

NZ Transport Agency Johnstone's Hill Tunnels



Passive Nitrogen Dioxide Air Quality Monitoring Report March to June 2010

Prepared for
NZ Transport Agency
By



Laboratory Services
Air Quality Department

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1 Summary

This report contains air quality results at Johnstone’s Hill Tunnels (JHT), Waiwera for NZ Transport Agency (NZTA). The passive nitrogen dioxide (NO₂) monthly samples were monitored for three months from 29 March to 23 June 2010. The monitoring project was located along the west side of the northbound tunnel south of Puhoi. There were 17 sites spread 50m apart from 200m outside the entrance to 200m outside the exit.

The passive diffusion sampling method involved is widely used in two ways; to assess direct exposure to NO₂; and as a surrogate for indirect exposures to other traffic-related pollutants such as carbon monoxide, sulfur oxides, particulate matter, benzene, polycyclic aromatic hydrocarbons, 1,3-butadiene and other organic compounds derived from combustion processes.

The monitoring was conducted by Watercare Services Ltd, on behalf of the NZTA. The monitoring site was established to measure key air pollutants within the tunnel and forms part of NZTA’s review of existing tunnels in the State Highway Network.

The key findings were:

- Data return was good with only two missing samplers and one invalid sample.
- The centre of the tunnel had the highest overall NO₂ concentration of 62.7µg/m³.
- NO₂ concentrations generally tapered away from the centre of the tunnel.
- There were seven sites within the tunnel, located approximately 150m either side of the tunnel centre with overall average NO₂ concentrations above the World Health Organization (WHO) air quality standard annual average of 40µg/m³.
- NO₂ concentrations were higher outside of the tunnel exit compared to the outside of the tunnel entrance.

2 Introduction

In February 2010, NZ Transport Agency (NZTA) commissioned Watercare Services Ltd to conduct passive monitoring of nitrogen dioxide (NO₂) within and around the Johnstone’s Hill Tunnels (JHT). The monitoring was undertaken as part of NZTA’s review of existing tunnels.

The Johnstone’s Hill Tunnels at the end of the Northern Gateway Toll Road were completed in January 2009. The 7.5km long toll road bypasses Orewa reducing State Highway (SH) traffic congestion. The two lane twin tunnels are 15m apart, 12m wide, 9m high and 380m long. Currently, the northbound tunnel merges into one lane before the tunnel entrance to accommodate the existing one lane road structure at the tunnel exit. The nitrogen dioxide passive diffusion sampler monitoring project was undertaken along the length of the northbound tunnel and 200m either side of the tunnel.

This report presents a summary of data for three months from 29 March to 23 June 2010 to determine relative levels of road tunnel vehicle pollution.

This report presents the following:

- summary of ambient air quality targets, guidelines and standards
- monitoring site description
- overview of the method
- data summary and statistics

3 Ambient Air Quality Limits, Guidelines and Standards

The measurements of air quality made at Johnstone’s Hill Tunnels can be compared with various air quality limits, guidelines or standards. The Ministry for the Environment (MfE) National Environmental Standards (NES) for ambient air quality superseded the Ambient Air Quality Guidelines (AAQG) 2002 in some areas. In 2009 NZTA proposed interim air quality guidelines for road tunnels that are similar to other workplace exposure limits.

The AAQG also include New Zealand critical levels for protecting ecosystems based on the WHO (1996) and Australia and New Zealand Environment and Conservation Council (ANZECC) guideline values. For NO₂ there is an annual average critical level of 30µg/m³. This concentration is used in this report as a marker to identify elevated levels of NO₂.

World Health Organization (WHO) has an annual average guideline for NO₂ monitoring of 40µg/m³ set to protect human health. This limit is used in this report as the threshold. Table 1 outlines the relevant limits.

Table 1: Air quality NO₂ limits

Source	Averaging Period	Limit	Environment
NZTA	15 min	1ppm	Workplace
NES	1 hr	200µg/m ³	Ambient
AAQG	24 hr	100µg/m ³	Ambient
AAQG	Annual	30µg/m ³	Ambient
WHO	Annual	40µg/m ³	Ambient

4 Monitoring sites

The two lane twin Johnstone’s Hill Tunnels are at the end of the Northern Gateway Toll Road south of Puhoi (see front page). The air quality monitoring was conducted on the west side of the northbound tunnel. The northbound tunnel merges into one lane before the tunnel entrance to accommodate the one lane road layout at the tunnel exit.

