TAG Oil (NZ) Limited
Sidewinder Production Station
Monitoring Programme
Annual Report
2014-2015

Technical Report 2015-101

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Executive summary

TAG Oil (NZ) Limited (the Company) holds consents for a petrochemical production station located on Upper Durham Road at Inglewood, in the Waitara catchment. The Sidewinder Production Station processes oil and gas from the Company's adjacent Sidewinder wellsite. This report for the period July 2014 to June 2015 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the Company's environmental performance during the period under review, and the results and environmental effects of the Company's activities.

The Company holds three resource consents in relation to the Sidewinder Production Station, which include a total of 43 conditions setting out the requirements that the Company must satisfy. The Company holds one consent to discharge treated stormwater and production water from hydrocarbon exploration and production operations at the Sidewinder site into the Piakau Stream, and two consents to discharge emissions related to production activities into the air at this site.

During the monitoring period, the Company demonstrated an overall high level of environmental performance.

The Council's monitoring programme for the period under review included three inspections, three water samples collected for physicochemical analysis, two biomonitoring surveys of receiving waters and two ambient air quality surveys.

Monitoring of the stormwater discharge from the site found that all applicable conditions in the consent were complied with. There were no adverse effects found in the receiving waters of the Piakau Stream.

There were no adverse effects on the environment resulting from the exercise of the air discharge consent. The ambient air quality monitoring at the site showed that levels of carbon monoxide, combustible gases, PM10 particulates and nitrogen oxides were all below levels of concern at the time of sampling. No offensive or objectionable odours were detected beyond the boundary during inspections and there were no complaints in relation to air emissions from the site.

During the period under review, the Company demonstrated an overall high level of both environmental performance and administrative compliance with the resource consents. There were no unauthorised incidents recorded by the Council in relation to the Company's activities. The Sidewinder Production Station was well managed and maintained.

For reference, in the 2014-2015 year, 75% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 22% demonstrated a good level of environmental performance and compliance with their consents.

This report includes a recommendation for the 2015-2016 year.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2014-June 2015 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by TAG Oil (NZ) Limited (the Company). The Company operates the Sidewinder Production Station situated on Upper Durham Road at Inglewood, in the Waitara catchment.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consent held by the Company that relates to discharges of water within the Waitara catchment, and the air discharge permits held by the Company to cover emissions to air from the site.

One of the intents of the *Resource Management Act 1991* (RMA) is that environmental management should be integrated across all media, so that a consent holder's use of water, air, and land should be considered from a single comprehensive environmental perspective. Accordingly, the Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects of the Company's use of water, land and air, and is the second combined annual report by the Council for the Sidewinder Production Station.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the RMA and the Council's obligations and general approach to monitoring sites though annual programmes, the resource consents held by TAG in the Waitara catchment, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted at the Sidewinder Production Station.

Section 2 presents the results of monitoring during the period under review, including scientific and technical data.

Section 3 discusses the results, their interpretations, and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2015-2016 monitoring year.

A glossary of common abbreviations and scientific terms, and a bibliography, are presented at the end of the report.

1.1.3 The Resource Management Act 1991 and monitoring

The *Resource Management Act 1991* (RMA) primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

(a) the neighbourhood or the wider community around a discharger, and may include cultural and social-economic effects;
(b) physical effects on the locality, including landscape, amenity and visual effects;
(c) ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;
(d) natural and physical resources having special significance (for example recreational, cultural, or aesthetic);
(e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with Section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and consent performance

Besides discussing the various details of the performance and extent of compliance by the consent holder during the period under review, this report also assigns a rating as to the Company's environmental and administrative performance.

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. **Administrative performance** is concerned with the Company's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

Events that were beyond the control of the consent holder and unforeseeable (i.e. a defence under the provisions of the RMA can be established) may be excluded with regard to the performance rating applied. For example loss of data due to a flood destroying deployed field equipment.

The categories used by the Council for this monitoring period, and their interpretation, are as follows:

Environmental Performance

- **High:** No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

- **Good:** Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

  For example:

  - High suspended solid values recorded in discharge samples, however the discharge was to land or to receiving waters that were in high flow at the time;
  - Strong odour beyond boundary but no residential properties or other recipient nearby.

- **Improvement required:** Likely or actual adverse effects of activities on the receiving environment were more than minor, but not substantial. There were some issues noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent minor non-compliant activity could elevate a minor issue to this level. Abatement notices and infringement notices may have been issued in respect of effects.

- **Poor:** Likely or actual adverse effects of activities on the receiving environment were significant. There were some items noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent moderate non-compliant activity could elevate an 'improvement required' issue to this level. Typically there were grounds for either a prosecution or an infringement notice in respect of effects.

Administrative compliance

- **High:** The administrative requirements of the resource consents were met, or any failure to do this had trivial consequences and were addressed promptly and co-operatively.

- **Good:** Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason was provided

for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.

- **Improvement required:** Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the period under review. The Council may have issued an abatement notice to attain compliance.

- **Poor:** Material failings to meet the administrative requirements of the resource consents. Significant intervention by the Council was required. Typically there were grounds for an infringement notice.

For reference, in the 2014-2015 year, 75% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 22% demonstrated a good level of environmental performance and compliance with their consents.

1.2 Process description

The Sidewinder Production Station was commissioned in late 2011 following the successful drilling and testing of the Sidewinder-1, 2, 3 and 4 exploration wells, which produce gas-rich condensate. A major site expansion to the southwest of the production station was carried out over the summer of 2012/13 to allow for the drilling of three further exploration wells in 2013. Upgrades were also made to the site facilities to allow for increased throughput of oil and gas.

Photo 1 Sidewinder Production Station and wellsite in February 2012

The facilities are designed to process up to 30 million cubic feet of gas per day, along with any associated condensate. Processed gas is exported via a 3.5 km pipeline which

was constructed to provide a connection from the Sidewinder site to the North Island gas network. Condensate is exported via a truck load-out facility.

All chemical storage is contained within bunds and isolated from the stormwater system. Stormwater from these areas is directed for treatment through a three-stage API interceptor. The site's stormwater drain system consists of open culvert ring-drains which capture general surface water run-off. All stormwater passes through two lined skimmer pits before discharging to land near the Piakau Stream at the southeastern corner of the site.

1.3 Resource consents

1.3.1 Water discharge permit

Section 15(1)(a) of the RMA stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

The Company holds water discharge permit **7595-1** to discharge treated stormwater and production water from hydrocarbon exploration and production operations at the Sidewinder wellsite into the Piakau Stream. This permit was issued by the Council on 11 February 2010 under Section 87(e) of the RMA. It has been varied twice previously, on 14 January 2011 to account for a site name change, and 6 December 2011 to increase the size of the catchment area. A variation was also granted during the current monitoring period, on 5 August 2014, to change the purpose of the consent to discharge directly into the Piakau Stream. This included changes to an existing condition, and the addition of a new condition, relating to the stormwater upgrade. It is due to expire on 1 June 2027.

Conditions 1 and 2 require adoption of the best practicable option and place a limit on the maximum catchment area.

Conditions 3 and 4 require works notifications and provision of a contingency plan.

Conditions 5 to 8 relate to the stormwater system design and bunding of hazardous substance storage areas.

Conditions 9 to 11 stipulate limits on constituents in the discharge and effects on receiving waters.

Conditions 12 to 14 relate to site reinstatement, lapse and review.

The permit is attached to this report in Appendix I.

1.3.2 Air discharge pemits

Section 15(1)(c) of the RMA stipulates that no person may discharge any contaminant from any industrial or trade premises into air, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

The Company holds air discharge permit **7777-1** to discharge emissions to air associated with production activities at the Sidewinder wellsite, including flaring from well workovers, and emergency situations, and other miscellaneous activities. This permit was issued by the Council on 7 February 2011 under Section 87(e) of the RMA. It is due to expire on 1 June 2027.

Conditions 1 and 2 require notification of significant flaring events to the Council and neighbouring residents, and the maintenance of a record of all enquiries or complaints.

Conditions 3 and 4 exclude the flaring of liquid or solid hydrocarbons.

Condition 5 requires adoption of the best practicable option at all times.

Conditions 6 to 10 relate to the prevention and minimisation of emissions.

Conditions 11 and 12 require provision of an analysis of the well stream upon request and maintenance of a flaring log.

Conditions 13 and 14 are lapse and review provisions.

The Compan also holds air discharge permit **7822-1** to discharge emissions into the air from the flaring of hydrocarbons arising from hydrocarbon production and processing operations, together with miscellaneous emissions, at the Sidewinder Production Station. This permit was issued by the Council on 22 June 2011 under Section 87(e) of the RMA. It is due to expire on 1 June 2027.

Condition 1 requires adoption of the best practicable option at all times.

Conditions 2 to 6 detail requirements for the recording and provision of information.

Conditions 7 and 8 require notification of site alterations and instances of continuous flaring.

Conditions 9 to 13 relate to the prevention and minimisation of emissions.

Conditions 14 and 15 are lapse and review provisions.

These permits are attached to this report in Appendix I.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets out obligations upon the Council to gather information, monitor, and conduct research on the exercise of resource consents, and the effects arising, within the Taranaki region and report upon these.

The Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations, and seek information from consent holders.

The monitoring programme for the Sidewinder Production Station consisted of four primary components.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in:

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any reviews;
- renewals;
- new consents;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3 Site inspections

The Sidewinder Production Station and wellsite was visited three times during the monitoring period. With regards to the consent for discharges to land/water, the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Air inspections focused on plant processes with associated actual and potential emission sources and characteristics, including potential odour, dust, noxious or offensive emissions. Sources of data being collected by the consent holder were identified and accessed, so that performance in respect of operation, internal monitoring, and supervision could be reviewed by the Council. The neighbourhood was surveyed for environmental effects.

1.4.4 Chemical sampling

The Council undertook sampling of both the discharges from the site and the water quality upstream and downstream of the discharge point and mixing zone.

The Sidewinder Production Station discharge was sampled on one occasion, and the samples analysed for chlorides, conductivity, hydrocarbons, pH, suspended solids and turbidity. The Piakau Stream was sampled concurrently, and the samples analysed for the same constituents.

The Council also undertook sampling of the ambient air quality outside the boundary of the site. A multi-gas meter was deployed on one occasion in the vicinity of the plant, with monitoring consisting of continuous measurements of gas concentrations for the gases of interest (carbon monoxide and combustible gases). A PM10 particulate monitor was deployed concurrently with the multi-gas meter. Two nitrogen oxide measuring devices were also deployed in the vicinity of the plant on one occasion during the year under review. The Company supplied data on flaring causes and flare volumes throughout the period.

1.4.5 Biomonitoring surveys

A biological survey was performed on two occasions in the Piakau Stream to determine whether or not the discharge of stormwater from the Sidewinder Production Station was having a detrimental effect upon the communities of the stream.

2. Results

2.1 Water

2.1.1 Inspections

Three inspections were undertaken at the Sidewinder Production Station during the period under review. The following was found during the inspections:

29 July 2014
The site was inspected during upgrades to the stormwater system. Ring drain levels and alignment had been improved to prevent ponding and the skimmer pit discharge point to the stream was being modified to prevent any stream bank erosion. The contents of the skimmer pits were very clear. There were no visual issues and no flaring was evident. The site was tidy and well managed.

7 October 2014
Inspection was undertaken with the site crew. The stormwater system had recently been modified and additional silt control measures installed. No flaring was occurring at the time of inspection apart from the pilot flare. The truck load out area and separator were clear of any contaminants. The site was well managed tidy. Everything was satisfactory.

12 March 2015
Inspection was undertaken during fine weather. The site was neat and tidy. No flaring was being undertaken aside from the pilot flare. The skimmer pits were 75% full with clear water. The truck load out area and separator system were clear of all contaminants. Everything was satisfactory.

2.1.2 Results of discharge monitoring

Chemical water quality sampling of the discharge from the Sidewinder Production Station was undertaken on one occasion during the 2014-2015 period. The samples were collected on 3 June 2015. Table 1 presents the results. The location of the sampling site (IND002050) is shown in Figure 1.

Table 1 Results for discharge monitoring from Sidewinder Production Station

Parameter	Units	3 June 2015	Consent limits
Chloride	g/m^3	7.2	50
Conductivity	mS/m	3.4	-
Hydrocarbons	g/m^3	<0.5	15
Suspended solids	g/m^3	21	100
Temperature	Deg. C	10.2	-
pH		6.9	6.0 – 9.0
Turbidity	NTU	17	-

All results were in compliance with the applicable conditions of consent 7595-1 at the time of sampling.

