



Gorgon Gas Development and Jansz Feed Gas Pipeline

Coastal Stability Management and Monitoring Plan Supplement: Management Triggers

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Terminology, Definitions and Abbreviations

Terms, definitions and abbreviations used in this document are listed below. These align with the terms, definitions and abbreviations defined in Schedule 2 of the Western Australian Gorgon Gas Development Ministerial Implementation Statement No. 800 (Statement No. 800) and the Commonwealth Gorgon Gas Development Ministerial Approvals (EPBC Reference: 2003/1294, 2008/4178).

BD	Base of Primary Dune; sampling site located at the base of the primary dune.
Beach Face	Sloping section of beach directly affected by wave action.
CBF	Crest of Beach Face; sampling site located at the change in slope at the transition between the Beach Face and Foredune Area.
Coast	The land adjacent to the sea upon which waves have an effect, extending from Mean Low Water to beyond the permanent dune vegetation line.
Construction	Construction includes any Proposal-related (or action-related) construction and commissioning activities within the Terrestrial and Marine Disturbance Footprints, excluding investigatory works such as, but not limited to, geotechnical, geophysical, biological and cultural heritage surveys, baseline monitoring surveys and technology trials.
Construction Period	The period from the date on which the Gorgon Joint Venture participants first commence construction of the Proposal until the date on which the Gorgon Joint Venture participants issue a notice of acceptance of work under the EPCM, or equivalent contract entered into in respect of the second LNG train of the Gas Treatment Plant.
Cth	Commonwealth of Australia
DEC	Western Australian Department of Environment and Conservation
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts
DoT	Western Australian Department of Transport (previously Department for Planning and Infrastructure)
EPBC Reference: 2003/1294	Commonwealth Ministerial Approval (for the Gorgon Gas Development) as amended or replaced from time to time.
EPBC Reference: 2008/4178	Commonwealth Ministerial Approval (for the Revised Gorgon Gas Development) as amended or replaced from time to time.
EPCM	Engineering, Procurement and Construction Management
FA	Foredune Area; sampling site located between the beach face and the primary dune, which is populated by scattered vegetative hummocks and marine turtle body holes.
Gorgon Gas Development	The Gorgon Gas Development as approved under Statement No. 800 and EPBC Reference: 2003/1294 and 2008/4178 as amended or replaced from time to time.

GPS	Global Positioning System
LNG	Liquefied Natural Gas
m	Metre
MAD	Median Absolute Deviation
Management Triggers	Are quantitative, or where this is demonstrated to be not practicable, qualitative matters above or below whichever relevant additional Management Measures or investigations must be considered.
Marine Facilities	In relation to Condition 17.2 of Statement No. 800 and Condition 13.2 of EPBC Reference: 2003/1294 and 2008/4178, the Marine Facilities are the: <ul style="list-style-type: none">• Materials Offloading Facility (MOF)• LNG Jetty.
Marine Turtles	Refers to Flatback, Green and Hawksbill Turtles nesting on Barrow Island.
MOF	Materials Offloading Facility
MTEP	Marine Turtle Expert Panel
Operations (Gorgon Gas Development)	In relation to Statement No. 800 and EPBC Reference: 2003/1294 and 2008/4178, for the respective LNG trains, this is the period from the date on which the Gorgon Joint Venturers issue a notice of acceptance of work under the Engineering, Procurement and Construction Management (EPCM) contract, or equivalent contract entered into in respect of that LNG train of the Gas Treatment Plant; until the date on which the Gorgon Joint Venturers commence decommissioning of that LNG train.
PD	Primary Dune; sampling site located on the primary dune beyond the permanent vegetation line.
Performance Standards	Are matters which are developed for assessing performance, not compliance, and are quantitative targets or where that is demonstrated to be not practicable, qualitative targets, against which progress towards achievement of the objectives of conditions can be measured.
Practicable	Practicable means reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge. For the purposes of the conditions of EPBC Reference 2003/1294 and 2008/4178 which include the term "practicable", when considering whether the draft plan meets the requirements of these conditions, the Commonwealth Minister will determine what is „practicable“ having regard to local conditions and circumstances including but not limited to personnel safety, weather or geographical conditions, costs, environmental benefit and the current state of scientific and technical knowledge
Primary Dune	The largest and most mature seaward dune.

Project Attributable	Attributable to the construction and/or operation of the MOF or LNG Jetty
PSD	Particle Size Distribution
RTK GPS	Real Time Kinematic Global Positioning System
Significant Impact	An impact on a Matter of National Environmental Significance, relevant to EPBC Reference: 2003/1294 and 2008/1478 that is important, notable or of consequence having regard to its context or intensity.
Statement No. 800	Western Australian Ministerial Implementation Statement No. 800 (for the Gorgon Gas Development) as amended or replaced from time to time.
Transect	The path along which a surveyor moves, counts and records observations.

1.0 Introduction

The Gorgon Gas Development and Jansz Feed Gas Pipeline Coastal Stability Management and Monitoring Plan (Chevron Australia 2009a) was developed as required by Condition 25 of Ministerial Implementation Statement No. 800 (Statement No. 800) for the Revised and Expanded Gorgon Gas Development, which was approved by the Director General of the Western Australian Department of Environment and Conservation on 10 September 2009. The Plan was also required under Condition 18 of the Commonwealth Approval for the Revised and Expanded Gorgon Gas Development (EPBC Reference: 2003/1294 and 2008/4178), and was approved by the Assistant Secretary, Environment Assessment Branch of the Commonwealth Department of Environment, Water, Heritage and the Arts on 14 September 2009.

The Coastal Stability Management and Monitoring Plan Supplement: Management Triggers (this Supplement) has been prepared to meet the requirements of Condition 25.4.iv of Statement No. 800 and Condition 18.4.iv of EPBC Reference: 2003/1294 and 2008/4178 that the Coastal Stability Management and Monitoring Plan addressed in a preliminary way but that required supplementing. This Supplement should be read in conjunction with the Coastal Stability Management and Monitoring Plan, which includes details of the monitoring program, including sampling methodology, rationale for selection of monitoring beaches, baseline information (July 2008 to July 2009) and proposed an approach for the development of Management Triggers.

The requirements of this Supplement, as stated in Condition 25.4.iv of Statement No. 800 and Condition 18.4.iv of EPBC Reference: 2003/1294 and 2008/4178 are listed in **Error! Reference source not found.. Error! Reference source not found.** also references the specific sections of this Supplement where each requirement is addressed.

Table 1.1 Requirements of this Coastal Stability Management and Monitoring Plan Supplement: Management Triggers

Ministerial Document	Condition No.	Requirement	Section Reference in this Supplement
Statement No. 800	25.4.iv	The Plan must include: iv. Management Triggers.	Section 2.0 <i>Note that the collection of additional information and other data analysis not included in Management Trigger analysis is discussed in Section 3.0. The Management Measures that may be implemented when a Management Trigger is exceeded are detailed in Section 4.0. Baseline information covering the period July 2008 to October 2009, for selected beach transects, with relevant analysis, is presented in Section 5.0.</i>
EPBC Reference: 2003/1294 and 2008/4178	18.4.iv	The Plan must include: iv. Management Triggers.	Section 2.0 <i>Note that the collection of additional information and other data analysis not included in Management Trigger analysis is discussed in Section 3.0. The Management Measures that may be implemented when a Management Trigger is exceeded are detailed in Section 4.0. Baseline information covering the period July 2008 to October 2009, for selected beach transects, with relevant analysis, is presented in Section 5.0.</i>

Following approval, this Supplement will be considered to be approved as part of the Coastal Stability Management and Monitoring Plan, but will be maintained as a stand-alone document. Where relevant, amendments made to the Coastal Stability Management and Monitoring Plan will also be considered to be amendments to this Supplement. Any matters or requirements in the Supplement that are taken from the Coastal Stability Management and Monitoring Plan (rather than Statement No. 800 or EPBC Reference: 2003/1294 and 2008/4178) may be amended from time to time in accordance with amendments to the Coastal Stability Management and Monitoring Plan. Amendments to this Supplement may also be made directly in accordance with Section 8.3 of the Coastal Stability Management and Monitoring Plan. Note that if there is any difference or inconsistency between the Coastal Stability Management and Monitoring Plan and this Supplement in relation to either Condition 25.4.iv of Statement No. 800 or Condition 18.4.iv of EPBC Reference: 2003/1294 and 2008/4178, then this Supplement is to be preferred.

1.1 Objectives

The key objective of this Supplement is to identify the Management Triggers, which are values for beach slope, beach volume and sediment particle size that have been established to “trigger” additional Management Measures. The Management Measures that may be implemented when a Management Trigger is exceeded are also set out in this Supplement. The actions required if monitoring shows that beach profiles and sand grain size change beyond the set Performance Standards are defined by Condition 25.6 of Statement No. 800 and Condition 18.6 of EPBC Reference: 2003/1294 and 2008/4178. The Performance Standards are defined in Section 6.3 of the Coastal Stability Management and Monitoring Plan. Section 5.3 of the Coastal Stability Management and Monitoring Plan sets out the potential mitigation measures which may be considered in the event that there is a change in beach profile and sand grain size beyond the Performance Standards.

1.2 Stakeholder Consultation

Under Condition 25.2 of Statement No. 800 and Condition 18.2 of EPBC Reference: 2003/1294 and 2008/4178, the Western Australian Department of the Environment and Conservation (DEC), the Western Australian Department for Transport (DoT), the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) and the Marine Turtle Expert Panel (MTEP), are to be consulted during the preparation of the Coastal Stability Management and Monitoring Plan.

This Supplement to the Coastal Stability Management and Monitoring Plan has been prepared with input from:

- DEC: The DEC has reviewed and provided comment on the Draft Supplement.
- DoT: The DoT was provided with the Draft Supplement for their review.
- MTEP: The MTEP was provided with a verbal briefing and discussed the Draft Supplement at an Expert Panel meeting on 8 December 2009.
- Dr M. Chaloupka, Ecological Modelling Services Pty Ltd, Independent Reviewer: Dr Chaloupka reviewed the Draft Supplement and his comments have been incorporated or otherwise resolved.

2.0 Management Triggers

Section 5.2 of the Coastal Stability Management and Monitoring Plan proposed an approach for the development of Management Triggers for measurement of significant adverse impacts on beach structure (beach volume and beach slope) and beach sediment (beach sand particle size) (Table 2.1), which could have implications for marine turtles nesting on the beaches adjacent to Town Point (Terminal Beach and Bivalve Beach). The proposed approach provided

for Management Triggers that would highlight changes outside the „normal“ range of variation of selected parameters.

In this Supplement, baseline data for the period July 2008 to October 2009 have been used to establish the „normal“ range of variation for the selected parameters. Routine beach profile and beach sediment surveys have been and will continue to be conducted quarterly as outlined in the Coastal Stability Management and Monitoring Plan. Beach profile and beach sediment survey data will continue to be collected prior to the commencement of construction activities associated with the Materials Offloading Facility (MOF) and LNG Jetty at Town Point and will be included in the baseline data, which may result in amendments to the Management Triggers (Table 2.1) based on updated means and standard deviations of the baseline data.

Table 2.1 Management Triggers for Beach Structure and Beach Sediments

Parameter (State)	Proposed Impacts Management Triggers/Criteria for Measuring Significant Adverse Impacts	Proposed Analysis	Management Trigger
Beach Volume	Change in volume of beach at specific points of interest (cubic metres of sediment per metre of longshore beach width [$m^3/5 m^2$]) outside the „normal“ range of oscillation in beach volume	Shewhart control charts at selected points of interest along selected transects	Management Trigger based on mean and standard deviation of baseline data: Table 2.4
Beach Slope	Change in beach slope at specific points of interest outside the „normal“ range of oscillation in beach slope		
Beach Sediment Characteristics	Change in sediment characteristics at specific depths at points of interest outside the „normal“ range of oscillation in sediment characteristics	Plot of particle size distribution	Change in sediment particle size from medium sand to either fine gravel or coarse silt at 0.6 m depth at the Fore dune Area or 0.3 m depth at the Crest of Beach Face along selected transects

Source: Adapted from Table 5.1, Chevron Australia 2009a.

Other parameters proposed in the Coastal Stability Management and Monitoring Plan will be used for further information to investigate and assess whether there are significant adverse impacts on beach structure and beach sediments, should a Management Trigger be exceeded on Terminal Beach or Bivalve Beach (Table 2.2). Table 2.2 includes those parameters monitored and managed through the Long-term Marine Turtle Management Plan (Chevron Australia 2009b). Implementing an investigation following exceedance of a Management Trigger is detailed in Section 4.0 of this Supplement.

Table 2.2 Parameters used for Further Information to Investigate and Measure Significant Adverse Impacts on Beach Structure and Sediments

Parameter (State)	Proposed Impacts Management Triggers/Criteria for Measuring Significant Adverse Impacts	Proposed Analysis and Use
Beach Envelope of Change	Beach profile outside „normal“ range of oscillation in beach morphology	Beach Profiles along selected transects indicating range of changes. This provides a visual summary of change a long beach profile. Profiles for selected transects are presented in Section 5.0 for information.
Beach Volume	Change in volume of beach at specific points of interest (cubic metres of sediment per metre of longshore beach width [$m^3/5 m^2$]) outside the „normal“ range of oscillation in beach volume	Range of slope and volume at points of interest along selected transects with controls applied from quality control charts (Brownlee 1957). To provide a summary of the range of variation in beach slope and volume.
Beach Slope	Change in beach slope at specific points of interest outside the „normal“ range of oscillation in beach slope	
Beach Sediment Characteristics	Change in sediment characteristics at specific depths at points of interest outside the „normal“ range of oscillation in sediment characteristics	Particle size distribution, moisture content and density data.
Dune Vegetation	Change in the position of vegetation lines from baseline (pre-2008)	Overlay of vegetation lines on aerial photos.
Number of Tracks left by marine turtles traversing the beach for nesting*	Change in track density on east coast beaches adjacent to Town Point	Sections 7.3 and 7.4 of the Long Term Marine Turtle Management Plan (Chevron Australia 2009b), included Management Triggers required in respect of the matters of National Environmental Significance, as required by Condition 3.2.6 of EPBC Reference 2003/1294 and 2008/4178. Monitoring of trends may be conducted over time and specific management responses for each parameter triggered may be developed using the best available knowledge at the time, in consultation with the Marine Turtle Expert Panel (MTEP) (Chevron Australia 2009b). Information generated from these trends regarding each of the listed parameters may be available for use as further information should the Management Triggers in this Supplement be exceeded, triggering the requirement for further investigation.
Nesting Success*	Percentage of females that emerge on a night to successfully lay a clutch of eggs on east coast beaches adjacent to Town Point	
Marine Turtle Hatching Success*	Percentage of eggs that produce embryos on east coast beaches adjacent to Town Point	
Marine Turtle Hatchling Emergence Success*	Change in percentage of eggs laid that produce hatchlings to surface on east coast beaches adjacent to Town Point	

* Parameters related to Marine Turtles are included for information only. These parameters will not form a part of monitoring under the Coastal Stability Management and Monitoring Plan or this Supplement.