The samplers were exposed on a monthly basis and visits were scheduled on the partial road tunnel closure dates listed in Table 2. There were 17 passive sampling sites along the roadside described in Table 3. There were five sites outside the entrance and five sites outside the exit of the tunnel with seven sites inside the tunnel. At the passive sampling sites, samples were installed on or near lamp posts and on the tunnel wall at 1-2 m above the road level. The distance between each site was approximately 50m. Appendix A gives details of site locations and site photos.

Table 2: NO₂ sample exposure dates

Month	Start Date	End Date
April	29 Mar 2010	28 Apr 2010
May	28 Apr 2010	26 May 2010
June	26 May 2010	23 Jun 2010

5 Method

The NO₂ passive diffusion tube tunnel project was setup and operated in general accordance with “Local Air Quality Management (LAQM) Technical Guidance Document LAQM. TG (03)”.

The sampler consists of an acrylic or PTFE tube 70mm long and 10mm internal diameter with the ends machined to take close fitting polythene caps. Two stainless steel mesh discs, coated with triethanolamine (TEA), are at one end of the tube and held in position by an opaque coloured cap to aid identification and prevent degradation of NO₂ on the TEA complex by sunlight. The other clear removable cap is used as a lid to seal the diffusion tube before and after exposure.

The passive samplers were analysed by and sub-contracted to Staffordshire County Council Scientific Services. The amount of NO₂ is determined spectrophotometrically by a variation of the Saltzman reaction. All concentrations have been converted to the New Zealand standard conditions of temperature (0°C) and pressure (1atm).

A travel blank was transported and analysed with the samplers to ensure that contamination of the samplers had not occurred. The travel blank results ranged from 1.3µg/m³ to 4.5µg/m³.

6 Results

This section provides the site performance and an overview of the results for passive nitrogen dioxide monitoring.

6.1 Data capture

According to LAQM TG (03), for screening studies a captured data rate of 75% is required. There were no missing samplers for April and June. However, during May AUC160 (8N) and AUC163 (11N) were missing. Table 3 below shows overall site performance for the reporting period.

In June, AUC162 (10N) reported an unusually high NO₂ concentration of 94.7µg/m³ relative to the results from this site and other surrounding sites. This sample may have been contaminated. The result was considered as spurious and invalid.

6.2 Overview

The passive NO₂ diffusion project at the Johnstone’s Hill Tunnels from April to June 2010 is plotted in Figure 1. The sites are numbered from south to north or from entrance to exit. The monthly NO₂ site results are examined in Table 3 and Figure 2. Figure 3 presents the average NO₂ concentrations and the standard deviations over the three month period.

The passive NO₂ diffusion monitoring showed:

- AUC161 (9N) had the highest monthly NO₂ concentration of 71.9µg/m³ and the highest overall average NO₂ concentration of 62.7µg/m³. This site was located approximately 200m from the entrance and was near the centre of the tunnel. NO₂ concentrations generally tapered away from the centre of the tunnel.
- AUC163 (11N) had the second highest monthly NO₂ concentration of 63.0µg/m³ located approximately 300m from the entrance.
- AUC153 (1N) had the lowest monthly NO₂ concentration of 9.0µg/m³ located approximately 200m outside the entrance.
- The seven sites within the tunnel had overall average NO₂ concentrations above the WHO air quality standard annual average of 40µg/m³ (red).
- There were nine network sites that had NO₂ concentrations over the AAQG annual average critical level of 30µg/m³ (orange). These sites were located between approximately 200m north and south of the tunnel centre.
- NO₂ concentrations remained higher outside of the tunnel exit compared to outside of the tunnel entrance. Overall average NO₂ concentrations were above 20µg/m³ (yellow) up to approximately 100m outside the tunnel exit.
- On average monthly NO₂ concentrations at each tunnel site were similar with the highest deviations at the tunnel centre (9N), the entrance (5N) and the exit (13N).

