PATTLE DELAMORE PARTNERS LTD

Maui Pipeline (403Line)
Assessment of Geohazard Features
Huntly Offtake to Huntly Power Station

A02676751-R004-0416

Vector Limited

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Huntly Offtake to Huntly Power Station

Report Number

A02676751-R004-0416

Prepared for

Vector Limited

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Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the specific instructions of Vector Limited for the limited purposes described in the report. PDP accepts no liability to any other person for their use of or reliance on this report, and any such use or reliance will be solely at their own risk.

With the exception of the geohazard features visited by PDP for field review/assessment, this report has been prepared using information provided by Vector Limited including identification and observations at the geohazard features along the pipeline route assessed by Vector Limited to be relevant for pipeline risk assessment. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

The risk ranking provided in this report is based on visual engineering geological observations and/or desktop assessment of the pipeline route at the selected geohazard features. With the exception of field evaluations at selected features, no subsurface investigation has been carried out to confirm the desktop/visual interpretation of the risk ranking at the features.

Executive Summary

This report is one of a set of six reports that document the geohazard assessment for six of the seven on-shore pipeline sections of the 307 km long Maui Pipeline (400Line (and 403Line)) running between the Oaonui Production Station and the Huntly Power Station. The geohazard assessment reports for the 400Line and 403Line comprise:

- Oaonui Production Station to Frankley Road Offtake
- Frankley Road Offtake to Mokau Compressor Station
- Mokau Compressor Station to Mahoenui Scraper Station
- Mahoenui Scraper Station to Tihiroa Scraper Station
- Tihiroa Scraper Station to Huntly Offtake
- **Huntly Offtake to Huntly Power Station (403Line).**

The Maui Pipeline section between Oaonui Production Station and Frankley Road Offtake includes the Frankley Road Offtake to New Plymouth Power Station pipeline known as the 404Line. This section of pipeline is not included in the geohazard assessment process because the operational status of the pipeline is suspended at the time of this assessment.

This report documents the geohazard assessment for the Huntly Offtake to Huntly Power Station section of the Maui Pipeline (403Line).

Vector Limited (Vector) requested that Pattle Delamore Partners Limited (PDP) provide geohazard advice in a desktop workshop and at selected locations in the field to assess the geohazard risk at geohazard features identified along this section of the 403Line.

Geohazard features are slope instability (e.g. landsliding and slumping), surface water erosion, sub-surface erosion, trench backfill consolidation and human related hazards (e.g. excess fill).

The Tihiroa Scraper Station to Huntly Offtake and Huntly Offtake to Huntly Power Station (403Line) sections of the pipeline were the first sections to be assessed for geohazard feature risk. As a result, the risk assessment process for these 2 pipeline sections has included additional stages compared to the process for the other 4 pipeline sections, namely:

- Initial assessment of geohazard feature risk was carried out using a precursor version of the Vector Geohazard Feature Risk Ranking Assessment Tool (GFRRAT). Subsequent re-ranking of risk using the updated version of the GFRRAT was therefore required to ensure consistency with the risk assessment carried out for other sections of the pipeline.

- A Vector pipeline integrity assessment carried out in April 2014 recommended that field evaluations be carried out at a number of geohazard features as part of pipeline risk treatment actions. Information collected during these field evaluations (June 2014) has been used to provide the most up-to-date risk ranking for the geohazard features in this report.

Key conclusions arising from the desktop workshops and field reviews, assessments and evaluations are:

- There are a total of 25 geohazard features along this section of the pipeline.
- All 25 features have been risk assessed, namely:
  - 21 features assessed for geohazard risk using desktop methods only.
  - 4 features assessed using desktop and field methods.
- The geohazard risk ranking summary for the 25 geohazard features is:
  - 3 High risk
  - 2 Intermediate risk
  - 14 Low risk
  - 6 Negligible risk
- Field assessments indicate that the High risk rankings assigned in the desktop workshop are valid.
- Field review of geohazard features with a range of risk rankings, but with emphasis on the higher risk features is considered appropriate in the wider context of the overall risk assessment process.
- Based on all information available at completion of the field reviews (3 February 2014), no urgent actions were deemed necessary for geohazard features assessed in this report. Vector advised that the geohazard features would be evaluated using the Vector pipeline integrity assessment process and risk treatment actions would be identified and carried out as required, consistent with this process (refer below). In recognition of the potential for changes to geohazard risk with time from natural events such as heavy rainfall and flooding, Vector also advised that the geohazard features would be subject to ongoing monitoring as part of Vector's routine pipeline surveillance. This monitoring includes special emphasis on High risk geohazard features and site specific monitoring.

The findings from field assessments and monitoring related to slope movement in mid-2015 at geohazard feature F2-2013 are included in this report.

The geohazard features and associated geohazard risk identified in this assessment will be considered along with pipeline related factors in further Vector pipeline integrity assessment processes (based on AS2885.1 2012). The Vector pipeline integrity assessment will determine the need for and scope of any further risk treatment actions at the geohazard features.

Vector has advised that the geohazard features for the entire pipeline will be maintained and documented within the Vector GIS (Geographic Information System) framework.

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1.0 Introduction

This report is one of a set of six reports that document the geohazard assessment for six of the seven on-shore pipeline sections of the 307 km long Maui Pipeline (400Line (and 403line)) running between the Oaonui Production Station and the Huntly Power Station. The geohazard assessment reports for the 400Line and 403Line comprise:

- Oaonui Production Station to Frankley Road Offtake
- Frankley Road Offtake to Mokau Compressor Station
- Mokau Compressor Station to Mahoenui Scraper Station
- Mahoenui Scraper Station to Tihiroa Scraper Station
- Tihiroa Scraper Station to Huntly Offtake
- **Huntly Offtake to Huntly Power Station (403Line).**

The Maui Pipeline section between Oaonui Production Station and Frankley Road Offtake includes the Frankley Road Offtake to New Plymouth Power Station pipeline known as the 404Line. This section of pipeline is not included in the geohazard assessment process because the operational status of the pipeline is suspended at the time of this assessment.

This report documents the geohazard assessment for the Huntly Offtake to Huntly Power Station section of the Maui Pipeline (403Line).

Vector Limited (Vector) requested that Pattle Delamore Partners Limited (PDP) provide advice in a desktop workshop and at selected locations in the field to assess the geohazard risk to the Maui Pipeline (403Line) at geohazard features identified between the Huntly Offtake and Huntly Power Station. For purposes of clarity, the pipeline outlined above will be referred to as “the pipeline” or “pipeline” in the remainder of the report.

For the purposes of the assessment, geohazard features are slope instability (e.g. landsliding and slumping), surface water erosion, sub-surface erosion, trench backfill consolidation and human related hazards (e.g. excess fill). Other geohazards such as seismic hazards (e.g. fault rupture and liquefaction) are outside the scope of the assessment.

A total of 25 geohazard features have been identified and considered along the pipeline section. All features were identified in a foot assessment undertaken by Derek Coombe (Senior Pipeline Integrity Specialist, Vector). Geohazard features identified during the walkover included small (slumping) and large (landslide) scale slope instability, pipeline trench consolidation, stream erosion and human related features such as fill areas.

The geohazard identification and assessment process has comprised:

- Identification of geohazard features by foot assessment which was undertaken by Derek Coombe (Senior Pipeline Integrity Specialist) from Vector in September/October 2013.
- An initial desktop workshop assessment carried out by Derek Coombe and Neil Crampton (Technical Director Engineering Geology) and Chris Foote (Engineering Geologist) from PDP in October/November 2013.
- Field review of selected geohazard features by Derek Coombe and Neil Crampton in February 2014.
- GFRRAT re-ranking workshop assessment carried out by Derek Coombe, Neil Crampton and Chris Foote in March 2014.
- Vector pipeline integrity assessment process (based on AS2885.1 2012 *Pipelines – Gas and liquid petroleum. Part 1: Design and construction*) carried out by Vector, PDP and GNS in April 2014.
- Field evaluations recommended by the Vector pipeline integrity assessment.
- Recent field assessment and monitoring at 1 geohazard feature due to fresh slope movement in mid-2015.

