
0.425	98.5
0.300	96.7
0.150	65.7
0.075	18.2



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by :

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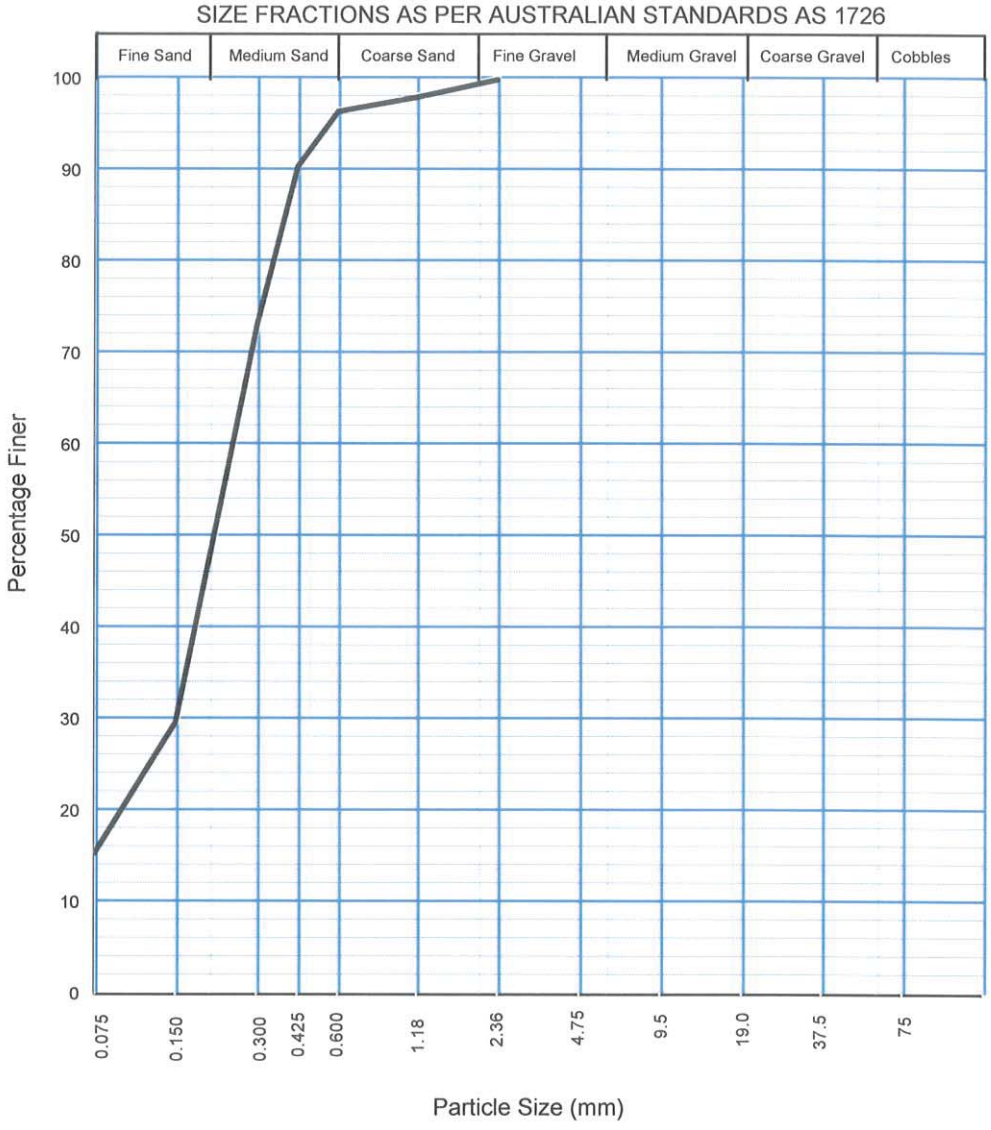
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18243
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301921
AAA Lab. ID :	H 23/07/2015	Project Ref.:	A15/3936/27
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	98.1
0.600	96.5
0.425	90.5
0.300	73.2
0.150	29.8
0.075	15.4



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : NF

Checked by :

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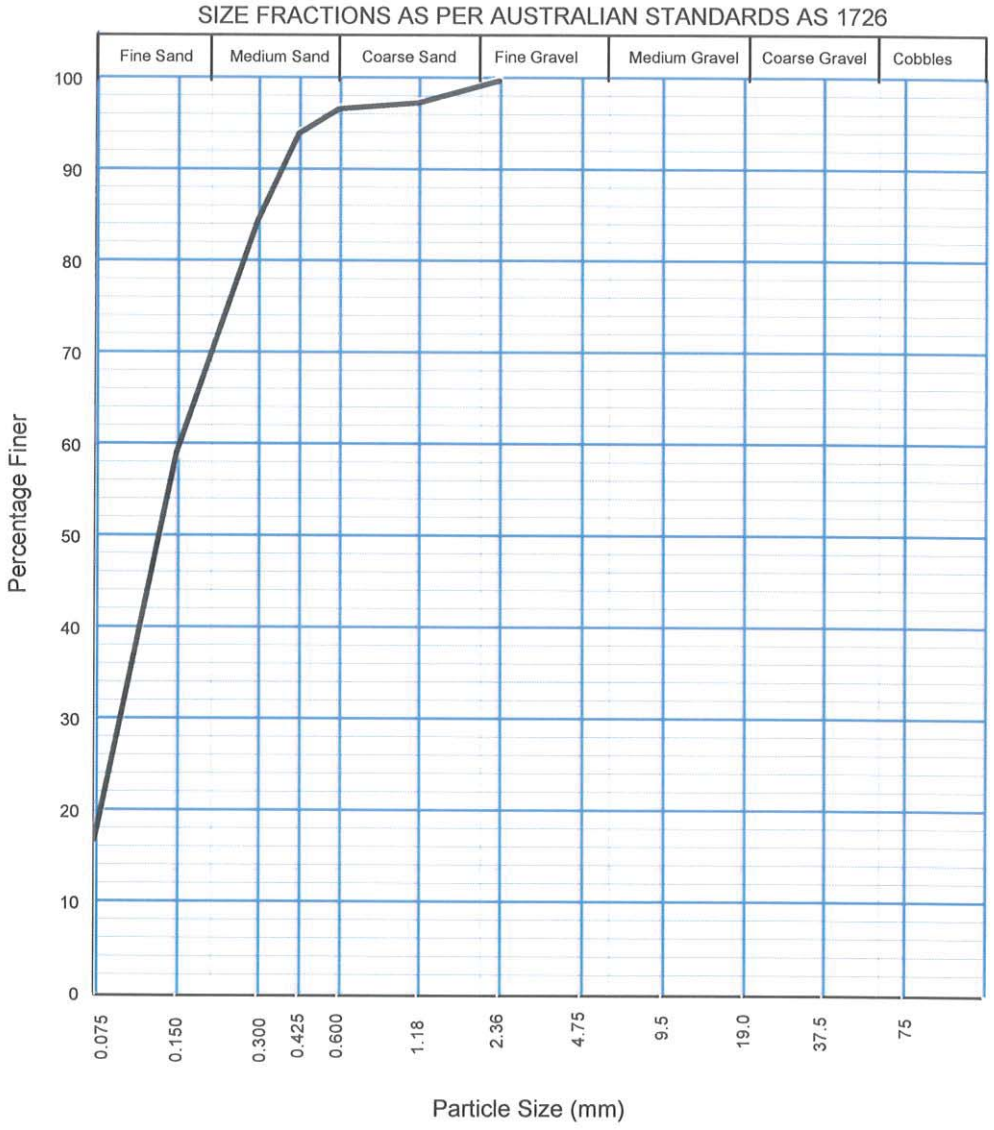
Client :	Advanced Analytical Australia	Report No. :	R18244
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301922
AAA Lab. ID :	I 23/07/2015	Project Ref.:	A15/3936/28
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	97.6
0.600	96.9
0.425	94.2
0.300	84.7
0.150	59.4
0.075	17.0



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : Checked by :