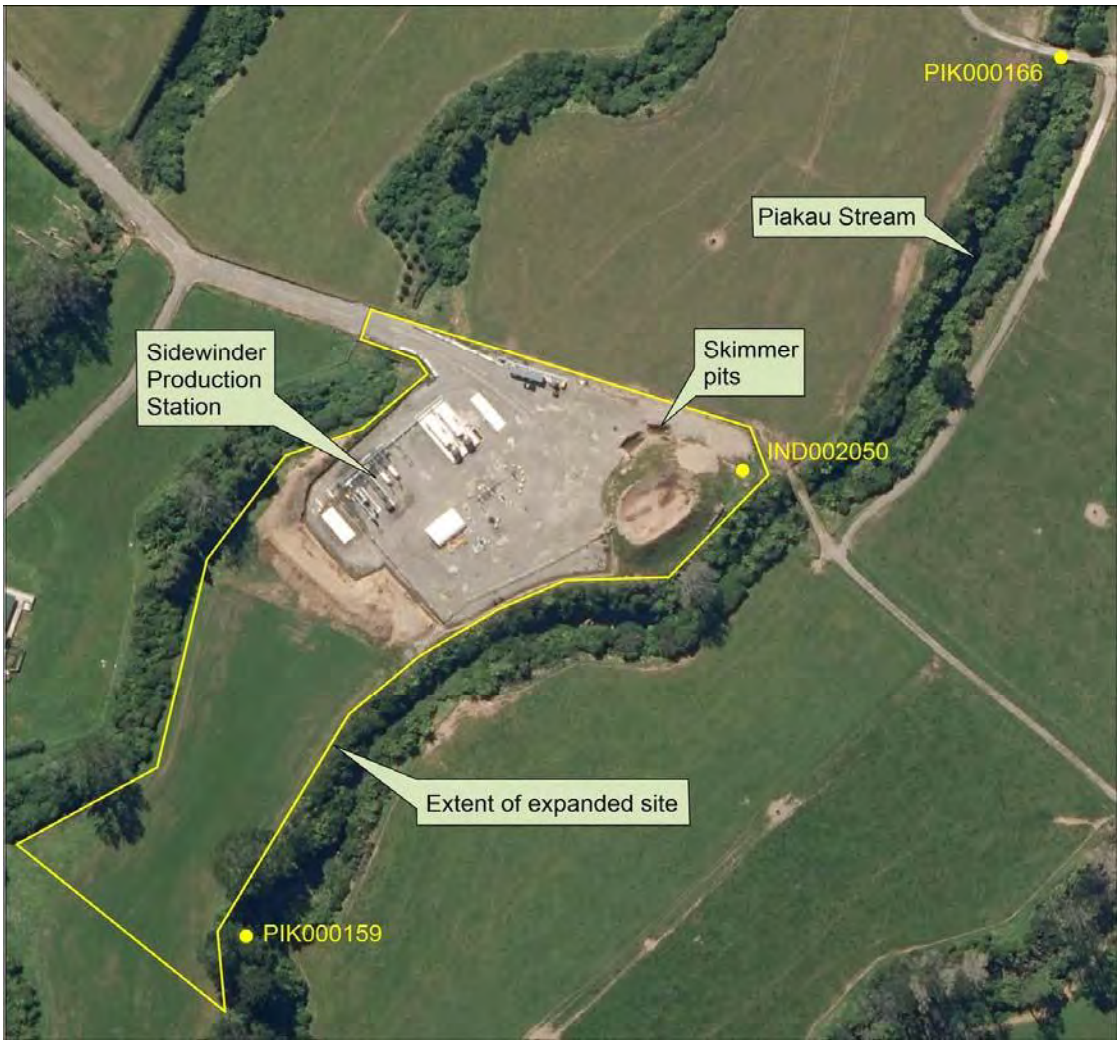

Figure 1 Sidewinder Production Station and associated water quality sampling sites

2.1.3 Results of receiving environment monitoring

2.1.3.1 Chemical

Receiving water quality sampling was undertaken in conjunction with discharge sampling at points upstream (PIK000159) and downstream (PIK000166) of the discharge. The results are presented in Table 2 and the sampling sites are shown in Figure 1. These sites were chosen because they provide safe access to the stream during periods of rain and are outside of the discharge mixing zone. The stretch of the Piakau Stream between these two points has very high, steep banks which would not permit easy escape in the event of rising waters.

The results indicate that the discharge was not affecting the water quality of the Piakau Stream and was in compliance with all applicable consent conditions for receiving waters at the times of sampling.

Table 2 Receiving environment results for the Piakau Stream on 3 June 2015

Parameter	Units	Upstream site PIK000159	Downstream site PIK000166	Consent 7595-1 conditions
Chloride	g/m^3	8.7	9.1	-
Conductivity	mS/m	5.5	5.7	-
Hydrocarbons	g/m^3	<0.5	<0.5	No conspicuous oil films or foams
Suspended solids	g/m^3	27	15	No conspicuous change
Temperature	Deg. C	10.1	9.9	< 2 Deg C increase
pH		7.1	7.2	-
Turbidity	NTU	17	12	No conspicuous change

2.1.3.2 Biomonitoring

The Council's standard 'kick-sampling' technique was used at three established sites on two occasions to collect streambed macroinvertebrates from the Piakau Stream, to assess whether discharges from the Sidewinder Production Station had had any detrimental effects on the macroinvertebrate communities of this stream. The sites are shown in Figure 2. Site 1 (PIK000160) is 60 m upstream of the Sidewinder Production Station discharge. Site 2 (PIK000162) is 25 m downstream and site 3 (PIK000165) 100 m downstream of the discharge. This section of the stream can be safely accessed for biomonitoring because the work is undertaken in fine weather. Samples were sorted and identified to provide the number of taxa (richness) and MCI and SQMCI$_S$ scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects or organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The SQMCI$_S$ takes into account taxa abundance as well as sensitivity to pollution, and may reveal more subtle changes in communities, particularly if non-organic impacts are occurring. Significant differences in either the MCI or the SQMCI$_S$ between sites may indicate the degree of adverse effects (if any) of the discharges being monitored.

Both the spring (16 October 2014) and summer (24 February 2015) macroinvertebrate surveys indicated that the discharge of treated stormwater and production water to land and to water from the Sidewinder Production Station site had not had any recent detrimental effects on the macroinvertebrate communities of the Piakau Stream.

Taxonomic richness was relatively consistent across all three sites indicting that there were no toxic discharges from the production station. The MCI scores indicated that the stream communities were of 'good' health. The MCI scores among the three sites were also similar to each other and were also all higher or similar to their respective predictive scores for equivalent sites in the upper mid-reaches of ringplain streams. In the spring survey the macroinvertebrate communities of the stream contained very high proportions of 'sensitive' taxa at all sites. In addition, communities at all sites had a number of common dominant taxa. In summer Site 1 did have a significantly lower MCI score compared with the median score for the site which was probably due to a combination of higher light levels compared with the two downstream sites and mild

nutrient enrichment resulting in periphyton growths. There were no significant changes in SQMCIs scores between sites, coincident with very similar habitat at all sites.

Overall, there was no evidence that discharges from the Sidewinder Production Station had had any impact on the macroinvertebrate communities present in the Piakau Stream.

The full biomonitoring reports are attached to this report in Appendix II.

Figure 2 Biomonitoring sites in the Piakau Stream adjacent to the Sidewinder Production Station

2.2 Air

2.2.1 Inspections

Air inspections were carried out in conjunction with site inspections as discussed in section 2.1.1 above. No issues regarding air quality were noted during the monitoring period.

2.2.2 Results of receiving environment monitoring

2.2.2.1 Carbon monoxide and combustible gases

During the monitoring year, a multi-gas meter was deployed on one occasion in the vicinity of the plant. The deployment lasted approximately 43 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continuous measurements of gas concentrations for the gases of interest (carbon

monoxide and combustible gases). The monitoring sites used in the year under review are shown in Figure 3.

Because of the nature of the activities on the site, it was considered that the primary information of interest in respect of gases potentially emitted from the site was the average downwind concentration, rather than any instantaneous peak value. That is, the long-term exposure levels, rather than short-term maxima, are of most interest. The gas meter was therefore set up to create a data set based on recording the average concentration measured during each minute as raw data.

Figure 3 Air monitoring sites at Sidewinder Production Station for 2014-2015

The details of the sample run are summarised in Table 3 and the data from the sample run are presented graphically in Figure 4.

The consent covering air discharges from the Sidewinder Production Station has specific limits related to particular gases. Special condition 11 of consent 7822-1 sets a limit on the carbon monoxide concentration at or beyond the production station's boundary. The limit is expressed as 10 mg/m^3 for an eight hour average or 30 mg/m^3 for a one hour average exposure. The maximum concentration of carbon monoxide found during the monitoring run was 14.1 mg/m^3 while the average concentration for the entire dataset was only 0.11 mg/m^3 which comply with consent conditions. This is in line with the pattern found in previous years.

Table 3 Results of carbon monoxide and LEL monitoring at Sidewinder Production Station

	Period	08/09/2014 12:42 to 10/09/2014 09:50
Max	CO(ppm)	12.3
	LEL(%)	0.20
Mean	CO(ppm)	0.00
	LEL(%)	0.00
Min	CO(ppm)	0.00
	LEL(%)	0.00

Notes: (1) the instrument records in units of ppm. At 25°C and 1 atm, 1ppm CO = 1.145 mg/m3
(2) because the LEL of methane is equivalent to a mixture of approximately 5% methane in air, then the actual concentration of methane in air can be obtained by dividing the percentage LEL by 20.

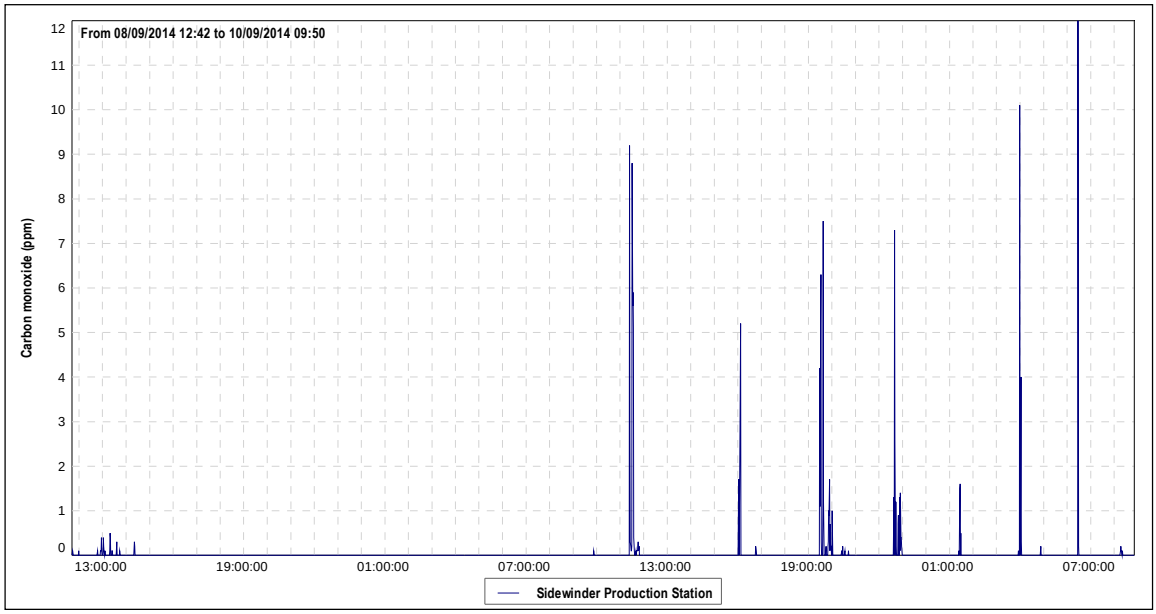

Figure 4 Ambient CO levels in the vicinity of Sidewinder Production Station

Lower Explosive Limit (LEL) gives the percentage of the lower explosive limit, expressed as methane that is detected in the air sampled. The sensor on the instrument reacts to gases and vapours such as acetone, benzene, butane, methane, propane, carbon monoxide, ethanol, and higher alkanes and alkenes, with varying degrees of sensitivity. The Council's Regional Air Quality Plan has a typical requirement that no discharge shall result in dangerous levels of airborne contaminants, including any risk of explosion. At no time did the level of explosive gases downwind of the Sidewinder Production Station reach any more than a trivial level.

2.2.2.2 PM10 particulates

In September 2004 the Ministry for the Environment enacted National Environmental Standards (NESs) relating to certain air pollutants. The NES for PM10 particulates is 50 $\mu g/m^3$ (24-hour average).

Particulates can be derived from many sources, including motor vehicles (particularly diesel), solid and oil-burning processes for industry and power generation, incineration and waste burning, photochemical processes, and natural sources such as pollen, abrasion, and sea spray.

PM10 particles are linked to adverse health effects that arise primarily from the ability of particles of this size to penetrate the defences of the human body and enter deep into the lungs, significantly reducing the exchange of gases across the lung walls. Health effects from inhaling PM10 include increased mortality and the aggravation of existing respiratory and cardiovascular conditions such as asthma and chronic pulmonary diseases.

During the reporting period, a DustTrak PM10 monitor was deployed on one occasion in the vicinity of Sidewinder Production Station. The deployment lasted approximately 45 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continual measurements of PM10 concentrations.

The location of the DustTrak monitor during the sampling run is shown in Figure 3. The results of the sample run are presented in Figure 5 and Table 4.

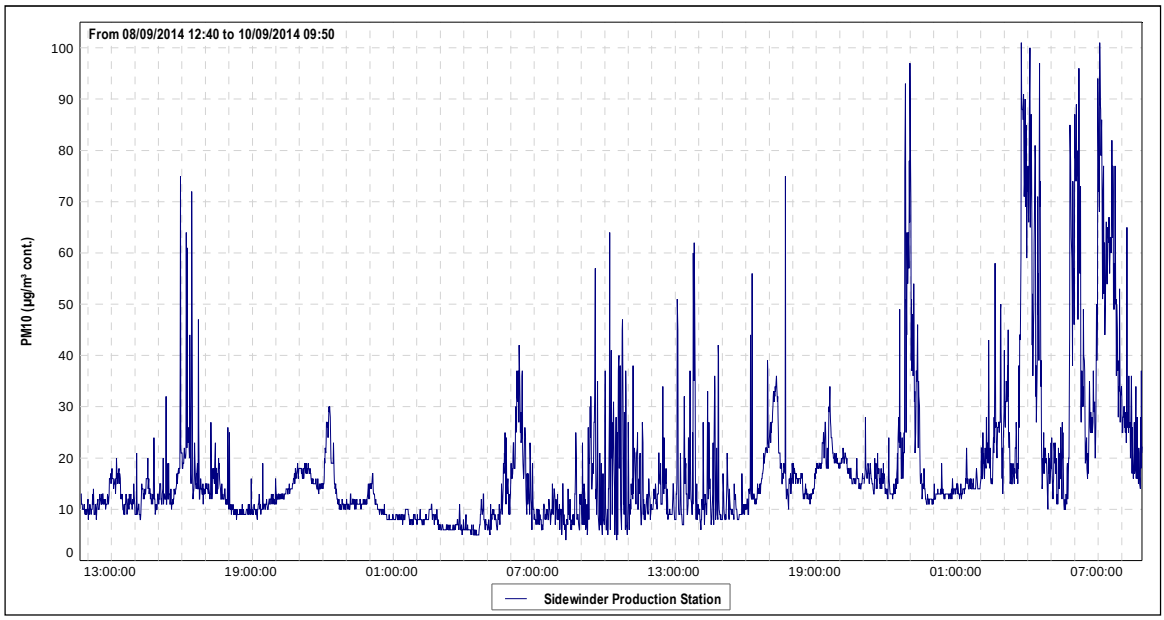

Figure 5 PM10 concentrations (µg/m³) at Sidewinder Production Station

Table 4 Daily averages of PM10 results from monitoring at Sidewinder Production Station

	45 hours 08-10/09/2014	
24 hr. set	Day 1	Day 2
Daily average	12.8 µg/m³	23.0 µg/m³
NES limit (24 hour average)	50 µg/m³	

During the 45 hour run, from 8 September to 10 September 2014, the average recorded PM10 concentration was 12.8 µg/m³ for the first 24 hour period and 23.0 µg/m³ for the second 24 hour period. These daily averages equate to 26% and 46%, respectively, of the 50 µg/m³ value that is set by the NES. Background levels of PM10 in the region have been found to be typically around 11 µg/m³.