This report outlines the methodology and presents the findings from the assessment of geohazard features along this section of the pipeline including the geohazard feature risk ranking assessment record, the number of features in each risk category, conclusions and recommendations.

The geohazard features and associated geohazard risk identified in this assessment will be considered along with pipeline related factors in further Vector pipeline integrity assessment processes. The Vector pipeline integrity assessment will determine the need for and scope of any further risk treatment actions at the geohazard features.

Vector has advised that the geohazard features for the entire pipeline will be maintained and documented within the Vector GIS (Geographic Information System) framework.

2.0 Scope and Objectives

The Tihiroa Scraper Station to Huntly Offtake and Huntly Offtake to Huntly Power Station (403Line) sections of the pipeline were the first sections to be assessed for geohazard feature risk. As a result, the risk assessment process for these 2 pipeline sections has included additional stages compared to the process for the other 4 pipeline sections. The additional stages, which are described in the following sections, are:

- Initial assessment of geohazard feature risk was carried out using a precursor version of the Geohazard Feature Risk Ranking Assessment Tool (GFRRAT). Subsequent risk re-ranking with the updated version of the GFRRAT was therefore required to ensure consistency with the risk assessment carried out for other sections of the pipeline.
- A Vector pipeline integrity assessment carried out in April 2014 recommended that field assessments be carried out at a number of geohazard features as part of pipeline risk treatment actions. Information collected during these field assessments (June 2014) has been used to provide the most up-to-date risk ranking for the geohazard features in this report.

2.1 Initial Desktop Workshop and Field Reviews

2.1.1 Initial Desktop Workshop

The initial workshop had the objective of using the available information to assess and rank risk to the pipeline at each geohazard feature identified during the foot assessment (and any additional geohazard feature identified during the workshop), where this was possible based on the available information.

2.1.2 Field Reviews

The objectives of the field reviews were to:

- Provide a degree of calibration for the desktop risk assessment process.
- Based on all information available, determine whether any geohazard features require urgent action at the time of completion of the field reviews. Vector advised that the geohazard features would subsequently be evaluated using the Vector pipeline integrity assessment process and that the features would be subject to ongoing monitoring as part of Vector’s routine pipeline surveillance in recognition that geohazard risk can change over time.

The scope of the field reviews involved locating and determining the depth to the pipeline (using electronic locator) and carrying out a brief (up to 1hr duration) engineering geological site assessment (walkover) at each geohazard feature. In addition, engineering geology evaluation was used to infer geohazard mechanisms and the likelihood of geohazard effects on the pipeline at each feature for risk assessment purposes.

The field reviews were based on visual appraisal of the geohazard feature only and have not been confirmed by a detailed geohazard assessment (e.g. subsurface investigations) which may modify the allocated risk ranking.

2.1.3 Initial Risk Assessment

The initial assessment of geohazard feature risk was based on the initial desktop workshop and field reviews and was carried out using a precursor version of the Geohazard Feature Risk Ranking Assessment Tool (GFRRAT). The precursor risk assessment was superseded by the risk assessment subsequently carried out (refer below) which used the Vector GFRRAT current at the time of writing (Vector Document #3208429, Appendix A). Information from the foot assessment, initial desktop workshop and field reviews were used for both the initial and updated risk assessment.

2.2 GFRRAT Re-Ranking Assessment

The purpose of the GFRRAT re-ranking assessment was to apply the updated GFRRAT and obtain a risk ranking for each geohazard feature, utilising information from the foot assessment, initial desktop workshop and field reviews.

The GFRRAT re-ranking assessment was based solely on desktop methods and essentially involved determining a feature mechanism, severity category, frequency class and risk rank for each geohazard feature.

2.3 Vector Pipeline Integrity Assessment Field Evaluations

The Vector pipeline integrity assessment (VPIA) carried out in April 2014 recommended field evaluations be carried out at a number of geohazard features as part of pipeline risk treatment actions. Two types of field evaluation were recommended, namely:

- A Site Condition Assessment (SCA) at all High risk geohazard features. An SCA comprises desktop assessment and site investigation, including pipeline location/depth information, surface engineering geological evaluation and limited shallow sub-surface investigations.
- A Site Visit (SV) at a selection of Intermediate risk geohazard features. A SV involves a preliminary surface engineering geological evaluation (walkover) and a check on pipeline location/depth.

Information collected during the field evaluations has been used to provide the most up-to-date risk ranking for geohazard features in this report.

3.0 Geohazard Risk Ranking System

Vector has developed a Geohazard Feature Risk Ranking Assessment Tool (GFRRAT) for assigning a qualitative risk to geohazard features along the pipeline route (Appendix A).

The GFRRAT has the general framework contained in Appendix F of the AS2885.1 2012, risk matrix i.e. severity categories and frequency classes which are inputs for a matrix that determines risk. The GFRRAT has however been tailored for geohazard features and, as such is intended as one of a number of inputs into the Vector pipeline integrity assessment process which is based on AS2885.1 2012 (i.e. the GFRRAT is not intended to be correlated directly with the AS2885.1 2012 pipeline risk assessment categories).

The GFRRAT retains the AS2885.1 2012 severity category titles but contains qualitative or semi-qualitative descriptions for each category (refer to Appendix A). The frequency classes and descriptions, and the risk matrix used in the GFRRAT are as per AS2885.1 2012.

The first step in assessing the risk for a geohazard feature is to assign a mechanism of failure/process based on desktop and field assessment and engineering geological judgement. The current range of geohazard feature mechanisms to choose from is:

- **Landslide** (slope instability > approximately 10m x 10m in footprint area)
- **Slump** (slope instability < approximately 10m x 10m in footprint area)
- **Erosion** (either surface erosion e.g. stream or river bank, surface water rilling or sub-surface erosion e.g. tomo and piping)
- **Ground Consolidation** (e.g. trench backfill consolidation, weak ground consolidation)
- **Human** - human activity (e.g. pond excavation, fill stockpile).

The second step of the GFRRAT is to select an appropriate severity category for the geohazard feature based on the failure mechanism/process and the consequences to the pipeline/pipeline cover of this mode of failure. Some examples are (refer also to Appendix A):

- The pipeline crosses a landslide and the inferred failure surface is below the depth of the pipeline. The mechanism is Landslide and the appropriate severity category is Major because the geohazard feature (landslide) could result in pipeline deformation.
- Slope instability on the slopes of a ridge where the pipeline is located on the ridge shoulder. The mechanism would be Landslide and the appropriate severity category is likely to be Severe i.e. landslide failure would remove cover to less than minimum, result in exposure of the pipeline or result in loss of support over less than the self-supporting length.
- Slope instability on the bank of a shallow drain would be classed as Slumping and the appropriate severity category would be Minor (loss of cover but minimum cover retained).

The Catastrophic severity category has been retained for the GFRRAT but this category is only likely to apply to extreme consequences to the pipeline e.g. exposed pipeline in a river crossing subject to impact by rocks or an actively moving landslide with loss of containment.

The third step of the GFRRAT is to select the appropriate frequency class for the geohazard feature mechanism/severity category i.e. the frequency (likelihood) of the mechanism occurring such that the pipeline is subjected to the severity category consequences. For both the Landslide examples above, the frequency class may be judged to be Unlikely (unlikely to occur in the life of the pipeline but possible). For the Slumping example above, the frequency class may be judged to be Occasional (may occur occasionally in the life of the pipeline).

The fourth step of the GFRRAT is to determine the risk for the geohazard feature using the risk matrix. For the first landslide example, the severity category is Major and the frequency class is Unlikely – the resulting risk ranking is High. For the second landslide example, the severity category is Severe and the frequency class is Unlikely – the resulting risk ranking is Intermediate. For the slumping example, Minor and Occasional result in a Low risk ranking.

Along with site details and foot/geohazard assessment comments, the table in Appendix B contains the geohazard feature mechanism, severity category, frequency class and Risk Rank for each geohazard feature for the pipeline section.

4.0 Pipeline Route Characteristics

Summary information on the topography and geology along the pipeline route is provided below to set the scene for the geohazard assessment that follows (refer to Figure 1 for pipeline route overview).