Source: Adapted from Table 5.1, Chevron Australia 2009a and Chevron Australia 2009b.

The remainder of this Section discusses the selection of primary monitoring transects (Section 2.1.1) and points of interest (Section 2.1.2) and presents Management Triggers assigned to each of the relevant parameters, which may be subject to review (Section 4.1).

2.1 Data Included in Analysis for Management Triggers

2.1.1 Selection of Primary Monitoring Transects

The Coastal Stability Management and Monitoring Plan established 49 transects for monitoring beach structure and beach sediments on Terminal Beach and Bivalve Beach (25 and 24 transects respectively) and two transects on each of the reference beaches (Inga Beach, Yacht Club Beach North and Yacht Club Beach South) (Coastal Stability Management and Monitoring Plan, Section 5.1; this Supplement, Appendix 1). Data have been and will continue to be collected along all transects as described in the Coastal Stability Management and Monitoring Plan.

Management Trigger analysis is focused on two primary monitoring transects on Terminal Beach (T11 and T22) and two primary monitoring transects on Bivalve Beach (B11 and B22). The two transects were selected from the six established transects on Terminal Beach (T11, T13, T16, T19, T21 and T22) and Bivalve Beach (B1, B11, B16, B21, B22 and B24) that included beach sediment characteristic sampling (refer to Appendix 1). The two transects were chosen to facilitate comparison with reference beaches during any further analysis.

The transects located immediately adjacent to Town Point (T1 and B1; refer to Appendix 1) were not included in the Management Trigger analysis due to the presence of rock and the lack of a distinct Foredune Area. Therefore T11 and B11 were selected as being the closest to Town Point despite the restricted baseline data (January–October 2009), as these transects are amongst those most likely to be impacted as a consequence of the presence of the MOF and LNG Jetty should a significant adverse impact occur. Transects T22 and B22 were selected as they are located at comparable distances along the length of each beach to the reference beach transect locations (Appendix 1). Further data will be included in the baseline data set and the Management Trigger analysis, if collected prior to the commencement of construction of the MOF and LNG Jetty at Town Point (Section 2.0).

The investigation of significant change along the primary monitoring transects will be interpreted within the context of the suite of parameters collected from the other transects along Terminal Beach and Bivalve Beach, as well as from reference beaches, and which will be analysed and reviewed quarterly (Section 3.1). Implementation of an investigation following exceedance of a Management Trigger is detailed in Section 4.0.

2.1.2 Selection of Points of Interest

Figure 2.1 illustrates the typical (simplified) cross-section through the beaches on the east coast of Barrow Island, and includes the position of key points of interest along the cross-section, namely the:

- Primary Dune (PD)
- Base of the Primary Dune (BD)
- Foredune Area (FA)
- Crest of Beach Face (CBF).

When considering overall beach volume along a transect, it is recognised that changes in volume within the Primary Dune could potentially overshadow changes elsewhere along the transect, which could result in a failure to identify changes, for example, to the Crest of Beach Face or Foredune Area. Analysis of beach structure and beach sediment characteristics along the selected transects will therefore focus on the Foredune Area and the Crest of Beach Face for comparison against Management Triggers. Sampling points were established and located using Real Time Kinematic Global Positioning System (RTK GPS) to ensure continuity of future sampling regardless of changes to beach profile (i.e. the sampling locations will not change based on the beach formation present at the time of monitoring) (Coastal Stability Management and Monitoring Plan, Section 5.1.3.1).

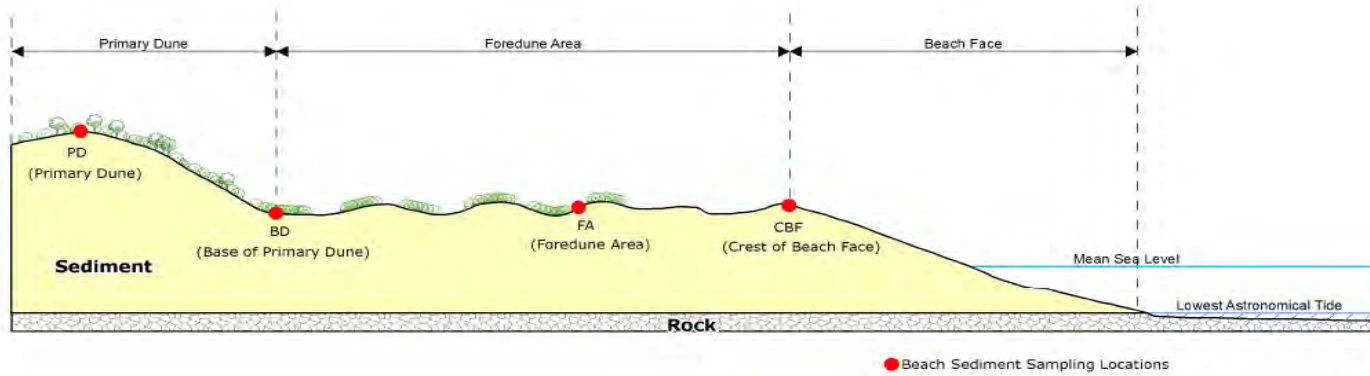


Figure 2.1 Coastal Dune System Beach Transect and Beach Sediment Sampling Locations

Source: Chevron Australia 2009a

Table 2.3 describes the analysis for each point of interest selected for beach volume and beach slope analysis.

Table 2.3 Selection of Information used for Analysis of Beach Volume and Beach Slope

Point of Interest	Reason for Selection	Analysis for Management Trigger
Primary Dune	Not considered further: limited direct relevance to marine turtles	
Base of Primary Dune		
Foredune Area	Marine turtle nesting area	Control Chart using Management Triggers: average of three consecutive, 5 x 1 m segments of beach on the selected transects (Figure 2.2). An average value ¹ of three segments was selected as the Foredune Area <i>tends</i> to be wide and the GPS location is in the centre of the Foredune Area.
Crest of Beach Face	Beach access and egress point for female turtles and hatchlings	Control Chart using Management Triggers: single 5 x 1 m segment of beach on the selected transects (Figure 2.2). The Crest of Beach Face <i>tends</i> to be narrower and have a greater slope than the Foredune Area.

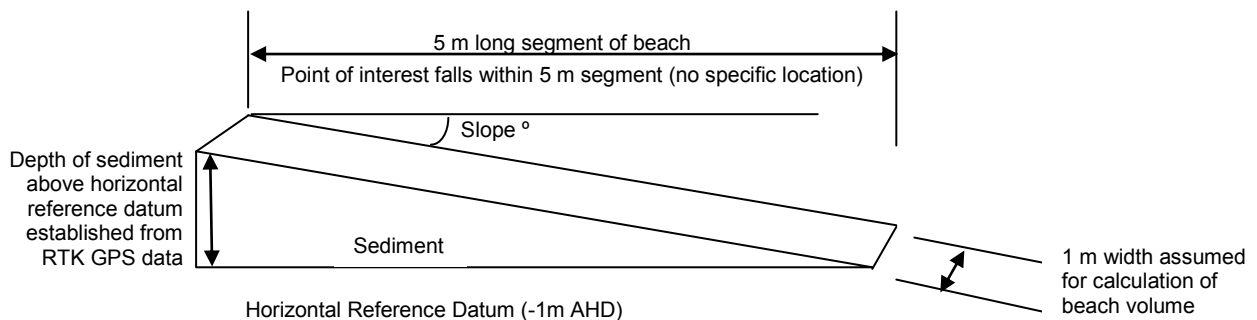


Figure 2.2 Beach Segments Used for Calculation of Beach Volume and Beach Slope (not to scale)

¹ Average values of the Foredune Area were used to reduce the potential for a marked change in profile affecting the dataset (i.e. show steeper slope or flatter slope than was common across the beach). The Crest of Beach Face was in several cases too narrow to allow averages to be used.

Data from the Primary Dune and the Base of the Primary Dune, along with the remainder of the transect, may be used for investigation should a Management Trigger be exceeded (Section 4.0).

Beach sediment characteristics have the potential to affect nesting success and hatching success (Coastal Stability Management and Monitoring Plan, Section 3.5.3). Selection of points of interest for sediment particle size therefore corresponds to depths relevant to marine turtles. In the Foredune Area which is used for marine turtle nesting, this is at approximately 60 cm below the surface, corresponding with the average depth of a Flatback Turtle (*Natator depressus*) nest, which is approximately 64 cm (Pendoley Environmental 2007). The Crest of Beach Face is where marine turtles access and leave the beach during nesting season and where hatchlings leave the beach after emergence. Selection of points of interest for sediment particle size at 30 cm below the surface provides an indication of whether the beach sediment characteristics vary (Section 2.3). Baseline information for surface sediment particle size data were limited and data that were available indicated greater variability, therefore surface sediment particle size at the Crest of Beach Face was not selected for Management Trigger analysis.

2.2 Selection of Appropriate Management Triggers: Beach Volume and Beach Slope

The Coastal Stability Management and Monitoring Plan proposed the use of statistical process control charts to display the variability in measurements over time, as well as the closeness of individual data points (or groups) to „expected“ values (Coastal Stability Management and Monitoring Plan, Section 5.2). The approach is consistent with that proposed by Chaloupka (2009), who provided background on the use of Shewhart control charts to graphically measure changes in the mean or variability over time when applied to demographic parameters for the Barrow Island Flatback Turtle population (Chevron Australia 2009b).

Control charts establish:

- a centreline (in this case the mean of the baseline information), with a slope of zero
- Upper and Lower Control Limits (Management Triggers) using 1, 2 and 3-sigma (σ) ($\pm 1, 2$ or 3 standard deviations) approach (Figure 2.3).

Baseline data may be collected over a series of survey periods on parameters such as beach volume and beach slope. By calculating the mean and standard deviations for baseline data, it is possible to identify if data from future surveys falls within or beyond one, two or three standard deviations.

Shewhart statistical process control charts are used as a quality control tool to monitor processes, with the application of a number of Management Triggers to detect non-random situations (NIST/SEMATECH 2006). By plotting through time some measure of a stochastic process with reference to its „expected“ value (based on the baseline data set in this case), control charts can help managers diagnose when a parameter of interest may show deviations beyond those „expected“ given the natural temporal variability measured across impact and reference beaches. Control charts can thus provide an „early warning signal“ of a system that may be going „out of control“ after just a single time of sampling after an impact and thus Management Measures can be implemented much earlier. The application of Management Triggers for statistical process control charts to assess changes in beach structure and beach sediment characteristics on east coast Barrow Island beaches may potentially enable detection of one-off events, seasonal, annual and longer-term smaller scale trends (Table 2.4). However, while control charts are a means of diagnosing what could be contributing to the detected change; they do not provide a means of attributing causality.

It is important to note that the Management Triggers presented in Table 2.4 are based on industrial applications with normally distributed data and strict process controls. Chaloupka (2009) highlighted problems with applying rules designed for industrial systems to natural environments where fluctuations were poorly understood. Consequently, Management Triggers based on industrial process controls may not be relevant to beach profile dynamics, i.e. where understanding of the natural variability of the oscillation in beach volume and slope parameters

on Barrow Island is limited. Accordingly, the Management Triggers presented in Table 2.4 will need to be regularly reviewed and updated accordingly (Section 4.1). In cases of non-parametric data distribution, the use of alternative approaches, such as median absolute deviation (MAD) limits, may also need to be considered (M. Chaloupka, pers. comm. December 2009).

Table 2.4 Management Triggers (based on Industrial Process Controls) Applied to Beach Volume and Beach Slope with Relevance to Monitoring Periods

Management Trigger (based on NIST/SEMATECH 2006)	Monitoring Time Horizon	Event that Application of the Management Trigger Would Capture
A single point falls outside the mean ± 3 Sigma (σ) limit (<i>Management Trigger 1: Figure 2.3</i>)	3 months	Investigation of a significant short-term change on the relevant beaches (e.g. may indicate changes recorded as a result of a cyclone)
Two out of three successive points fall outside of the mean $\pm 2\sigma$ limit (<i>Management Trigger 2: Figure 2.3</i>)	9 months (>1 season)	Investigation of change to beach structure that exceeds 1 season
Four out of five successive points fall outside of the mean $\pm 1\sigma$ limit (<i>Management Trigger 3: Figure 2.3</i>)	15 months (>1 year)	Investigation of change outside of „normal“ range over the course of a year
Eight consecutive points on the same side of the mean (<i>Management Trigger 4: Figure 2.3</i>)	24 months (>2 years)	Investigation of a longer-term ongoing beach change, i.e. accretion or erosion (indicating a long-term shift to the mean)

* See note, *Figure 2.3*.