2.2.2.3 Nitrogen oxides

From 2014 onwards, the Council implemented a coordinated region-wide compliance monitoring programme to measure nitrogen oxides (NOx). The programme involves deploying measuring devices at 28 NOx monitoring sites (including two sites in the vicinity of Sidewinder Production Station) on the same day, with retrieval three weeks later. This approach assists the Council in further evaluating the effects of local and regional emission sources and ambient air quality in the region.

The consents covering air discharges from the Sidewinder Production Station have specific limits related to particular gases. Special condition 12 of consent 7822-1 sets a limit on the nitrogen dioxide concentration at or beyond the production station's boundary. The limit is expressed as 200 µg/m³ for a 1-hour average or 100 µg/m³ for a 24-hour average exposure.

NOx passive adsorption discs were place at two locations in the vicinity of the Sidewinder Production Station on one occasion during the year under review. The discs were left in place for a period of 21 days. The calculated 1-hour and 24-hour theoretical maximum NOx concentrations found at Sidewinder Production Station during the year under review equate to 3.3 µg/m³ and 1.6 µg/m³, respectively. The results show that the ambient ground level concentration of NOx is well below the limits set out by consent 7822-1.

The full air monitoring reports are attached to this report in Appendix III.

Photo 2 Clean burning flare at the Sidewinder Production Station

2.2.3 Summary of flaring volumes reported by the Company

A full flow recycle system was installed at the Sidewinder facilities to allow off-specification gas to be reprocessed, thereby reducing flaring volumes and durations. There were only six flaring events during the period under review. These related to facility start-ups and shutdowns, and one process upset. No visible smoke events were recorded and no complaints were received by the Company or the Council during the 2014-2015 period. A summary of flaring volumes at Sidewinder Production Station is provided in Figure 6.

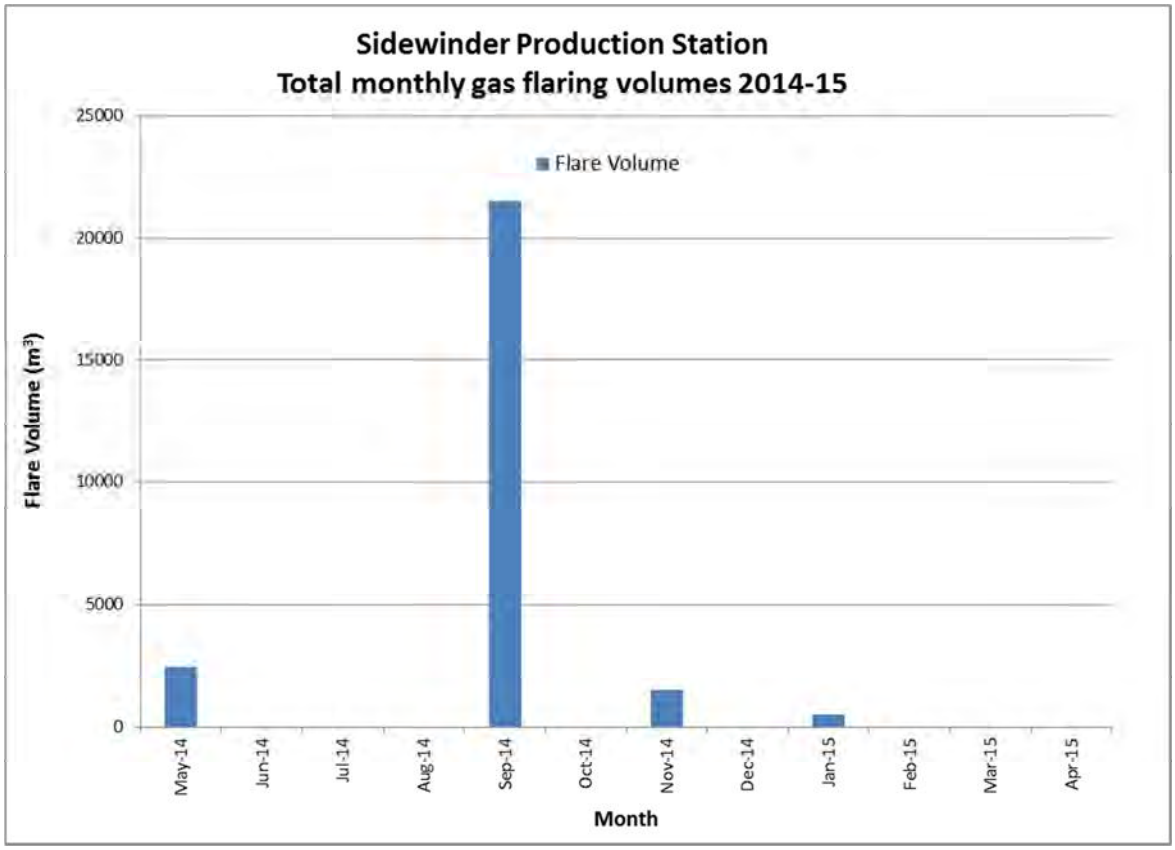

Figure 6 Monthly gas flaring for Sidewinder Production Station under consent 7822-1

2.3 Investigations, interventions, and incidents

The monitoring programme for the period was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the consent holder. During the period matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual courses of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

The Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The Incident Register (IR) includes events where the company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

Complaints may be alleged to be associated with a particular site. If there is potentially an issue of legal liability, the Council must be able to prove by investigation that the identified company is indeed the source of the incident (or that the allegation cannot be proven).

In the 2014-2015 period, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with the Company's conditions in resource consents or provisions in Regional Plans relating to the Sidewinder Production Station.

3. Discussion

3.1 Discussion of site performance

Monitoring the Sidewinder Production Station during the 2014-2015 year found that the site was well managed. All consent conditions relating to site operations and management were complied with. Any issues identified during inspections were quickly resolved.

3.2 Environmental effects of exercise of consents

Stormwater system inspections showed that discharges from the site complied with consent conditions. Receiving water inspections and sampling showed that the discharges were not causing any adverse effects on the Piakau Stream.

There were no adverse effects on the environment resulting from the exercise of the air discharge consent. The ambient air quality monitoring at the site showed that levels of carbon monoxide, combustible gases, PM10 particulates and nitrogen oxides were all below levels of concern at the time of sampling. No offensive or objectionable odours were detected beyond the boundary during inspections and there were no complaints in relation to air emissions from the site.

3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the period under review is set out in Tables 5-7.

Table 5 Summary of performance for Consent 7595-1

Purpose: ***To discharge treated stormwater and production water from hydrocarbon exploration and production operations at the Sidewinder wellsite into the Piakau Stream***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Adoption of the best practicable option	Inspection and liaison with consent holder	Yes
2. Maximum stormwater catchment area	Inspection and company records	Yes
3. Notification to Council seven days prior to site works and well drilling	Notifications received	Yes
4. Maintenance of a contingency plan	Latest update received 17 July 2013	Yes
5. Design and maintenance of stormwater system in accordance application documentation	Inspection and liaison with consent holder	Yes
6. All stormwater and produced water discharged through treatment system	Inspection	Yes
7. Skimmer pits to be lined and have shut off valves	Inspection	Yes
8. Bunding and containment of hazardous substances	Inspection	Yes

Purpose: ***To discharge treated stormwater and production water from hydrocarbon exploration and production operations at the Sidewinder wellsite into the Piakau Stream***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
9. Limits on constituents in the discharge	Sampling	Yes
10. Temperature increase of not more than 2 degrees Celsius in receiving waters	Sampling	Yes
11. Limits on effects in receiving waters	Inspection and sampling	Yes
12. 48 hrs notice prior to reinstatement	Site still active	N/A
13. Lapse provision	Consent exercised	N/A
14. Optional review provision	Next option for review June 2021	N/A
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		**High** **High**

N/A = not applicable

Table 6 Summary of performance for Consent 7777-1

Purpose: ***To discharge emissions to air associated with production activities at the Sidewinder wellsite, including flaring from well workovers, and emergency situations, and other miscellaneous activities***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Notification prior to continuous flaring	Notifications received	Yes
2. Notification of neighbours prior to flaring	No complaints received	Yes
3. Effective liquid and solid separation prior to flaring	Inspection and notifications	Yes
4. Only gaseous hydrocarbons to be flared	Inspection and notifications	Yes
5. Adoption of best practicable option to minimise effects from the flare	Inspection and air monitoring	Yes
6. No offensive odour or smoke beyond boundary	Inspection and public notification	Yes
7. Hydrocarbon storage vessels to have vapour recovery systems	Inspection	Yes
8. Control of carbon monoxide emissions	Air monitoring	Yes
9. Control of nitrogen oxide emissions	Air monitoring	Yes
10. Control of emissions to meet WES limits for other contaminants	Explosive gases and PM10 levels also monitored	Yes

Purpose: ***To discharge emissions to air associated with production activities at the Sidewinder wellsite, including flaring from well workovers, and emergency situations, and other miscellaneous activities***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
11. Analysis of typical gas and condensate stream	Analysis not requested	N/A
12. Keep and maintain a flaring log	Inspection and annual flaring report	Yes
13. Lapse provision	Consent exercised	N/A
14. Optional review provision	Next option for review June 2021	N/A
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		**High** **High**

Table 7 Summary of performance for Consent 7822-1

Purpose: ***To discharge emissions into the air from the flaring of hydrocarbons arising from hydrocarbon production and processing operations, together with miscellaneous emissions, at the Sidewinder Production Station***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Adoption of best practicable option to minimise effects from the flare	Inspection and air monitoring	Yes
2. Keep and maintain a flaring log	Inspection and annual flaring report	Yes
3. Monthly flaring information supplied	Information received	Yes
4. Provision of annual flaring and air emissions report	Report received	Yes
5. Keep and maintain a record of smoke emitting incidents	Inspection and annual flaring report	Yes
6. Analysis of typical gas and condensate stream	Analysis not requested	N/A
7. Consultation prior to plant alterations which may alter flare emissions	Inspection and liaison with consent holder	Yes
8. Notification of continuous flaring	Notifications received	Yes
9. No offensive odour, dust or smoke beyond boundary	Inspection and public notification	Yes
10. No hazardous/toxic/noxious contaminants beyond boundary	Inspections and air monitoring	Yes
11. Control of carbon monoxide emissions	Air monitoring	Yes
12. Control of nitrogen oxide emissions	Air monitoring	Yes
13. Control of emissions to meet WES limits for other contaminants	Explosive gases and PM10 levels also monitored	Yes

Purpose: *To discharge emissions into the air from the flaring of hydrocarbons arising from hydrocarbon production and processing operations, together with miscellaneous emissions, at the Sidewinder Production Station*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
14. Lapse provision	Consent exercised	N/A
15. Optional review provision	Next option for review June 2021	N/A
Overall assessment of environmental performance and compliance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

During the period under review, the Company demonstrated an overall high level of both environmental performance and administrative compliance with the resource consents as defined in Section 1.1.4. There were no unauthorised incidents recorded by the Council in relation to the Company's activities. The Sidewinder Production Station and associated wellsites were well managed and maintained.

3.4 Recommendations from the 2012-2014 Biennial Report

In the 2012-2014 Biennial Report, it was recommended:

1. THAT monitoring of consented activities at the Sidewinder Production Station in the 2014-2015 year be amended from that undertaken in 2012-2014 to reflect the Council's changes to the structure of all monitoring programmes.

2. THAT the option for review of resource consents in June 2015, as set out in conditions 13, 14 and 15 of consents 7595-1, 7777-1 and 7822-1, respectively, not be exercised on the grounds that the current conditions are considered adequate to deal with any adverse effects on the environment arising from the exercise of these resource consents.

These recommendations were implemented.

3.5 Alterations to monitoring programmes for 2015-2016

In designing and implementing the monitoring programmes for air/water discharges in the region, the Council has taken into account the extent of information made available by previous authorities, its relevance under the RMA, its obligations to monitor emissions/discharges and effects under the RMA, and report to the regional community. The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki emitting to the atmosphere/discharging to the environment.

It is proposed that for 2015-2016 the monitoring programme is amended to take into account the reduced level of activity at the Sidewinder facility in recent years and the high level of both environmental performance and administrative compliance with the resource consents demonstrated by the Company. It is proposed that biomonitoring of the Piakau Stream is discontinued due to the hazardous nature of accessing the adjacent section of the Piakau Stream; the number of inspections be reduced from six

annually to two; and the amount of time allocated for programme management is reduced commensurate with the decrease in the size of the programme.

A recommendation to this effect is presented in Section 4 of this report.

4. Recommendation

1. THAT monitoring of consented activities at the Sidewinder Production Station in the 2015-2016 year be amended from that undertaken in 2014-2015 to take into account the reduced level of activity at the Sidewinder facility in recent years and the high level of both environmental performance and administrative compliance with the resource consents demonstrated by the Company. It is proposed that biomonitoring of the Piakau Stream is discontinued due to the hazardous nature of accessing the adjacent section of the Piakau Stream; the number of inspections be reduced from six annually to two; and the amount of time allocated for programme management is reduced commensurate with the decrease in the size of the programme.

Glossary of common terms and abbreviations

The following abbreviations and terms may be used within this report:

Biomonitoring	Assessing the health of the environment using aquatic organisms.
Bund	A wall around a tank to contain its contents in the case of a leak.
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
g/m^3	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
IR	The Incident Register contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
mS/m	Millisiemens per metre.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
PM_{10}	Relatively fine airborne particles (less than 10 micrometre diameter).
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).

RMA	*Resource Management Act* 1991 and including all subsequent amendments.
SS	Suspended solids.
SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.

For further information on analytical methods, contact the Council's laboratory.

Bibliography and references

Taranaki Regional Council (2014): TAG Oil (NZ) Limited Sidewinder Production Station Monitoring Programme Biennial Report 2012-2014. Technical Report 2014-61

Appendix I

Resource consents held by TAG Oil (NZ) Limited

(For a copy of the signed resource consent please contact the TRC consent department)

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	TAG Oil (NZ) Limited PO Box 402 New Plymouth 4340	
Decision Date (Change):	05 August 2014	
Commencement Date (Change):	05 August 2014	(Granted Date: 11 February 2010)

Conditions of Consent

Consent Granted:	To discharge treated stormwater and production water from hydrocarbon exploration and production operations at the Sidewinder wellsite into the Piakau Stream
Expiry Date:	01 June 2027
Review Date(s):	June 2015, June 2021
Site Location:	Sidewinder wellsite, 323 Upper Durham Road, Inglewood
Legal Description:	Lot 4 DP 420600 (Discharge source & site)
Grid Reference (NZTM)	1703995E-5659276N
Catchment:	Waitara
Tributary:	Manganui Ngatoro Maketawa Piakau

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General condition

a. The consent holder shall pay to the Taranaki Regional Council all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment associated with the discharge of contaminants from the site.