4.1 Section Alignment and Geology

Between the Huntly Offtake (located at the Rotowaro Compressor Station) and the Huntly Power Station, the pipeline heads east towards the Waikato River. In this section, the pipeline crossing rolling farmland on generally east and south facing slopes as well as low lying swampy areas associated with Lake Waahi.

The geology throughout this pipeline section is a mixture of predominantly sandy Tauranga Group alluvium and softer Holocene alluvial materials such as peat and mud. The underlying Tertiary bedrock is typically Glen Massey Formation sandstone and siltstone.

4.2 Slope Instability Overview

Slope instability occurs on some slopes underlain by Tauranga Group alluvium and Tertiary bedrock along the pipeline alignment. These typically comprise large relic landslides which in some locations have more active internal lobes (e.g. F2-2013).

The relic landslides generally become more infrequent and eroded as the pipeline alignment heads eastward towards the Huntly Power Station.

5.0 Initial Desktop Workshop Assessment

The information inputs, methodology, outcome and recommendations from the initial desktop workshop phase of the geohazard assessment are outlined below.

5.1 Methodology and Inputs

Inputs and assessment methodology for the geohazard feature risk assessment carried out in the initial desktop workshop are outlined below.

5.1.1 Vector Foot Assessment Input

The pipeline foot assessment was undertaken by the Vector Senior Pipeline Integrity Specialist (Derek Coombe) during October 2013.

The following information was collected at each geohazard feature during the walkover:

- A GPS location point.
- Pipeline alignment located (electronic locator) and described.
- Geohazard feature described.
- Photographs taken of the geohazard feature and the general area.

5.1.2 Desktop Information Inputs

Desktop information inputs for the workshop include published geology, Google aerial photos, Vector line flight photos and historical reports. Key data sources used for the assessment of each geohazard feature in the workshop include:

- Geology Map
  - 1:250,000 QMAP Geology of the Auckland Region (Edbrooke, S.W. 2001).
- Aerial and Oblique Aerial Imagery
  - Line flight photographs.
  - Google Earth aerial imagery taken between 2001 and present day.
  - Vector in-house GIS layers.

5.1.3 Desktop Geohazard Feature Assessment Methodology

An assessment of each geohazard feature was carried out at the initial desktop workshop using the various inputs outlined above. The assessment typically included:

- Determine the instability mechanism at each geohazard feature based primarily on observed landforms (geomorphology) e.g. landslide, slump, erosion and ground consolidation.
- Consideration of the geology (e.g. rock/soil type, bedding orientation).
- Interpret the boundaries of each geohazard feature including depth (where relevant) and location within a larger geohazard feature (e.g. large relic landslide).
- Allocate a length of pipeline associated with each geohazard feature.
- Characteristics of each geohazard feature including:
  - Inferred mechanism of formation and contributing factors (e.g. groundwater, geology).
  - Inferred activeness and potential for future movement (reactivation).
  - Location of the pipeline with respect to the geohazard feature (including inferred depth relationship).
- A general assessment of likelihood and consequence of geohazard feature affecting the pipeline integrity.

5.1.4 Assessment of Geohazard Feature Risk

The assessment of geohazard feature risk during the initial desktop workshop was carried out using a precursor system of the current Geohazard Feature Risk Ranking Assessment Tool (GFRRAT) and therefore has not been included in this report. Geohazard feature risk for features along this section of the pipeline alignment is outlined in Section 7.

5.2 Outcomes

A total of 25 geohazard features were considered for assessment in the initial desktop workshop. These comprise:

- 22 geohazard features identified during the foot assessments.
- 3 geohazard features identified as part of the desktop workshop. These features comprised subdivision of whole slopes/large scale features into separate features to facilitate geohazard risk assessment.

The assessment summary for each geohazard feature from the initial desktop is presented in the geohazard feature risk ranking assessment record in Appendix

B. Note that the desktop assessment summaries in Appendix B combine the findings from the initial desktop workshop and the GFRRAT re-ranking assessment workshop (refer below).

5.3 Recommendations

Following the initial desktop workshop, it was recommended that field reviews be carried out at all higher risk geohazard features and selected lower risk features.

6.0 Initial Field Review and Assessment

The strategy, methodology, outcomes and recommendations for the field review and assessments phase of this geohazard assessment are outlined below.

6.1 Strategy

The strategy adopted for field review of geohazard features assessed in the desktop workshop was to review all High risk features (not previously assessed in the field) and a selection of lower risk features. The aim of the field review strategy was to provide a degree of calibration for the desktop risk assessment process with a greater emphasis on the higher risk geohazard features.

The strategy also involved carrying out a field assessment at any new geohazard features identified during the field review work. The same methodology (refer below) was adopted for field reviews and field assessments.

No new geohazard feature was identified during the field review work for this section of the pipeline and hence no field assessments were carried out.

6.2 Methodology

Field review was carried out at two geohazard features (F1-2013 and F2-2013) during February 2014.

The field review typically included the following at each geohazard feature:

- Locating and determining the depth to the pipeline (electronic locator).
- Carrying out a brief (up to 1hr duration) engineering geological site assessment (walkover) and using engineering geological evaluation and judgement to infer the extent, geometry, type, activity status and likelihood of effects on the pipeline from slope instability and other geohazard mechanisms.
- Determining if any urgent action was required.

6.3 Outcomes and Recommendations

The assessment summary for the two geohazard features reviewed in the field is presented in the geohazard feature risk ranking assessment record in Appendix B.

Based on all information available at completion of the field reviews (3 February 2014), no urgent actions were deemed necessary for geohazard features assessed in this report. Vector advised that the geohazard features would be evaluated using the Vector pipeline integrity assessment process and risk treatment actions would be identified and carried out as required, consistent with this process (refer below). In recognition of the potential for changes to geohazard risk with time from natural events such as heavy rainfall and flooding, Vector also advised that the geohazard features would be subject to ongoing monitoring as part of Vector's routine pipeline surveillance. This monitoring includes special emphasis on High risk geohazard features and site specific monitoring.

7.0 GFRRAT Risk Re-Ranking Assessment

7.1 Methodology

7.1.1 Re-ranking of Initial Geohazard Risk

The geohazard feature risk rankings assigned during the initial desktop workshop (using a precursor system of the current GFRRAT) were re-ranked using the updated GFRRAT in a desktop workshop in March 2014.

7.1.2 GFRRAT Risk Re-Ranking Methodology

The updated risk ranking was based on information from the geohazard feature descriptions and assessments determined during the initial phases of the assessment i.e. foot assessment, initial desktop workshop and field reviews.

The assessment also included confirming/defining the following attributes for each geohazard feature to inform the GFRRAT risk re-ranking:

- The instability mechanism.
- The consequence of the geohazard feature affecting the pipeline integrity (e.g. loss of cover, exposure of pipeline, deformation of pipeline).
- The likelihood of the pipeline being affected by the geohazard feature – currently or in the future.

7.2 Re-Ranking Workshop Outcomes

The geohazard risk ranking statistics for the 25 geohazard features on this section of the pipeline after the desktop workshops and field reviews are presented in Table 1.

Table 1: Geohazard Risk Ranking after GFRRAT Desktop Workshop Assessment

Risk Ranking	Number of Geohazard Features (~% of total geohazard features (25))
High	2 (8%)
Intermediate	3 (12%)
Low	14 (56%)
Negligible	6 (24%)
Total	**25**

8.0 Vector Pipeline Integrity Assessment Actions

8.1 Vector Pipeline Integrity Assessment

In April 2014, the geohazard features and associated geohazard risk identified in the above assessment were considered along with pipeline related factors in a Vector pipeline integrity assessment (VPIA) process based on AS2885.1 2012. The VPIA determined the need for and scope of any risk treatment actions at the geohazard features.