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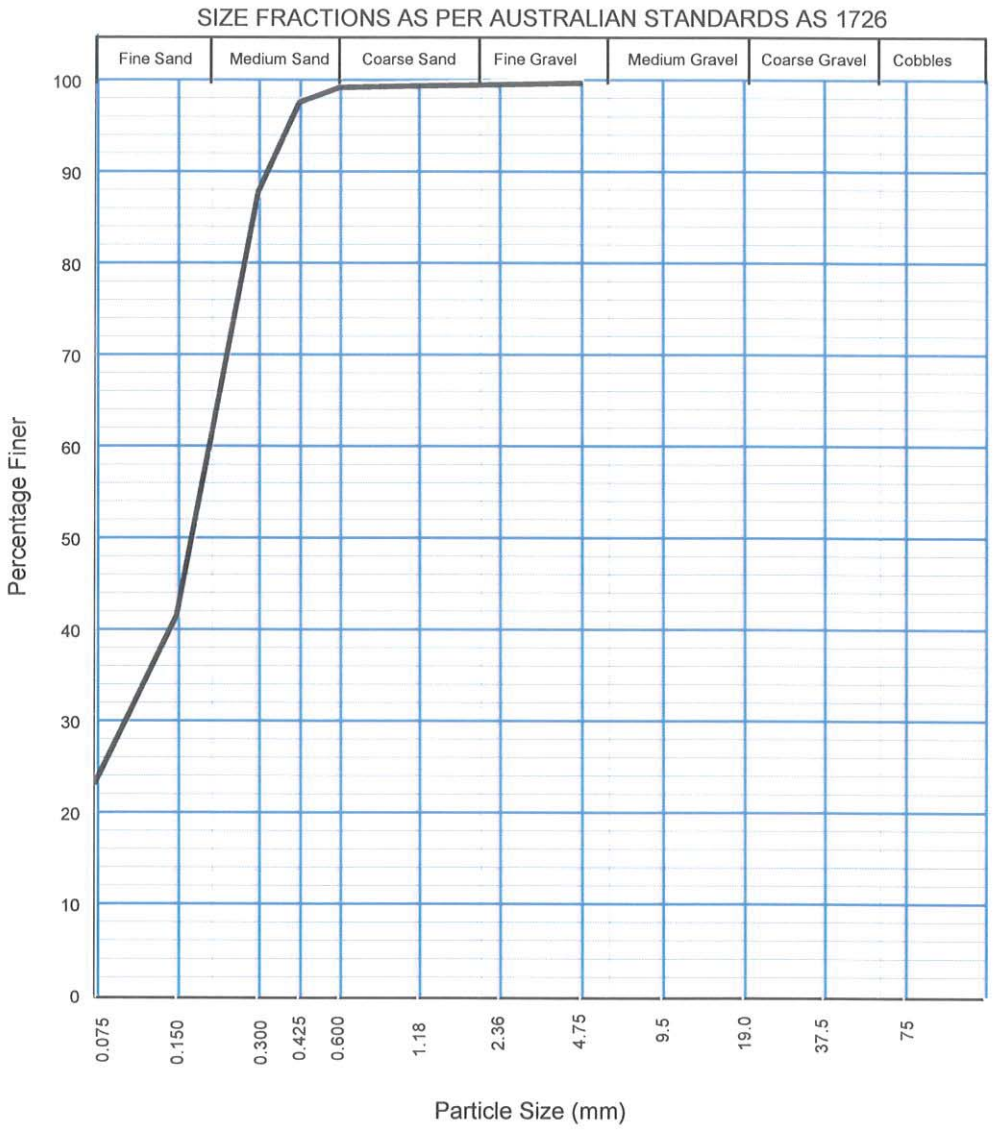
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18245
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301923
AAA Lab. ID :	J 24/07/2015	Project Ref.:	A15/3936/29
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	100.0
2.36	99.8
1.18	99.7
0.600	99.5
0.425	97.9
0.300	88.1
0.150	41.8
0.075	23.5



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by : DJ

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Senior Technical Officer
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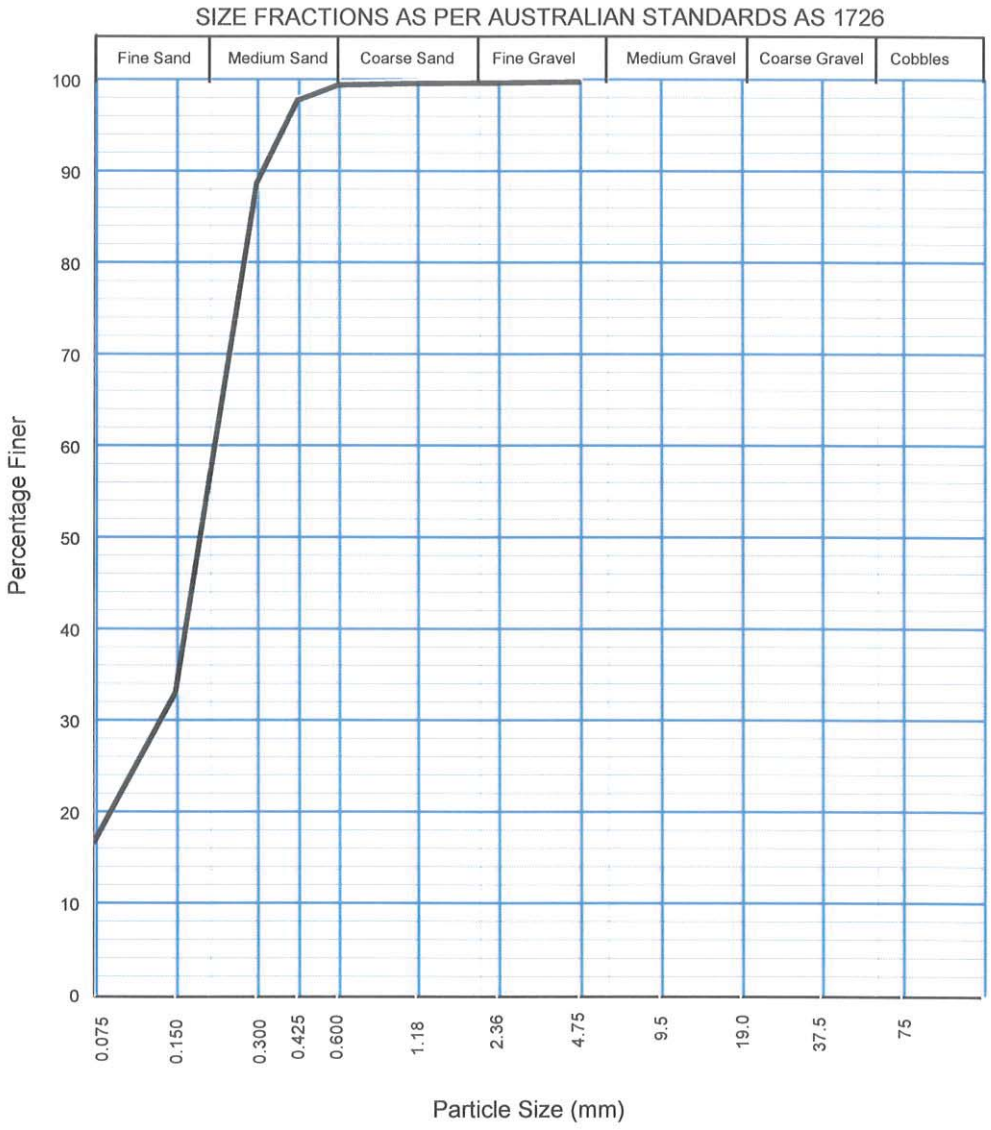
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18246
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301924
AAA Lab. ID :	K 24/07/2015	Project Ref.:	A15/3936/30
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	100.0
2.36	99.9
1.18	99.8
0.600	99.7
0.425	98.0
0.300	88.9
0.150	33.3
0.075	16.9