2. Stormwater discharged shall be collected from a catchment area of no more than 1.85 ha.

3. The Chief Executive, Taranaki Regional Council, shall be notified in writing at least 7 days prior to any site works commencing, and again in writing at least 7 days prior to any well drilling operation commencing. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.

4. The consent holder shall maintain a contingency plan that, to the satisfaction of the Chief Executive, Taranaki Regional Council, details measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not authorised by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge.

5. The design, management and maintenance of the stormwater system shall be undertaken in accordance with the information provided in support of the original application for this consent and with any subsequent application to change consent conditions. Where there is conflict between the applications, the later application shall prevail, and where there is conflict between an application and the consent conditions, the conditions shall prevail.

6. All stormwater and produced water shall be directed for treatment through the stormwater treatment system identified in condition 5 before being discharged.

7. All skimmer pits and any other stormwater retention areas shall be lined with an impervious material to prevent seepage through the bed and sidewalls, and all skimmer pits shall have a valve that can be shut off to prevent any discharge from the site.

8. Any significant volumes of hazardous substances (e.g. bulk fuel, oil, drilling fluid) on site shall be:

   a) contained in a double skinned tank, or
   b) stored in a dedicated bunded area with drainage to sumps, or to other appropriate recovery systems, and not directly to the site stormwater system.

9. Constituents in the discharge shall meet the standards shown in the following table.

Constituent	Standard
pH	Within the range 6.0 to 9.0
suspended solids	Concentration not greater than 100 gm^{-3}
total recoverable hydrocarbons	Concentration not greater than 15 gm^{-3}
chloride	Concentration not greater than 50 gm^{-3}

   This condition shall apply prior to the entry of the treated stormwater into the receiving waters of the Piakau Stream at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.

10. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to an increase in temperature of more than 2 degrees Celsius.

11. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to any of the following effects in the receiving water:

   a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
   b) any conspicuous change in the colour or visual clarity;
   c) any emission of objectionable odour;
   d) the rendering of fresh water unsuitable for consumption by farm animals;
   e) any significant adverse effects on aquatic life.

12. The consent holder shall advise the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to the reinstatement of the site and the reinstatement shall be carried out so as to minimise adverse effects on stormwater quality. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.

13. This consent shall lapse on 31 March 2015, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

14. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 05 August 2014

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	TAG Oil (NZ) Limited P O Box 262 STRATFORD 4352
Decision Date:	7 February 2011
Commencement Date:	7 February 2011

Conditions of Consent

Consent Granted:	To discharge emissions to air associated with production activities at the Sidewinder wellsite, including flaring from well workovers, and emergency situations, and other miscellaneous activities at or about (NZTM) 1703906E-5659287N
Expiry Date:	1 June 2027
Review Date(s):	June 2015, June 2021
Site Location:	Sidewinder wellsite, 323 Upper Durham Road, Inglewood [Property owner: B.F.F Limited]
Legal Description:	Lot 4 DP 420600 [Discharge source & site]
Catchment:	Waitara

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General condition

a. The consent holder shall pay to the Taranaki Regional Council [the Council] all the administration, monitoring and supervision costs of this consent, fixed in accordance to section 36 of the Resource Management Act.

Special conditions

1. Other than in emergencies, the consent holder shall notify the Chief Executive, Taranaki Regional Council, whenever the continuous flaring of hydrocarbons [other than purge gas] is expected to occur for more than five minutes in duration. Notification shall be no less than 24 hours before the flaring commences. Notification shall include the consent number and be emailed to worknotification@trc.govt.nz.

2. At least 24 hours before any flaring, other than in emergencies, the consent holder shall provide notification to all residents within 300 metres of the wellsite of the commencement of flaring. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received in respect of any flaring activity.

3. To the greatest extent possible, all gas that is flared must first be treated by effective liquid and solid separation and recovery.

4. Only gaseous hydrocarbons originating from the well stream shall be combusted within the flare pit.

5. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare, including, but not limited to having regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects [other than for the maintenance of a pilot flare flame].

6. The discharge shall not cause any objectionable or offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.

7. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.

8. The consent holder shall control all emissions of carbon monoxide to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 milligrams per cubic metre [mg/m^3] [eight-hour average exposure], or 30 mg/m^3 one-hour average exposure] at or beyond the boundary of the property where the wellsite is located.

9. The consent holder shall control all emissions of nitrogen oxides to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 100 micrograms per cubic metre [$\mu g/m^3$] [24-hour average exposure], or 200 $\mu g/m^3$ [1-hour average exposure] at or beyond the boundary of the of the property where the wellsite is located.

10. The consent holder shall control emissions to the atmosphere from the wellsite and flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any emissions from the flare, the maximum ground level concentration for any particular contaminant arising from the exercise of this consent measured at or beyond the boundary of the property where the wellsite is located, is not increased above background levels:

    a) by more than $1/30^{th}$ of the relevant Occupational Threshold Value-Time Weighted Average, or by more than the Short Term Exposure Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or

    b) if no Short Term Exposure Limit is set, by more than three times the Time Weighted Average at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

11. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C_6 or higher number of compounds.

12. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, a 'flaring log' that includes:

    a) the date, time and duration of all flaring episodes;

    b) the zone from which flaring occurred;

    c) the volume of substances flared;

    d) whether there was smoke at any time during the flaring episode and if there was, the time, duration and cause of each 'smoke event'.

13. This consent shall lapse on 31 March 2016, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

14. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015 and/or June 2021, for any of the following purposes:

    a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or

    b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or

    c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant.

Signed at Stratford on 7 February 2011

For and on behalf of
Taranaki Regional Council

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Director-Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	TAG Oil (NZ) Limited P O Box 262 STRATFORD 4352
Decision Date:	22 June 2011
Commencement Date:	22 June 2011

Conditions of Consent

Consent Granted:	To discharge emissions into the air from the flaring of hydrocarbons arising form hydrocarbon production and processing operations, together with miscellaneous emissions, at the Sidewinder Production Station at or about (NZTM) 1703971E-5659277N
Expiry Date:	1 June 2027
Review Date(s):	June 2015, June 2021
Site Location:	Sidewinder wellsite, 323 Upper Durham Road, Inglewood [Property owner: B.F.F Limited]
Legal Description:	Lot 4 DP 420600 [Discharge source & site]

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General condition

a. The consent holder shall pay to the Taranaki Regional Council [the Council] all the administration, monitoring and supervision costs of this consent, fixed in accordance to section 36 of the Resource Management Act.

Special conditions

Exercise of consent

1. The consent holder shall at all times adopt the best practicable option [as defined in section 2 of the Resource Management Act 1991] to prevent or minimise any actual or likely adverse effects on the environment associated with the discharge of contaminants into the environment arising from the emissions to air from the flare.

Recording and submitting information

2. The consent holder shall keep and maintain a log of all continuous flaring incidents lasting longer than 5 minutes and any intermittent flaring lasting for an aggregate of 10 minutes or longer in any 60-minute period. The log shall contain the date, the start and finish times, the quantity and type of material flared, and the reason for flaring. The log shall be made available to the Chief Executive, Taranaki Regional Council, upon request, and summarised annually in the report required under condition 4. Flaring, under normal operation in the low pressure flare, of rich mono-ethylene glycol degasser vapour, condensate tank vapours, non-condensibles from tri-ethylene glycol/mono-ethylene glycol regeneration and purge gas shall be excluded from this requirement.

3. The consent holder shall supply to the Taranaki Regional Council each month a copy of flaring information comprising: the type and amount of material flared [including any gas used to maintain a pilot flame], the date this was flared, the reason why flaring was undertaken, and an indication of whether smoke was produced from such flaring events.

4. The consent holder shall provide to the Taranaki Regional Council during May of each year, for the duration of this consent, a report:

    a) detailing gas combustion at the production station flare, including but not restricted to routine operational flaring and flaring logged in accordance with condition 2;
    b) detailing any measures that have been undertaken by the consent holder to improve the energy efficiency of the production station;
    c) detailing any measures to reduce smoke emissions;
    d) detailing any measures to reduce flaring,
    e) addressing any other issue relevant to the minimisation or mitigation of emissions from the production station flare; and
    f) detailing any complaints received and any measures undertaken to address complaints.

5. The consent holder shall keep and make available to the Chief Executive, Taranaki Regional Council, upon request, a record of all smoke emitting incidents, noting time, duration and cause. The consent holder shall also keep, and make available to the Chief Executive, upon request, a record of all complaints received as a result of the exercise of this consent.

Information and notification

6. The consent holder shall make available to the Chief Executive, Taranaki Regional Council upon request, an analysis of a typical gas and/or condensate stream from the Mt Messenger Formation, covering sulphur compound content and the content of compounds containing six or more carbon atoms in their molecular structure.

7. Prior to undertaking any alterations to the plant equipment, processes or operations, which may substantially alter the nature or quantity of flare emissions other than as described in the consent application, the consent holder shall first consult with the Chief Executive, Taranaki Regional Council, and shall obtain any necessary approvals under the Resource Management Act 1991.

8. The consent holder shall notify the Chief Executive, Taranaki Regional Council, as soon as practicable, whenever the continuous flaring of hydrocarbons [other than the flaring of rich mono-ethylene glycol degasser vapour, condensate tank vapours, non-condensibles from tri-ethylene glycol/mono-ethylene glycol regeneration and purge gas] is expected to occur for more than five minutes in duration.

Preventing and minimising emissions

9. The discharges authorised by this consent shall not, whether alone or in conjunction with any other emissions from the site arising, give rise to any levels of odour or dust or smoke that are offensive or obnoxious or objectionable at or beyond the boundary of the site as shown on attached aerial photograph [figure 1].

10. The consent holder shall not discharge any contaminant to air from the site at a rate or a quantity such that the contaminant, whether alone or in combination with other contaminants, is or is liable to be hazardous or toxic or noxious at or beyond the boundary of the site as shown on attached aerial photograph.

11. The consent holder shall control all discharges of carbon monoxide to the atmosphere from the flare, whether alone or in conjunction with any other emissions from the site, in order that the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 milligrams per cubic metre [eight-hour average exposure], or 30 milligrams per cubic metre [one-hour average exposure] at or beyond the boundary of the site as shown on attached aerial photograph.

12. The consent holder shall control all discharges of nitrogen dioxide or its precursors to the atmosphere from the flare, whether alone or in conjunction with any other discharges to the atmosphere from the site, in order that the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 200 micrograms per cubic metre [one hour average exposure], or 100 micrograms per cubic metre [twenty-four hour average exposure], at or beyond the boundary of the site as shown on attached aerial photograph [figure 1].

13. The consent holder shall control discharges to the atmosphere from the flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides, whether alone or in conjunction with any other emissions from the site, in order that the maximum ground level concentration for any particular contaminant arising from the exercise of this consent, measured at or beyond the boundary of the site as shown on attached aerial photograph, is not increased above background levels:

    a) by more than 1/30th of the relevant Workplace Exposure Standard-Time Weighted Average [exposure averaged over a duration as specified for the Workplace Exposure Standard-Time Weighted Average], or by more than 1/10th of the Workplace Exposure Standard-Short Term Exposure Limit over any short period of time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or

    b) if no Short Term Exposure Limit is set, by more than the General Excursion Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

Lapse and Review

14. This consent shall lapse on 30 June 2016, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

15. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015 and/or June 2021, for the purposes of:

    a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or

    b) requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or

c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant or contaminants.

Signed at Stratford on 22 June 2011

For and on behalf of
Taranaki Regional Council

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Director-Resource Management

Figure 1

Aerial photograph showing site boundary [white line]

Appendix II

Biomonitoring reports

To Job Manager, Callum McKenzie
From Scientific Officers, Darin Sutherland and Brooke Thomas
Report No DS032
Doc No 1560631
Date 28 August 2015

Biomonitoring of the Piakau Stream in relation to the Sidewinder Production Station, October 2014

Introduction

This was the first of two scheduled biomonitoring surveys relating to the Sidewinder Production Station of TAG Oil New Zealand Ltd for the 2014-2015 monitoring year.

The Production Station discharges stormwater and treated production water to land where they may enter the Piakau Stream. Two stage skimmer pits in the northeast corner of the site collect and treat water from the production and wellsite areas. The discharge from the second skimmer pit ponds in the adjacent grassed area. Overflow from this area flows down the bank and enters the Piakau Stream. Due to erosion problems at the point where the discharge entered the stream, presumably caused by ground saturation, a sock had been installed since the previous survey to rectify the issue. The consent provides for discharge onto land in the vicinity of the stream and includes conditions related to instream effects and allows for a 25 m mixing zone in the stream.

The purpose of this survey was to determine whether this discharge from the Production Station had resulted in any detrimental effects on the macroinvertebrate communities in the Piakau Stream downstream of the discharge.

Four previous surveys have been performed at these three sites which were established specifically for the purpose of monitoring the Sidewinder Production Station in the Piakau Stream sub-catchment of the Waitara River catchment.

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from three established sites in the Piakau Stream (Table 1, Figure 1) on 16 October 2014. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Table 1 Biomonitoring sites in the Piakau Stream surveyed in association with the Sidewinder Production Station.

Site No.	Site code	GPS reference	Location	Distance from National Park (km)	Elevation (masl)
1	PIK000160	E1703959 N5659234	60 m upstream of Sidewinder Production Station discharge	6.27	295
2	PIK000162	E1704023 N5659300	25 m downstream of Sidewinder Production Station discharge	6.35	295
3	PIK000165	E1704062 N5659354	100 m downstream of Sidewinder Production Station discharge	6.43	285

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly `sensitive' taxa were assigned the highest scores of 9 or 10, while the most `tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa collected from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More ‘sensitive’ communities inhabit less polluted waterways.

The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. MCI results can also reflect the effects of warm temperatures, slow current speeds and low dissolved oxygen levels, because the taxa capable of tolerating these conditions generally have low sensitivity scores. Usually more 'sensitive' communities (with higher MCI values) inhabit less polluted waterways. The use of this index in non-stony streams is possible if results are related to physical habitat (e.g., good quality muddy/weedy sites tend to produce lower MCI values than good quality stony sites). Weedy stream macroinvertebrate communities tend to be dominated by more 'tolerant' taxa than is the case in stony stream communities. It may therefore require more severe organic pollution to cause a significant decline in MCI value in weedy streams. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, therefore $SQMCI_s$ values range from 1 to 10.