The outcome of the VPIA for this section of the pipeline was for field evaluations to be carried out as follows:

- Carry out a Site Condition Assessment (SCA) at all (2) High risk geohazard features. A SCA comprises desktop assessment and field investigation including pipeline location/depth information, surface engineering geological evaluation and limited shallow sub-surface investigations. The aim of a SCA is to collect surface and subsurface data to better define the risk to the pipeline at the geohazard feature.
- Carry out a Site Visit (SV) at a selection (1) of Intermediate risk geohazard features. A SV involves a preliminary surface engineering geological evaluation (walkover) and a check on pipeline location/depth. The aim of a SV is to evaluate surface data to better define the risk to the pipeline at the geohazard feature.

8.2 VPIA Field Evaluations and Outcomes

The VPIA field evaluations outlined above were carried out at three sites during June 2014, namely:

- A SCA was carried out at High risk geohazard features F2-2013 and F4-2013.
- A SV was carried out at Intermediate geohazard feature F7-2013.

A summary of findings from the field evaluations are presented in the geohazard feature risk ranking assessment record in Appendix B.

On completion of the field evaluations, the risk ranking for each of the geohazard features was reassessed and updated as required (refer below).

8.3 Comparison of GFRRAT Workshop and VPIA Field Evaluation Risk Rankings

Table 2 presents the risk ranking comparison for the three geohazard features that were allocated a risk ranking in the GFRRAT desktop workshop and also during the VPIA field evaluations.

Table 2: Comparison of Desktop and VPIA Field Evaluated Geohazard Risk Rankings

Geohazard Risk Ranking	GFRRAT Desktop Workshop (No. of geohazard features)	Following VPIA Field Evaluation (No. of geohazard features)
High	2	3
Intermediate	1	0
Total	**3**	**3**

The field evaluations resulted in the following changes to the risk rankings assigned in the desktop workshop:

- The 2 High risk features retained their risk ranking.
- The risk ranking for the one Intermediate risk feature was increased by one ranking category to High.

These risk ranking comparisons indicate that the High risk rankings assigned in the desktop workshop are valid. The increase in geohazard risk (Intermediate to High) for feature F7-2013 was the result of clarifying the nature of the surface instability features and confirming the location and depth of the pipeline within the feature.

9.0 Recent Field Investigations and Monitoring

Additional field investigations and site monitoring have been carried out at geohazard feature F2-2013 since completing of the VPIA field evaluation in June 2014. The investigations and monitoring relate to slope movement events that were first detected in June 2015 and are inferred to have been triggered by a prolonged wet period in the preceding 6 weeks.

The findings from the field investigations and monitoring are presented in the geohazard feature risk ranking assessment record in Appendix B.

10.0 Overall Conclusions

There are a total of 25 geohazard features along this section of the pipeline. All 25 features have been assessed for geohazard risk as follows:

- 21 features assessed for geohazard risk using desktop methods only.
- 4 features assessed using desktop and field methods.

The geohazard risk ranking totals for the geohazard features on this section of the pipeline after both desktop workshop and field review/evaluation are presented in Table 3.

Table 3: Geohazard Risk Ranking after Workshop and Field Review/Evaluation

Risk Ranking	Number of Geohazard Features (~% of total geohazard features (25))
High	3 (12%)
Intermediate	2 (8%)
Low	14 (56%)
Negligible	6 (24%)
Total	**25**

Figure 1 illustrates the location and geohazard risk ranking for the geohazard features on the pipeline section.

Other key conclusions arising from the desktop workshop and field review/evaluation are:

- Field assessments indicate that the High risk rankings assigned in the desktop workshop are valid.
- The risk ranking for the one Intermediate risk feature was increased by one ranking category to High as a result of clarifying the nature of the

surface instability features and confirming the location and depth of the pipeline within the feature.

- Based on all information available at completion of the field reviews (3 February 2014), no urgent actions were deemed necessary for geohazard features assessed in this report. Vector advised that the geohazard features would be evaluated using the Vector pipeline integrity assessment process and risk treatment actions would be identified and carried out as required, consistent with this process. In recognition of the potential for changes to geohazard risk with time from natural events such as heavy rainfall and flooding, Vector also advised that the geohazard features would be subject to ongoing monitoring as part of Vector's routine pipeline surveillance. This monitoring includes special emphasis on High risk geohazard features and site specific monitoring.

The findings from field assessments and monitoring related to slope movement in mid-2015 at geohazard feature F2-2013 are included in this report.

The geohazard features and associated geohazard risk identified in this assessment will be considered along with pipeline related factors in further Vector pipeline integrity assessment processes (based on AS2885.1 2012). The Vector pipeline integrity assessment will determine the need for and scope of any further risk treatment actions at the geohazard features.

Vector has advised that the geohazard features for the entire pipeline will be maintained and documented within the Vector GIS (Geographic Information System) framework.

11.0 References

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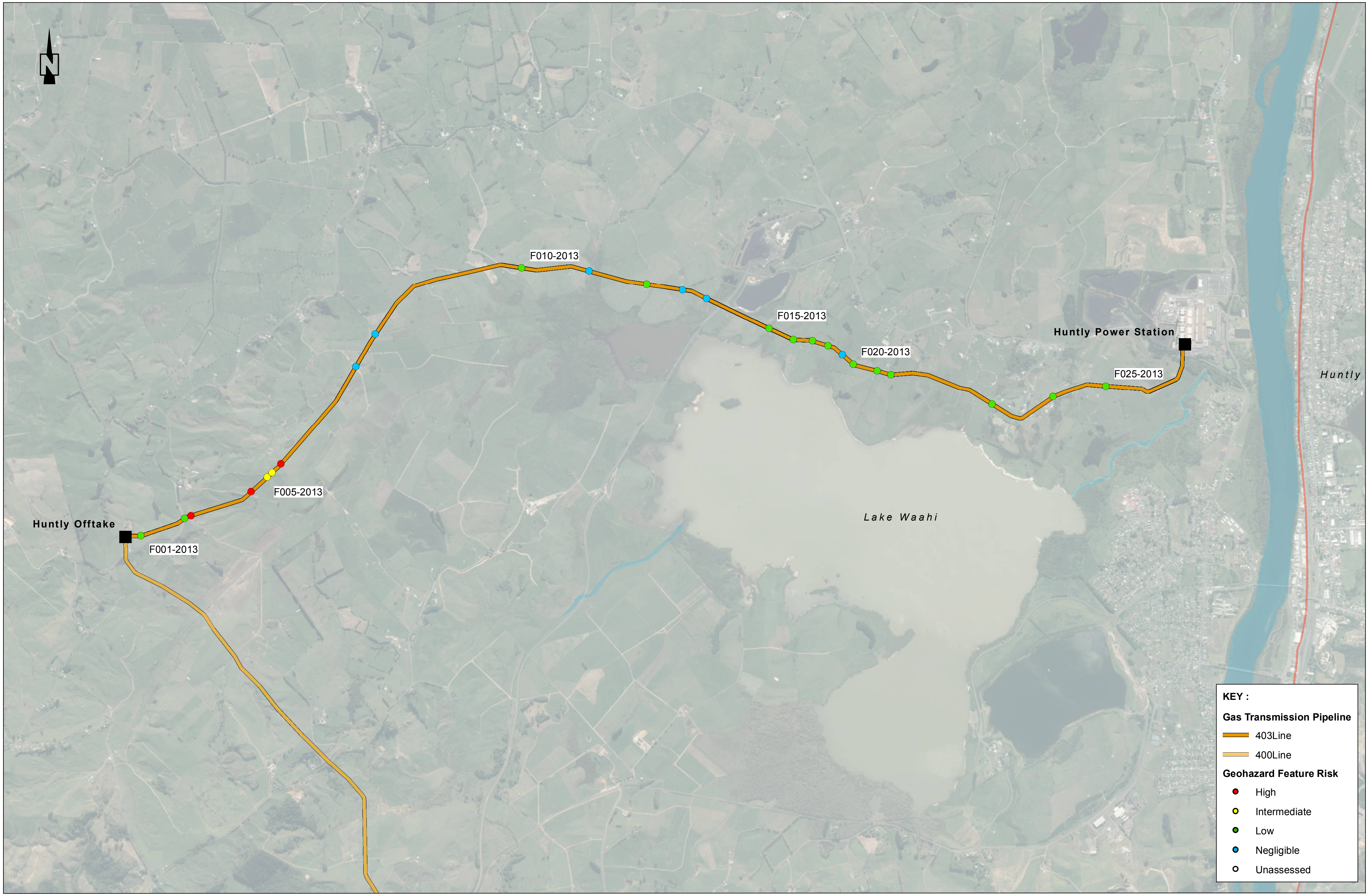


SOURCE:
1. GEOHAZARD FEATURE LABELS SAPCED APPROXIMATELY EVERY 5 FEATURES.
2. FEATURE RANKING AS PER VECTOR GEOHAZARD FEATURE RISK RANKING TOOL.
3. PIPELINE LOCATION PROVIDED BY VECTOR LTD 0800 734 567.
4. AERIAL IMAGES SOURCED FROM THE LINZ DATA SERVICE (FLOWN WRC 2012-2013) AND LICENSED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 3.0 NEW ZEALAND LICENSE.