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MT | Checked by : DJ

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Approved Signatory

Senior Technical Officer
NATA Accred. No. : 1961

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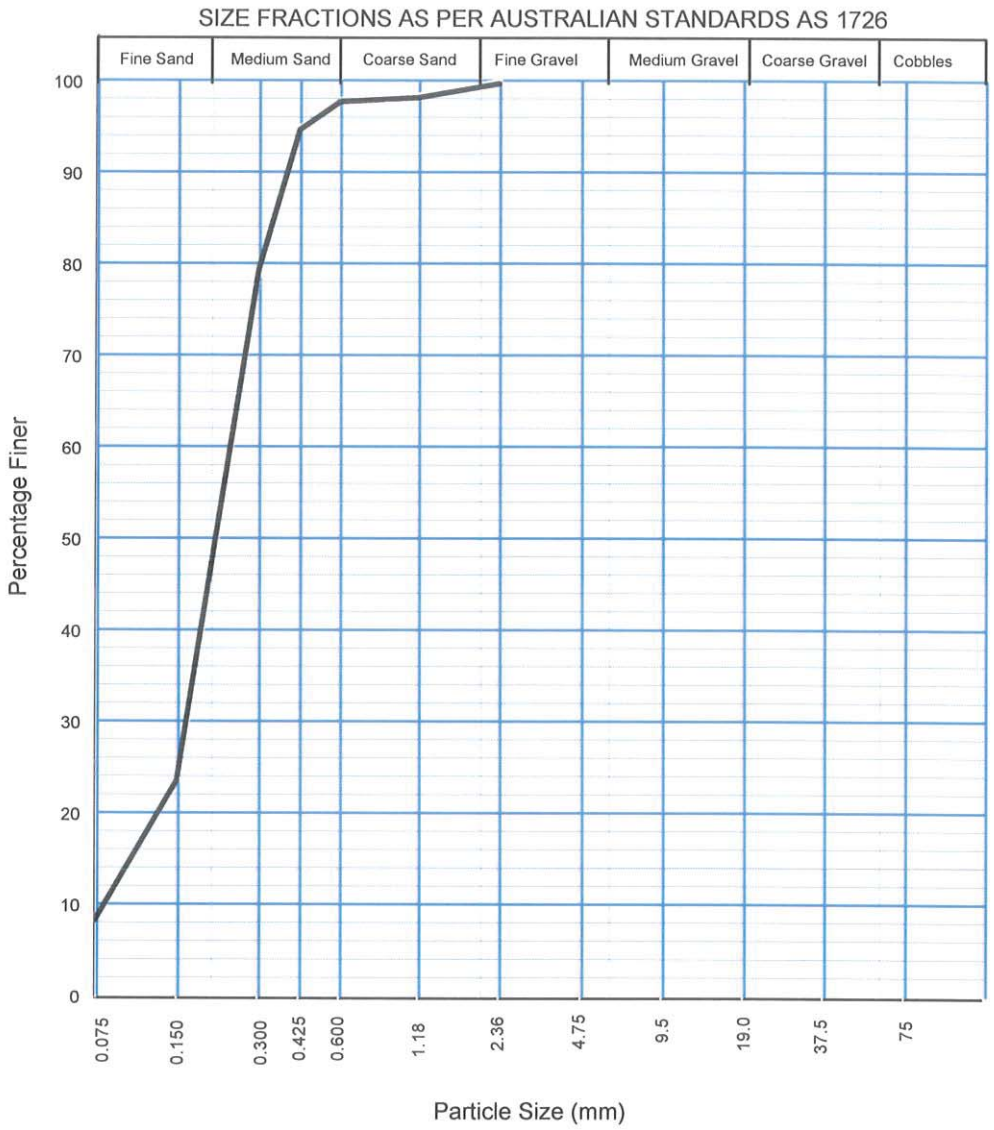
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18247
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301925
AAA Lab. ID :	L 24/07/2015	Project Ref.:	A15/3936/31
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	98.5
0.600	98.0
0.425	94.9
0.300	79.7
0.150	23.8
0.075	8.5



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : NF

Checked by : [signature]

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Approved Signatory

Senior Technical Officer
NATA Accred. No. : 1961

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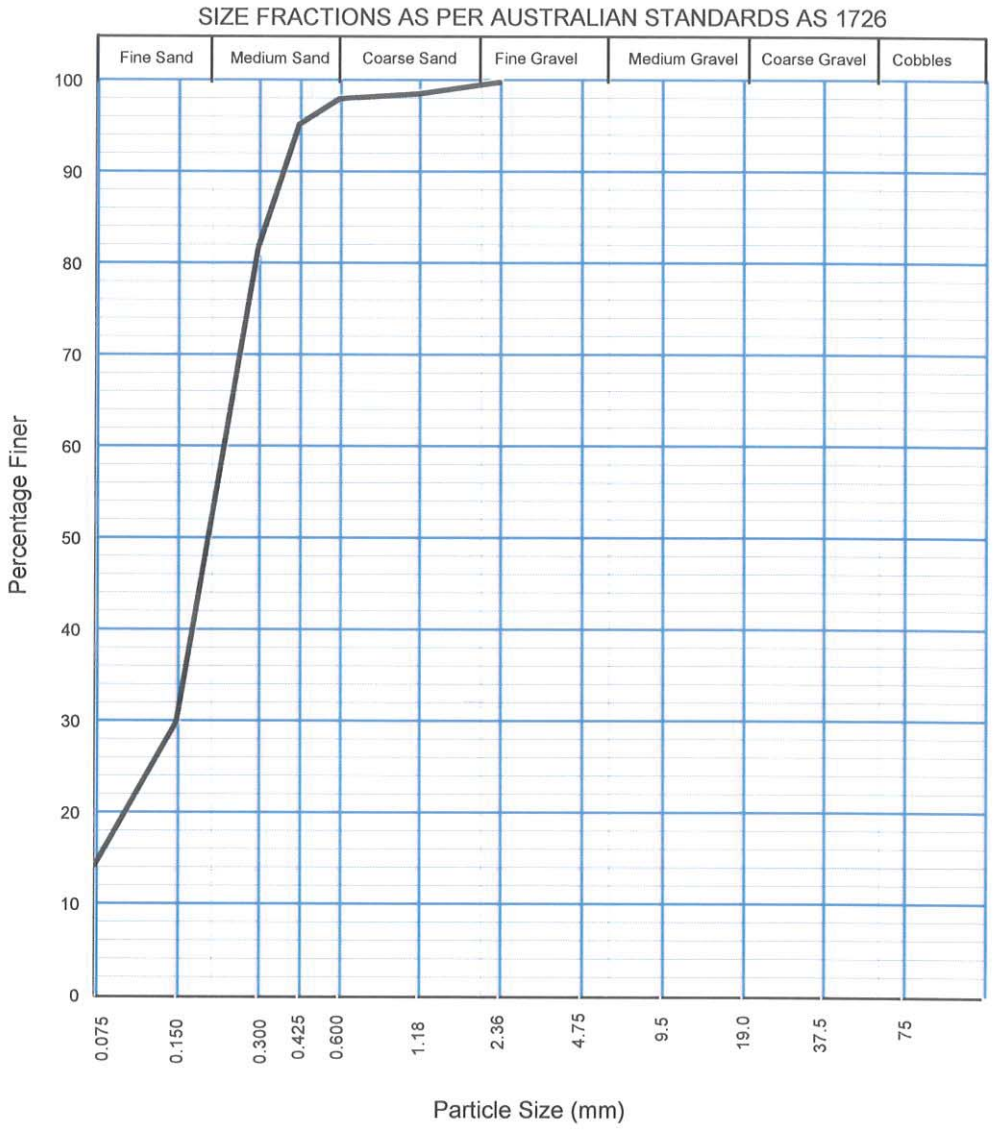
Email : bnelab@golder.com.au

PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18248
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301926
AAA Lab. ID :	M 24/07/2015	Project Ref.:	A15/3936/32
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	98.7
0.600	98.2
0.425	95.4
0.300	81.9
0.150	30.0
0.075	14.4