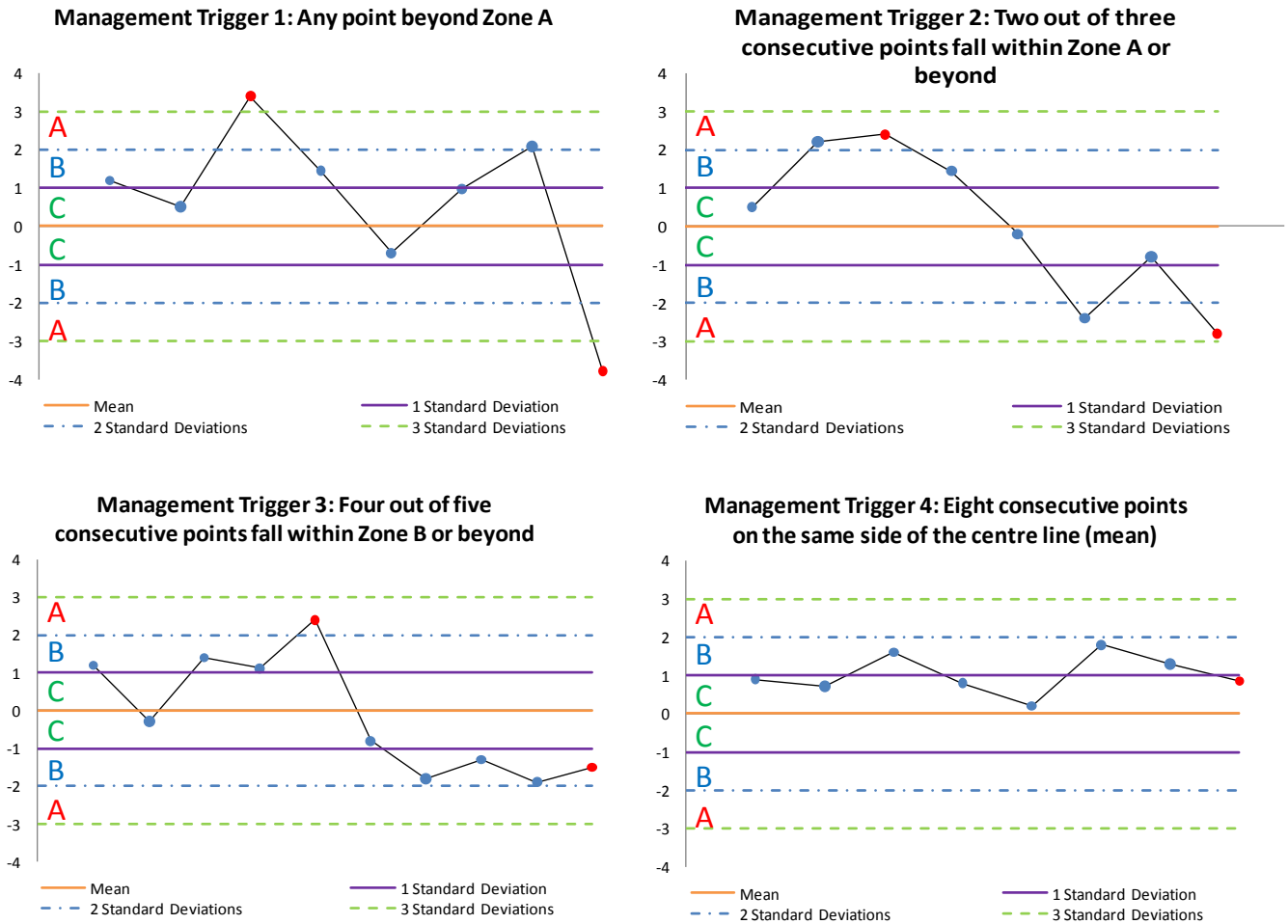


Figure 2.3 Diagrammatic Representation of the Management Triggers for Beach Volume and Beach Slope and Indication of when an “alert” would be Triggered (red dots)

Source: Based on Wikipedia Contributors* 2009.

* Note that Wikipedia acknowledges that Management Trigger 4 is disputed, NIST/SEMTECH 2006 use 8 consecutive points on the same side of the centre line, as per Table 2.4.

2.3 Selection of Appropriate Management Triggers: Beach Sediment Characteristics

Beach sediment characteristics (particle size, moisture and density) were determined at selected points of interest (Section 2.1.2) along each of six established transects on each of Terminal Beach (T11, T13, T16, T19, T21 and T22) and Bivalve Beach (B1, B11, B16, B21, B22 and B24), and both transects on each reference beach (refer to Appendix 1). Baseline data indicated that sediments were medium sands at the Fore dune Area (at 60 cm depth below existing surface level) and the Crest of Beach Face (at 30 cm depth below existing surface level), with minimal variation between beaches and over time (Section 5.0).

If sediment particle size deviates from medium sand to either fine gravel or coarse silt at either of the selected points of interest on the selected primary monitoring transects at Terminal Beach and Bivalve Beach, at relevant depths below the surface level, it will constitute an exceedance of the Management Trigger.

3.0 Further Analysis Not Included in Management Trigger Analysis

3.1 Ongoing Review

3.1.1 Range of Beach Volume and Beach Slope: Selected Transects

The range of beach volume and beach slope for each of the six transects and points of interest on each of Terminal Beach (T11, T13, T16, T19, T21 and T22) and Bivalve Beach (B1, B11, B16, B21, B22 and B24) (Section 2.1) are presented as an indication of the variation of these parameters during the baseline period July 2008 to October 2009 (Section 5.0). Note that the baseline information will be updated as further baseline surveys are undertaken prior to the commencement of construction activities associated with the MOF and LNG Jetty at Town Point. A Management Trigger was not established for the range of beach volume or beach slope; rather, range may be used as additional information, should investigation be undertaken as part of an Alert Measure (Section 4.0).

The range of average Foredune Area volume and slope and the range of Crest of Beach Face volume and slope along the selected transects were established from baseline data. Inner and outer control limits were determined based on the number of sampling occasions included in baseline data (n=6). Control chart limits were standard values based on assumed standard deviations in normally distributed populations (Brownlee 1957).

Some transects were sampled four times (i.e. quarterly, commencing in January 2009); however, using values for n=6 provided a more stringent control than applying the lower control chart limits for n=4. Inner and outer control limits will be revised if additional data are included in the baseline. These limits are established for information only and are not associated with any Management Triggers.

3.1.2 Sediment Characteristics: Selected Transects

Sediment particle size at selected depths at points of interest are included as a Management Trigger (Table 2.1). Sediment moisture content and sediment density have been excluded from consideration as Management Triggers, as they may be more influenced by environmental parameters (e.g. moisture content influenced by tidal state and rainfall events). However, data for these parameters may be reviewed for the selected transects as part of ongoing monitoring or should investigation be undertaken as part of an Alert Measure (Section 4.0).

3.1.3 Beach Envelope of Change: All Transects

Beach Envelope of Change figures depict vertical change along the length of the transect over time. Beach profiles for the primary monitoring transects are presented in Section 5.0.

No specific Management Triggers have been established for Beach Envelope of Change as beach volume and beach slope data were derived from the beach transects and specific Management Triggers have been assigned to these parameters. Nevertheless, Beach Envelopes of Change may be used as additional information, should investigation be undertaken as part of an Alert Measure (Section 4.0). Review of Beach Envelopes of Change for all transects will also be undertaken as part of the ongoing monitoring of all transects.

3.1.4 Dune Vegetation: All Beaches

Dune vegetation lines were plotted on historic aerial photography and presented in the Coastal Stability Management and Monitoring Plan. Dune vegetation lines from recent aerial photography may be used as additional information where relevant, should investigation be undertaken as part of an Alert Measure (Section 4.0).

3.2 Cyclone Monitoring

The Coastal Stability Management and Monitoring Plan outlined proposed monitoring following major storm or cyclonic events, where monitoring would be undertaken at fortnightly intervals until the next quarterly monitoring occasion, where reasonably practicable (Coastal Stability Management and Monitoring Plan, Section 5.1.4). Results of such „major event“ monitoring will not be included in Management Trigger analysis, which focus on the regular quarterly monitoring.

Identified Management Triggers should highlight significant events by way of variations in excess of the defined limits (i.e. Table 2.4). Major event monitoring may provide information useful to further understanding of beach profile dynamics and will be included in the ongoing review of all transects (Section 3.1).

4.0 Exceeding a Management Trigger: Implementing Management Measures

Exceedance of a Management Trigger may result in consideration of appropriate responses, including measures that aim to investigate and establish the significance of any Project Attributable adverse impacts to the beaches adjacent to the MOF and LNG Jetty and the implications for marine turtle nesting.

These Management Measures are summarised in Figure 4.1, which presents alignment of the Management Measures with notification and reporting requirements (Section 4.2), and may include:

Alert: Review of existing data and other relevant information to assess whether the Management Trigger exceedance is Project Attributable and has resulted in a significant adverse impact to the beaches adjacent to the MOF and LNG Jetty. This Management Measure may include:

- examination of Beach Envelopes of Change and other monitored parameters
- review of metocean data
- comparison of changes in beach volume, beach slope and sediment particle size along other monitored transects on Terminal Beach and Bivalve Beach in the first instance
- followed by comparison with changes in beach volume, beach slope and sediment particle size on monitored transects on reference beaches.

The Alert Measure is completed when Chevron Australia can determine, based on results of preliminary investigations, whether beach profiles and sand grain size have changed beyond the Performance Standards established in the Coastal Stability Management and Monitoring Plan (Coastal Stability Management and Monitoring Plan, Table 6.1). If that change has occurred, Chevron Australia will notify the DEC and the DEWHA of detection of that change (Figure 4.1). The Alert Measure does not preclude further management action being implemented.

Review: Undertake further assessment with the aim of diagnosing the cause of the change, which may involve reviews of the risks associated with exceeding the Performance Standard. This may include:

- further field surveys of beach structure and sediment characteristics to assist with trend diagnosis
- a review of trends in parameters related to marine turtle nesting, hatching and emergence success (Table 2.2) on beaches adjacent to Town Point in relation to the identified trends in beach volume, beach slope or beach sediment characteristics
- advice from MTEP as appropriate (this does not preclude consultation with other stakeholders)

- a risk assessment.

The Review Measure does not preclude further management action being implemented.

Action: Following the Review Measure, Chevron Australia may consider a range of potential beach management options, including a robust evaluation of the environmental benefits and environmental costs of each option. Actions may include “do nothing” or “continue monitoring” as considered appropriate. Potential management options are identified in Section 5.3 of the Coastal Stability Management and Monitoring Plan.

Chevron Australia will develop a report that complies with the requirements of Statement No. 800, Condition 25.6 and EPBC Reference: 2003/1294 and 2008/4178, Condition 18.6 (Section 4.2). The report will document the investigations undertaken, outcomes of any risk assessment, advice provided by MTEP and will include recommended actions for implementation. Consultation will also be undertaken (Condition 25.7 of Statement No. 800 and Condition 18.7 of EPBC Reference: 2003/1294 and 2008/4178; Section 4.2; Figure 4.1) as part of the Action Measure.

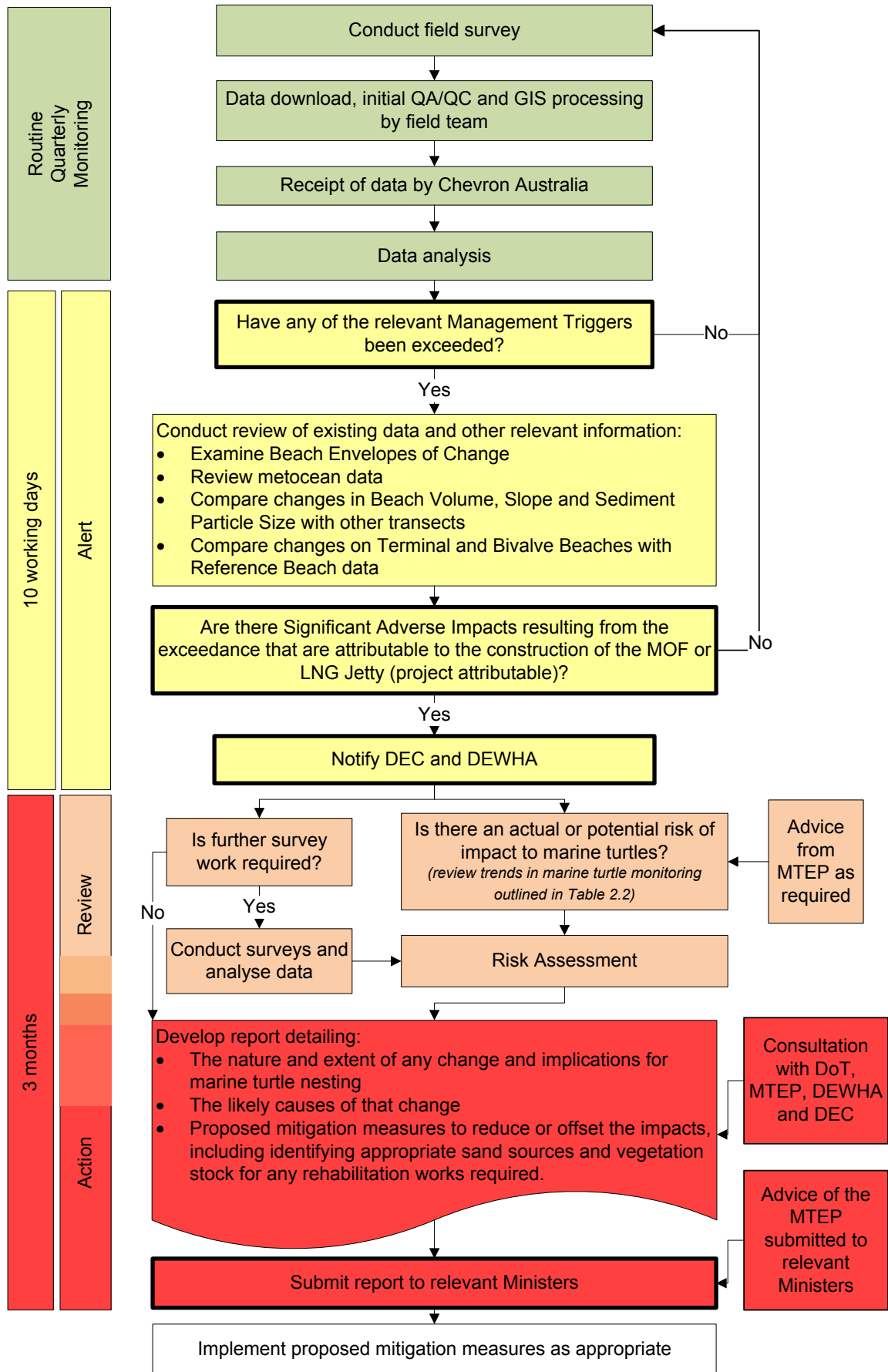


Figure 4.1 Management Measures and Reporting Associated with Exceedance of Coastal Stability Management Triggers

4.1 Revision of this Supplement

Acknowledging the limited length of the baseline datasets, in particular the lack of long-term data for Barrow Island east coast beaches, as well as the current lack of data following a storm or tropical cyclone event, limited baseline data have been available to identify Management Triggers (Section 2.0). These Management Triggers for assessing significant adverse impacts are likely to change over time and may therefore initially be reviewed on an annual basis and subsequently as required. If necessary, the Management Triggers for assessing significant adverse impacts may be refined to incorporate new information.

Review of this Supplement may be undertaken in accordance with Section 8.3 of the Coastal Stability Management and Monitoring Plan.

4.2 Reporting

If monitoring shows that beach profiles and sediment grain size change beyond the Performance Standards set under Statement No. 800, Condition 25.4.iii, and EPBC Reference: 2003/1294 and 2008/4178, Condition 18.4.iii, and as defined in Section 6.3 of the Coastal Stability Management and Monitoring Plan, then Chevron Australia:

- will notify the Department of Environment and Conservation (WA) and Department of Environment, Water, Heritage and the Arts (Cth) within ten working days of detection of that change; and
- shall submit a report to the Minister for the Environment (WA) and the Minister for Environment Protection, Heritage and the Arts (Cth), within three months of the detection that beach profiles and sand grain size change beyond the Performance Standards, describing:
 - the nature and extent of any change and implications for marine turtle nesting
 - the likely causes of that change
 - proposed mitigation measures to reduce or offset the impacts, including identifying appropriate sand sources and vegetation stock for any rehabilitation works required.