FIGURE 1: OVERVIEW OF GEOHAZARD FEATURE RISK

SCALE : 1:25,000 (A3)

0 250 500 1,000
Meters

Appendix A

Geohazard Feature Risk Ranking Assessment Tool (Vector)

GEOHAZARD FEATURE RISK RANKING ASSESSMENT TOOL

	GEOHAZARD FEATURE EVALUATION & RANKING					
	SEVERITY CATEGORY	**TRIVIAL**	**MINOR**	**SEVERE**	**MAJOR**	**CATASTROPHIC**
	Geohazard Feature E.g. Landsliding, slumping, erosion (sub-surface and/or surface), ground consolidation	**No Impact on easement or pipeline integrity** E.g. Land feature identified but Pipeline within vicinty or feature considered not to be active	**Minimal Impact or effect to the easement and/or pipeline integrity, effects noted outside of the easement** E.g. pipeline crosses or is in close proximity a relic landslide (considered not active), erosion outside easement, pipeline slide slopes or within crest of a ridge, loss of cover (but minimum retain) due to erosion slumping, trench backfill consolidation or land modification.	**Significant Impact to easement and/or pipeline integrity, effects within easement** E.g. Pipeline is in close proximity (≈6m) an active land feature or shallow feature extends or encompassses the easement, regression is within the easement, loss of cover (is less than minimum) due to landsliding, erosion, slumping or land modification (or the impact to the instability of a feature)	**Major Impact to pipeline integrity, significant effects within easement** E.g. Pipeline is within an active land feature, potential for pipeline deflection, pipeline at risk to be exposed (but under self supported length), feature is associated with other data (i.e. ILI, coatings, ground monitoring, etc...), land modification (has meant impact to the instability of a feature).	**Extreme and/or Current Impact on the pipeline** E.g. Pipeline exposed (subject to impact, i.e river, rock fall), pipeline alignment within an actively moving landslide feature

FREQUENCY CLASSES

	Transmission Pipeline Operation
Frequent	Expected to occur once per year or more
Occasional	May occur occasionally in the life of the pipeline
Unlikely	Unlikely to occur within the life of the pipeline but possible.
Remote	Not anticipated for this pipeline at this location
Hypothetical	Theoretically possible but has never occurred on a similar pipeline

RISK MATRIX

	Catastrophic	**Major**	**Severe**	**Minor**	**Trivial**
Frequent	**Extreme**	**Extreme**	**High**	**Intermediate**	**Low**
Occasional	**Extreme**	**High**	**Intermediate**	**Low**	**Low**
Unlikely	**High**	**High**	**Intermediate**	**Low**	**Negligible**
Remote	**High**	**Intermediate**	**Low**	**Negligible**	**Negligible**
Hypothetical	**Intermediate**	**Low**	**Negligible**	**Negligible**	**Negligible**

Notes

This table is used for the purpose to Risk Rank Geohazard Features related to gas transmission pipeline operations typically in a workshop environment. The risk ranking process is based on surface visual assessment and available desktop material only, such as listed below;

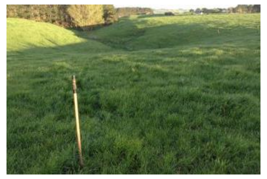
1. Field Observation Notes
2. Proximity of Pipeline(s) to the Feature
3. Site Images
4. Published Geology
5. Aerial Imagery

If further detail is made available such as detailed mapping, In Line Inspection data or sub-surface data (hand augers, test pits, core drilling), a review of the assumptions made during the first ranking will be carried out. Those observations ranked as Intermediate or higher shall be reviewed through the Safety Management Study (SMS), those ranked Low or Negligible would be continued to be monitored for change through routine surveillance

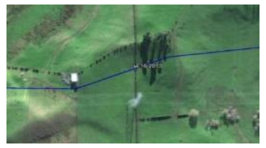
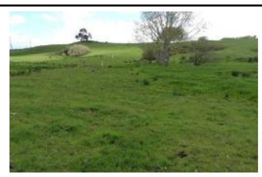
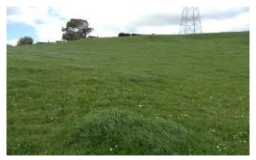
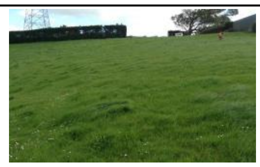
Appendix B

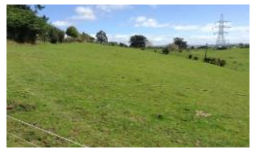
Geohazard Feature Risk Ranking Assessment Record

Geohazard Feature Risk Ranking Assessment Record
403 Line - Maui Pipeline - Huntly Lateral
Huntly Offtake to Huntly Power Station