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MK

Checked by : DJ

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Approved Signatory

Senior Technical Officer
NATA Accred. No. : 1961

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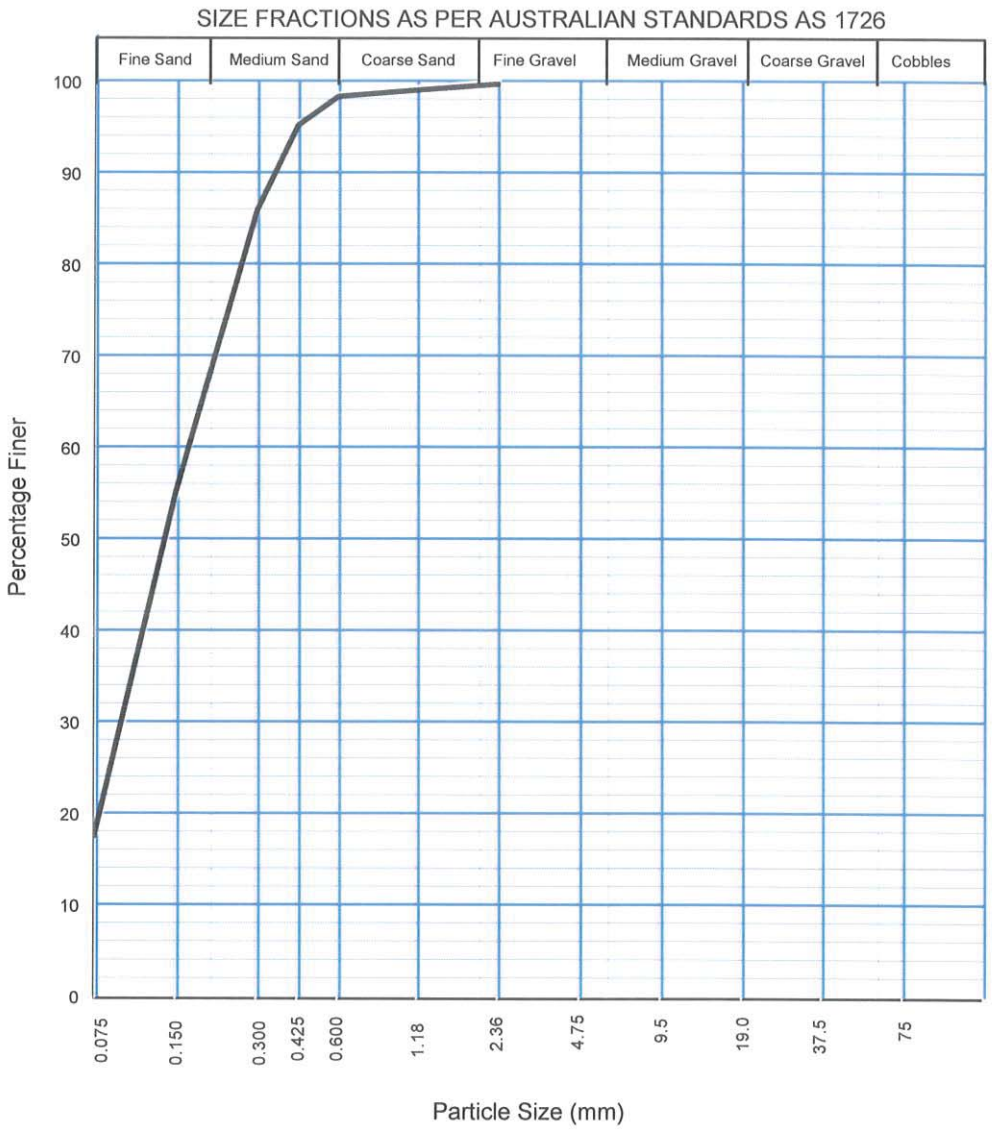
Email : bnelab@golder.com.au

PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18249
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301927
AAA Lab. ID :	N 24/07/2015	Project Ref.:	A15/3936/33
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.3
0.600	98.6
0.425	95.5
0.300	86.2
0.150	55.4
0.075	17.7



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : NL

Checked by : DJ

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Phone : (07) 3840 9500
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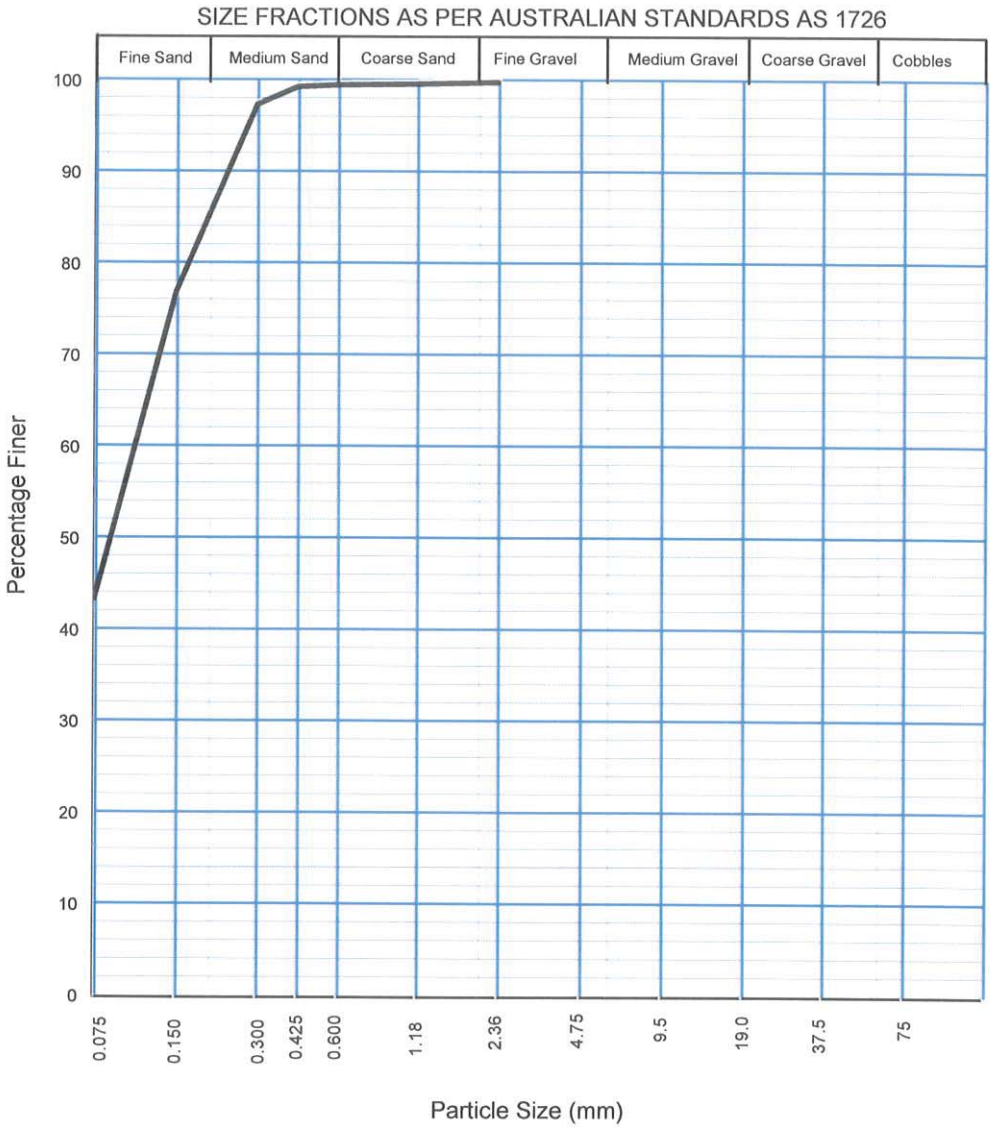
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18252
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301930
AAA Lab. ID :	Q 24/07/2015	Project Ref.:	A15/3936/36
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	99.8
0.600	99.7
0.425	99.5
0.300	97.6
0.150	77.1
0.075	43.5



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MF

Checked by :