As required under Condition 25.7 of Statement No. 800 and Condition 18.7 of EPBC Reference: 2003/1294 and 2008/4178, Chevron Australia will consult with DoT, MTEP, DEWHA and DEC during the preparation of any report. The report will be submitted to the Minister for the Environment (WA) and the Minister for Environment Protection, Heritage and the Arts (Cth), with the advice of the MTEP, within three months of the detection that beach profiles and sand grain size have changed beyond the Performance Standards.

5.0 Baseline Information

The Coastal Stability Management and Monitoring Plan identified the limited length of datasets, and the current lack of data following a storm or tropical cyclone event as a significant limitation to the development of Management Triggers. Data presented in this Section includes the baseline monitoring program over the period July 2008–October 2009, for the selected primary monitoring transects and points of interest, with relevant controls established for Management Triggers. Further data will be included in the baseline if collected prior to the commencement of construction activities associated with the MOF and LNG Jetty at Town Point. Results of additional monitoring and analysis (i.e. monitoring following a cyclone or significant storm event, Section 3.2) will be available for use in investigations of significant adverse impacts as required.

5.1 Terminal Beach

5.1.1 Beach Envelope of Change

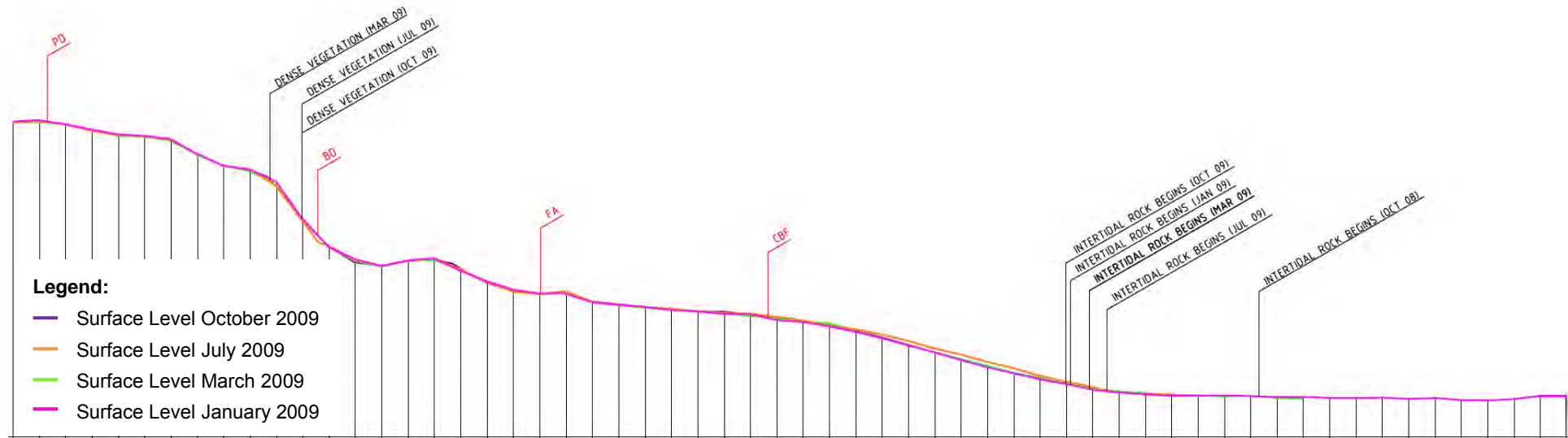


Figure 5.1 Terminal Beach Transect 11 Beach Envelope of Change, January 2009 – October 2009

Notes: PD: Primary Dune; BD: Base of Primary Dune; FA: Foredune Area; CBF: Crest of Beach Face.

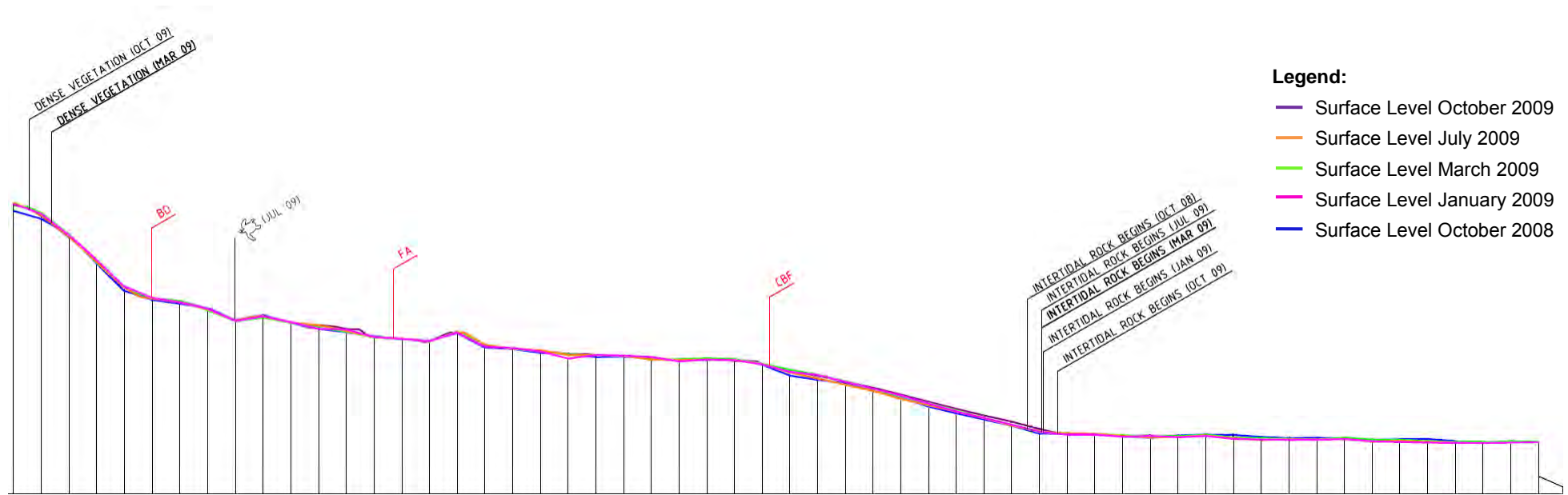
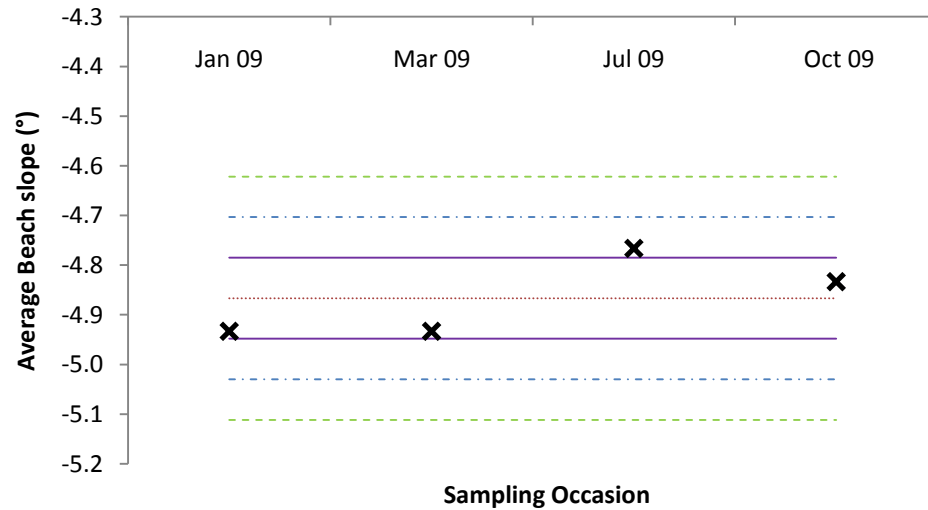


Figure 5.2 Terminal Beach Transect 22 Beach Envelope of Change, October 2008 – October 2009

Notes:  denotes a marine turtle body pit. BD: Base of Primary Dune; FA: Foredune Area; CBF: Crest of Beach Face.

5.1.2 Beach Slope

Terminal Beach Transect 11 Foredune Slope



Terminal Beach Transect 11 Crest of Beach Face Slope

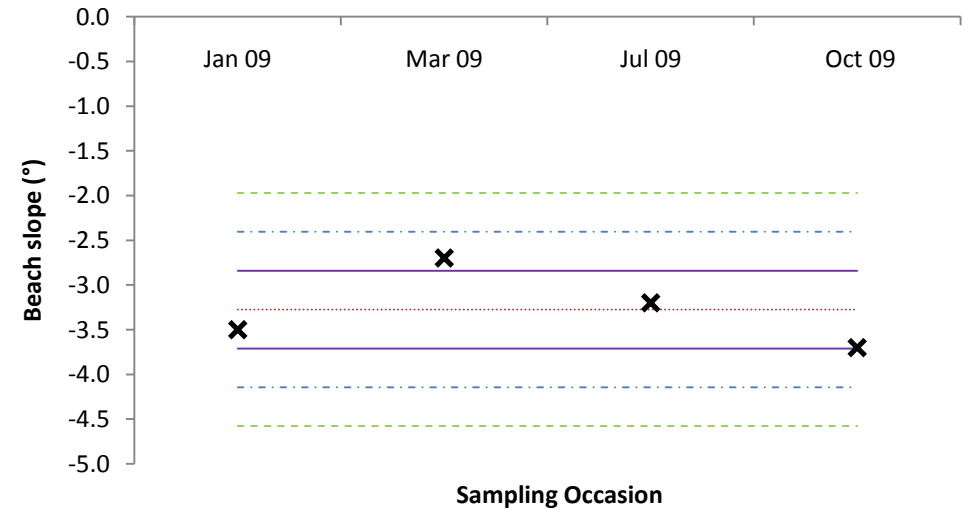
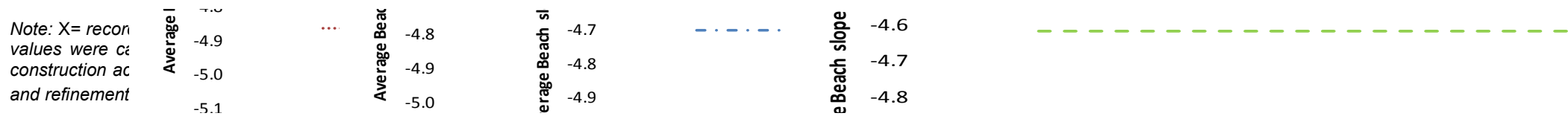
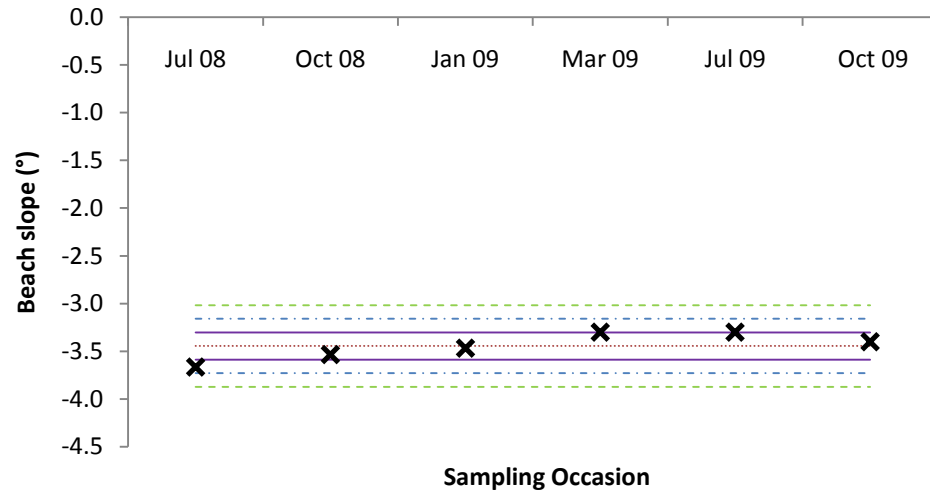


Figure 5.3 Indicative Control Charts based on Baseline Data (January 2009 – October 2009) for Terminal Beach Transect 11 Beach Slope at the Foredune Area and Crest of Beach Face



Terminal Beach Transect 22 Foredune Slope



Terminal Beach Transect 22 Crest of Beach Face Slope

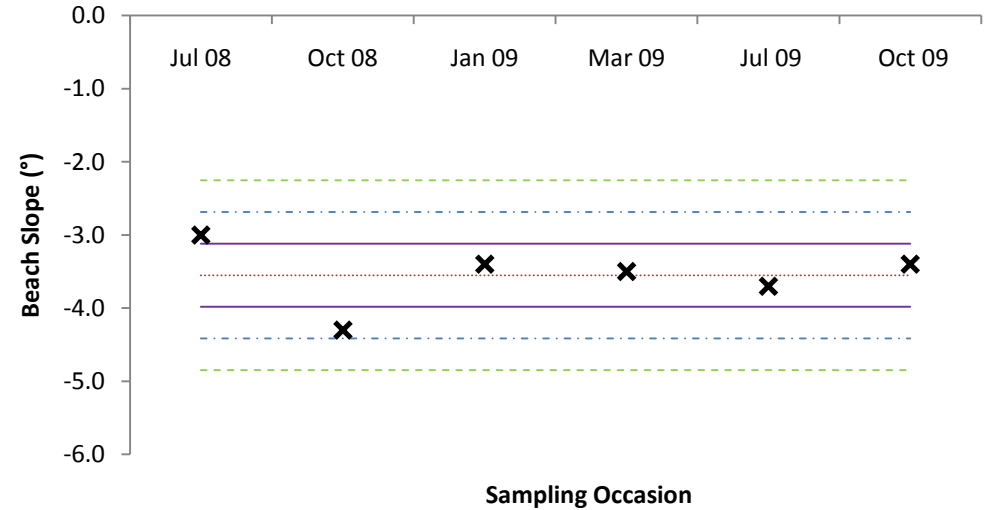
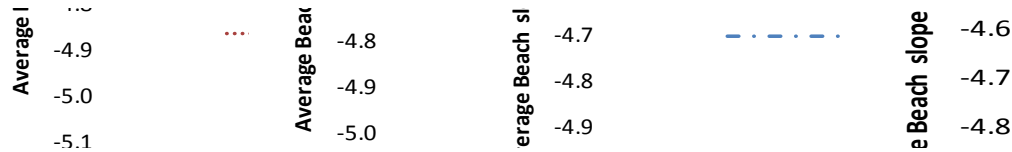


Figure 5.4 Indicative Control Charts based on Baseline Data (July 2008 – October 2009) for Terminal Beach Transect 22 Beach Slope at the Foredune Area and Crest of Beach Face

Note: X= recon values were c
 construction ac
 and refinement



5.1.3 Range in Beach Slope

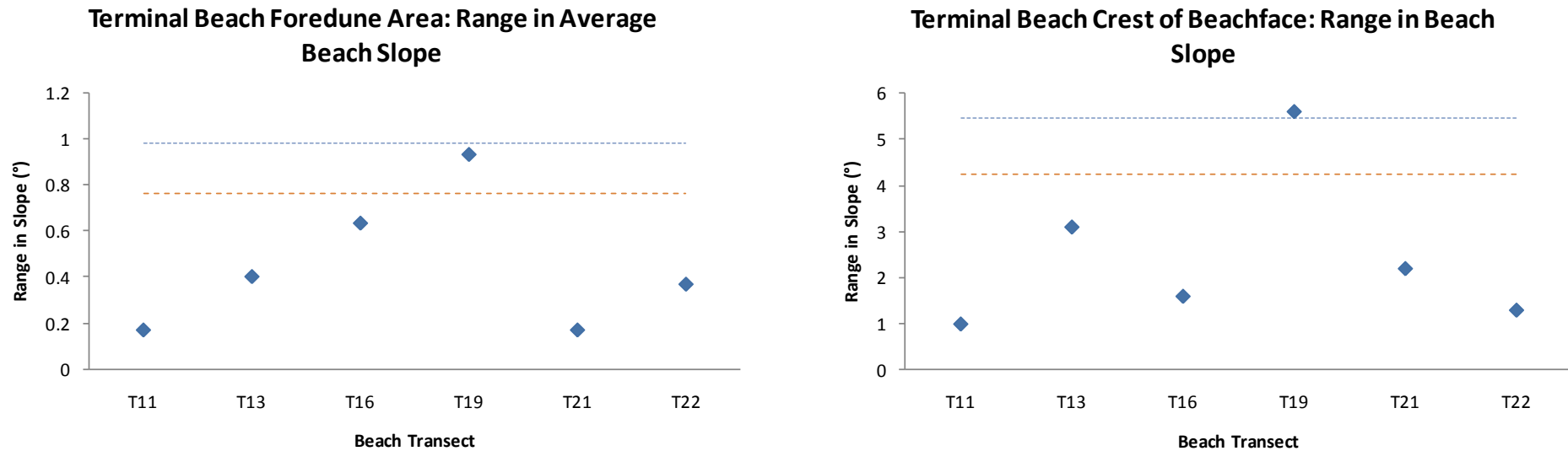


Figure 5.5 Indicative Control Charts for Range of Beach Slope at the Foredune Area and Crest of Beach Face for Terminal Beach

--- n²) 1.2
 Sample size = n=6 sampling occasions.