Site ID	Pipeline	Pipeline Section	Section Description	Start NZMG_Y	Start NZMG_X	Observation Images	Assessment	Comment	Historical Feature ID	Geology	Feature Length	Instability Feature Mechanism	Severity Category	Frequency Class	Risk Ranking
Huntly Offtake															
F001-2013	Maui 403	Rotowaro CS to Huntly PS	Rotowaro CS to Waikokowai Road	6402724.7	2692890.1		September/October 2013 - Foot Assessment	The pipeline traverses rolling pastured farmland, from Rotowaro CS to Waikokowai Road there are a number of depressions that the pipeline traverses through (assumed to be dry drainage lines), the north east corner of the compressor station is assumed to intersect or modified one of these lines (at the time of this assessment shallow ponding was occurring in this area). To the true left approx 20 to 40m and downslope of the pipeline in these depressions are visible water seepage, the ground surface is very dry and competent. It is assumed this is a large relic landslide feature (The Compressor Station is within the feature).		Tauranga Group - Sand [Walton Subgroup]	310 m				
							October/November 2013 - Desktop Workshop	As per previous assessment. Compressor station to Waikowai Rd Crossing appears to be in a large relic landslide. Uncertain about likelihood of movement affecting the pipeline. Potential movement direction is perpendicular to oblique to the pipeline. Mechanism is reactivation of the relic landslide causing pipeline deformation.							
							3 February 2014 - Field Review	As per previous assessments. For this entire length the pipe side slopes around the degraded headscarp of a large relic landslide. Gentle side slopes. Towards Waikokowai Road pipe crosses 2 shallow rounded gullies downslope from main headscarp. Landslide debris for relic slide starts approx. 150m downslope to LH side of pipe. Graben gully at base of headscarp before debris. Only sign of seepage on easement was during DC walkover (Nov 2013) in gully near Waikokowai Road. Last gully near Waikokowai Road has seepage area in gully end 20m downslope of pipe. Retain risk ranking.							
							Final Geohazard Ranking					Landslide	Major	Hypothetical	Low
F002-2013	Maui 403	Rotowaro CS to Huntly PS	Rotowaro CS to Waikokowai Road	6402864.9	2693238.6		September/October 2013 - Foot Assessment	The pipeline traverses down through the head of what is assumed a large landslide feature, the top boundary or headscarp has been modified for pipeline construction, the toe of this boundary is wet with exposed material, a number of visible stumps of what is assumed pine trees, a small plantation of willow trees are showing signs to be leaning downslope, further downslope and to either side of the pipeline are drainage lines flowing in the same direction of the pipeline originating from water seepage.		Tauranga Group - Sand [Walton Subgroup]	200 m				
							October/November 2013 - Desktop Workshop	As per previous assessment. Pipeline drops down into landslide feature over a scarp (3-4m height) and down gentle to moderate rolling to hummocky slope inferred to be debris of a landslide lobe below the head scarp. Follow up required due to uncertainties. Movement direction is sub-parallel to the pipeline. Mechanism is pipeline deformation from landsliding.							
							3 February 2014 - Field Review	As per previous assessments. 200 - 400mm high scarp approx. 40m long at downslope edge of back tilted block below headscarp - extends across pipeline. Movement direction approx. 20 degrees to pipe alignment (failing towards drainage line). Note localised partial slumping in toe of debris near drainage line. Also signs of partially failed slump headscarps within the slide mass indicating movement towards drainage line and nearly perpendicular to pipe. Other desktop comments but headscarp more like 6 m high. Pipe side slopes out of debris onto secondary ridge which appears currently stable. Total length in active lobe approx. 150m. Retain Risk Ranking.							
							June 2014 - Site Condition Assessment	The SCA utilises a scope comprising desktop assessment and site information, including pipeline location/depth information, surface engineering geological evaluation and limited shallow sub-surface investigations to achieve the assessment objective. Pipeline depth was between 1.6 to 4.6 m below ground level. The findings of the SCA was that the pipeline is located near the northern lateral margin of a active landslide lobe. It is possible (but uncertain) that the pipeline is located above the active lobe failure/surface break out planes for a length of approximately 27 m. Suspected lateral offset of the pipeline (from an assumed as-built straight line) of up to 300 mm to the south-east between the active lobe margins. The active lobe movement direction near the pipeline is inferred to be westward ie oblique to the pipeline.	PDP Report# A02676754-SCA01-0715						
							June 2015 - Site Condition Assessment Update	SCA update was carried out at the site to revise the SCA due to fresh headscarp (10-20 mm aperture) tension cracking identified at the site. Key clarifications to the original SCA conceptual landslide model were: The active lobe failure plane is near-vertical in the vicinity of the pipeline. Pipe length in the active lobe revised to 22 m. Possible lateral offset of the pipeline revised to 0.2 m to the south over a distance of 17 m. An elevated groundwater level is indicated upslope of the activate lobe margin and convex changes in slope up slope of the pipeline indicate the potential for upslope retrogression of the active lobe if continued movement was to occur. Risk ranking change from High: (Major, Unlikely) to High: (Major, Occasional) to reflect the observed ongoing movement of the active landslide lobe. Preliminary site monitoring network installed.	PDP Letter# A02676757-L001-0815						
							August 2015 - Site Monitoring Visit	Site monitoring visit was carried out to check renewed headscarp cracking at the site (>100 mm aperture). Observed active lobe increase in headscarp height, shear cracking along the northern lateral margins and 300 mm high toe over thrusting toe bulge. One rudimentary inclinometer (part of the site monitoring network) located downslope of the pipeline was sheared off from the movement. Recheck of the pipeline survey was carried out - no suspected lateral offset of the pipeline could be identified. Recommendation to continue with ongoing monitoring.	PDP Letter# A02676757-L002-1015						
							Final Geohazard Ranking					Landslide	Major	Occasional	High
F003-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6402844.6	2693195.2		September/October 2013 - Foot Assessment	The pipeline traverses downslope through and across the lower boundary of what is assumed a large relic landslide feature, the pipeline crosses two wet swampy drainage lines, upstream there is very minor trench settlement for approx 20m.		Tauranga Group - Sand [Walton Subgroup]	640 m				
							October/November 2013 - Desktop Workshop	Pipeline crosses through large relic landslide area over a total length of 600m. Firstly dropping down over headscarp (F2-2013) near Waikokowai Rd into eroded basin and exit out the steeper lateral margin at F4. Numerous drains in basin, slopes in basin generally uniform and rolling. Refer F2&F4 for details of steeper lateral margins. Movement direction is parallel to perpendicular. mechanism is reactivation of the relic landslide causing pipeline deformation.							
							February 2014 - Field Review	As per previous assessments. Headscarp approximately 6 m high. No significant change since foot assessment. Retain risk ranking.							
							Final Geohazard Ranking					Landslide	Major	Hypothetical	Low
F004-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6403030.1	2693657.6		September/October 2013 - Foot Assessment	The pipeline traverses upslope through what is assumed the head of a large relic landslide, at the toe of this feature is a wet swampy drainage line crossing the pipeline left to right. The surface of this feature is very hummocky, a circular shear feature extends across the pipeline area below the top boundary.		Tauranga Group - Sand [Walton Subgroup]	170 m				
							October/November 2013 - Desktop Workshop	As per previous assessment. Pipeline exits large relic landslide up moderate lateral margin 140m length. Slope has numerous hummocky to rounded instability related features. Seepages in the lower part of the slope. Indication of scarp features extending across the easement (indistinct). Movement direction is oblique to parallel to the pipeline. Mechanism is reactivation of the landslide causing pipeline deformation.							
							June 2014 - Site Condition Assessment	The SCA utilises a scope comprising desktop assessment and site information, including pipeline location/depth information, surface engineering geological evaluation and limited shallow sub-surface investigations to achieve the assessment objective. Pipeline depth was between 1.7 to 2.9 m below ground level. The findings of the SCA was that the site contains three potential instability areas: relic landslide scarp, mid-slope scarp and toe area. Aerial photograph interpretation indicates that the midslope scarp appeared active in the 1940s, with no future movement observed to this day. Slope is very hummocky with potential to form new features over time. However no new features have developed across the pipeline easement which could indicate potential slope movement since construction. Possible slope activations to the west of the pipeline alignment. A pipeline alignment survey was carried out at the site which indicated the pipe was generally straight with no lateral offset through the site features. Following the SCA the risk ranking was retained.	PDP Report # A02676754-SCA02-Draft (in draft)						
							Final Geohazard Ranking					Landslide	Major	Unlikely	High