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Approved Signatory

Senior Technical Officer
NATA Accred. No. : 1961

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PO Box 3427 Sth Brisbane BC QLD 4101
Phone : (07) 3840 9500
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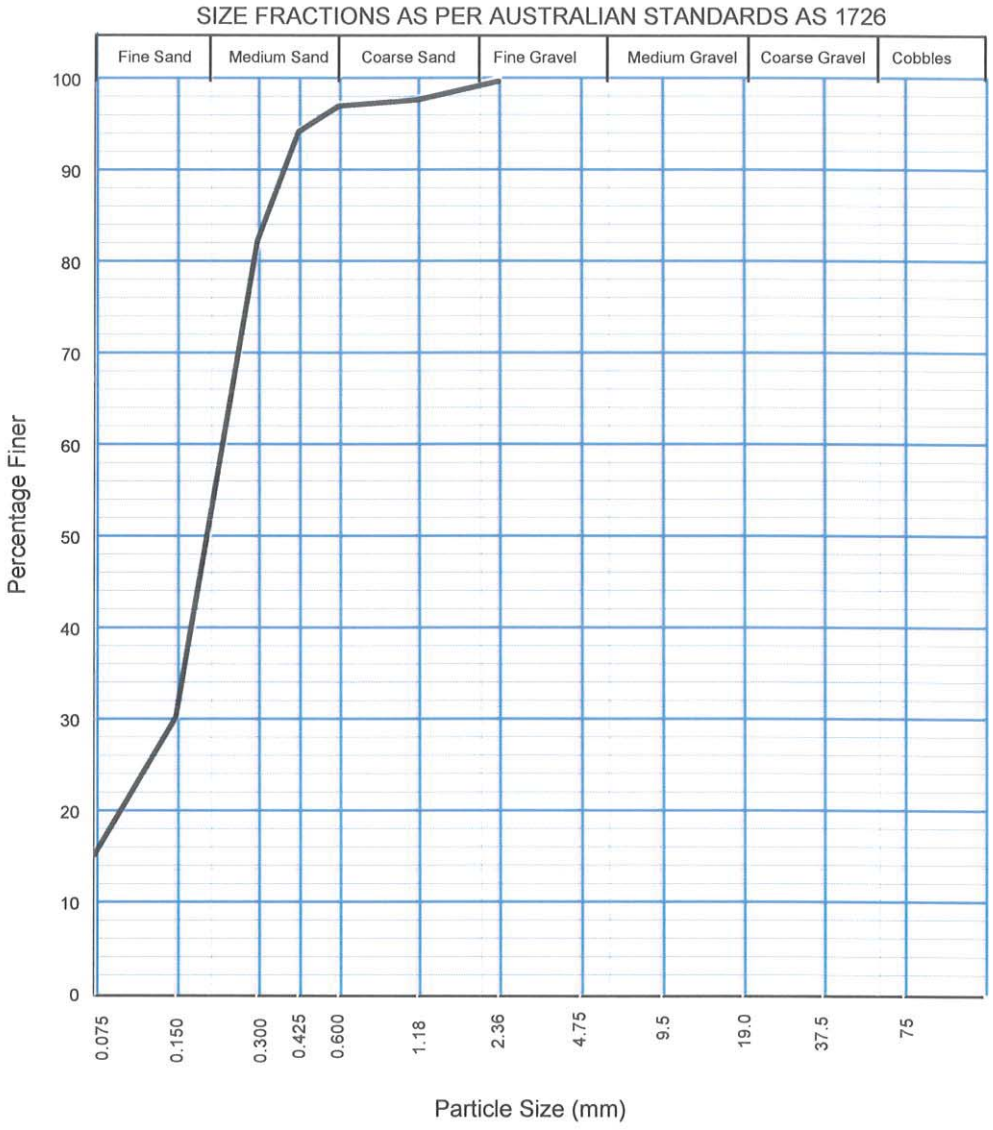
PARTICLE SIZE DISTRIBUTION

Client :	Advanced Analytical Australia	Report No. :	R18253
Address :	PO Box 153, Hamilton 4007	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301931
AAA Lab. ID :	R 24/07/2015	Project Ref.:	A15/3936/37
		Date Received :	31-Jul-15
		Sampled By :	Clients Rep.

Sieve Size (mm)	Percent Passing
150	
75	
37.5	
19.0	
9.5	
4.75	
2.36	100.0
1.18	98.0
0.600	97.3
0.425	94.4
0.300	82.5
0.150	30.4
0.075	15.4



Remarks :

Test Procedure : AS 1289 3.6.1

Prepared by : MT

Checked by : DJC

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Phone : (07) 3840 9500
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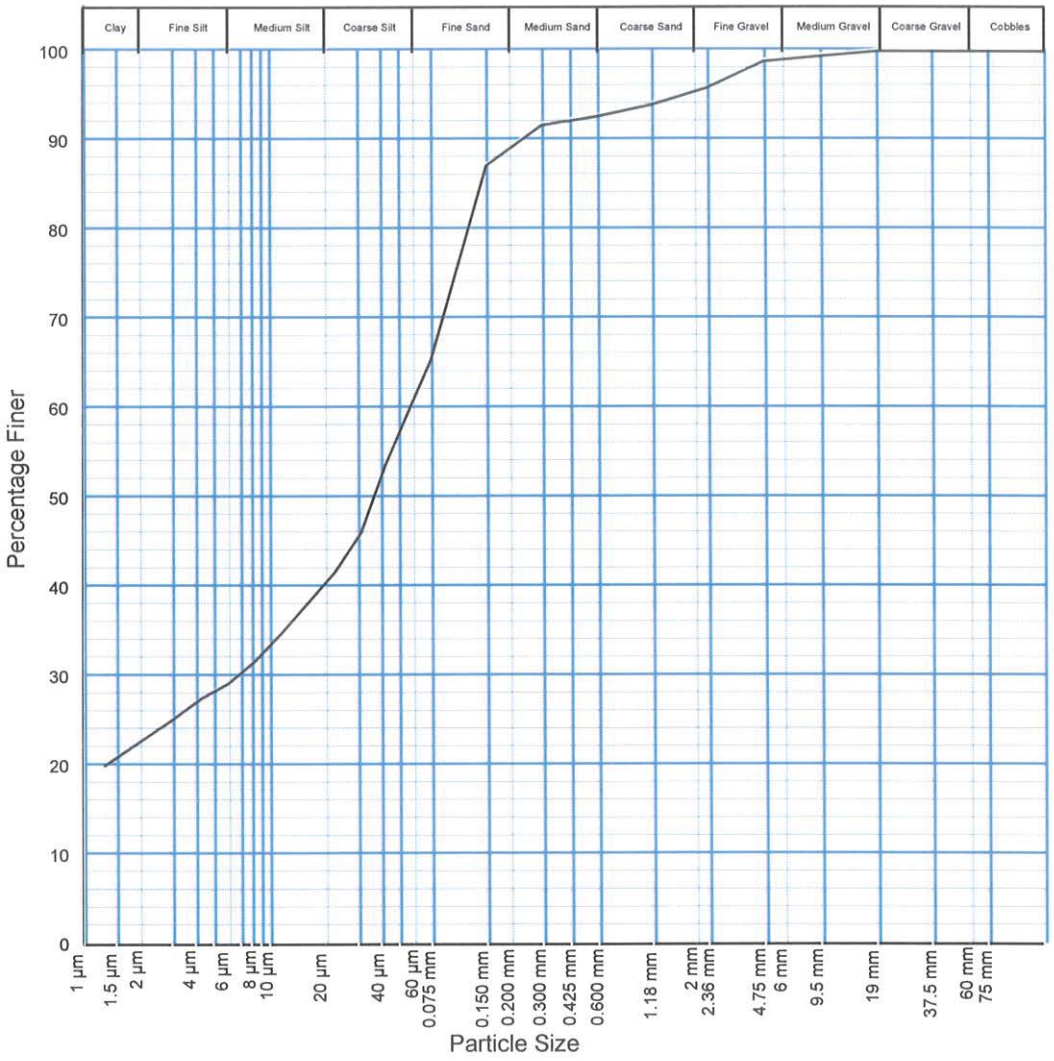
PARTICLE SIZE DISTRIBUTION BY HYDROMETER

Client :	Advanced Analytical Australia	Report No. :	R18220
Address :	482 Kingsford Smith Drive, Hamilton	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301898
AAA Lab. ID :	6 23/07/2015	Project Ref.:	A15/3936/4
		Date Received :	31/07/2015
		Sampled By :	Client

SIZE FRACTIONS AS PER AUSTRALIAN STANDARDS AS 1726

Particle Size (mm)	Percent Passing
150	
75	
37.5	
19.0	100.0
9.5	99.5
4.75	98.9
2.36	96.0
1.18	94.0
0.600	92.8
0.425	92.3
0.300	91.8
0.150	87.2
0.075	65.5
Particle Size (Microns)	Percent Passing
42.5	53.7
31.4	46.2
22.8	41.8
11.7	34.9
8.4	31.8
6.0	29.3
4.3	27.6
3.0	25.3
1.3	20.1



Pretreatment	Tested as received	Soil Particle Density (assumed)	2.70 t/m³
Loss in Pretreatment (%)	-	Type of Hydrometer	ASTM E100
Method of Dispersion	Mixer		
Test Procedure : AS 1289.3.6.3	- Variations to test method a)assumed particle density used b) testing up to 24 hours		
Prepared by :		Checked by :	

Accredited for compliance with ISO/IEC 17025.