5.1.4 Beach Volume

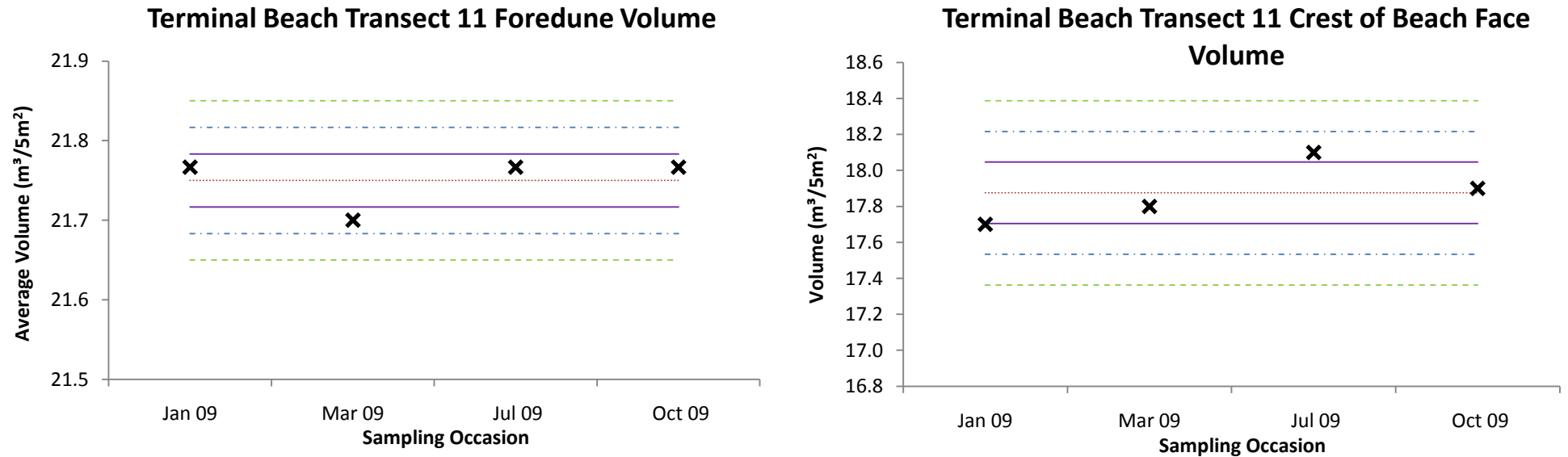
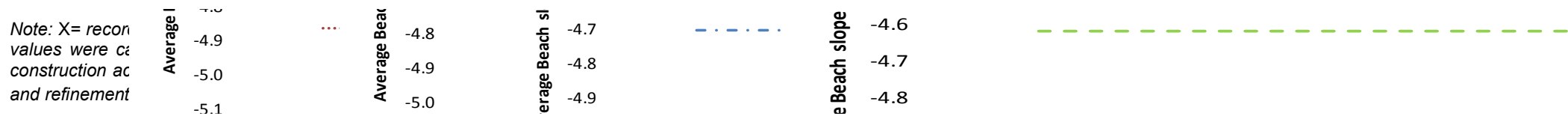


Figure 5.6 Indicative Control Charts based on Baseline Data (January 2009 – October 2009) for Terminal Beach Transect 11 Beach Volume at the Foredune Area and Crest of Beach Face



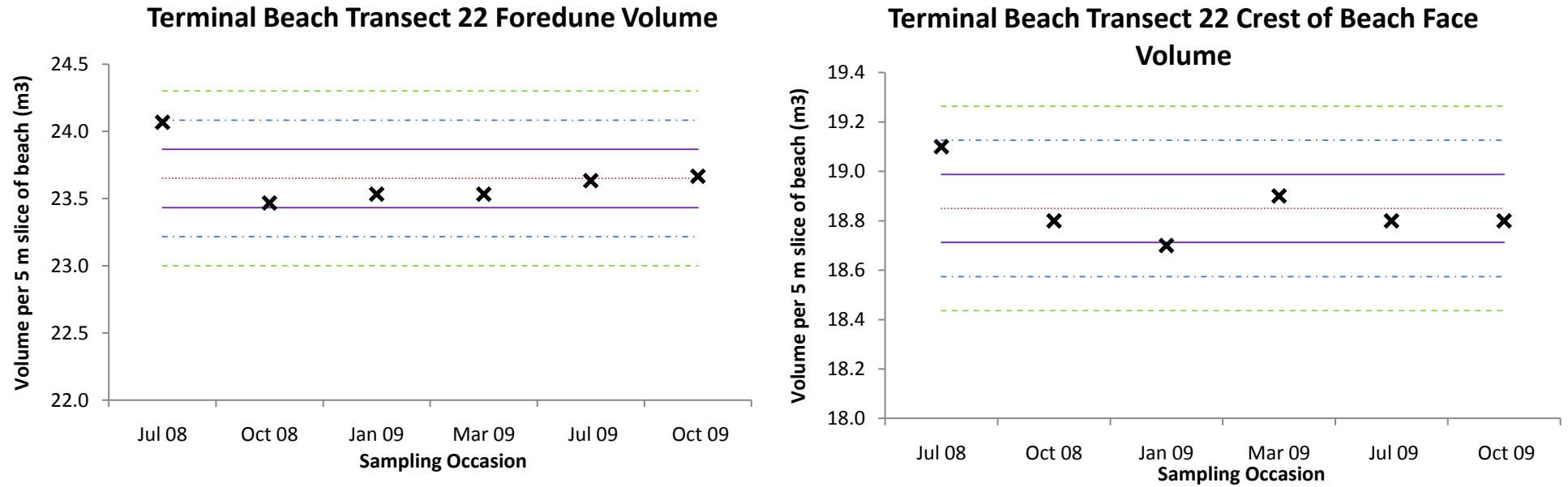


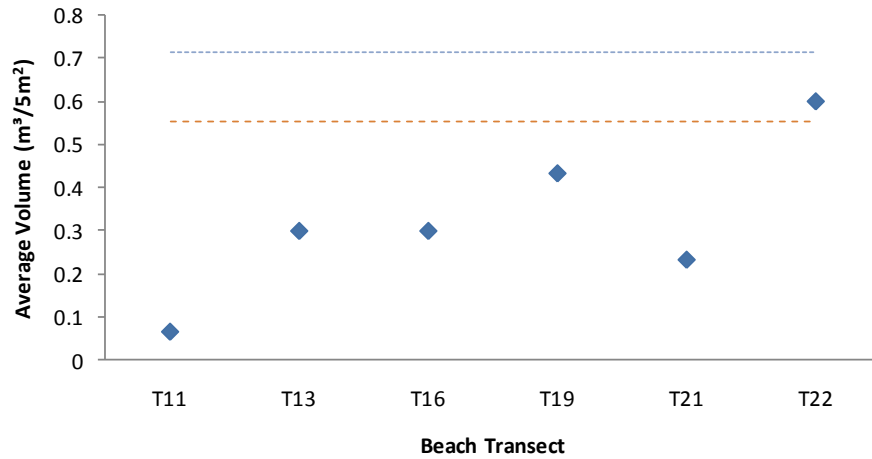
Figure 5.7 Indicative Control Charts based on Baseline Data (July 2008 – October 2009) for Terminal Beach Transect 22 Beach Volume at the Foredune Area and Crest of Beach Face

Note: X= recon values were c construction ac and refinement

Line Style	Value
Solid Purple	Average
Dotted Red	Average Beat
Dashed Green	Average Beach slope

5.1.5 Range in Beach Volume

Terminal Beach Foredune Area: Range in Average Beach Volume



Terminal Beach Crest of Beach Face: Range in Beach Volume

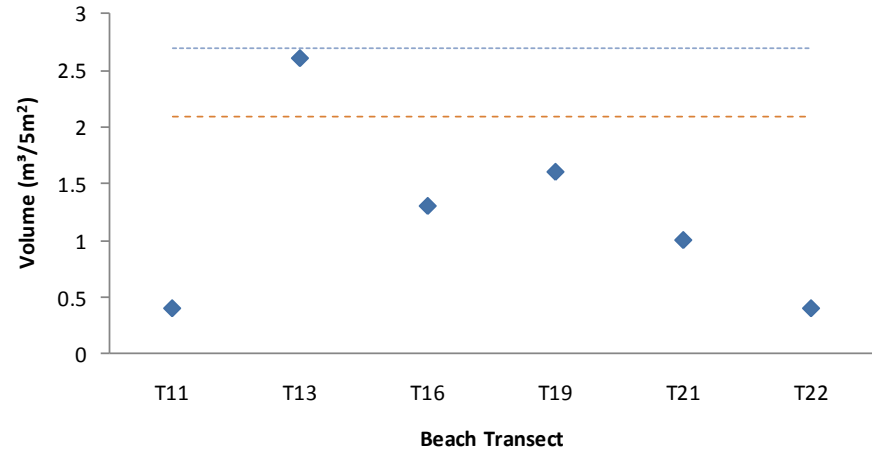


Figure 5.8 Indicative Control Charts for Range of Beach Volume at the Foredune Area and Crest of Beach Face for Terminal Beach

Sample size = $n=6$ sampling occasions.

5.1.6 Beach Sediment

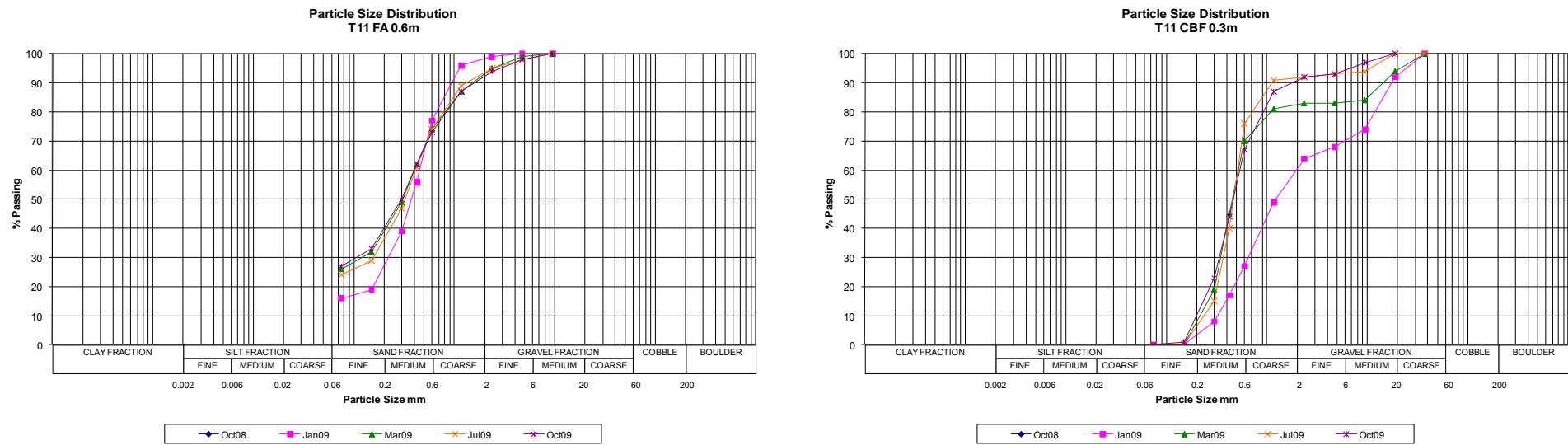


Figure 5.9 Terminal Beach Transect 11 Particle Size Distribution Charts: Foredune Area at 0.6 m Depth and Crest of Beach Face at 0.3 m Depth, October 2008 – October 2009