Table 3: Passive NO₂ results – 2010

NZTA Site Identification	Project Identification	Site Name	NO ₂ Results (µg/m ³)			
			Apr-10	May-10	Jun-10	Average
AUC153	1N	200m outside Tunnel Entrance	10.7	12.1	9	10.6
AUC154	2N	150m outside Tunnel Entrance	11.1	13.9	9.2	11.4
AUC155	3N	100m outside Tunnel Entrance	11.7	13.4	10.4	11.8
AUC156	4N	50m outside Tunnel Entrance	16	21	18.7	18.6
AUC157	5N	Tunnel Entrance	28	32.5	37.9	32.8
AUC158	6N	50m inside Tunnel Entrance	53.5	47.2	47.1	49.3
AUC159	7N	100m inside Tunnel Entrance	52	58.7	55.3	55.3
AUC160	8N	150m inside Tunnel Entrance	56.6	Missing	57.9	57.3
AUC161	9N	200m inside Tunnel Entrance	71.9	61.1	55.1	62.7
AUC162	10N	250m inside Tunnel Entrance	54.4	55.1	94.7 ¹	54.8
AUC163	11N	300m inside Tunnel Entrance	59.1	Missing	63	61.1
AUC164	12N	350m inside Tunnel Entrance	60.1	56	54.4	56.8
AUC165	13N	10m outside Tunnel Exit	43.2	40.2	34.8	39.4
AUC166	14N	50m outside Tunnel Exit	24.8	22.5	19.5	22.3
AUC167	15N	100m outside Tunnel Exit	23.6	22.3	22.4	22.8
AUC168	16N	150m outside Tunnel Exit	19.5	17.2	18.3	18.3
AUC169	17N	200m outside Tunnel Exit	16.8	18.5	16.6	17.3
	Blank	Travel Blank	4.5	1.3	1.5	2.4

¹ Invalid result – unusually high

NO ₂ scale (µg/m ³)	<10	10-19.9	20-29.9	30-39.9	≥40
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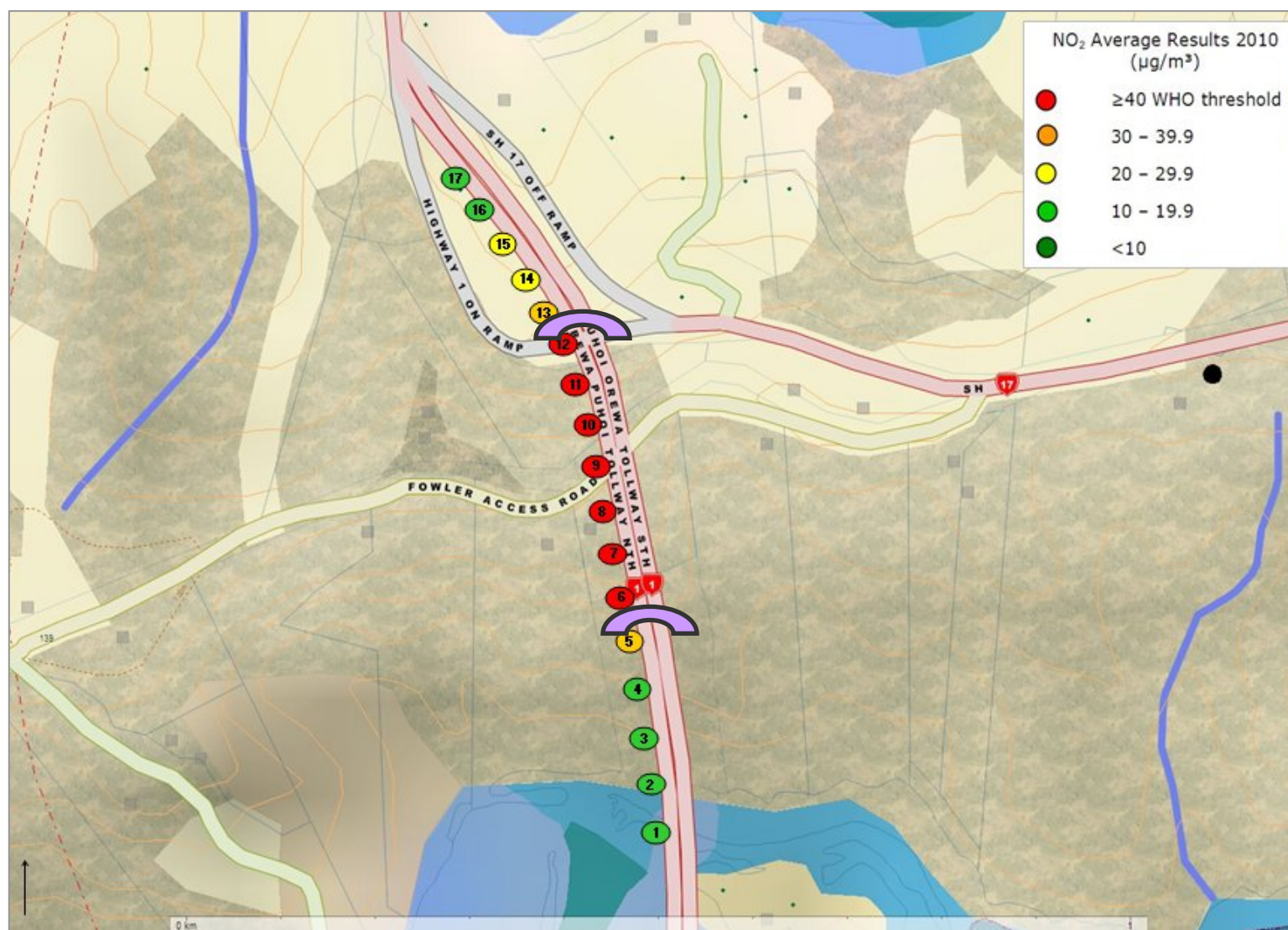