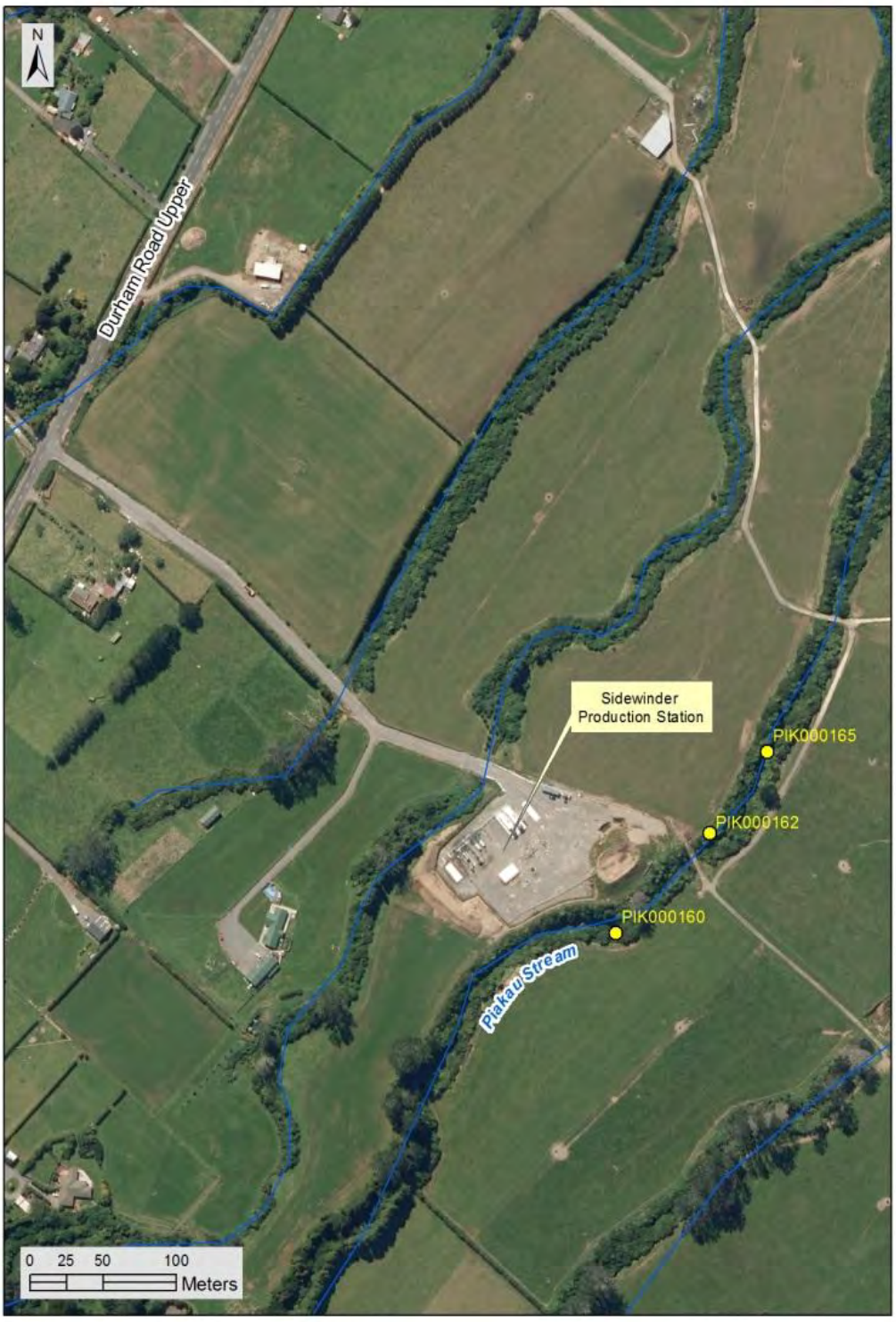

Figure 1 Biological sampling sites in the Piakau Stream related to the Sidewinder Production Station.

Results

Site characteristics and hydrology

This October 2014 survey followed a period of ten days since a fresh in excess of three times median flow, and 17 days since a fresh in excess of seven times median flow. In the month prior to this survey there had been seven fresh events, three of which exceeded three times median flow and four that had exceeded seven times median flow.

At the time of this survey, water temperatures in the Piakau Stream ranged from 10.8°C to 10.9°C. There was a moderate, steady or swift flow of uncoloured clear water at all the sites. The sites had a predominately cobble and boulder substrate. The sites had slippery mats, no filamentous algae, patchy moss, leaves and wood. There were no macrophytes present on the streambed. All three sites had partial shading from overhanging vegetation.

Macroinvertebrate communities

Four surveys have been performed at the three sites in the Piakau Stream, prior to the current survey. Historical results and results of the current survey are summarised in Table 2.

Table 2 Number of taxa, MCI, and $SQMCI_s$ values for the Piakau Stream, sampled in relation to the Sidewinder Production site on 16 October 2014 and a summary of historical data for these sites and predicted MCI scores (from Stark and Fowles, 2009).

Site No	Number of previous surveys	Numbers of taxa			MCI values			$SQMCI_s$ values			Predicted MCI scores	
		Median	Range	Current	Median	Range	Current	Median	Range	Current	Altitude	Distance
1	4	24	21-26	25	124	121-132	118	7.5	7.1-7.6	7.3	114	111
2	4	23	18-27	21	119	112-132	113	6.9	6.7-7.3	6.9	114	111
3	4	25	22-26	24	117	114-132	117	7.5	7.0-7.6	7.2	113	111

The macroinvertebrate fauna recorded by the current survey at each of the three sites are presented in Table 3.

Table 3 Macroinvertebrate fauna of the Piakau Stream in relation to Sidewinder Production Station sampled on 16 October 2014.

Taxa List	Site Number	MCI score	1	2	3
	Site Code		PIK000160	PIK000162	PIK000165
	Sample Number		FWB14313	FWB14314	FWB14315
ANNELIDA (WORMS)	Oligochaeta	1	R	C	R
CRUSTACEA	*Paranephrops*	5	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	A	A
	Coloburiscus	7	VA	VA	XA
	Deleatidium	8	VA	VA	VA
	Nesameletus	9	A	A	A
	Zephlebia group	7	A	A	VA
PLECOPTERA (STONEFLIES)	*Acroperla*	5	A	C	C
	Austroperla	9	R	-	R
	Megaleptoperla	9	R	-	-
	Zelandobius	5	R	-	R
	Zelandoperla	8	A	-	C
COLEOPTERA (BEETLES)	Elmidae	6	A	A	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A	C
	Hydrobiosis	5	R	R	-
	Polyplectropus	6	-	-	R
	Beraeoptera	8	VA	A	VA
	Confluens	5	C	C	-
	Helicopsyche	10	R	C	C
	Pycnocentria	7	-	C	C
	Pycnocentrodes	5	C	C	C
	Triplectides	5	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C	C
	Eriopterini	5	-	R	-
	Orthocladiinae	2	C	R	R
	Polypedilum	3	R	-	R
	Tanypodinae	5	R	-	-
	Dolichopodidae	3	R	-	-
	Empididae	3	-	C	R
	Austrosimulium	3	-	C	R
		No of taxa	25	21	24
		MCI	118	113	117
		SQMCIs	7.3	6.9	7.2
		EPT (taxa)	17	13	15
		%EPT (taxa)	68	62	63

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 1 (upstream of Production Station discharge)

A moderately high macroinvertebrate community richness of 25 taxa was found at site 1 ('control' site) at the time of the survey which was one more than the median number recorded for the site (median taxa richness 24; Table 2) and four more than the previous sample (taxa richness 21).

The MCI score of 118 units indicated a community of 'good' biological health (TRC, 2015) which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 124 units; Table 2) but was significantly lower (Stark, 1998) than the previous survey score (MCI score 132 units). This current MCI score was also not significantly different (Stark, 1998) to the predicted altitude (114 MCI units) and distance from the National Park boundary (111 MCI units) MCI scores (Stark and Fowles, 2009; Table 2).

The $SQMCI_s$ score of 7.3 units was very similar to the median value calculated from previous surveys at the same site (median $SQMCI_s$ score 7.5 units; Table 2) and was also very similar to the previous survey score ($SQMCI_s$ score 7.1 units).

The community was characterised by five 'moderately sensitive' taxa [mayflies (*Austroclima*, *Coloburiscus* and *Zeplebia* group), stonefly (*Acroperla*) and elmid beetles], and four 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*), stonefly (*Zelandoperla*), and caddisfly (*Beraeoptera*)] (Table 3).

Site 2 (25 m downstream of Production Station discharge)

A moderate macroinvertebrate community richness of 21 taxa was found at site 2 ('primary impacted' site) at the time of the survey which was two less than the median number recorded for the site (median taxa richness 23; Table 2) and three more than the previous sample (taxa richness 18).

The MCI score of 113 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 119 units; Table 2) or to the previous survey score (MCI score 112 units). This current MCI score was also not significantly different (Stark, 1998) to the predicted altitude (114 MCI units) and distance from the National Park boundary (111 MCI units) scores (Stark and Fowles, 2009; Table 2).

The $SQMCI_S$ score of 6.9 units was the same as the median value calculated from previous surveys at the same site (median $SQMCI_S$ score 6.9 units; Table 2) and the same as the previous survey score ($SQMCI_S$ score 6.9 units).

The community was characterised by one 'tolerant' taxon [caddisfly (*Hydropsyche-Aoteapysche*)], five 'moderately sensitive' taxa [mayflies (*Austroclima*, *Coloburiscus* and *Zeplebia* group), elmid beetles and dobsonfly (*Archichauliodes*)], and three 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*), and caddisfly (*Beraeoptera*)] (Table 3).

Site 3 (100 m downstream of Production Station discharge)

A moderate macroinvertebrate community richness of 24 taxa was found at site 3 ('secondary impacted' site) at the time of the survey which was one less than the median number recorded for the site (median taxa richness 25; Table 2) and two less than the previous sample (taxa richness 26).

The MCI score of 117 units indicated a community of 'good' biological health which was the same MCI score as the median value calculated from previous surveys at the same site (median MCI score 117 units; Table 2) and was not significantly different (Stark, 1998) to the previous survey score (MCI score 114 units). This current MCI score was also not significantly different (Stark, 1998) to the predicted altitude (114 MCI units) and distance from the National Park boundary (111 MCI units) scores (Stark and Fowles, 2009; Table 2).

The $SQMCI_S$ score of 7.2 units was similar to the median value calculated from previous surveys at the same site (median $SQMCI_S$ score 7.5 units; Table 2) and to the previous survey score ($SQMCI_S$ score 7.0 units).

The community was characterised by five 'moderately sensitive' taxa [mayflies (*Austroclima*, *Coloburiscus* and *Zeplebia* group), elmid beetles and dobsonfly (*Archichauliodes*)] and three 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*), and caddisfly (*Beraeoptera*)] (Table 3).

Discussion and Conclusions

Taxa richnesses were moderate to moderately high with little variation among all three sites. Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges such as high chloride levels which may occur due to production station discharges. Macroinvertebrates when exposed to toxic chemicals may die or become moribund and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). There was no evidence that there had been any significant toxic discharges from the Sidewinder Production Station since the previous survey.

The MCI and $SQMCI_S$ scores indicated that the macroinvertebrate communities present in the Piakua Stream were of 'good' health. This result was typical of the upper, mid-reaches of Taranaki ringplain streams. There were minimal, insignificant differences in MCI and $SQMCI_S$ scores among sites. There were also no significant differences in MCI scores between the expected values calculated for both distance and altitude compared with observed results. These results all indicate that discharges from the Sidewinder Production Station had not had an affect on the macroinvertebrate communities present in the Piakau Stream since the previous survey.

The only notable change in macroinvertebrate community indices since the previous survey was a significant decrease (Stark, 1998) of 14 MCI units at site 1. This was largely due to the presence of the very low scoring oligochaete worms and low scoring true flies (*Polypedilum*, Tanypodinae and Dolichopodidae) which were all present during the current survey at very low numbers (1-4 individuals) but absent during the previous survey. The presence of these low scoring taxa at very low numbers also explains why the two $SQMCI_S$ scores were only

0.2 units apart and probably gives a better reflection of the health of the biological communities than the MCI score which does not take into account taxa abundances. Furthermore, site 1 was also the 'control site' and therefore changes in there macronvertebrate communities present there would be unrelated to any production station discharges.

Overall, there was no evidence that discharges from the Sidewinder Production Station had had any impact on the macroinvertebrate communities present in the Piakau Stream.

Summary

The Council's standard 'kick-sampling' technique was used at three established sites to collect streambed macroinvertebrates from the Piakau Stream, to assess whether discharges from the Sidewinder Production Station had had any detrimental effects on the macroinvertebrate communities of this stream. Samples were sorted and identified to provide the number of taxa (richness) and MCI and $SQMCI_S$ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to acutely toxic discharges. The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_S$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

This spring macroinvertebrate survey indicated that the discharge of treated stormwater and production water to land and to water from the Sidewinder Production Station site had not had any recent detrimental effects on the macroinvertebrate communities of the Piakau Stream.

Taxonomic richness was relatively consistent across all three sites indicting that there were no toxic discharges from the production station. The MCI scores indicated that the stream communities were of 'good' health. The MCI scores among the three sites were also similar to each other and were also all higher or similar to their respective predictive scores for equivalent sites in the upper mid-reaches of ringplain streams. The macroinvertebrate communities of the stream contained very high proportions of 'sensitive' taxa at all sites. In addition, communities at all sites had a number of common dominant taxa. There were no significant changes in $SQMCI_S$ scores between sites, coincident with very similar habitat at all sites.

Overall, there was no evidence that discharges from the Sidewinder Production Station had had any impact on the macroinvertebrate communities present in the Piakau Stream.

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To Job Manager, Callum McKenzie
From Scientific Officer, Darin Sutherland
Report No DS033
Doc No 1562804
Date 31 August 2015

Biomonitoring of the Piakau Stream in relation to the Sidewinder Production Station, February 2015

Introduction

This was the second survey completed of the two scheduled biomonitoring surveys relating to the Sidewinder Production Station of TAG Oil New Zealand Ltd for the 2014-2015 monitoring year.

