Appendix 11: Traffic and Transport Assessment

Proposed Augmentation and Safety Upgrade for Chaffey Dam, NSW

Worley Parsons

Traffic Study

October 2012

Mark Waugh Pty Ltd

ABN 67 106 169 180

Document History and Status

Issue	Ver.	Issued To	Qty	Date	Reviewed	Approved
Draft	Ver01	Worley Parsons Services Pty Ltd	1 Electronic	2nd August 2012	K Barkley	C. Thomas
Final	Ver02	Worley Parsons Services Pty Ltd	1 Electronic	11th October 2012	K Barkley	C. Thomas
Final	Ver03	Worley Parsons Services Pty Ltd	1 Electronic	22nd October 2012	K Barkley	C. Thomas

Printed:	23 October 2012
Last Saved:	23 October 2012
File Name:	P0927 WP Chaffey Dam Ver 03.docx
Author:	Mark Lucas
Name of Organisation:	Worley Parsons Services Pty Ltd
Name of Project:	Proposed Augmentation and Safety Upgrade EIS for Chaffey Dam, NSW
Name of Document:	Traffic Study
Document Version:	Final
Project Number:	P0927

Contents

1 Introduction

Better Transport Futures has been commissioned by WorleyParsons Services Pty Ltd (WorleyParsons) on behalf of the State Water Corporation (State Water) to prepare a traffic study to support an Environmental Impact Assessment for the proposed augmentation and safety upgrade of Chaffey Dam, New South Wales (NSW). A site plan displaying the proposed amendments to Chaffey Dam is included in Appendix A.

The project has been classified as state significant infrastructure under the *Environmental Planning and Assessment Act 1979* and Director General's Requirements (DGRs) have been issued for the project.

Due to the potential impact of the development construction traffic upon the local road network and at intersections along the New England Highway (that forms part of the regional road network) the NSW Roads and Maritime Services (RMS) will be required to review the proposal and provide concurrence for the development, in accordance with State Environmental Planning Policy (Infrastructure) 2007.

It is noted that as a "State Significant Infrastructure" project, the *Environmental Planning and Assessment Act, 1979* provides guidelines relating to appeals and approvals.

Scope of Report

The scope of this report is to review the traffic and access implications for the construction phases of the proposed development. Once completed, the improvements to the dam will create no additional trips and as such have no impact on the numbers of trips generated by the facility.

The current activity associated with the dam is associated with its routine maintenance, which is in the order of 2 – 3 trips per day impacting on the Tamworth Nundle Road and the other roads in the vicinity of the subject site. These flows are negligible given that dams are not major trip generators.

There is also some recreational activity associated with the dam, namely fishing, camping and boating. During the site work however there were no visitors observed and typical of this type of recreational facility the majority of people visit of a weekend or during warmer holiday periods. As such these do not coincide with road network peak hours.

Issues and Objectives of the Study

The issues relative to the proposal are:

- Assess impact on the arterial and local road network due to the additional traffic flows;
- Assess the impact of the access requirements for the project in terms of road safety especially for the construction activities of the project;
- Review the access arrangements for the construction of the development;
- Review the internal site layout during construction;
- Review the service arrangement for the future development; and
- Assess any other transport impacts associated with the development.

The objective of the report is to document the impacts of the proposed development and provide advice on any infrastructure work required as part of the development proposal.

Planning Context

As part of the development of this document, the following guides and publications were used:

- Austroads Guide to Traffic Management (2009);
- RTA Guide to Traffic Generating Developments, Version 2.2 Dated October 2002;
- Australian / New Zealand Standard – Parking Facilities Part 1 : off-street car parking (AS2890.1:2004); and
- Accident Data for the Northern Region, provided by the RMS (Grafton office).

Authority Requirements

▪ *Table 1-1 DGR Response*

Comment	Report Inclusion
Identification of the construction traffic routes and the nature of the existing traffic on these routes.	Section 2.3 and Section 4.2.
Assessment of the construction traffic volumes.	Section 4.1
Potential impact upon the regional and local road network (including safety and levels of service) and potential disruption to existing public transport/school bus services and access to properties and businesses.	Section 4.4.
Operational traffic and transport impacts to the local and regional road network, including changes to local connectivity and impacts on local traffic arrangements, road capacity, safety and modified access to realigned roads.	Section 4.4 and Section 4.5

Source: Department of Planning and Infrastructure

The Roads and Maritime Services (RMS) of NSW have indicated that they have no objection in principle to the proposed development; however, their comments with respect to its traffic impacts are detailed in Table 1.2.