NATA
WORLD RECOGNISED ACCREDITATION

10/8/15

Nick Farrer
Approved Signatory

Senior Technical Officer
NATA Accred. No. : 1961

Golder Associates

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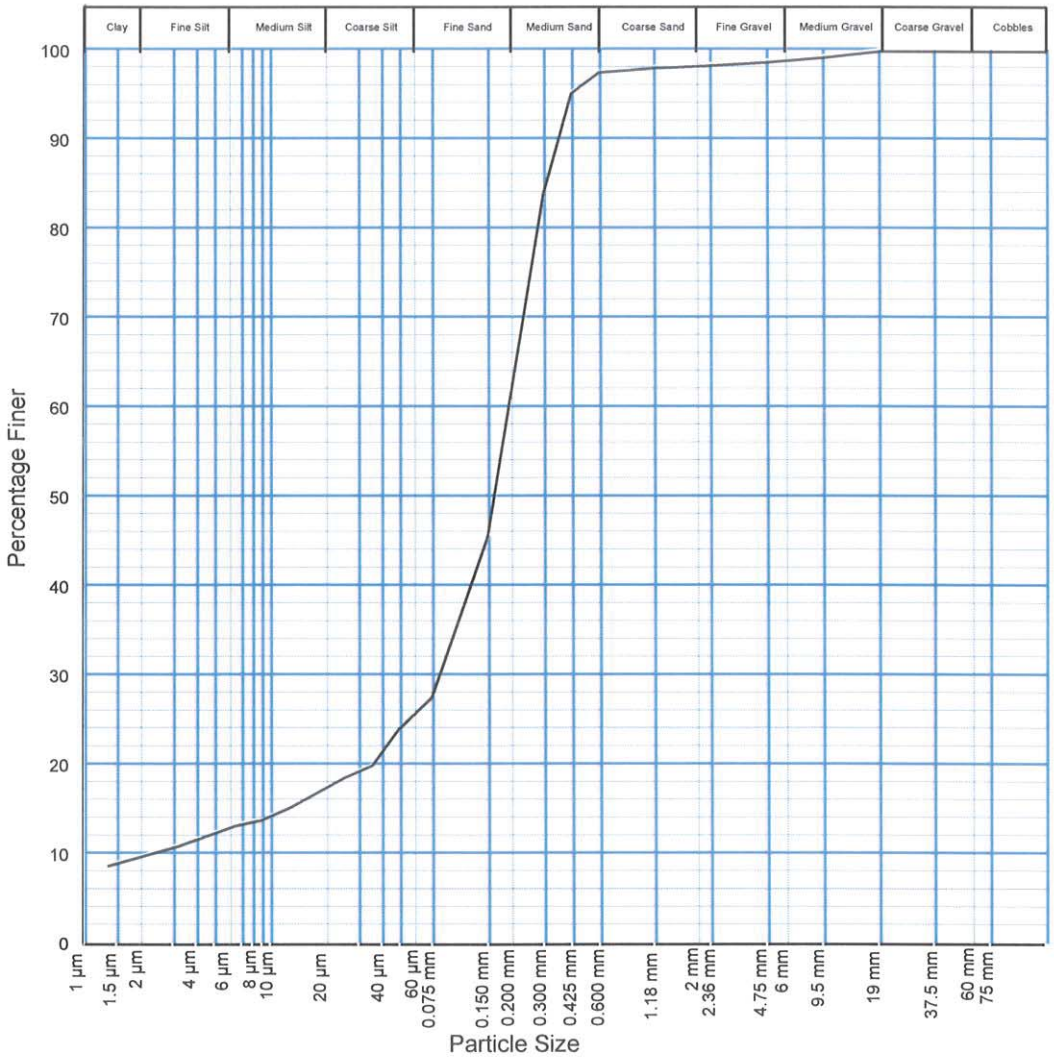
PARTICLE SIZE DISTRIBUTION BY HYDROMETER

Client :	Advanced Analytical Australia	Report No. :	R18224
Address :	482 Kingsford Smith Drive, Hamilton	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301902
AAA Lab. ID :	11 24/07/2015	Project Ref.:	A15/3936/8
		Date Received :	31/07/2015
		Sampled By :	Client

SIZE FRACTIONS AS PER AUSTRALIAN STANDARDS AS 1726

Particle Size (mm)	Percent Passing
150	
75	
37.5	
19.0	100.0
9.5	99.3
4.75	98.8
2.36	98.4
1.18	98.1
0.600	97.7
0.425	95.3
0.300	84.1
0.150	45.7
0.075	27.7
Particle Size (Microns)	Percent Passing
49.7	24.1
35.8	20.0
25.4	18.7
12.8	15.3
9.1	14.0
6.5	13.3
4.6	12.1
3.2	11.0
1.4	8.8



Pretreatment	Tested as received	Soil Particle Density (assumed)	2.70 t/m³
Loss in Pretreatment (%)	-	Type of Hydrometer	ASTM E100
Method of Dispersion	Mixer		
Test Procedure : AS 1289.3.6.3	- Variations to test method a)assumed particle density used b) testing up to 24 hours		
Prepared by : MF		Checked by :	

Accredited for compliance with ISO/IEC 17025.
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

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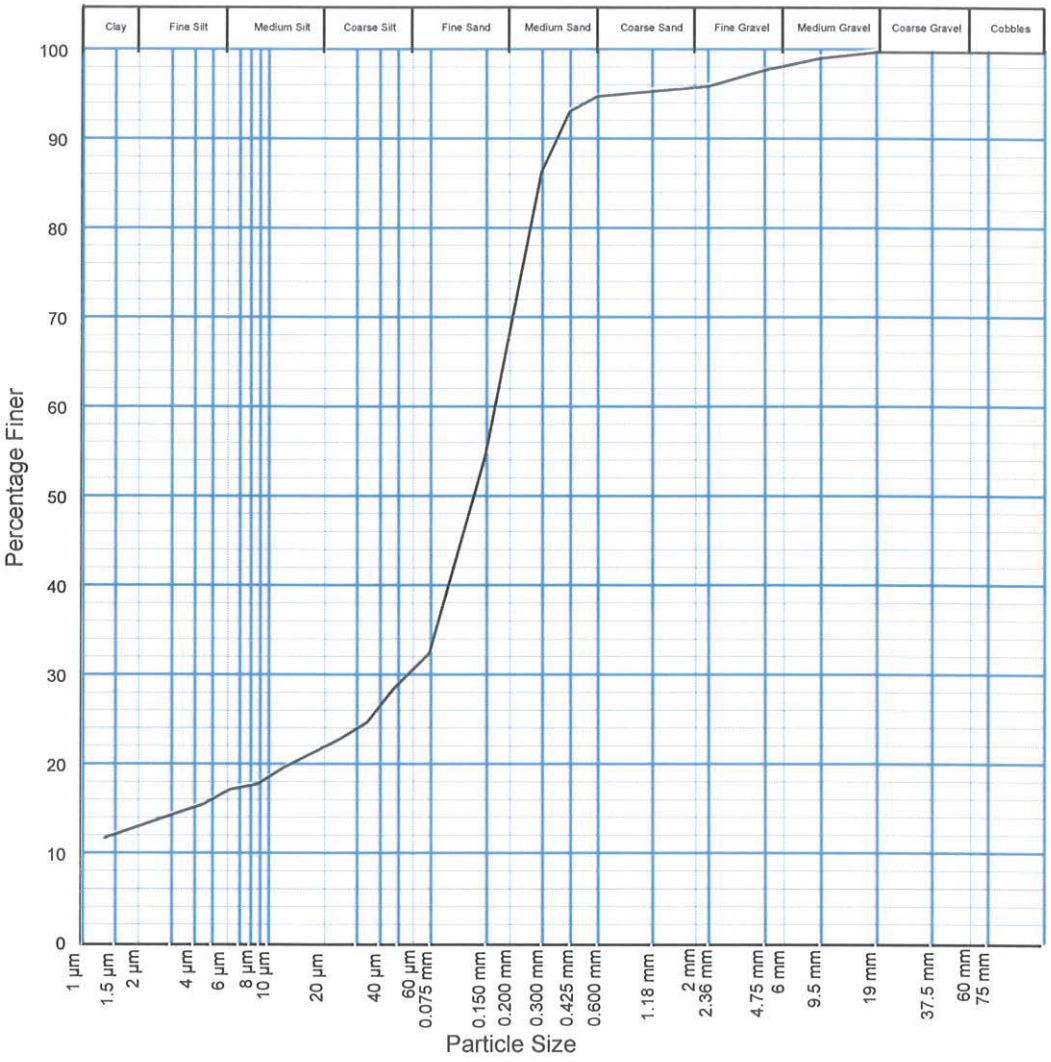
PARTICLE SIZE DISTRIBUTION BY HYDROMETER