The Production Station discharges stormwater and treated production water to land where they may enter the Piakau Stream. Two stage skimmer pits in the northeast corner of the site collect and treat water from the production and wellsite areas. The discharge from the second skimmer pit ponds in the adjacent grassed area. Overflow from this area flows down the bank and enters the Piakau Stream. The consent provides for discharge onto land in the vicinity of the stream and includes conditions related to instream effects and allows for a 25m mixing zone in the stream.

The purpose of this survey was to determine whether this discharge from the Production Station had resulted in any detrimental effects on the macroinvertebrate communities in the Piakau Stream downstream of the discharge.

Five previous surveys have been performed at these three sites which were established specifically for the purpose of monitoring the Sidewinder Production Station in the Piakau Stream sub-catchment of the Waitara River catchment.

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from three established sites in the Piakau Stream (Table 1, Figure 1) on 24 February 2015. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Table 1 Biomonitoring sites in the Piakau Stream surveyed in association with the Sidewinder

Production Station.

Site No.	Site code	GPS reference	Location	Distance from National Park (km)	Elevation (masl)
1	PIK000160	E1703959 N5659234	60 m upstream of Sidewinder Production Station discharge	6.27	295
2	PIK000162	E1704023 N5659300	25 m downstream of Sidewinder Production Station discharge	6.35	295
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Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
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A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly `sensitive' taxa were assigned the highest scores of 9 or 10, while the most `tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa collected from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More ‘sensitive’ communities inhabit less polluted waterways.

The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. MCI results can also reflect the effects of warm temperatures, slow current speeds and low dissolved oxygen levels, because the taxa capable of tolerating these conditions generally have low sensitivity scores. Usually more 'sensitive' communities (with higher MCI values) inhabit less polluted waterways. The use of this index in non-stony streams is possible if results are related to physical habitat (e.g., good quality muddy/weedy sites tend to produce lower MCI values than good quality stony sites). Weedy stream macroinvertebrate communities tend to be dominated by more 'tolerant' taxa than is the case in stony stream communities. It may therefore require more severe organic pollution to cause a significant decline in MCI value in weedy streams. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, therefore $SQMCI_s$ values range from 1 to 10.

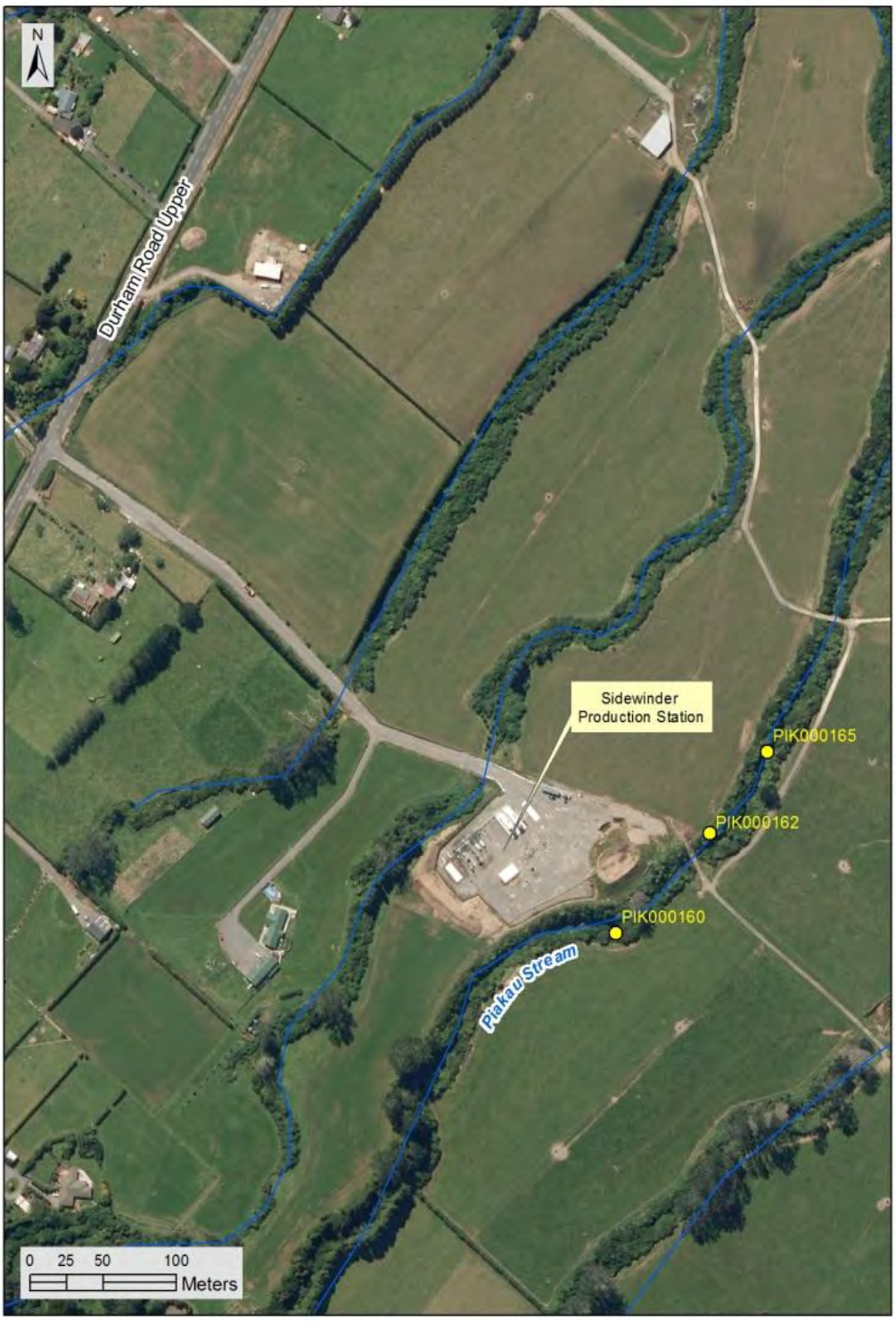

Figure 1 Biological sampling sites in the Piakau Stream related to the Sidewinder Production Station.

Results

Site characteristics and hydrology

This February 2015 survey followed a period of 22 days since a fresh in excess of three times median flow, and 23 days since a fresh in excess of seven times median flow. In the month prior to this survey there had been two fresh events, both of which exceeded seven times median flow.

At the time of this survey, water temperatures in the Piakau Stream ranged from 15.3°C to 15.9°C. There was a very low, swift flow of uncoloured clear water at all the sites. The sites had a predominately cobble and boulder substrate. Site 1 had slippery mats and patchy filamentous algae while sites 2 and 3 had no mats or algae present. Sites 1 and 2 had patchy moss, leaves and wood while site 3 had widespread moss, patchy leaves and no wood. There were no macrophytes present on the streambed at any of the sites. All three sites had partial shading from overhanging vegetation.

Macroinvertebrate communities

Five surveys have been performed at the three sites in the Piakau Stream, prior to the current survey. Historical results and results of the current survey are summarised in Table 2.

Table 2 Number of taxa, MCI, and $SQMCI_s$ values for the Piakau Stream, sampled in relation to the Sidewinder Production site on 24 February 2015 and a summary of historical data for these sites and predicted MCI scores (from Stark and Fowles, 2009).

Site No	Number of previous surveys	Numbers of taxa			MCI values			$SQMCI_s$ values			Predicted MCI scores	
		Median	Range	Current	Median	Range	Current	Median	Range	Current	Altitude	Distance
1	5	25	21-26	30	121	118-132	110	7.4	7.1-7.6	6.3	114	111
2	5	23	18-27	24	115	112-132	114	6.9	6.7-7.3	6.9	114	111
3	5	24	22-26	27	117	114-132	116	7.2	7.0-7.6	6.9	113	111

The macroinvertebrate fauna recorded by the current survey at each of the three sites are presented in Table 3.

Table 3 Macroinvertebrate fauna of the Piakau Stream in relation to Sidewinder Production Station sampled on 24 February 2015.

Taxa List	Site Number	MCI score	1	2	3
	Site Code		PIK000160	PIK000162	PIK000165
	Sample Number		FWB15183	FWB15184	FWB15185
ANNELIDA (WORMS)	Oligochaeta	1	R	R	R
MOLLUSCA	*Potamopyrgus*	4	-	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	C	C
	Coloburiscus	7	VA	A	VA
	Deleatidium	8	VA	A	VA
	Nesameletus	9	A	A	A
	Zephlebia group	7	R	A	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	R	-
	Megaleptoperla	9	-	-	R
	Zelandoperla	8	C	R	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	C	A
	Hydraenidae	8	R	-	R
	Ptilodactylidae	8	R	-	-
	Staphylinidae	5	-	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	C	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA	C	A
	Costachorema	7	R	-	R
	Hydrobiosis	5	C	R	C
	Psilochorema	6	-	R	R
	Beraeoptera	8	A	A	A
	Confluens	5	C	-	-
	Helicopsyche	10	-	R	-
	Oeconesidae	5	-	R	-
	Olinga	9	R	-	R
	Pycnocentria	7	-	R	R
	Triplectides	5	-	R	R
	Zelolessica	7	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	C	A
	Eriopterini	5	R	-	-
	Orthocladiinae	2	C	R	R
	Polypedilum	3	R	C	C
	Tanypodinae	5	R	R	R
	Tanytarsini	3	R	-	-
	Dolichopodidae	3	R	-	-
	Empididae	3	R	-	R
	Muscidae	3	C	-	R
	Austrosimulium	3	R	C	C
	Tanyderidae	4	R	-	-
		No of taxa	30	24	27
		MCI	110	114	116
		SQMCIs	6.3	6.9	6.9
		EPT (taxa)	14	15	15
		%EPT (taxa)	47	63	56

'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 1 (upstream of Production Station discharge)

A high macroinvertebrate community richness of 30 taxa was found at site 1 ('control' site) at the time of the survey which was five more than the median number recorded for the site (median taxa richness 25; Table 2) and the previous sample (taxa richness 25).

The MCI score of 110 units indicated a community of 'good' biological health (TRC, 2015) which was significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median MCI score 121 units; Table 2) and was the lowest score recorded to date at this site by eight MCI units. The result was not significantly different (Stark, 1998) to the previous survey score (MCI score 118 units) and was also not significantly different (Stark, 1998) to the predicted altitude (114 MCI units) and distance from the National Park boundary (111 MCI units) MCI scores (Stark and Fowles, 2009; Table 2).

The $SQMCI_S$ score of 6.3 units was lower than the median value calculated from previous surveys at the same site (median $SQMCI_S$ score 7.4 units; Table 2) and was also lower than the previous survey score ($SQMCI_S$ score 7.3 units).

The community was characterised by one 'tolerant' taxon [caddisfly (*Hydropsyche-Aoteapsyche*)], five 'moderately sensitive' taxa [mayflies (*Austroclima* and *Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*) and cranefly (*Aphrophila*)], and three 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*), and caddisfly (*Beraeoptera*)] (Table 3).

Site 2 (25 m downstream of Production Station discharge)

A moderate macroinvertebrate community richness of 24 taxa was found at site 2 ('primary impacted' site) at the time of the survey which was one more than the median number recorded for the site (median taxa richness 23; Table 2) and three more than the previous sample (taxa richness 21).

The MCI score of 114 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 115 units; Table 2) or to the previous survey score (MCI score 113 units). This current MCI score was also not significantly different (Stark, 1998) to the predicted altitude (114 MCI units) and distance from the National Park boundary (111 MCI units) scores (Stark and Fowles, 2009; Table 2).

The $SQMCI_S$ score of 6.9 units was the same as the median value calculated from previous surveys at the same site (median $SQMCI_S$ score 6.9 units; Table 2) and the same as the previous survey score ($SQMCI_S$ score 6.9 units).

The community was characterised by two 'moderately sensitive' taxa [mayflies (*Coloburiscus* and *Zeplebia* group)] and three 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*), and caddisfly (*Beraeoptera*)] (Table 3).

Site 3 (100 m downstream of Production Station discharge)

A moderately high macroinvertebrate community richness of 27 taxa was found at site 3 ('secondary impacted' site) at the time of the survey which was three more than the median number recorded for the site (median taxa richness 24; Table 2) and the previous sample (taxa richness 24).

The MCI score of 116 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 117 units; Table 2) and was the same as the previous survey score (MCI score 117 units). This current MCI score was also not significantly different (Stark, 1998) to the predicted altitude (114 MCI units) and distance from the National Park boundary (111 MCI units) scores (Stark and Fowles, 2009; Table 2).

The $SQMCI_S$ score of 6.9 units was similar to the median value calculated from previous surveys at the same site (median $SQMCI_S$ score 7.2 units; Table 2) and to the previous survey score ($SQMCI_S$ score 7.2 units).

The community was characterised by one 'tolerant' taxon [caddisfly (*Hydropsyche-Aoteapsyche*)], four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*) and cranefly (*Aphrophila*)] and three 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*) and caddisfly (*Beraeoptera*)] (Table 3).

Discussion and Conclusions

Taxa richnesses were moderate to high with minor variation among the three sites. Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges such as high chloride levels which may occur due to production station discharges. Macroinvertebrates when exposed to toxic chemicals may die or become moribund and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). There was no evidence that there had been any significant toxic discharges from the Sidewinder Production Station since the previous survey.

The MCI and $SQMCI_S$ scores indicated that the macroinvertebrate communities present in the Piakua Stream were of 'good' health. This result was typical of the upper, mid-reaches of Taranaki ringplain streams. There were minimal, insignificant differences in MCI and $SQMCI_S$ scores among sites. There were also no significant differences in MCI scores between the expected values calculated for both distance and altitude compared with observed results. These results all indicate that discharges from the Sidewinder Production Station had not had an effect on the macroinvertebrate communities present in the Piakau Stream since the previous survey. There were also no significant or marked differences between any of the macroinvertebrate indices recorded during the current survey compared with the previous survey.

Site 1 had a MCI score significantly lower (Stark, 1998) than the median score recorded for the site and it also recorded its lowest historical MCI score. Site 1 is the 'control' site and is unaffected by the production station discharges. The previous survey conducted in October 2014 (Sutherland and Thomas, 2014) also found that site 1 had a MCI score significantly lower than the previous survey in spring 2013. Though all three sites were partially shaded,

site 1 had the least amount of shading which was probably the main factor explaining the presence of periphyton at the site. The decline of MCI scores at site 1 may therefore be due to a combination of limited shading at the site coupled with increased nutrients promoting periphyton growth. Generally, taxa with lower tolerance values prefer sites with higher levels of periphyton.