Site ID	Pipeline	Pipeline Section	Section Description	Start NZMG_Y	Start NZMG_X	Observation Images	Assessment	Comment	Historical Feature ID	Geology	Feature Length	Instability Feature Mechanism	Severity Category	Frequency Class	Risk Ranking
F005-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6403131.7	2693770.7		September/October 2013 - Foot Assessment	The pipeline traverses above on a ridge or across the top boundary of what is assumed an old landslide feature, from the true right of the pipeline or downslope of this feature are visible water seepage points and drainage lines.		Tauranga Group - Sand [Walton Subgroup]	35 m				
							October/November 2013 - Desktop Workshop	As per previous assessment. Pipeline crosses rounded ridge crest, steeper slope headscarp of landslide to RHS minimum 20m from pipeline. Evidence of seepages at base of slope. Movement direction is perpendicular to oblique to the pipeline. Mechanism is retrogression of the relic landslide headscarp causing pipeline deformation.							
							Final Geohazard Ranking					Landslide	Major	Remote	Intermediate
F006-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6403163.7	2693804.1		September/October 2013 - Foot Assessment	The pipeline traverses over a crest of a rise and across a ridge downslope, approx 20 m upstream and to the true right of the pipeline approx 3m is a visible scar 11m long x 0.5m deep, to the true right of at this same location and further upslope approx 12m is a defined line parallel with the crest of the rise, the face below this surface is very wet, below this feature some 10m is a right hand IP direction change, from downstream this feature is very large and circular in shape slope across the pipeline towards a large wet swampy pond (F7-2013). NOTE on the margin of this feature and F7-2013 discussions with the landowner indicated that a Vector excavation was completed here in Autumn 2012, noted since is that the ground is very wet.		Tauranga Group - Sand [Walton Subgroup]	110 m				
							October/November 2013 - Desktop Workshop	As per previous assessment. 11m long scarp at upstream end of lateral margin boundary of relic landslide (see below). Very wet. Landowner comment pipeline is deep and ground is wet, unstable with no mechanical strength. Movement direction is perpendicular to the pipeline. Mechanism is reactivation of the landslide causing pipeline deformation.							
							Final Geohazard Ranking					Landslide	Severe	Unlikely	Intermediate
F007-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6403224.4	2693866.1		September/October 2013 - Foot Assessment	The pipeline traverses across and downslope a relic landslide LHS - RHS of pipeline. To the true left of the pipeline approx 11m is a face that is wet with soil creep lines visible down to the toe, at the toe is a very large wet swampy pond draining to the north.		Tauranga Group - Sand [Walton Subgroup]	180 m				
							October/November 2013 - Desktop Workshop	As per previous assessment. Possible secondary indistinct lobe and back-tilted slope upslope of pond (in head region of relic landslide). Pond depression downslope origin uncertain (eroded seepage, landowner modification or landslide feature?). Movement direction perpendicular to the pipeline. Mechanism is reactivation of the relic landslide causing pipeline deformation.							
							4 June 2014 - Site Visit	As per previous assessments. Pipe locator readings every 40 m across the feature indicate typical pipe depths are 1.4 m - 2.3 m through the feature. No significant change since foot assessment. Pipeline integrity excavation (coatings defect?) carried out few years prior adjacent to field review located adjacent to the upstream fence at start of feature location. Slope toe could possibly daylight in pond. Recent shallow activations on slope between pipeline and pond. Movement direction is perpendicular to oblique to the pipeline. Mechanism is landsliding causing pipeline deformation. Retain Major severity class, increase frequency class from remote to unlikely. New risk ranking: High.							
							Final Geohazard Ranking					Landslide	Major	Unlikely	High
F008-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6403902.6	2694390.3		September/October 2013 - Foot Assessment	The pipeline traverses through from a metalled farm access track, on the downstream side of this in a shallow hollow the ground surface is very wet and boggy, to the true right of the pipeline approx 15m material has been bunded up, this is restricting surface water to flow down stream in a drainage line		Tauranga Group - Sand [Walton Subgroup]	30 m				
							October/November 2013 - Desktop Workshop	Surface water ponding on RHS of easement due to small bund constructed across a surface drainage channel. Pond extends back to easement, ground is boggy.							
							Final Geohazard Ranking					Erosion	Minor	Remote	Negligible
F009-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6404128.0	2694525.5		September/October 2013 - Foot Assessment	The pipeline traverses across flat to rolling pastured farmland, upstream for approx 100m the area generally directly confined over the pipeline is very wet and boggy, noted also is a visible trench settlement, Intersecting this area are wet drainage lines typically flowing left to right.		Tauranga Group - Sand [Walton Subgroup]	140 m				
							October/November 2013 - Desktop Workshop	Minor TBC over 140m in a wet swampy area. Flat ground with a number of drainage lines intersecting the trench. TBC is inferred to be related to pipeline construction. Mechanism is a reduction in pipeline cover from TBC.							
							Final Geohazard Ranking					Ground Consolidation	Minor	Remote	Negligible
F010-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6404587.8	2695547.7		September/October 2013 - Foot Assessment	The pipeline traverses through what is assumed an old landslide feature, the feature is very circular in nature and tilting downslope from the true right of the pipeline, intersecting the pipeline is a wet drainage line flowing left to right this is originated from the true left or upslope of the pipeline from a water seepage point.		Alluvium - Peat	210 m				
							October/November 2013 - Desktop Workshop	Pipeline crosses gentle slope angles sloping left to right toward the lake. Uniform to gently rolling, with damp ground. Relic landslide is eroded. Low ridge with old landslide feature 70m to LHS of easement. Slope between feature and pipe gentle and uniform. Movement direction is oblique to perpendicular to the pipeline. Mechanism is reactivation of the relic landslide causing pipeline deformation.							
							Final Geohazard Ranking					Landslide	Major	Hypothetical	Low
F011-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6404564.9	2696017.6		September/October 2013 - Foot Assessment	Pipeline traverses flat to rolling pastured farmland to cross a wet swampy marsh land, at this point there is vegetation growing over the easement. This made easement impassable - unable to complete an assessment.		Tauranga Group - Sand [Walton Subgroup]	100 m				
							October/November 2013 - Desktop Workshop	Area not assessed on ground as inaccessible due to vegetation and water. Feature 100m long. Wet and swampy but negligible slope instability issues. Mechanism is minor trench backfill consolidation reducing pipeline cover.							
							Final Geohazard Ranking					Ground Consolidation	Minor	Remote	Negligible
F012-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6404472.9	2696419.5		September/October 2013 - Foot Assessment	The pipeline traverses flat to rolling pastured farmland, the alignment is through a circular depression, to the true right of the pipeline is a wet drainage line associated with water seepage.		Tauranga Group - Sand [Walton Subgroup]	100 m				
							October/November 2013 - Desktop Workshop	Pipeline crosses upslope (approx. 10m) of a seepage area to RHS in gully head - minor side slope and seepages close to pipe. Evidence of possible easement fill within head of seepage area (ranked feature). Note: This feature is within an indistinct relic landslide feature approximately 380m in length. Gentle side-slope left to right along pipeline. Some seepage areas with downstream drains. Mechanism is migration of the gully head into the pipeline easement reducing pipeline cover.							
							Final Geohazard Ranking					Slump	Minor	Unlikely	Low
F013-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6404434.6	2696669.4		September/October 2013 - Foot Assessment	The pipeline traverses over a very steep ridge and through to wet swampy wet drainage line flowing left to right, to the true left of the pipeline there has been historical failures, downstream of this feature is a right hand IP direction change.		Tauranga Group - Sand [Walton Subgroup]	180 m				
							October/November 2013 - Desktop Workshop	Pipeline descends the western lateral margin slope via a ramp - localised instability on the lateral margin slopes RHS and LHS of pipe (ranked feature). Pipe then crosses flat area with 2 wet swampy drainage lines (RH IP change between drains). Pipe then ascends gentle slopes to the east. No noticeable seepage/wet areas away from drains. Mechanism is enlargement of the LHS feature reducing pipeline cover.							
							Final Geohazard Ranking					Slump	Minor	Remote	Negligible