Client :	Advanced Analytical Australia	Report No. :	R18227
Address :	482 Kingsford Smith Drive, Hamilton	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301905
AAA Lab. ID :	16 24/07/2015	Project Ref.:	A15/3936/11
		Date Received :	31/07/2015
		Sampled By :	Client

SIZE FRACTIONS AS PER AUSTRALIAN STANDARDS AS 1726

Particle Size (mm)	Percent Passing
150	
75	
37.5	
19.0	100.0
9.5	99.3
4.75	98.0
2.36	96.2
1.18	95.6
0.600	95.0
0.425	93.4
0.300	86.5
0.150	54.9
0.075	32.7
Particle Size (Microns)	Percent Passing
48.2	28.7
34.7	24.9
24.8	23.1
12.5	19.9
8.9	18.0
6.3	17.4
4.5	15.7
3.2	14.6
1.3	12.0



Pretreatment	Tested as received	Soil Particle Density (assumed)	2.70 t/m³
Loss in Pretreatment (%)	-	Type of Hydrometer	ASTM E100
Method of Dispersion	Mixer		
Test Procedure : AS 1289.3.6.3	- Variations to test method a)assumed particle density used b) testing up to 24 hours		
Prepared by :		Checked by :	

Accredited for compliance with ISO/IEC 17025.

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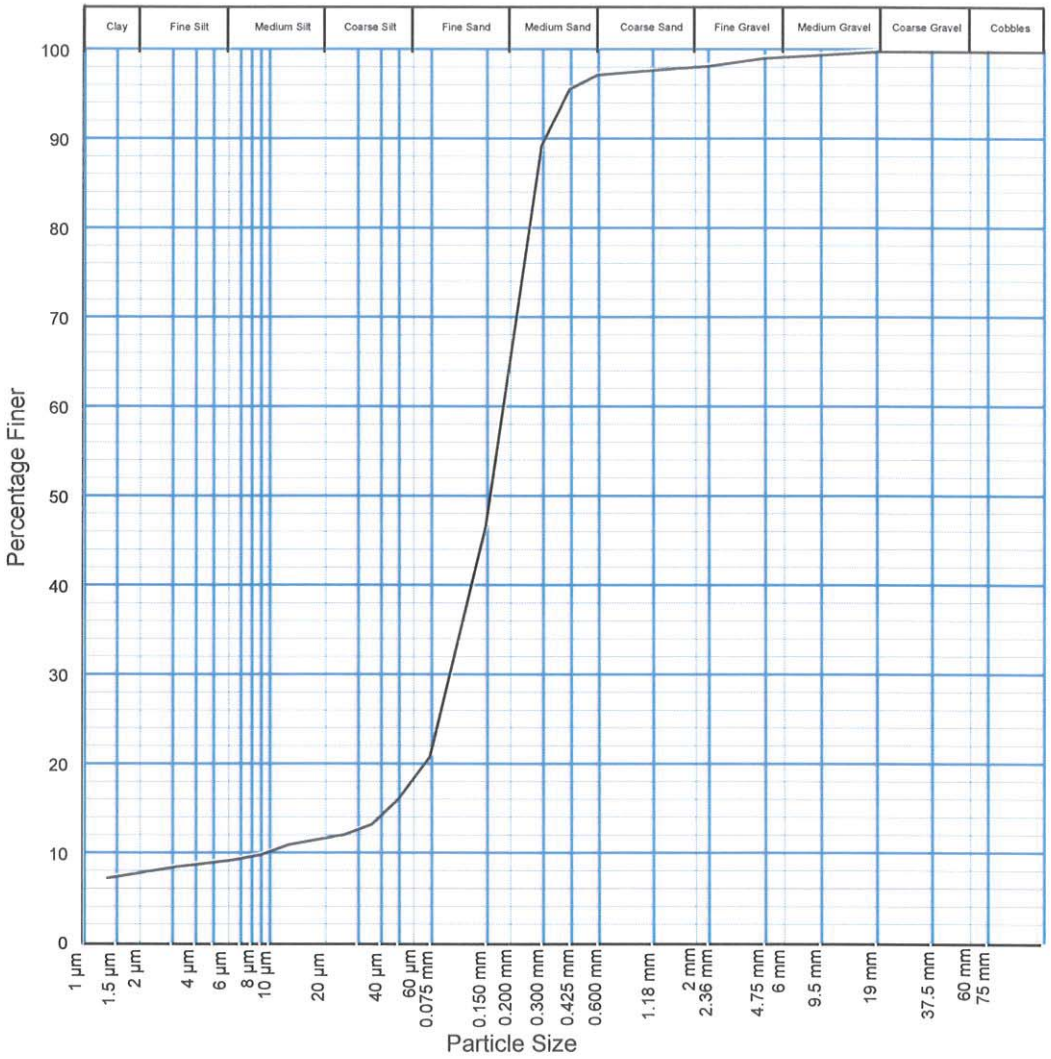
PARTICLE SIZE DISTRIBUTION BY HYDROMETER

Client :	Advanced Analytical Australia	Report No. :	R18250
Address :	482 Kingsford Smith Drive, Hamilton	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301928
AAA Lab. ID :	O 24/07/2015	Project Ref.:	A15/3936/34
		Date Received :	31/07/2015
		Sampled By :	Client

Particle Size (mm)	Percent Passing
150	
75	
37.5	
19.0	100.0
9.5	99.6
4.75	99.3
2.36	98.4
1.18	97.9
0.600	97.4
0.425	95.8
0.300	89.5
0.150	46.8
0.075	21.0
Particle Size (Microns)	Percent Passing
50.7	16.3
36.4	13.4
25.9	12.3
13.0	11.2
9.2	10.0
6.5	9.5
4.6	9.1
3.2	8.7
1.4	7.4

SIZE FRACTIONS AS PER AUSTRALIAN STANDARDS AS 1726



Pretreatment	Tested as received	Soil Particle Density (assumed)	2.70 t/m³
Loss in Pretreatment (%)	-	Type of Hydrometer	ASTM E100
Method of Dispersion	Mixer		
Test Procedure : AS 1289.3.6.3	- Variations to test method a)assumed particle density used b) testing up to 24 hours		
Prepared by : NL		Checked by :	