Figure 1: Location map of passive NO₂ sites at the Johnstone’s Hill Tunnels

**NZTA – Johnstone’s Hill Tunnels
NO₂ – Monthly Results
April to June 2010**

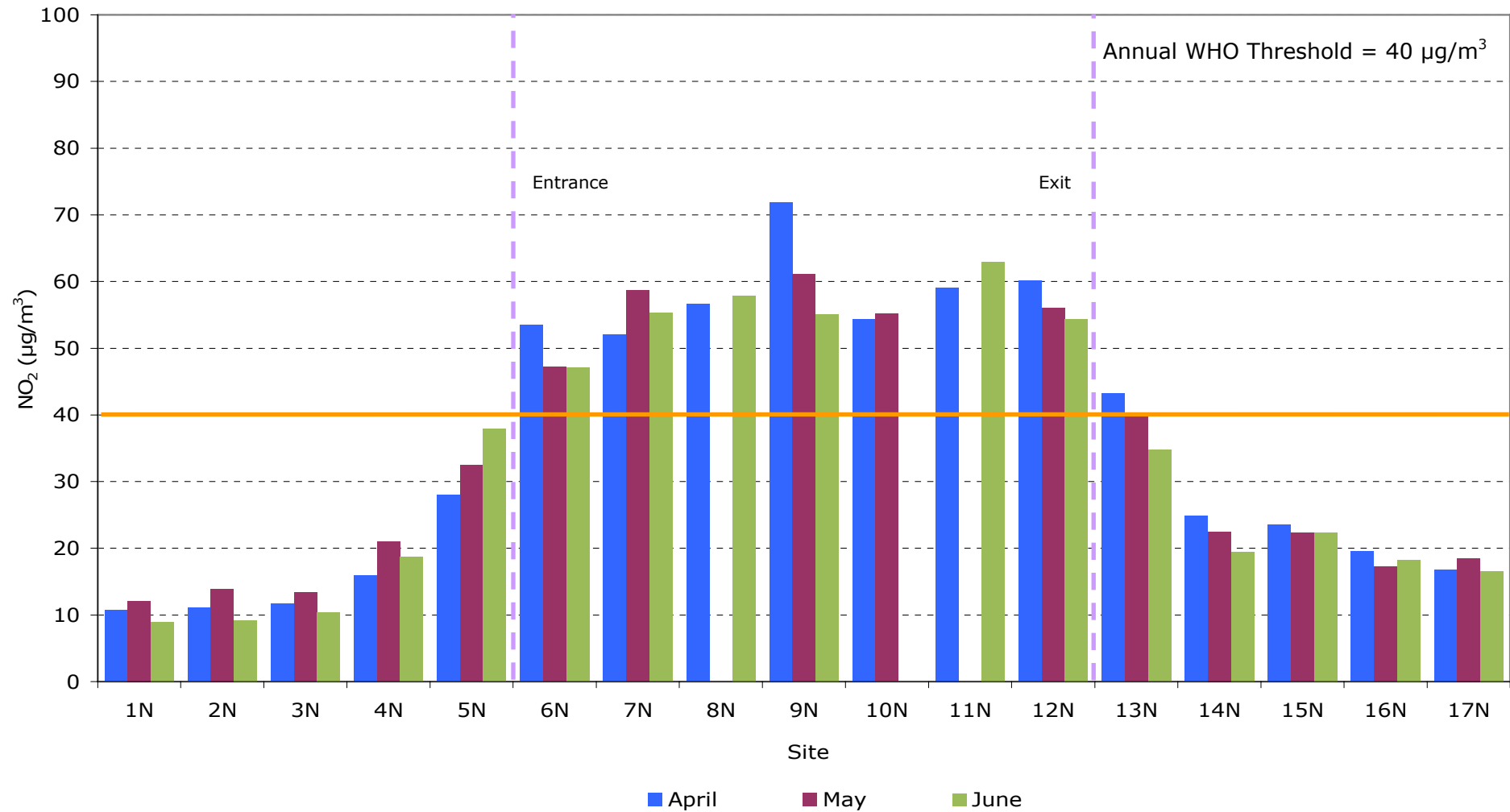


Figure 2: NZTA – Johnstone’s Hill Tunnels: NO₂ monthly results

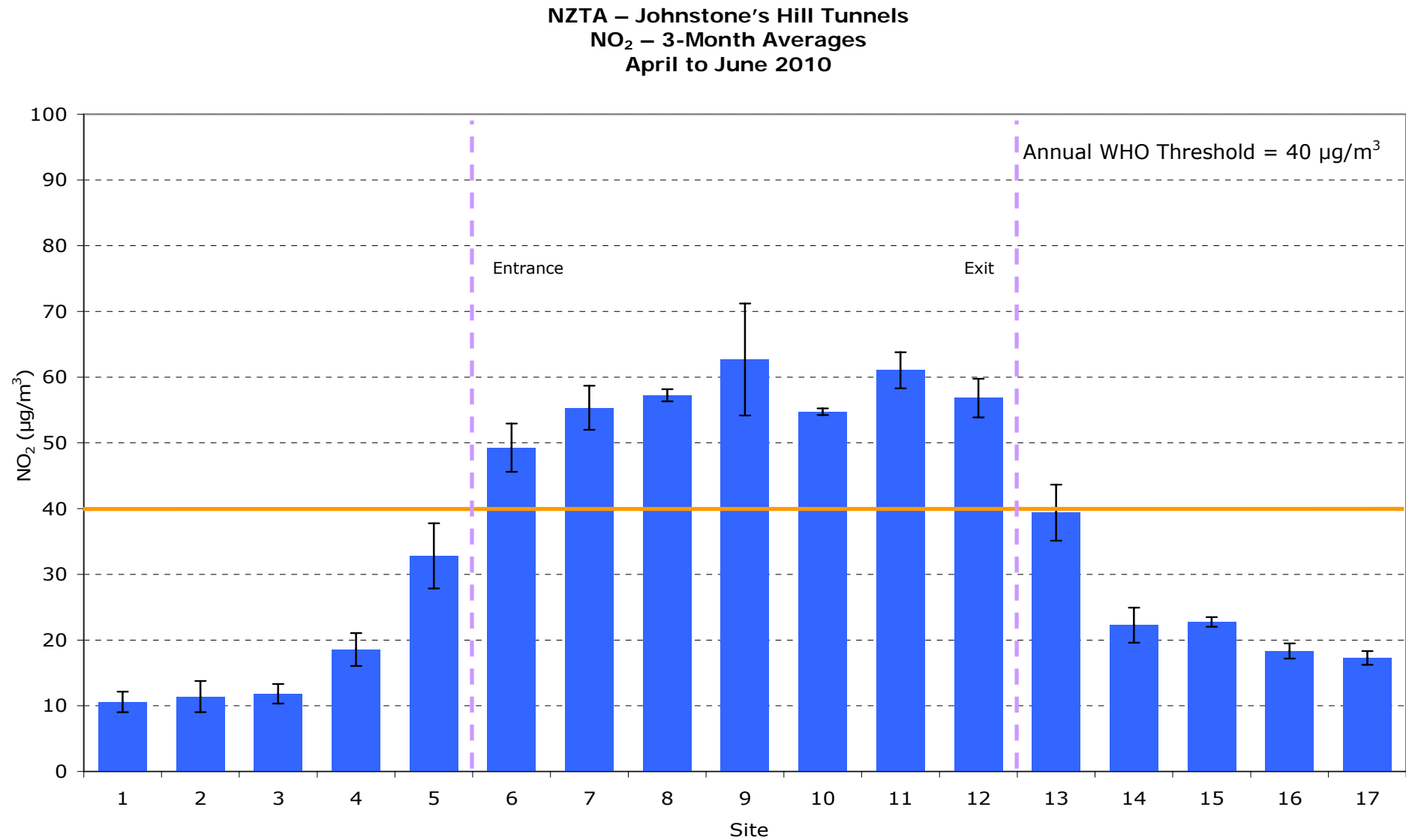


Figure 3: NZTA – Johnstone’s Hill Tunnels: NO₂ 3-month averages

Appendix A

Site Details

Site Name

200m outside Tunnel Entrance

Site Identification

AUC153

Project Identification

1N

Nearest Location

Lamp post (NG2-9)

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

1m

Monitoring Period

29-Mar-10 to 23-Jun-10

**Site Name**

150m outside Tunnel Entrance

Site Identification

AUC154

Project Identification

2N

Nearest Location

Lamp post (NG2-11)

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

1m

Monitoring Period

29-Mar-10 to 23-Jun-10



Site Name

100m outside Tunnel Entrance

Site Identification

AUC155

Project Identification

3N

Nearest Location

Lamp post (NG2-13)

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

1m

Monitoring Period

29-Mar-10 to 23-Jun-10

**Site Name**

50m outside Tunnel Entrance

Site Identification

AUC156

Project Identification

4N

Nearest Location

Lamp post (NG2-15)