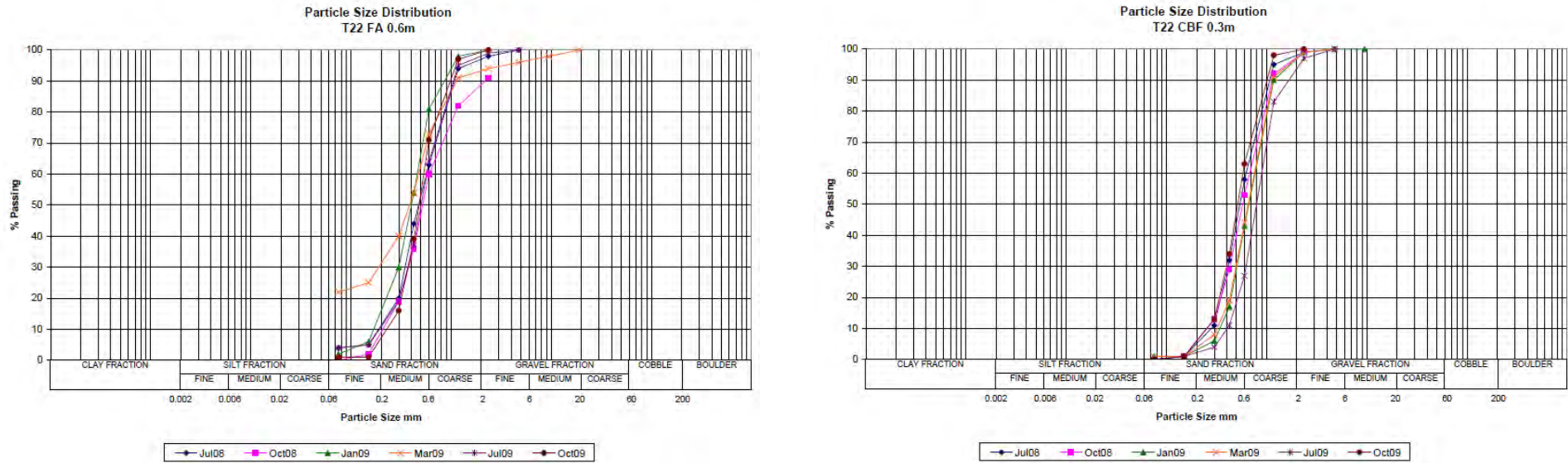


Figure 5.10 Terminal Beach Transect 22 Particle Size Distribution Charts: Foredune Area at 0.6 m Depth and Crest of Beach Face at 0.3 m Depth, July 2008 – October 2009

5.2 Bivalve Beach

5.2.1 Beach Envelope of Change

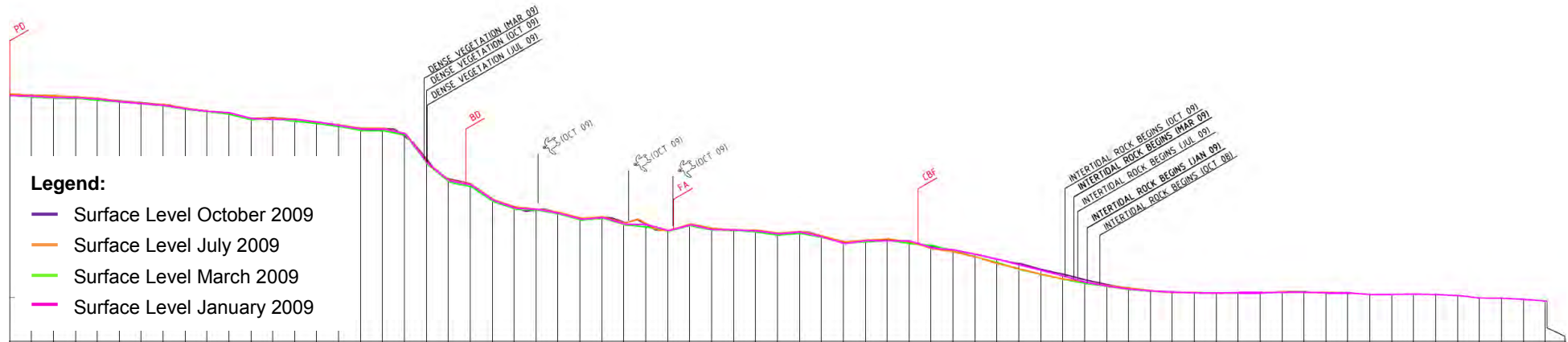



Figure 5.11 Bivalve Beach Transect 11 Beach Envelope of Change, January 2009 – October 2009

Notes:  denotes a marine turtle body pit. PD: Primary Dune; BD: Base of Primary Dune; FA: Foredune Area; CBF: Crest of Beach Face.

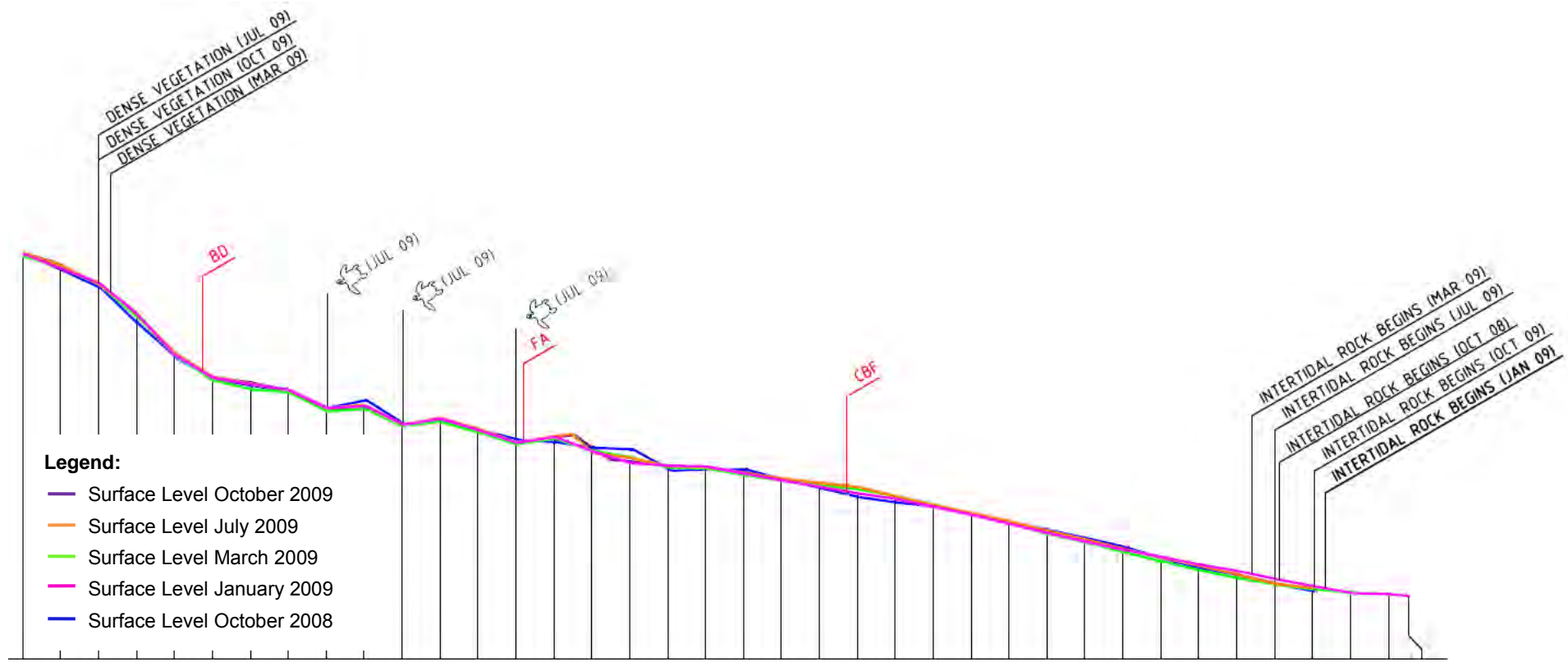
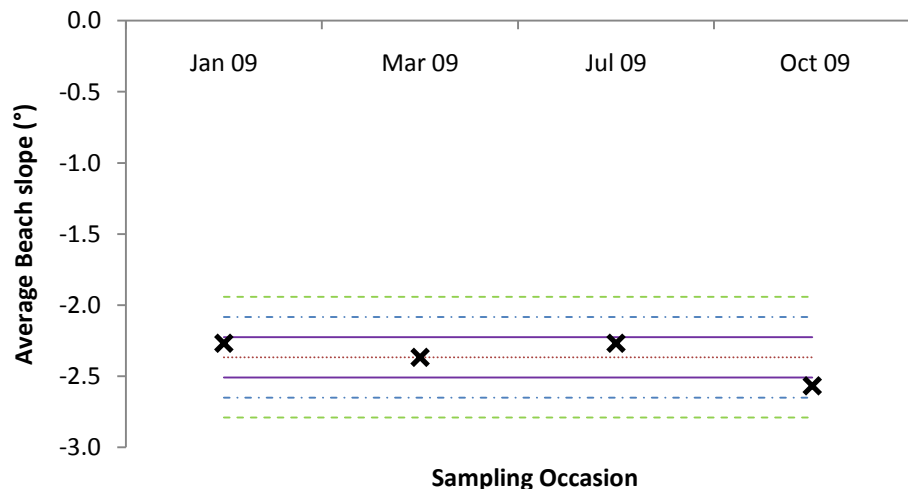


Figure 5.12 Bivalve Beach Transect 22 Beach Envelope of Change, October 2008 – October 2009

Notes: denotes a marine turtle body pit. BD: Base of Primary Dune; FA: Foredune Area; CBF: Crest of Beach Face.

5.2.2 Beach Slope

Bivalve Beach Transect 11 Foredune Slope



Bivalve Beach Transect 11 Crest of Beach Face Slope

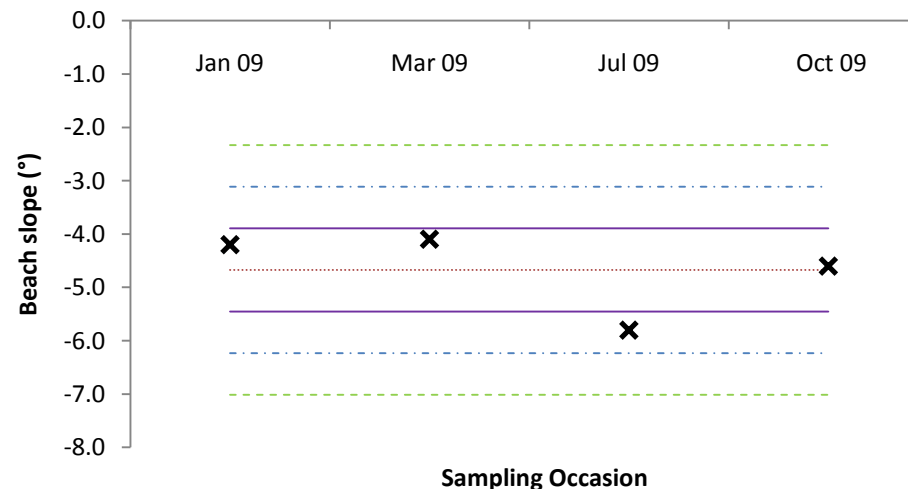
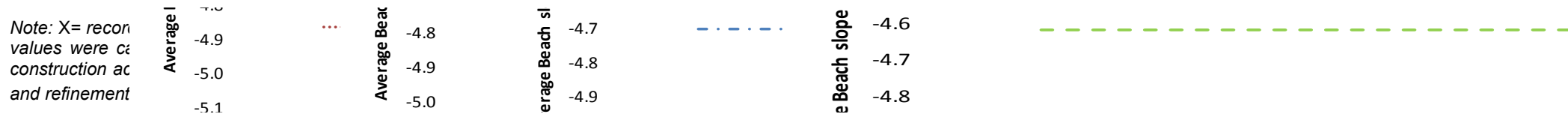
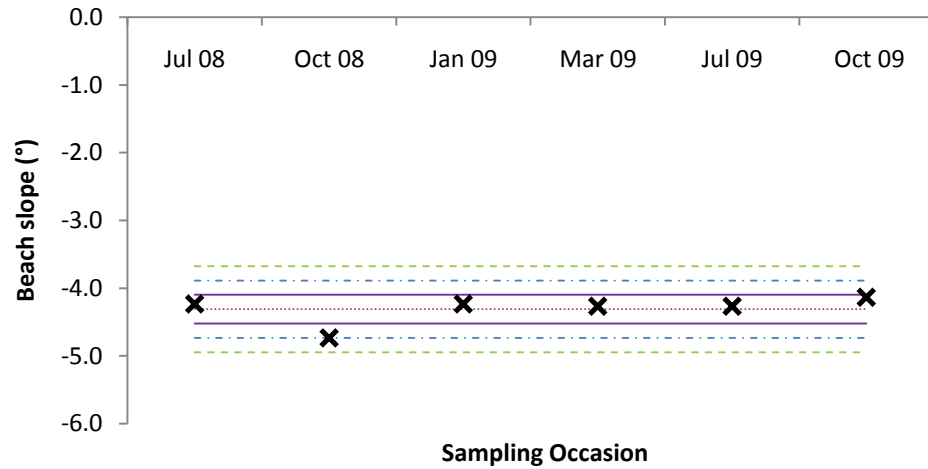


Figure 5.13 Indicative Control Charts based on Baseline Data (January 2009 – October 2009) for Bivalve Beach Transect 11 Beach Slope at the Foredune Area and Crest of Beach Face



Bivalve Beach Transect 22 Foredune Slope



Bivalve Beach Transect 22 Crest of Beach face Slope

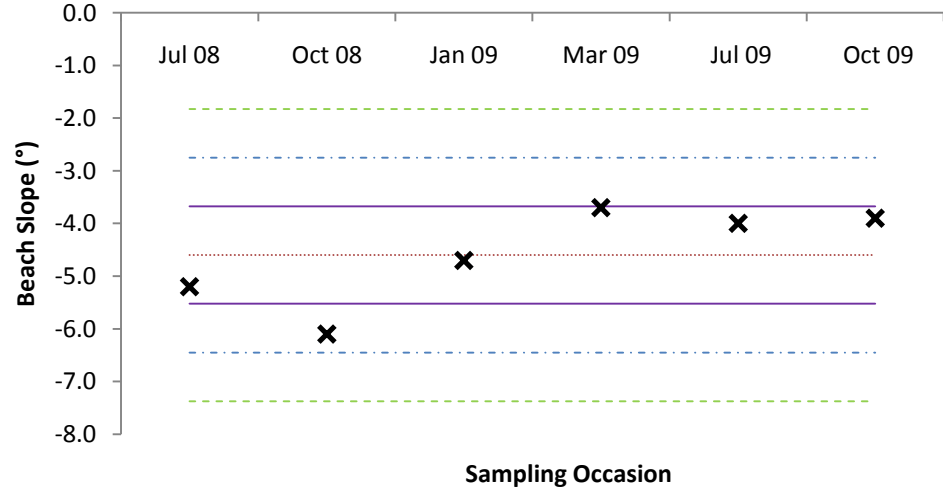
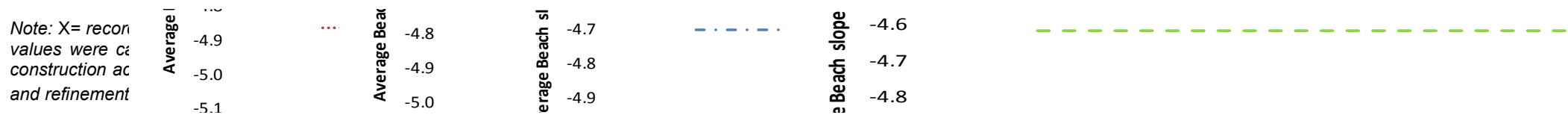
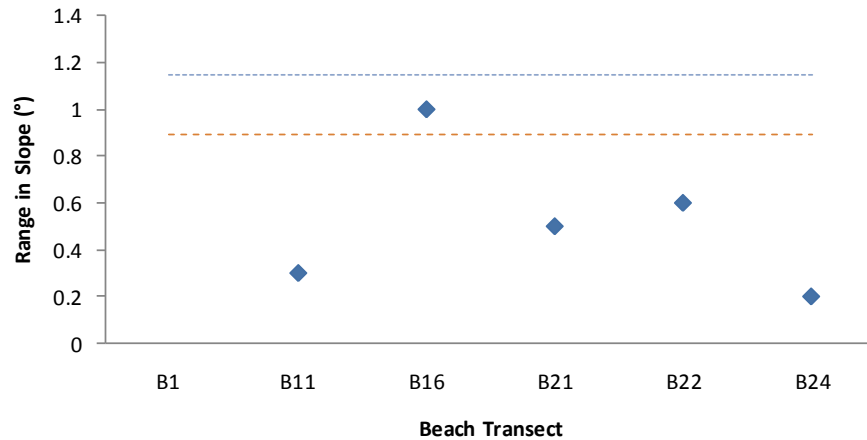