NATA

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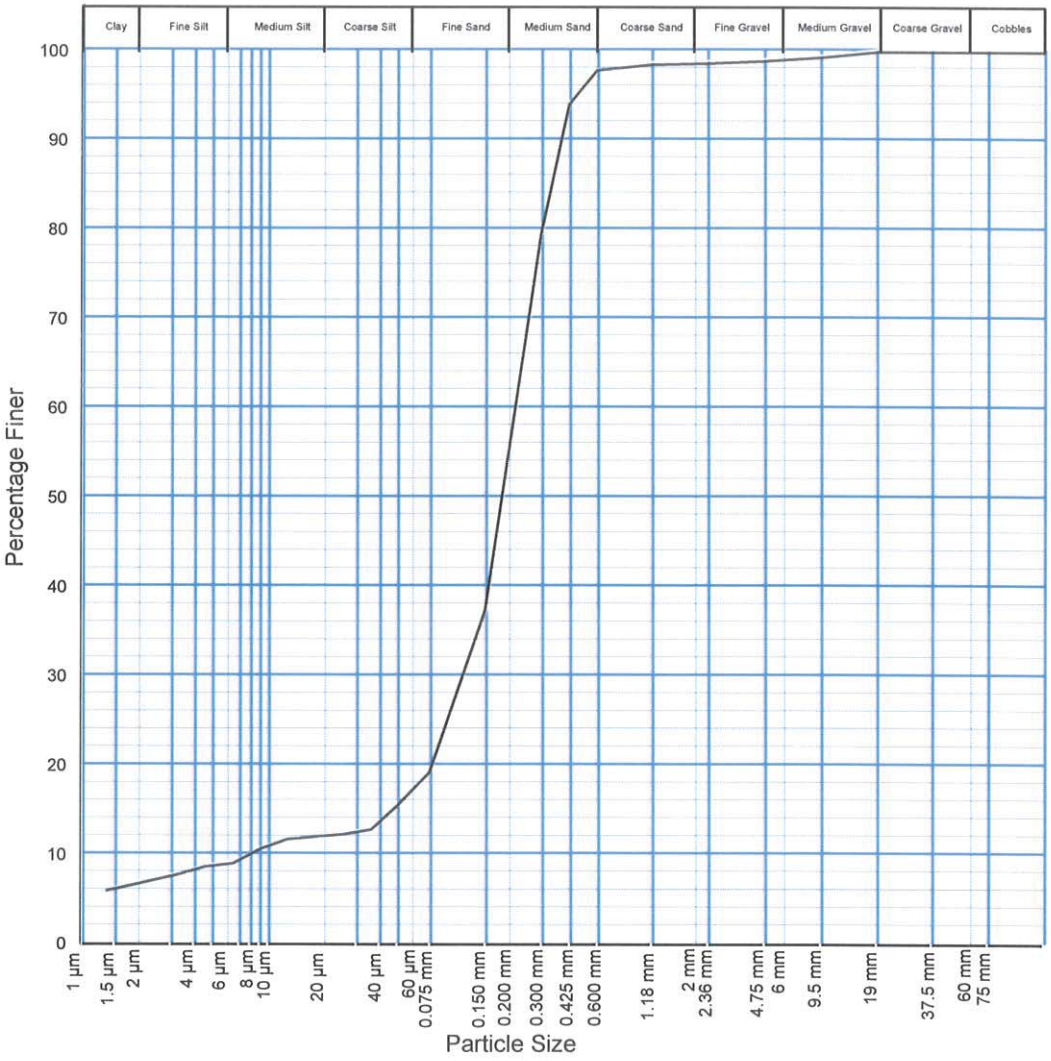
PARTICLE SIZE DISTRIBUTION BY HYDROMETER

Client :	Advanced Analytical Australia	Report No. :	R18251
Address :	482 Kingsford Smith Drive, Hamilton	Job No. :	1529881
Project :	Delivered Samples	Reg'n No. :	15301929
AAA Lab. ID :	P 24/07/2015	Project Ref.:	A15/3936/35
		Date Received :	31/07/2015
		Sampled By :	Client

SIZE FRACTIONS AS PER AUSTRALIAN STANDARDS AS 1726

Particle Size (mm)	Percent Passing
150	
75	
37.5	
19.0	100.0
9.5	99.4
4.75	99.0
2.36	98.7
1.18	98.6
0.600	97.9
0.425	94.1
0.300	79.6
0.150	37.4
0.075	19.3
Particle Size (Microns)	Percent Passing
50.7	15.6
36.4	12.9
25.8	12.3
12.9	11.8
9.2	10.7
6.5	9.1
4.6	8.7
3.3	7.8
1.4	6.0



Pretreatment	Tested as received	Soil Particle Density (assumed)	2.70 t/m³
Loss in Pretreatment (%)	-	Type of Hydrometer	ASTM E100
Method of Dispersion	Mixer		
Test Procedure : AS 1289.3.6.3	- Variations to test method a)assumed particle density used b) testing up to 24 hours		
Prepared by : MK		Checked by :	

NATA

10/8/15

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C.2 PSD Summary and Hydrometer Results

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TEST RESULTS

Client :	Advanced Analytical Australia	Job No. :	1529881
Project :	Delivered Samples	Date Received :	31/07/2015
Project Ref. :	A15/3936	Sampled by :	Clients Rep.

PARTICLE SIZE SUMMARY

Reg'n No.	Sample ID	Sample No.	Percent Gravel (+ 2 mm)	Percent Sand (2 mm - 0.060 mm)	Percent Silt (0.060 mm - 0.002 mm)	Percent Clay (-0.002 mm)
15301895	2 23/07/2015	1	0	81	19	
15301896	4 23/07/2015	2	0	60	40	
15301897	5 23/07/2015	3	0	86	14	
15301898	6 23/07/2015	4	5	34	39	22
15301899	7 23/07/2015	5	0	71	29	
15301900	8 23/07/2015	6	0	95	5	
15301901	9 23/07/2015	7	0	98	2	
15301902	11 24/07/2015	8	2	72	16	10
15301903	12 23/07/2015	9	0	86	14	
15301904	13 23/07/2015	10	0	53	47	
15301905	16 24/07/2015	11	4	66	17	13
15301906	17 23/07/2015	12	0	94	6	
15301907	18 23/07/2015	13	0	43	57	
15301908	20 24/07/2015	14	0	88	12	
15301909	21 23/07/2015	15	0	87	13	
15301910	22 23/07/2015	16	0	23	77	
15301911	24 24/07/2015	17	0	6	94	
15301912	25 23/07/2015	18	0	76	24	
15301913	26 23/07/2015	19	0	70	30	
15301914	29 23/07/2015	20	0	73	27	
15301915	A 23/07/2015	21	0	96	4	
15301916	B 23/07/2015	22	1	96	3	
15301917	C 23/07/2015	23	0	96	4	
15301918	D 23/07/2015	24	0	96	4	
15301919	E 23/07/2015	25	0	76	24	
15301920	F 23/07/2015	26	0	82	18	
15301921	H 23/07/2015	27	0	85	15	
15301922	I 23/07/2015	28	1	82	17	
15301923	J 24/07/2015	29	0	76	24	
15301924	K 24/07/2015	30	0	83	17	
15301925	L 24/07/2015	31	1	90	9	
15301926	M 24/07/2015	32	0	86	14	
15301927	N 24/07/2015	33	0	82	18	
15301928	O 24/07/2015	34	2	80	10	8
15301929	P 24/07/2015	35	2	81	10	7
15301930	Q 24/07/2015	36	0	56	44	
15301931	R 24/07/2015	37	1	84	15	

Remarks :			
Test Procedures :	AS1289.3.6.1 & AS1289.3.6.3		
Prepared by :	NF	Checked by	DJ

C.3 Bulk Sediment Summary

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TEST RESULTS

Client :	Advanced Analytical Australia	Job No. :	01529881
Project :	Delivered Samples	Date Received :	31/07/2015
Project Ref. :	A15/3936	Sampled by :	Clients Rep.

BULK DENSITY SUMMARY

Reg'n No.	Sample ID	Sample No.	Bulk Density (t/m³)
15301898	6 23/07/2015	4	1.519
15301902	11 24/07/2015	8	1.669
15301905	16 24/07/2015	11	1.563
15301916	B 23/07/2015	22	1.712
15301928	O 24/07/2015	34	1.684
15301929	P 24/07/2015	35	1.741

Remarks :

Prepared by : NF Checked by DJ

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