▪ *Table 1-2 RMS Comments*

Comment	Report Inclusion
Identify if traffic routes relating to the proposal will include any State Roads, particularly the Oxley Highway (HW12) and New England Highway (HW9)	Section 4.2
Assess the potential impact upon safety and efficiency on the state road network	Section 4.5
Identify suitable measures to mitigate and control any identified impacts upon the state road network so as to ensure that the safety and efficiency is maintained.	Section 5.3
Any road works required on a State road will require the developer to enter into a Works Authorisation Deed (WAD) with the RMS. All works will be undertaken at full cost to the developer to the satisfaction of the RMS. Should works on a state road be identified as necessary then the developer is encouraged o discuss the matter with the RMS at their earliest convenience.	Section 5.4

2 Existing Situation

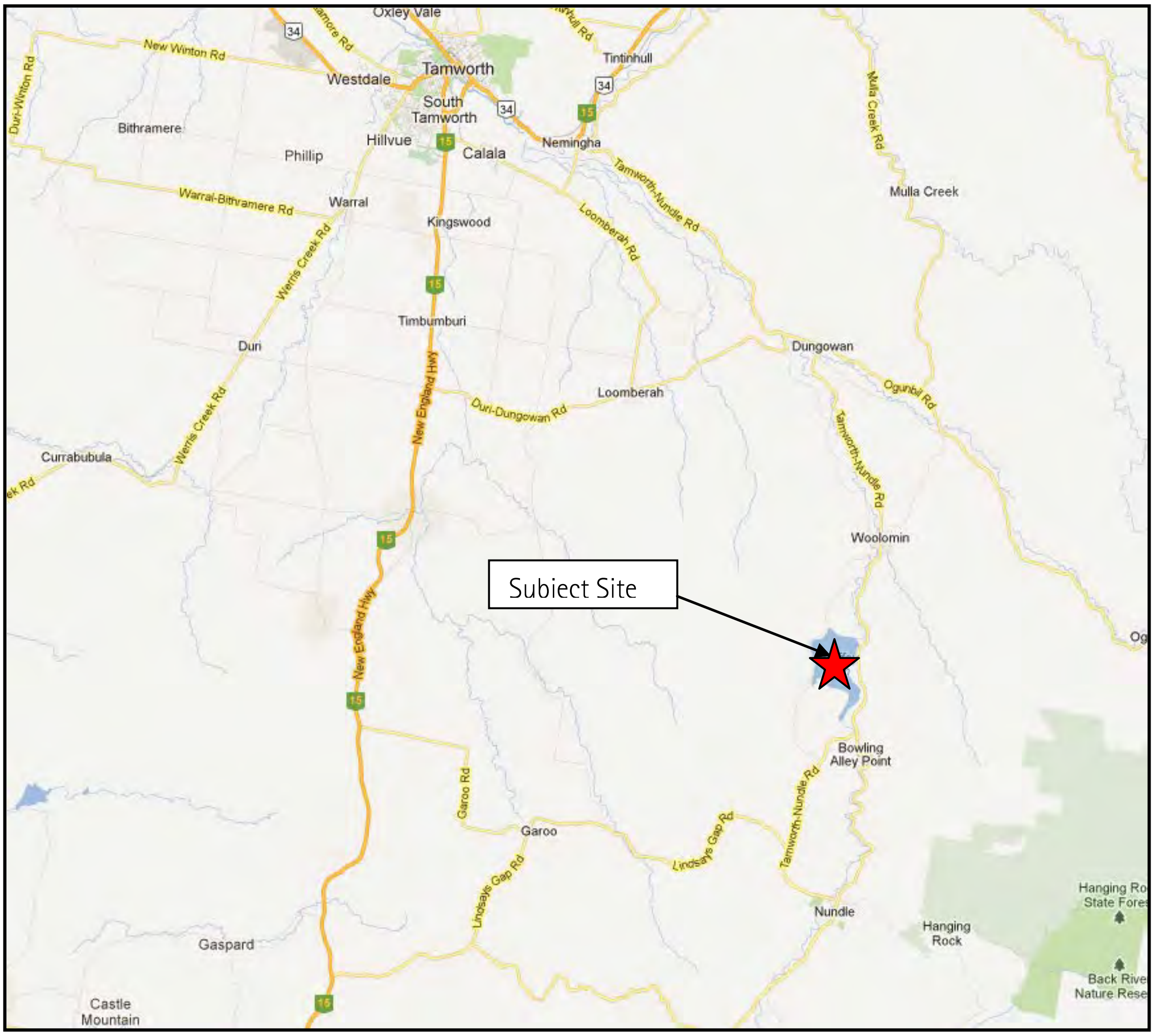
2.1 Site Description and Proposed Activity

2.1.1 Site Location and Access

The subject site is located on the Peel River in Woolomin, south of Tamworth. The site has frontage to the Tamworth-Nundle Road, which intersects the New England Highway at Nemingha south east of Tamworth. The Tamworth-Nundle Road can also be accessed from Garoo Road and Lindsays Gap Road both of which intersect the New England Highway to the west of the subject site at priority controlled junctions.