Figure 5.14 Indicative Control Charts based on Baseline Data (July 2008 – October 2009) for Bivalve Beach Transect 22 Beach Slope at the Foredune Area and Crest of Beach Face



5.2.3 Range in Beach Slope

Bivalve Beach Foredune Area: Range in Average Beach Slope



Bivalve Beach Crest of Beachface: Range in Beach Slope

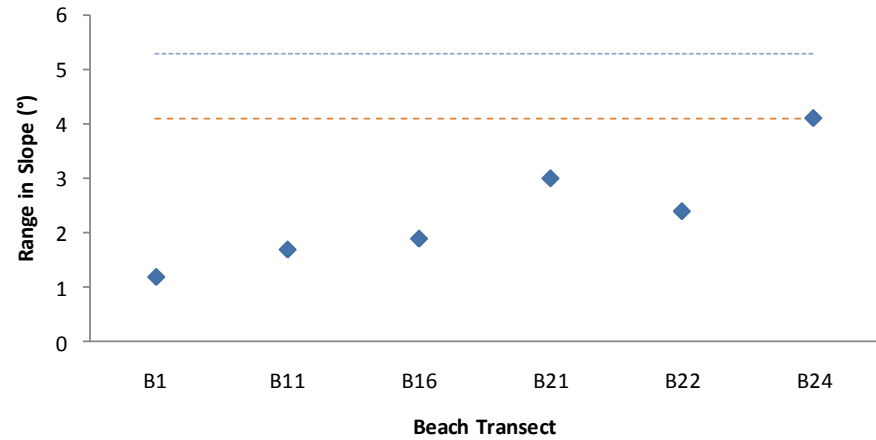


Figure 5.15 Indicative Control Charts for Range of Beach Slope at the Foredune Area and Crest of Beach Face for Bivalve Beach

--- n²) 1.2 ---
 Sample size = n=6 sampling occasions.

5.2.4 Beach Volume

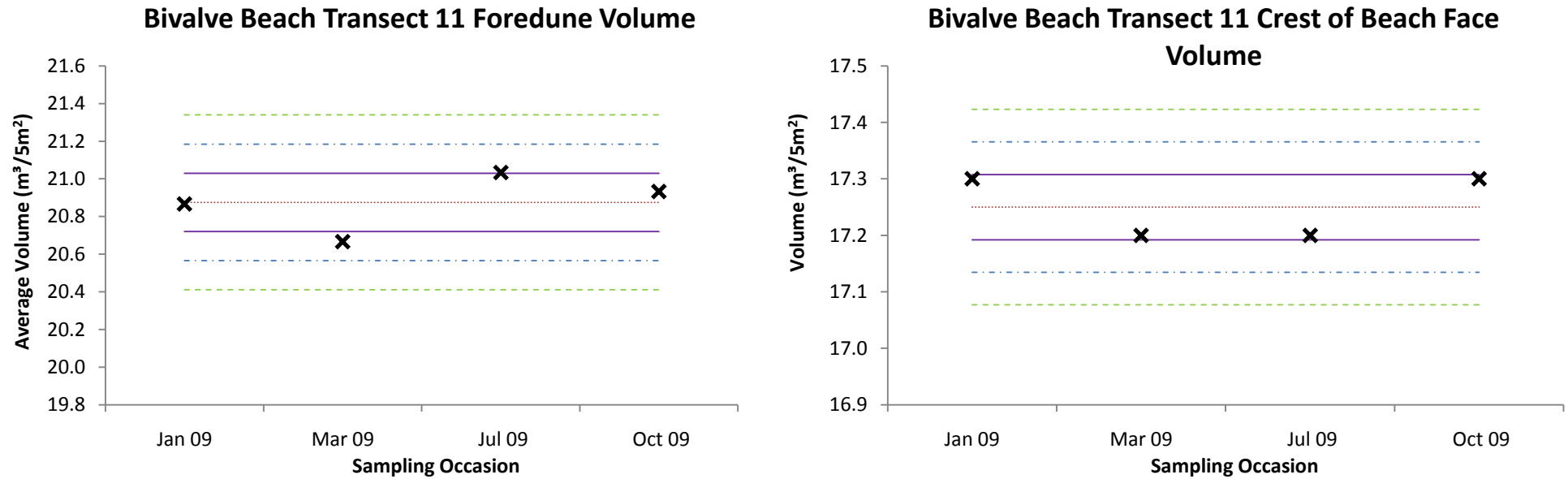
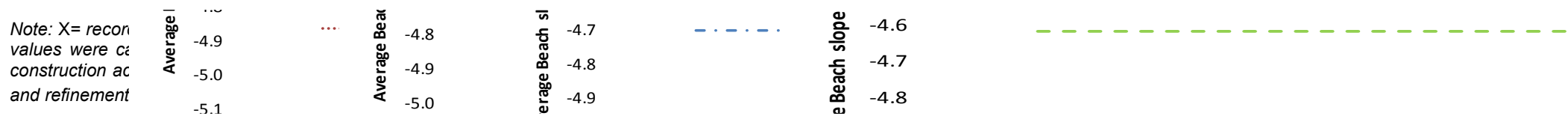


Figure 5.16 Indicative Control Charts based on Baseline Data (January 2009 – October 2009) for Bivalve Beach Transect 11 Beach Volume at the Foredune Area and Crest of Beach Face



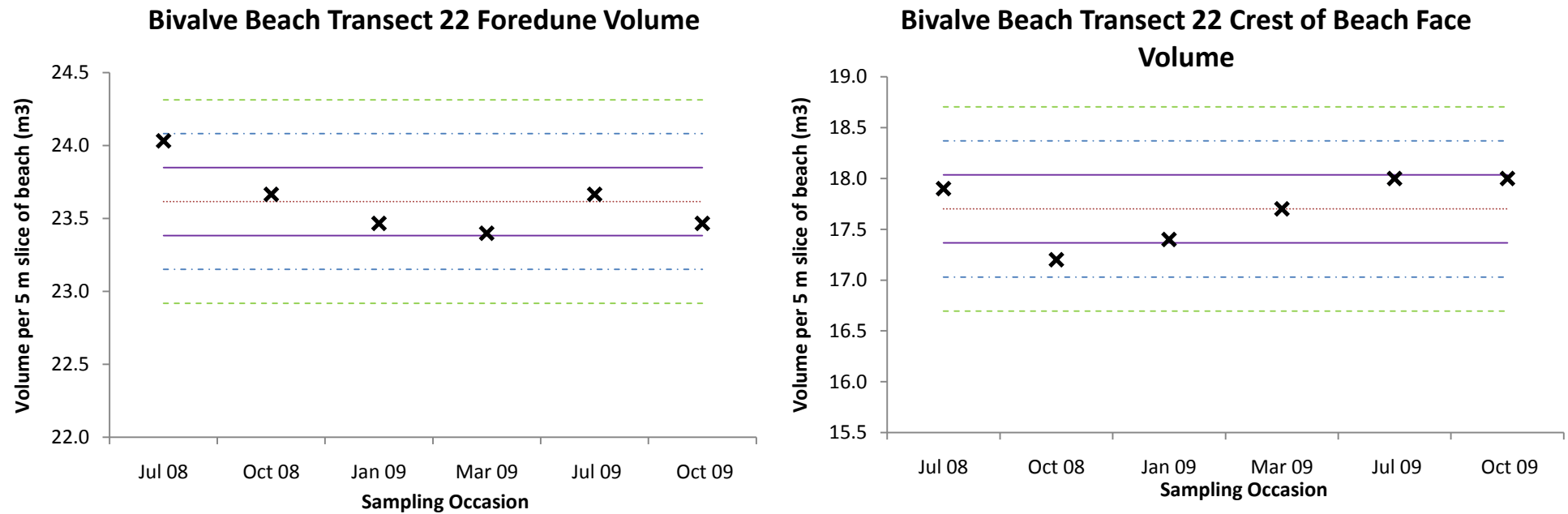
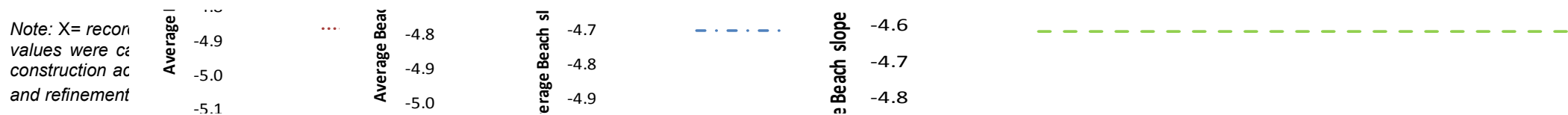
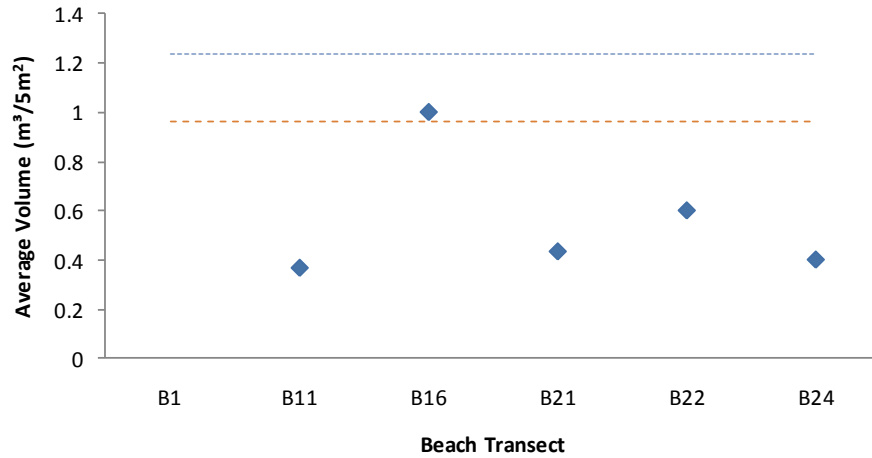


Figure 5.17 Indicative Control Charts based on Baseline Data (July 2008 – October 2009) for Bivalve Beach Transect 22 Beach Volume at the Foredune Area and Crest of Beach Face



5.2.5 Range in Beach Volume

Bivalve Beach Foredune Area: Range in Average Beach Volume



Bivalve Beach Crest of Beach Face: Range in Beach Volume

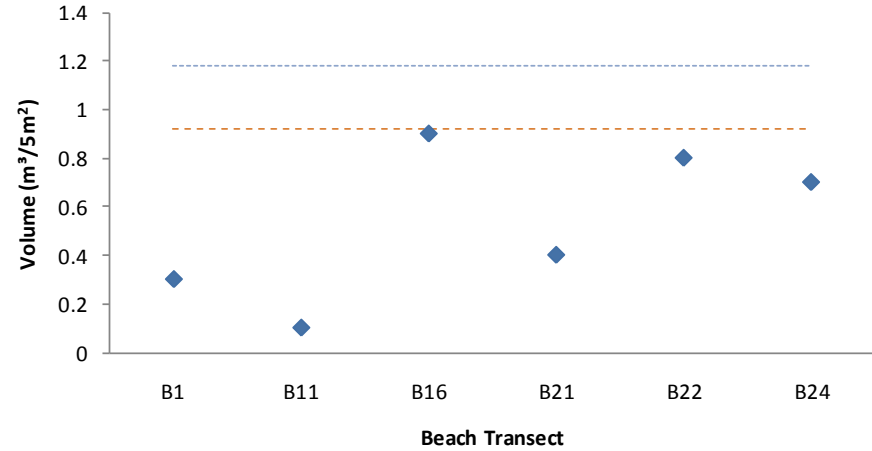


Figure 5.18 Indicative Control Charts for Range of Beach Volume at the Foredune Area and Crest of Beach Face for Bivalve Beach

\bar{n} 1.2
 Sample size = $n=6$ sampling occasions.