Overall, there was no evidence that discharges from the Sidewinder Production Station had had any impact on the macroinvertebrate communities present in the Piakau Stream.

Summary

The Council's standard 'kick-sampling' technique was used at three established sites to collect streambed macroinvertebrates from the Piakau Stream, to assess whether discharges from the Sidewinder Production Station had had any detrimental effects on the macroinvertebrate communities of this stream. Samples were sorted and identified to provide the number of taxa (richness) and MCI and $SQMCI_S$ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to acutely toxic discharges. The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_S$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

This summer macroinvertebrate survey indicated that the discharge of treated stormwater and production water to land and to water from the Sidewinder Production Station site had not had any recent detrimental effects on the macroinvertebrate communities of the Piakau Stream.

Taxonomic richness was relatively consistent across all three sites indicting that there were no toxic discharges from the production station. The MCI scores indicated that the stream communities were of 'good' health. The MCI scores among the three sites were also similar to each other and similar to their respective predictive scores for equivalent sites in the upper mid-reaches of ringplain streams. Site 1 did have a significantly lower MCI score compared with the median score for the site which was probably due to a combination of higher light levels compared with the two downstream sites and mild nutrient enrichment resulting in periphyton growths. There were no significant changes in $SQMCI_S$ scores between sites, coincident with the similar habitat at all sites.

Overall, there was no evidence that discharges from the Sidewinder Production Station had had any impact on the macroinvertebrate communities present in the Piakau Stream.

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Appendix III

Air monitoring reports

Memorandum

To	Fiza Hafiz, Scientific Officer – State of the Environment Job Managers - Callum MacKenzie, Emily Roberts, James Kitto
From	Brian Cheyne, Scientific Officer – Air Quality
File	Frodo # 1545133
Date	29 July 2015

Monitoring of nitrogen oxides (NOx) levels in Taranaki near the NOx emitting sites, year 2014-2015

From 2014 onwards, the Taranaki Regional Council (TRC) has implemented a coordinated region-wide monitoring programme to measure NOx, not only at individual compliance monitoring sites near industries that emit NOx, but simultaneously at the urban sites (the Council regional state of the environment programme). The programme involves deploying all measuring devices on the same day, with retrieval three weeks later. This approach will assist the Council to further evaluate the effects of local and regional emission sources and ambient air quality in the region.

Nitrogen oxides

Nitrogen oxides (NOx), a mixture of nitrous oxide (N2O), nitric oxide (NO) and nitrogen dioxide (NO2), are produced from natural sources, motor vehicles and other fuel combustion processes. Indoor domestic appliances (gas stoves, gas or wood heaters) can also be significant sources of nitrogen oxides, particularly in areas that are poorly ventilated. NO and NO2 are of interest because of potential effects on human health.

Nitric oxide is colourless and odourless and is oxidised in the atmosphere to form nitrogen dioxide. Nitrogen dioxide is an odorous, brown, acidic, highly corrosive gas that can affect our health and environment. Nitrogen oxides are critical components of photochemical smog – nitrogen dioxide produces the yellowish-brown colour of the smog.

Environmental and health effects of nitrogen oxides

Nitrogen dioxide is harmful to vegetation, can fade and discolour fabrics, reduce visibility, and react with surfaces and furnishings. Vegetation exposure to high levels of nitrogen dioxide can be identified by damage to foliage, decreased growth or reduced crop yield.

Nitric oxide does not significantly affect human health. On the other hand, elevated levels of nitrogen dioxide cause damage to the mechanisms that protect the human respiratory tract and can increase a person's susceptibility to, and the severity of, respiratory infections and asthma. Long-term exposure to high levels of nitrogen dioxide can cause chronic lung disease. It may also affect sensory perception, for example, by reducing a person's ability to smell an odour.

National environmental standards and guidelines

In 2004, national environmental standards (NES) for ambient (outdoor) air quality were introduced in New Zealand to provide a guaranteed level of protection for the health of New Zealanders. The national standard for nitrogen dioxide (NO2) is set out below.

In any 1-hour period, the average concentration of nitrogen dioxide in the air should not be more than 200 $\mu g/m^3$.

Before the introduction of the national environmental standards, air quality was measured against the national air quality guidelines. The national guidelines were developed in 1994 and revised in 2002 following a comprehensive review of international and national research and remain relevant. The national guideline for nitrogen dioxide (NO2) is set out below.

In any 24-hour period, the average concentration of nitrogen dioxide in the air should not be more than 100 $\mu g/m^3$.

Nitrogen dioxide limits are also set in the special conditions of the resource consents. The consents limits are the same as those imposed under the NES and MfE's guideline.

Measurement of nitrogen oxides

The Taranaki Regional Council has been monitoring nitrogen oxides (NOx) in the Taranaki region since 1993 using passive absorption discs. Research to date indicates that this is an accurate method, with benefits of simplicity of use and relatively low cost. To date 527 samplers of nitrogen oxides have been collected in Taranaki region. Discs are sent to EUROFINS ELS Ltd. Lower Hutt for analysis. Passive absorption discs are placed at the nominated sites. The gases diffuse into the discs and any target gases (nitrogen dioxide or others) are captured.

In the 2014-15 year, passive absorption discs were placed on one occasion at twenty eight sites, staked about two metres off the ground for a period of 21 days, for the purpose of Compliance Monitoring and SEM studies.

Conversion of exposure result to standardised exposure time period

From the average concentration measured, it is possible to calculate a theoretical maximum daily or one hour concentrations that may have occurred during the exposure period. Council data on NOx is gathered over a time period other than exactly 24 hours or one hour. There are mathematical equations used by air quality scientists to predict the maximum concentrations over varying time periods. These are somewhat empirical, in that they take little account of local topography, micro-climates, diurnal variation, etc. Nevertheless, they are applied conservatively and have some recognition of validity.
One formula in general use is of the form:

$$C(t_2) = C(t_1) \times \left(\frac{t_1}{t_2}\right)^P$$

where C(t) = the average concentration during the time interval t, and p = a factor lying between 0.17 and 0.20. When converting from longer time periods to shorter time periods, using p = 0.20 gives the most conservative estimate (i.e. the highest calculated result for time period t_2 given a measured concentration for time period t_1). Using the 'worst case' factor of p = 0.20, the monitoring data reported above has been converted to equivalent 'maximum' 1-hour and 'maximum'24-hour exposure levels.

Results

The location of the NOx monitoring sites are shown in Figure 1 and the details of the NOx results are presented in Table 1 and Figure 2.

Table 1 Actual (laboratory) and recalculated ambient NOx results, NES and MfE guideline.

	Survey at	Site code	NOx(µg/m³) Lab. results	NOx 1/hr (µg/m³) Theoretical max.	NOx 24/hr (µg/m³) Theoretical max.
Petrochemical	McKee PS	AIR007901	4.5	15.6	8.3
		AIR007902	8.8	30.5	16.2
	Turangi PS	AIR007922	2.9	10.1	5.3
		AIR007824	3.5	12.1	6.4
	Kaimiro PS	AIR007817	1.8	6.2	3.3
		AIR007818	4.7	16.3	8.6
	Sidewinder PS	AIR007831	1.1	3.8	2.0
		AIR007832	0.8	2.8	1.2
	Maui PS	AIR008201	1.6	5.6	2.9
		AIR008214	2.1	7.3	3.9
	Kupe PS	AIR007827	Lost	N/A*	N/A*
		AIR007830	2.3	8.0	4.2
	Kapuni PS	AIR003410	5.5	19.1	10.1
		AIR003411	7.9	27.4	14.5
	Cheal PS	AIR007841	5.7	19.8	10.5
		AIR007842	5.8	20.1	10.7
	Waihapa PS	AIR007815	1.8	6.2	3.3
		AIR007816	0.5	1.7	0.9
	Ballance AUP	AIR003401	7.2	25.0	13.2
		AIR003404	6.0	21.0	11.0
Dairy factory	Fonterra	AIR002410	3.2	11.1	5.9
		AIR002711	6.8	23.6	12.5
		AIR002412	4.7	16.3	8.6
		AIR002413	3.2	11.1	5.9
SEM	NPGHS	AIR000012(NW)	7.5	26.0	13.8
		AIR000012(NE)	5.4	18.7	9.9
		AIR000012(SW)	6.2	21.5	11.4
		AIR000012(SE)	8.2	28.5	15.1
National Environmental Standard (NES) and MfE guideline				**200 (NES)**	**100 (guideline)**

*no results

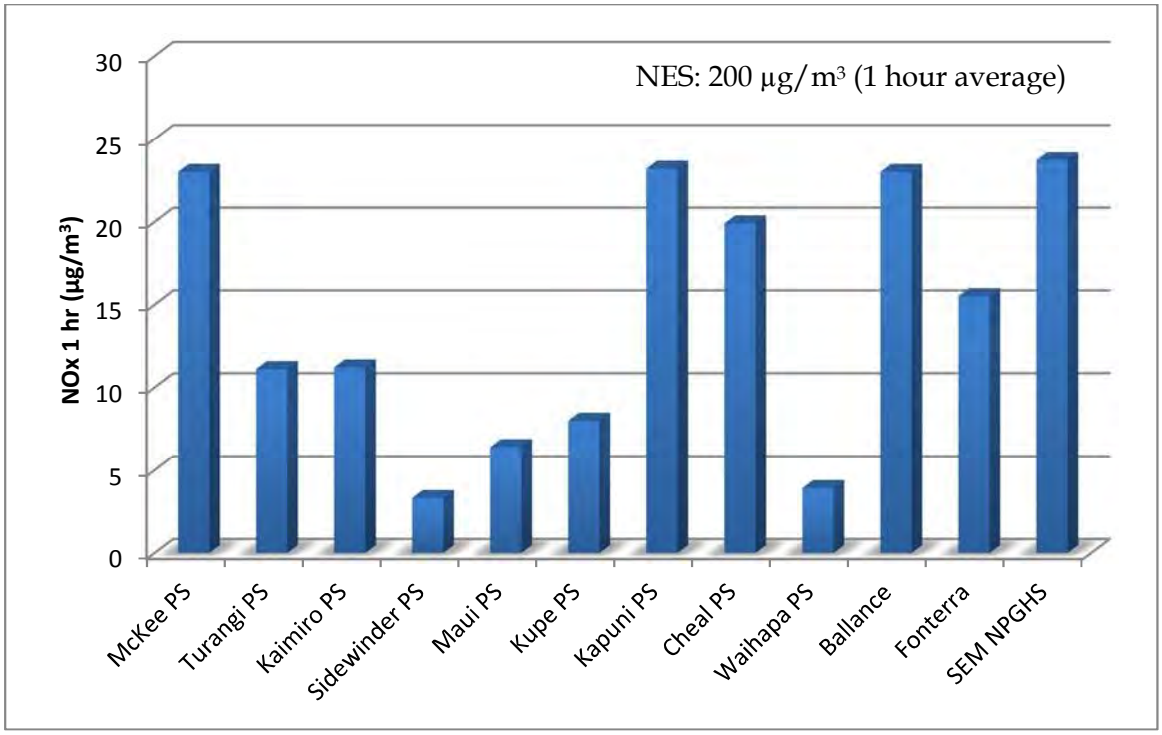

Figure 2 Average NOx levels at 12 surveyed locations throughout the region (year 2014-2015).

Discussion

The calculated 1-hour and 24-hour theoretical maximum concentrations (using a power law exponent of 0.2) ranged from 1.7 µg/m³ to 30.5 µg/m³ and 0.9 µg/m³ to 16.2 µg/m³ respectively. The highest results were obtained from the NOx emitting sites at four different locations:

1. In New Plymouth's urban area near a busy traffic intersection and next to the heavy road realignment works.
2. Around the Fonterra's Whareroa co-generation plant.
3. In Kapuni heavy industrial area around the STOS production station and Ballance ammonia/urea plant.
4. And from the sites at McKee production station and power generation plant.

All values were within the National Environmental Standards, Ministry for the Environment Ambient Air Quality Guidelines and the respective resource consents limits. This continues the pattern found in previous years.

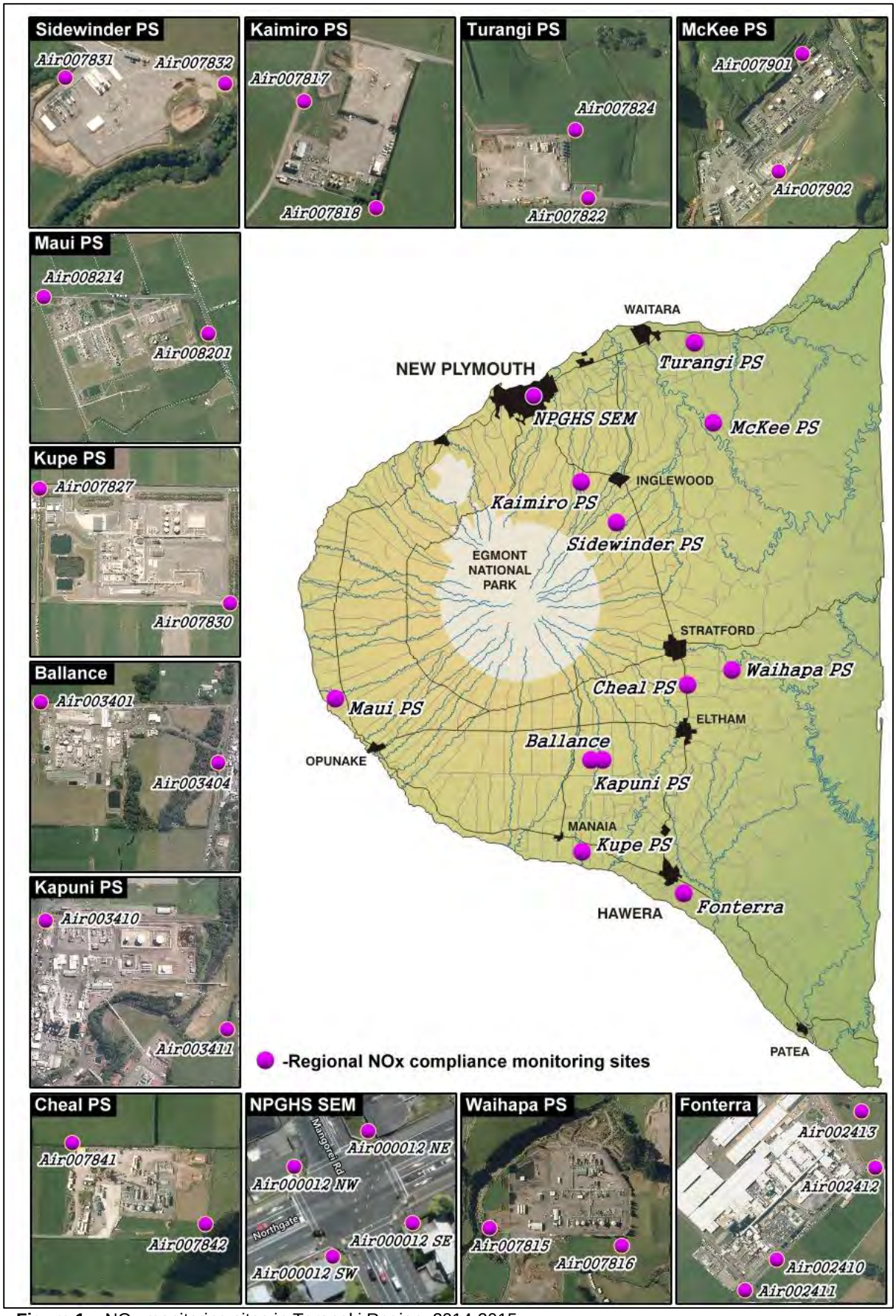

Figure 1 NOx monitoring sites in Taranaki Region, 2014-2015

Ministry for the Environment environmental performance indicator

Ministry for the Environment uses an environmental performance indicator to categorise air quality. These categories are set out in Table 2 and further details of the entire NOx results are set out in Table 3.