The site is currently occupied by Chaffey Dam with surrounding land being arable and rural land.

The location of the site is shown below in Figure 2-1.



Source: Google maps

■ *Figure 2-1 - Site Location*

2.2 Existing Traffic Conditions

2.2.1 Road Hierarchy

The main road in the vicinity of the site is the New England Highway, a regional road which, in the vicinity of Chaffey Dam, is under the control of Tamworth Regional Council with concurrence for any new access or development adjacent to the highway required from the Roads and Maritime Services (RMS). Road classification criteria are included in Appendix B.

New England Highway

The New England Highway is a regional road that links NSW and Queensland. It traverses the Hunter Valley and New England regions of NSW and the Southern and Darling Downs regions of Queensland. The New England Highway is 887 kilometres long and carries high volumes of heavy vehicles.

There are no kerbs and gutters or footpaths provided on the New England Highway in proximity to its intersections with Lindsays Gap Road and Garoo Road.

South of Tamworth the New England Highway operates under a posted speed limit of 100 km/h. Further to the north, the speed limit reduces to 60 km/h within the urban limits of Tamworth.

The majority of the intersections along its length to the south of Tamworth are simple give way controlled junctions. This is reflective of the low traffic flows on the side roads as well as providing priority to the north and south traffic flows on the New England Highway. These side roads typically provide access to nearby towns such as Nundle and Woolomin as well as the rural land with associated farming activities.

It is noted at the intersections with Lindsays Gap Road and Garoo Road that additional short right turn and left turn deceleration lanes are provided on the New England Highway. These lanes physically separate turning vehicles from through movements and provide a safer environment for intersection users.

■ *Photo 1 Sight Distances North on the New England Highway from Lindsays Gap Road*

▪ *Photo 2 Sight Distances South on the New England Highway from Lindsays Gap Road*

Lindsays Gap Road

Lindsays Gap Road is a sealed road with a reserve width of 6m (approximately) and with single lanes in each direction that connect the New England Highway to the Tamworth-Nundle Road. It intersects both these roads at priority controlled junctions as well as its intersection with Garoo Road.

The quality of Lindsays Gap Road is variable with some sections appearing recently sealed while other sections have uneven surfaces and pot holes that have been patched. Painted road marking are inconsistent along the length of Lindsays Gap Road.

There are a number of small bridges over streams on Lindsays Gap Road that restrict travel to a single lane with vehicle movement controlled by Give Way signs on either side of the bridge. These bridges are able to accommodate the movement of cars and large heavy goods vehicles.

There are no kerbs and gutters, shoulders, verges, footpaths or street lighting provided along the length of Lindsays Gap Road. This is reflective of the low volumes of vehicles that use the road, its rural nature and remote location.

No posted speed limits were observed on Lindsays Gap Road, however, vehicles were observed to travel at up to 100km/hour, which is consistent with the speed limit permitted on unmarked country roads.

■ *Photo 3 View East Along Lindsays Gap Road Showing Typical Cross Section*

■ *Photo 4 An Example of a Small Bridge on Lindsays Gap Road*

Garoo Road

Garoo Road is a sealed road with a reserve width of 6m (approximately) and with single lanes in each direction that connect the New England Highway to Lindsays Gap Road at the locality of Garoo. It intersects the New England Highway and Lindsays Gap Road at priority controlled junctions.

Similar to Lindsays Gap Road the quality of Garoo Road is variable with some sections recently sealed and other sections having uneven surfaces and surface repairs. There is a small bridge over a stream on Garoo Road that restricts the right of way and limits travel to a single direction.

There are no kerbs and gutters, shoulders, verges, footpaths or street lighting provided along the length of Garoo Road. This is reflective of the low volumes of vehicles that use the road, its rural nature and remote location.

No posted speed limits were observed on Garoo Road, however, vehicles were observed to travel at up to 100km/hour, which is consistent with the speed limit permitted on unmarked country roads.

▪ *Photo 5 View East Along Garoo Road Showing Typical Cross Section*

Tamworth-Nundle Road

Tamworth-Nundle Road is a sealed road with a reserve width of 7m (approximately) with a single lane in each direction that connects the town of Nemingha in the north to the town of Nundle in the south. The Tamworth-Nundle Road traverses the eastern side of Chaffey Dam.

The quality of Tamworth-Nundle Road is variable with some sections appearing recently sealed while other sections have uneven surfaces and pot holes that have been patched. Painted road marking are inconsistent along the length of Tamworth-Nundle Road.