5.2.6 Beach Sediment

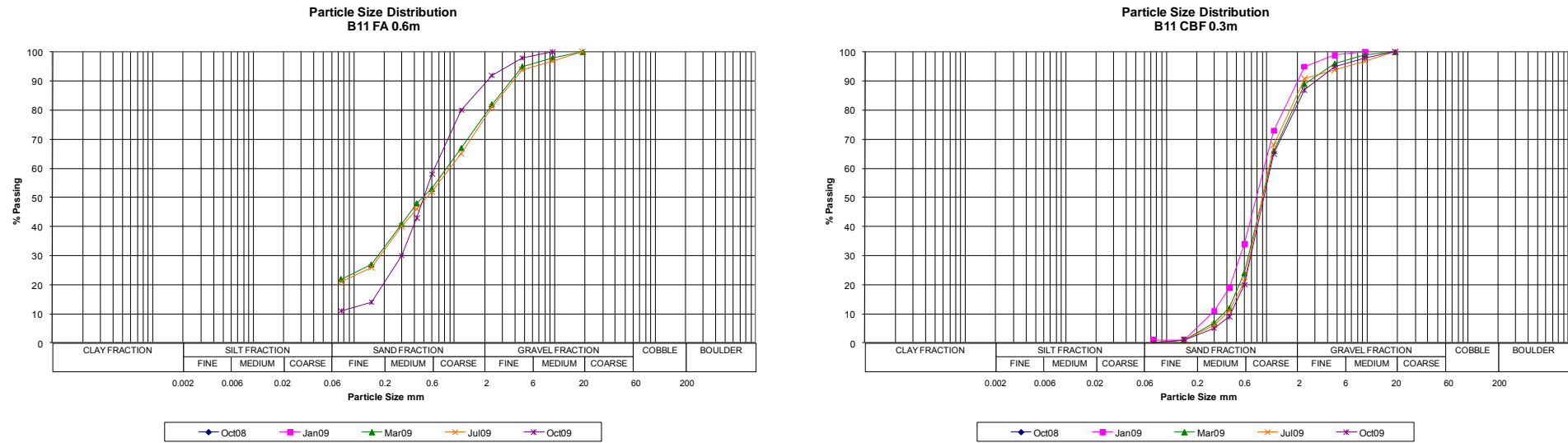


Figure 5.19 Bivalve Beach Transect 11 Particle Size Distribution Charts: Foredune Area at 0.6 m Depth and Crest of Beach Face at 0.3 m Depth, October 2008 – October 2009

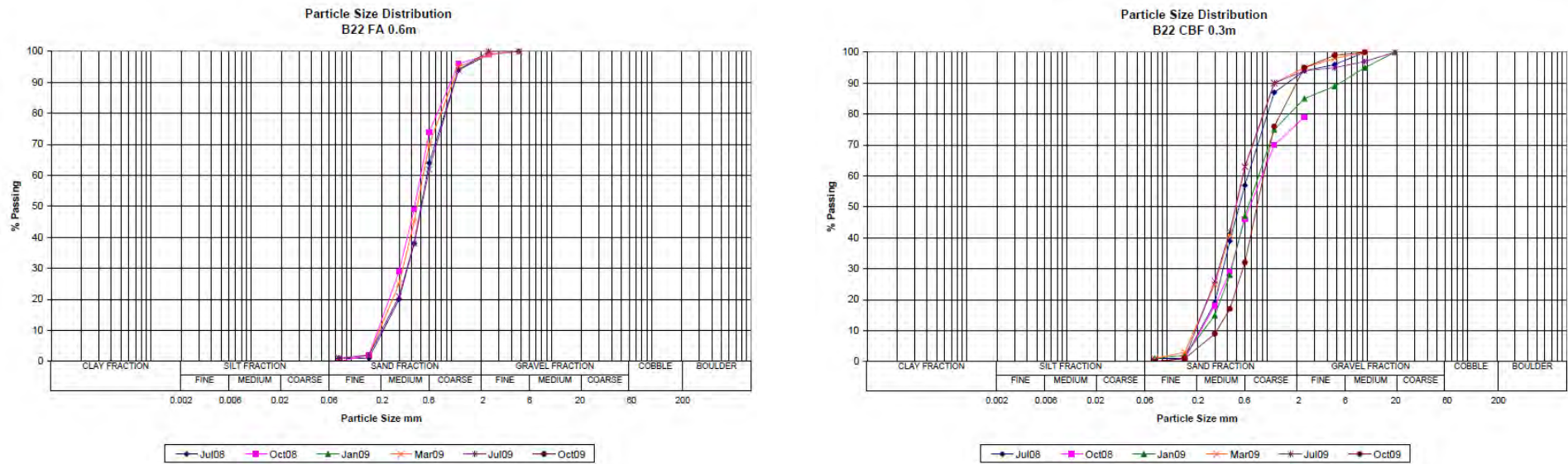
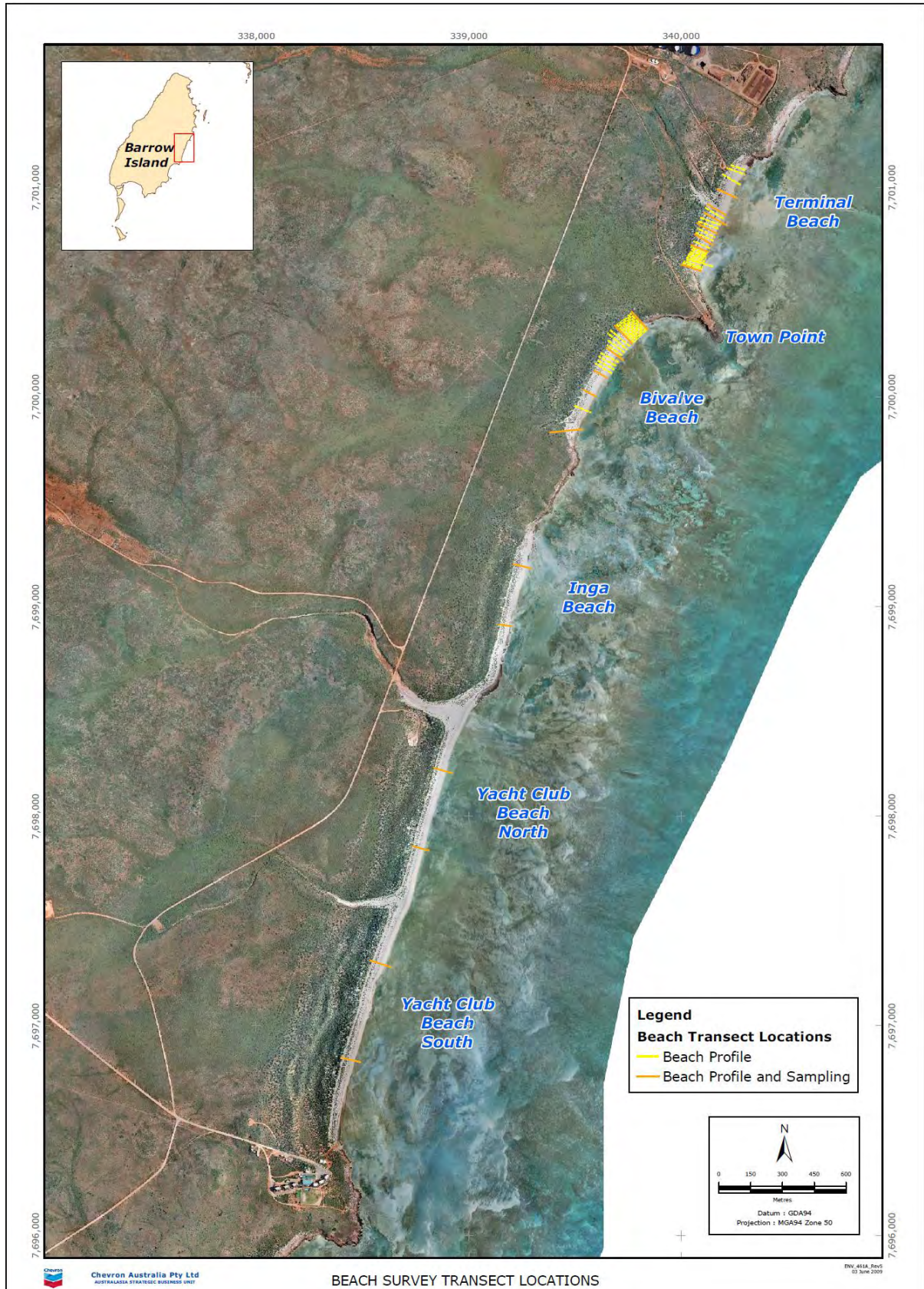


Figure 5.20 Bivalve Beach Transect 22 Particle Size Distribution Charts: Fore dune Area at 0.6 m Depth and Crest of Beach Face at 0.3 m Depth, July 2008 – October 2009

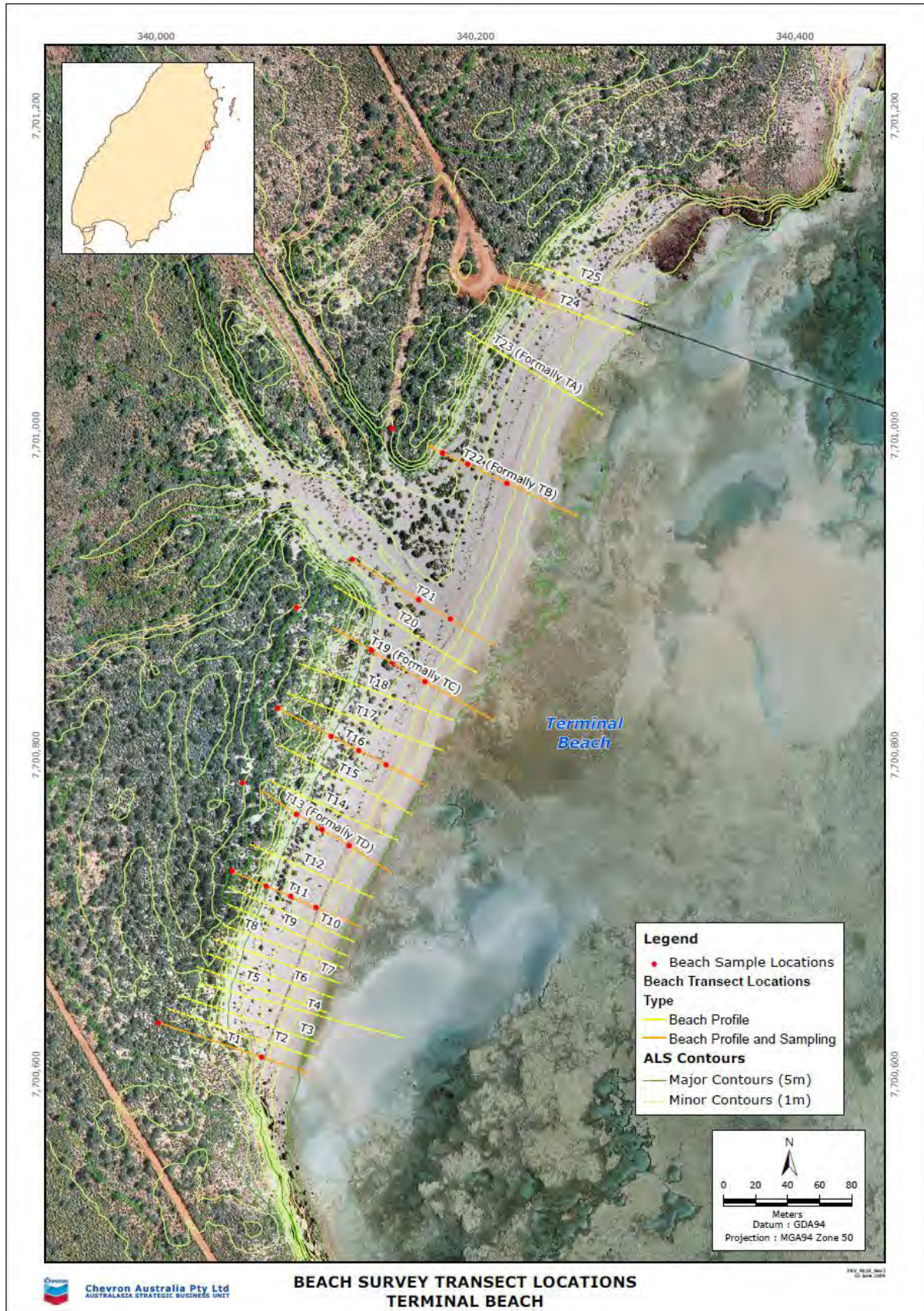
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[Accessed 16 November 2009]

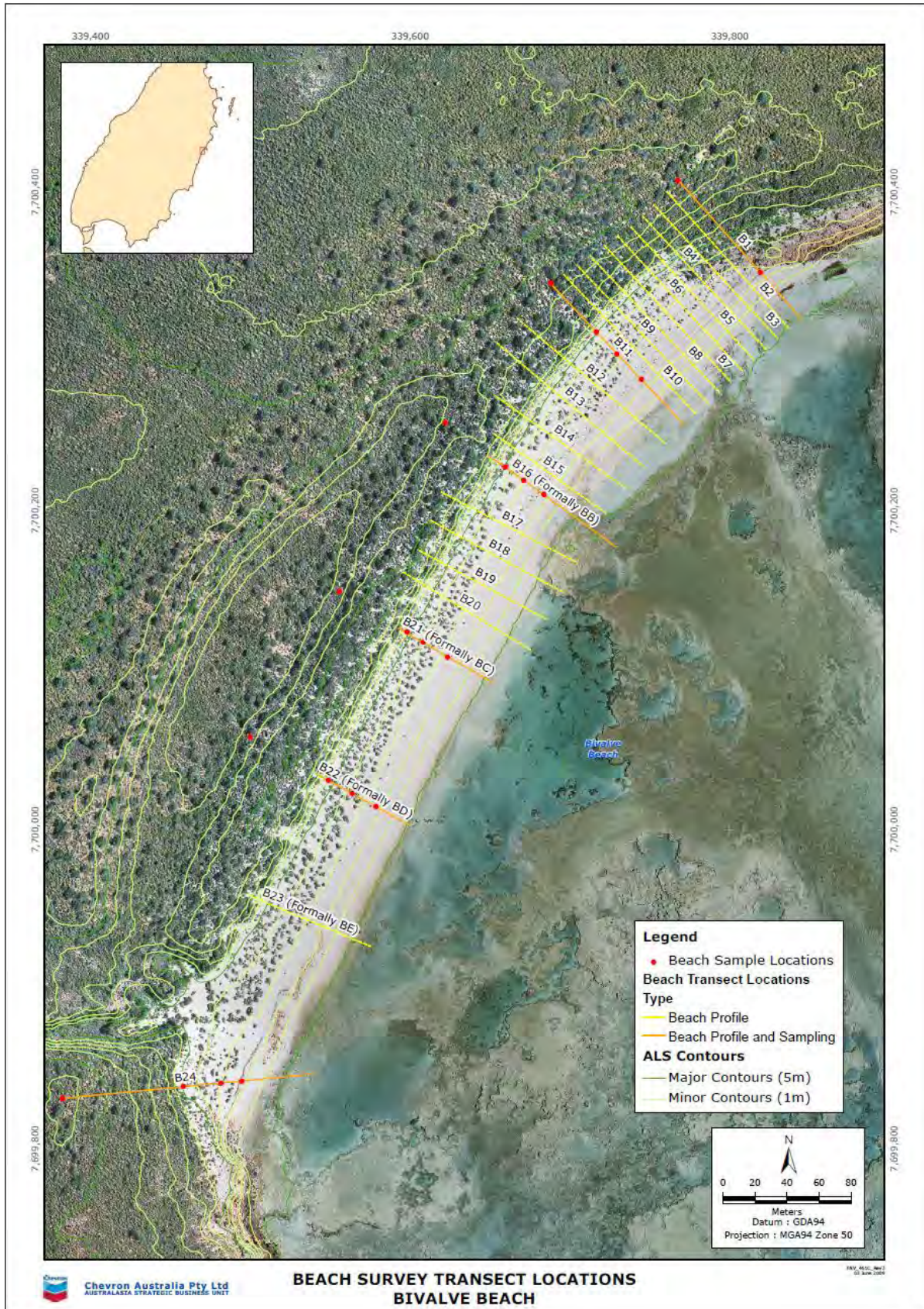
Appendix 1 Location of Beach Monitoring Transects



Beach Survey Transect Locations



Terminal Beach Survey Transect Locations



Bivalve Beach Survey Transect Locations