Table 2 Environmental Performance Indicator air quality categories

Measured value	Less than 10% of NES	10-33% of NES	33-66% of NES	66-100% of NES	More than 100% of NES
Category	*excellent*	*good*	*acceptable*	*alert*	*action*

Table 3 Categorisation of results

National Environmental Standard for NO2 = 200 µg/m³- 1 hour average.		
Category	**Measured values**	
Excellent	<10% of the NES, (0-20µg/m³)	**18** (67%)
Good	10-33% of the NES, (20-66µg/m³)	**9** (33 %)
Acceptable	33-66% of the NES, (66-132 µg/m³)	**0** (0%)
Alert	66-100% of the NES, (132-200 µg/m³)	**0** (0%)
Total number of samples		**27** (100%)

Conclusion

The monitoring showed that 67% of the 1-hour average results fell into Ministry's 'excellent' categories and 33% of the results lay within Ministry's 'good' category. No results ever entered the 'acceptable' or 'alert' categories, i.e., no results ever exceeded the National Environmental Standard of 200µg/m³.

These results, and all regional monitoring to date, have shown that Taranaki has very clean air, and on a regional basis there are no significant pressures upon the quality of the air resource.

Memorandum

To Job Manager, Callum MacKenzie
From Scientific Officer - Air Quality, Brian Cheyne
File 1656567
Date March 18, 2016

Ambient Gas (PM10, NOx, CO and LEL) Monitoring at Sidewinder Production Stations during 2014-2015 monitoring year

Introduction

In September 2014 and January 2015 as part of the compliance monitoring programme for the Sidewinder production station, a survey of ambient air quality sampling was carried out by the Taranaki Regional Council (the Council) in the vicinity of the plant. The main objectives were to measure:

- The concentrations of PM10 using a portable data logging TSI 'DustTrak';
- To measure the concentrations of the nitrogen oxides (NOx) using a passive sampling method, that gives a result for average exposure;
- And to measure carbon monoxide (CO) using a portable multi gas meter that provides instantaneous data throughout the monitoring period.

The findings of this study are presented in this memorandum, together with the locations of the monitoring sites which are provided in Figure 1.

Carbon monoxide (CO) and Lower explosive limit (LEL)

During the monitoring year, a multi-gas meter was deployed on one occasion in the vicinity of the plant. The deployment lasted approximately 43 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continuous measurements of gas concentrations for the gases of interest (carbon monoxide and combustible gases).

Because of the nature of the activities on the site, it was considered that the primary information of interest in respect of gases potentially emitted from the site was the average downwind concentration, rather than any instantaneous peak value. That is, the long-term exposure levels, rather than short-term maxima, are of most interest. The gas meter was therefore set up to create a data set based on recording the average concentration measured during each minute as raw data.

Figure 1 Air monitoring sites at Sidewinder production station (2014-2015)

The details of the sample run are summarised in Table 1 and the data from the sample run are presented graphically in Figure 2**.**

The consents covering air discharges from the Sidewinder production station have specific limits related to particular gases. Special condition 11 of consent 7822-1 set a limit on the carbon monoxide concentration at or beyond the production station's boundary. The limit is expressed as 10 mg/m³ for an eight hour average or 30 mg/m³ for a one hour average exposure. The maximum concentration of carbon monoxide found during the monitoring run was 14.1 mg/m³ with average concentration for the entire dataset was only 0.11 mg/m³ which comply with consent conditions. This is in line with the pattern found in previous years.

Table 1 Results of carbon monoxide and LEL monitoring at Sidewinder production station

Period (from-to)		08/09/2014 12:42 to 10/09/2014 09:50
Max	CO(ppm)	12.3
	LEL(%)	0.20
Mean	CO(ppm)	0.00
	LEL(%)	0.00
Min	CO(ppm)	0.00
	LEL(%)	0.00

Note: (1) the instrument records in units of ppm. At 25°C, 1 atm.
1ppm CO = 1.145 mg/m³

(2) See text for explanation of LEL. Because the LEL of methane is equivalent to a mixture of approximately 5% methane in air, then the actual concentration of methane in air can be obtained by dividing the percentage LEL by 20.

LEL gives the percentage of the lower explosive limit, expressed as methane that is detected in the air sampled. The sensor on the instrument reacts to gases and vapours such as acetone, benzene, butane, methane, propane, carbon monoxide, ethanol, and higher alkanes and alkenes, with varying degrees of sensitivity. The Council's Regional Air Quality Plan has a typical requirement that no discharge shall result in dangerous levels of airborne contaminants, including any risk of explosion. At no time did the level of explosive gases downwind of the Sidewinder production station reach any more than a trivial level.

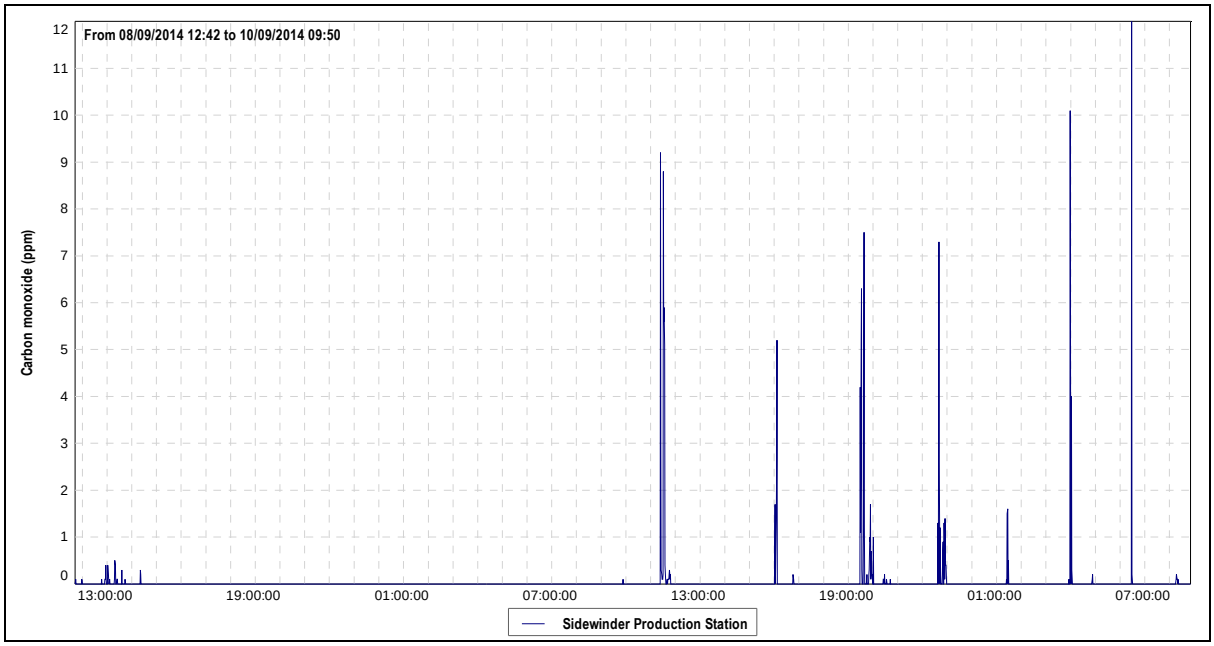

Figure 2 Graph of ambient CO levels in the vicinity of the Sidewinder production station

PM10

In September 2004 the Ministry for the Environment made public National Environmental Standards (NESs) relating to certain air pollutants. The NES for PM10 is 50 µg/m^3 (24-hour average).

Particulates can be derived from many sources, including motor vehicles (particularly diesel), solid and oil-burning processes for industry and power generation, incineration and waste burning, photochemical processes, and natural sources such as pollen, abrasion, and sea spray.

PM10 particles are linked to adverse health effects that arise primarily from the ability of particles of this size to penetrate the defences of the human body and enter deep into the lungs significantly reducing the exchange of gases across the lung walls. Health effects from inhaling PM10 include increased mortality and the aggravation of existing respiratory and cardiovascular conditions such as asthma and chronic pulmonary diseases.

During the reporting period, a "DustTrak" PM10 monitor was deployed on one occasion in the vicinity of the Sidewinder production station. The deployment lasted approximately 45 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continual measurements of PM10 concentrations. The location of the "DustTrak" monitor during the sampling run is shown in Figure 1.

The details of the sample run are presented in Figure 3 and Table 2.

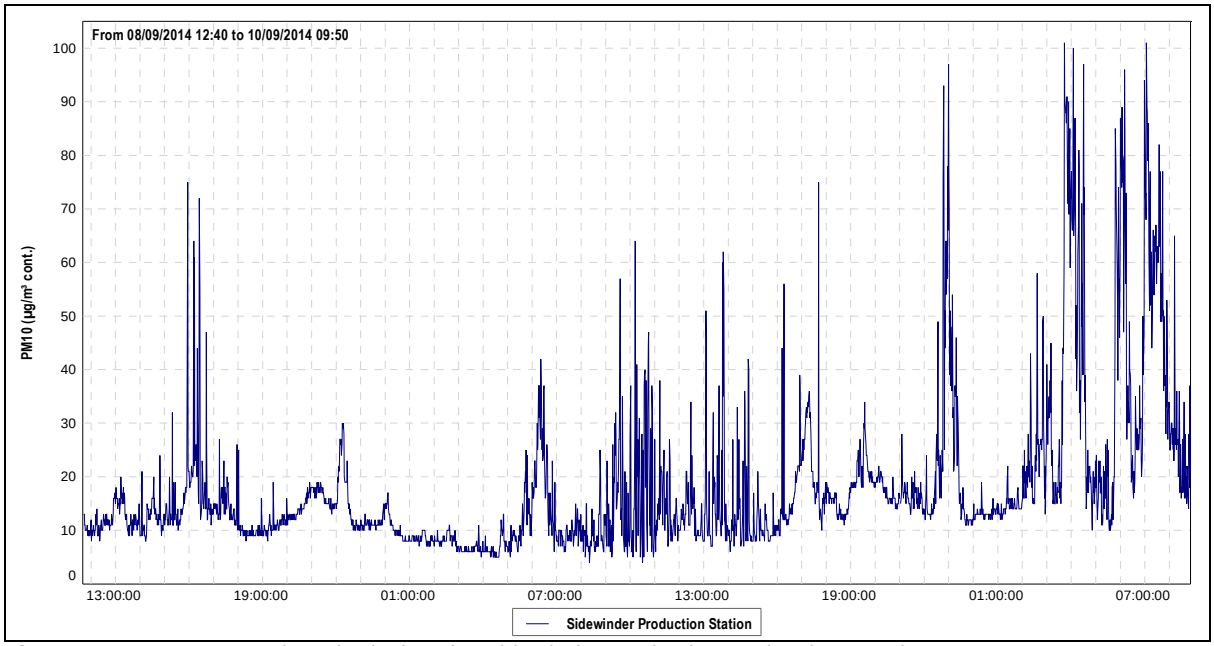

Figure 2 PM10 concentrations (µg/m³) at the Sidewinder production station (2014-15)

	(45 hours) (08-10/09/2014)	
24 hr. set	Day 1	Day 2
Daily average	12.8 µg/m³	23.0 µg/m³
NES	50µg/m³	

Table 1 Daily mean of PM10 results during two days' monitoring at Sidewinder production station

During the 45-hour run, from 8th of September to 10th of September 2014, the average recorded PM_{10} concentration for the first 24 hour period was 12.8 µg/m³ and 23.0 µg/m³ for the second 24 hour period. These daily means equate to 25.6% and 46%, respectively, of the 50 µg/m³ value that is set by the National Environmental Standard.

Background levels of PM_{10} in the region have been found to be typically around 11 µg/m³.

Nitrogen oxides (NOx)

From 2014 onwards, the Council has implemented a coordinated region-wide compliance monitoring programme to measure NOx. The programme involves deploying all measuring devices at 28 NOx monitoring sites (including two sites in the vicinity of the Sidewinder production station) on the same day, with retrieval three weeks later. This approach assists the Council in further evaluating the effects of local and regional emission sources and ambient air quality in the region.

The complete report covering region-wide NOx monitoring is attached in the Appendix to this memorandum and can also be found at the following link:
http://www.trc.govt.nz/assets/Publications/state-of-the-environment-monitoring/environmental-monitoring-technical-reports/1541533.pdf

The consents covering air discharges from the Sidewinder production station have specific limits related to particular gases. Special condition 12 of consent 7822-1 set a limit on the nitrogen dioxide concentration at or beyond the production station's boundary. The limit is

expressed as 100 µg/m³ for a 24 hour average or 200 µg/m³ for a one hour average exposure.

NOx passive adsorption discs were place at two locations in the vicinity of the Sidewinder production station on one occasion during the year under review. The discs were left in place for a period of 21 days.

The calculated 1-hour and 24-hour theoretical maximum NOx concentrations found at the Sidewinder production station during the year under review equates to 3.3 µg/m³ and 1.6 µg/m³ respectively. The results show that the ambient ground level concentration of NO_x is well below the limits set out by consent 7822-1.