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10



Site Name

Tunnel Entrance

Site Identification

AUC157

Project Identification

5N

Nearest Location

Entrance wall

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10

**Site Name**

50m inside Tunnel Entrance

Site Identification

AUC158

Project Identification

6N

Nearest Location

-

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10



Site Name

100m inside Tunnel Entrance

Site Identification

AUC159

Project Identification

7N

Nearest Location

-

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10

**Site Name**

150m inside Tunnel Entrance

Site Identification

AUC160

Project Identification

8N

Nearest Location

-

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10



Site Name

200m inside Tunnel Entrance

Site Identification

AUC161

Project Identification

9N

Nearest Location

Centre

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10

**Site Name**

250m inside Tunnel Entrance

Site Identification

AUC162

Project Identification

10N

Nearest Location

-

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10



Site Name

300m inside Tunnel Entrance

Site Identification

AUC163

Project Identification

11N

Nearest Location

-

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10

**Site Name**

350m inside Tunnel Entrance

Site Identification

AUC164

Project Identification

12N

Nearest Location

-

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10



Site Name

10m outside Tunnel Exit

Site Identification

AUC165

Project Identification

13N

Nearest Location

Lamp post (NG1-27) &
36m from 12N

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10

**Site Name**

50m outside Tunnel Exit

Site Identification

AUC166

Project Identification

14N

Nearest Location

Lamp post (NG1-29)

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10



Site Name

100m outside Tunnel Exit

Site Identification

AUC167

Project Identification

15N

Nearest Location

Lamp post (NG1-31)

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10

**Site Name**

150m outside Tunnel Exit

Site Identification

AUC168

Project Identification

16N

Nearest Location

Motorway Sign

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10



Site Name

200m outside Tunnel Exit

Site Identification

AUC169

Project Identification

17N

Nearest Location

Road Sign

Nearest Major Road (SH)

SH1 - Northern Gateway Toll Road
Northbound Johnstone's Hill Tunnel

Height Above Ground

2m

Monitoring Period

29-Mar-10 to 23-Jun-10