Site ID	Pipeline	Pipeline Section	Section Description	Start NZMG_Y	Start NZMG_X	Observation Images	Assessment	Comment	Historical Feature ID	Geology	Feature Length	Instability Feature Mechanism	Severity Category	Frequency Class	Risk Ranking
F014-2013	Maui 403	Rotowaro CS to Huntly PS	Waikokowai Road to Coal Haulage Road	6404371.8	2696835.6		September/October 2013 - Foot Assessment	Pipeline traverses a wet swampy area with vegetation over the easement This made easement impassable - unable to complete an assessment.		Tauranga Group - Sand [Walton Subgroup]	90 m				
							October/November 2013 - Desktop Workshop	Area assessed in workshop using aerial photographs. Possible minor TBC for 90 m. Ground appears wet and swampy. Negligible slope instability issues. Mechanism is minor (<0.1m) TBC reducing pipeline cover.							
							Final Geohazard Ranking					Ground Consolidation	Minor	Remote	Negligible
F015-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6404164.4	2697271.2		September/October 2013 - Foot Assessment	Pipeline traverses a wet swampy area with vegetation over the easement This made easement impassable - unable to complete an assessment.		Tauranga Group - Sand [Walton Subgroup]	180 m				
							October/November 2013 - Desktop Workshop	Area not assessed on ground as inaccessible due to vegetation and water feature 80m long. Wet and swampy, negligible slope instability issues. Potential for minor consolidation. Pipeline then runs along a flat terrace and gently sloping land with very indistinct relic landslide features (ranked feature) - 100m length. Impassable due to vegetation & stock. Assessed via walk over photos and aerial imagery. Movement direction parallel to the pipeline. Mechanism is a loss of pipeline cover from slumping.							
							Final Geohazard Ranking					Landslide	Severe	Remote	Low
F016-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6404085.5	2697441.3		September/October 2013 - Foot Assessment	This observation was separated from #F17-2013 observation during the Desktop Observation. See Comments below.		Tauranga Group - Sand [Walton Subgroup]	130 m				
							October/November 2013 - Desktop Workshop	Pipeline crosses below eroded headscarp slope of a relic landslide feature approximately 130m in length. Relic features indistinct. Gentle side-slope left to right along pipeline. No indication of wet areas or seepage. Uniform slopes. Movement direction is perpendicular to the pipeline. Mechanism is reactivation of the relic landslide causing pipeline deformation.							
							Final Geohazard Ranking					Landslide	Major	Hypothetical	Low
F017-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6404075.9	2697574.1		September/October 2013 - Foot Assessment	The pipeline traverses down slope and across a large bowl like feature, there is visible soil creep lines on the upstream face with very shallow minor activations upslope or true left of the pipeline, water seepage is visible downslope or to the true right of the pipeline		Tauranga Group - Sand [Walton Subgroup]	120 m				
							October/November 2013 - Desktop Workshop	Pipeline crosses a relic landslide feature approximately 120m in length. Relic features indistinct. Gentle side-slope left to right along pipeline. Potential water seepage from toe of slope 50m from pipeline. Uniform slopes. Movement direction is perpendicular to the pipeline. Mechanism is reactivation of the relic landslide causing pipeline deformation.							
							Final Geohazard Ranking					Landslide	Major	Hypothetical	Low
F018-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6404042.8	2697680.7		September/October 2013 - Foot Assessment	This observation was separated from #F19-2013 observation during the Desktop Observation. See Comments below.		Tauranga Group - Sand [Walton Subgroup]	80 m				
							October/November 2013 - Desktop Workshop	Pipeline crosses a relic landslide feature approximately 80m in length. Relic features indistinct. Pipeline cross slopes left to right, gentle slope. Also landslide headscarp feature 6-10m to RHS of easement approx 5m high, slopes below headscarp essentially flat and swampy (ranked feature). Seeps from headscarp area. Movement direction is perpendicular to the pipeline. Mechanism is loss of pipeline cover from migration of the swampy toe upslope to the pipeline easement.							
							Final Geohazard Ranking					Landslide	Severe	Remote	Low
F019-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6403978.3	2697781.9		September/October 2013 - Foot Assessment	The pipeline traverses through a wet swampy area with a wet drainage line flowing left to right, two large diameter culverts (assumed old construction) are in place downstream of the pipeline within the drainage line, these have deteriorated and exposed at both ends, visible trench settlement downstream for approximately 25m, upstream above the pipeline is lower lying than the farm access track.		Tauranga Group - Sand [Walton Subgroup]	80 m				
							October/November 2013 - Desktop Workshop	Minor TBC over 20m (max 200mm) in downstream part of this section in a wet swampy area. Pipeline follows mounded track through swampy area. Culvert through track mound requires maintenance. Potential for minor consolidation reducing pipeline cover thickness.							
							Final Geohazard Ranking					Ground Consolidation	Minor	Remote	Negligible
F020-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6403912.5	2697856.1		September/October 2013 - Foot Assessment	The pipeline traverses upslope around the left hand boundary of what is assumed a relic landslide, downslope the pipeline completes a left hand IP change before traversing up and across the left hand boundary.		Tauranga Group - Sand [Walton Subgroup]	150 m				
							October/November 2013 - Desktop Workshop	Pipeline crosses the eroded headscarp slope of a relic landslide feature approximately 130m in length. Relic landslide features are indistinct and slopes are uniform to rounded. Slope crosses pipeline left to right. Movement direction is perpendicular to the pipeline. Mechanism is reactivation of the relic landslide causing pipeline deformation.							
							Final Geohazard Ranking					Landslide	Major	Hypothetical	Low
F021-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6403866.4	2698023.4		September/October 2013 - Foot Assessment	The pipeline traverses below the crest and on the top boundary of a relic landslide.		Tauranga Group - Sand [Walton Subgroup]	100 m				
							October/November 2013 - Desktop Workshop	Pipeline crosses the top of the eroded headscarp slope of a relic landslide feature. Gentle slope crosses pipeline left to right. Steeper relic landslide slopes 15m to right of pipeline. Seepages at toe and soil creep on steep slope. Movement direction is perpendicular to the pipeline. Mechanism is reactivation of the relic landslide causing pipeline deformation.							
							Final Geohazard Ranking					Landslide	Major	Hypothetical	Low
F022-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6403839.1	2698120.4		September/October 2013 - Foot Assessment	This observation was separated from #F21-2013 observation during the Desktop Observation. See Comments below.		Tauranga Group - Sand [Walton Subgroup]	200 m				
							October/November 2013 - Desktop Workshop	Pipeline passes obliquely through the central part of the relic landslide 130 m. Indistinct rolling features within the landslide, prominent seepage 12m to RHS of pipeline which has formed a gully head (slope in this area slightly steeper) (ranked feature). Mechanism is loss of pipeline cover from the migration of the gully head upslope towards the pipeline.							
							Final Geohazard Ranking					Landslide	Severe	Remote	Low
F023-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6403633.6	2698823.8		September/October 2013 - Foot Assessment	The pipeline traverses from wet swampy flat terrace to upslope, the surface is very rolling with water seepage to above and the true left of the pipeline at approx the feature mid-point.		Tauranga Group - Sand [Walton Subgroup]	200 m				
							October/November 2013 - Desktop Workshop	Pipeline climbs across a relic landslide feature to Berrymans Access Road approximately 200m total length. Relic landslide features indistinct, hummocky/rolling. Prominent seepage in centre of landslide. Landslide slopes are gentle. Seepage LHS of pipeline in central slope area (possible water run off from surrounding dwelling). Slightly hummocky toe area of slide starts approximately 10m to RHS of pipeline (ranked feature). Mechanism is loss of pipeline cover from the migration of the seepage area upslope towards the pipeline.							
							Final Geohazard Ranking					Landslide	Severe	Remote	Low

Site ID	Pipeline	Pipeline Section	Section Description	Start NZMG_Y	Start NZMG_X	Observation Images	Assessment	Comment	Historical Feature ID	Geology	Feature Length	Instability Feature Mechanism	Severity Category	Frequency Class	Risk Ranking
F024-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6403685.8	2699250.2		September/October 2013 - Foot Assessment	The pipeline traverses around the mid-point of a slope of which is facing to the true left of the pipeline, at the toe of this face is a wet drainage line flowing with the pipeline, on this face there are visible soil creep lines, in the middle of this feature the pipeline complete a right hand IP change.		Tauranga Group - Sand [Walton Subgroup]	160 m				
							October/November 2013 - Desktop Workshop	Pipeline side slopes across gently right to dipping left slope. Slope is uniform, some soil creep in mid section of slope. No seepage in slope, stream gully in base of slope. No signs of slope instability. Mechanism is possible loss of pipeline cover from the shallow landsliding off the slope.							
							Final Geohazard Ranking					Landslide	Severe	Remote	Low
F025-2013	Maui 403	Rotowaro CS to Huntly PS	Coal Haulage Road to Hetherington Road	6403756.4	2699618.3		September/October 2013 - Foot Assessment	Pipeline traverses downslope on the right hand side of a narrow spur, there are visible soil creep lines across the faces, water seepage is visible either side of the easement area, downstream of the feature start (approx 50m) on the true left side of the pipeline is a wet swamp/pond, on the face between this pond and upslope to the pipeline are shallow scarps and soil creep.		Tauranga Group - Sand [Walton Subgroup]	480 m				
							October/November 2013 - Desktop Workshop	Pipeline drops obliquely down through relic landslide feature approximately 480m in length. Relic features are indistinct and include a number of lobes in the lower part of the slide downslope of pipe. Pipeline follows internal spur for some distance in central part of landslide with some side slopes (left to right) in places (ranked feature). Number of major seepages greater than 40m from pipe. No noticeable seepage along the pipeline easement. Movement direction is parallel to oblique to the pipeline. Mechanism is reactivation of the relic landslide causing pipeline deformation.							
							Final Geohazard Ranking					Landslide	Major	Hypothetical	Low
Huntly Power Station															

Description of Abbreviations	
Abr	**Description**
TBC	Trench Backfill Consolidation
LHS	Left hand side of pipeline (looking in direction of gas flow)
RHS	Right hand side of pipeline (looking in direction of gas flow)
IP	Inflection Point (pipeline bend)
L to R	Left to Right