There are no kerbs and gutters, shoulders, verges, footpaths or street lighting provided along the length of Tamworth-Nundle Road. This is reflective of the low volumes of vehicles that use the road, its rural nature and remote location.

To the south of Chaffey Dam at the intersection of Tamworth-Nundle Road with River Road a small bridge is provided on the Tamworth-Nundle Road over the Peel River (See Photo 7). At this intersection, vehicles are required to give way to those vehicles on River Road.

No posted speed limits were observed on Tamworth-Nundle Road, however, vehicles were observed to travel at up to 100km/hour, which is consistent with the speed limit permitted on unmarked country roads.

■ *Photo 6 Tamworth-Nundle Road North of Lindsays Gap Roads*

Western Foreshore Road

The Western Foreshore Road is an unsealed road with a carriageway width of approximately 6m that runs along the western periphery of Chaffey Dam.

There are no kerbs and gutters, shoulders, verges, footpaths or street lighting provided along the length of the Western Foreshore Road.

To the south of the subject site it intersects the Tamworth-Nundle Road at a priority controlled intersection and to the north it intersects Westbank Road in proximity to the township of Woolomin.

A small number of rural properties are accessed from the Western Foreshore Road and it is currently used by some fishing clubs to access Chaffey Dam.

■ *Photo 7 Bridge on Tamworth-Nundle Road over the Peel River at the Intersection with River Road*

2.2.2 Roadworks and Traffic Management Works

There are no road works or traffic management works currently occurring on the roads in the general vicinity of the subject site.

From discussions with the RMS and Tamworth Regional Council it is understood that other than routine maintenance by the road authorities there are no plans for any major road network changes in the immediate vicinity of the subject site.

It is noted, however, that the augmentation of Chaffey Dam project includes realignment and raising of the intersection of Tamworth-Nundle Road and River Road, as well as the raising and realignment of some sections of the Western Foreshore Road.

2.2.3 Pedestrian and Cycling Facilities

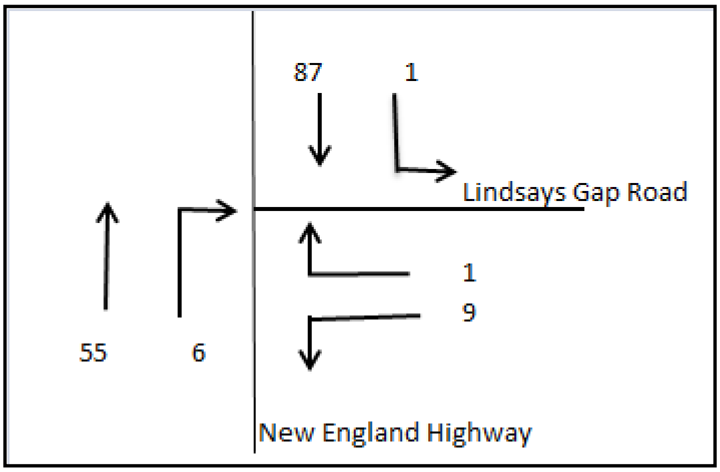
In keeping with its remote location, there are no dedicated pedestrian or cycling facilities on the local or regional roads in proximity to the subject site.

2.3 Traffic Flows

2.3.1 Peak Hour Flows

To identify existing traffic volumes a manual traffic survey was undertaken at the intersection of New England Highway and Lindsays Gap Road on the 15th May 2012 between 8:00am – 9:00am in order to account for the traffic associated with a typical morning peak period.

The traffic volumes identified in the traffic survey is presented in Figure 2-2.



■ *Figure 2-2 Existing Traffic Volumes*

The data indicates that the peak hour volumes are low with 55 northbound vehicles and 87 southbound vehicles on the New England Highway and 7 eastbound vehicles and 10 westbound vehicles on Lindsays Gap Road.

It is considered that the traffic volumes identified on Lindsays Gap Road are indicative of the traffic volumes on Garoo Road and the Tamworth-Nundle Road which were also observed to be negligible.

2.3.2 Daily Traffic Flows

Typically peak hour flows represent 8% - 12% of the daily flows. Based upon the AM peak hour data identified at the intersection of the New England Highway and Lindsays Gap Road in the surveys of 15th May 2012, this equates to 508 – 763 northbound vehicles per day and 733 – 1,100 southbound vehicles per day on the New England Highway in proximity to the proposed development.

On Lindsays Gap Road the peak hour flows equate to 70 eastbound vehicles and 100 westbound vehicles per day.

RMS 2007 traffic count data from Count Station 92.325 north of Tamworth indicates that the average annual daily traffic volumes on the New England Highway are 3,352 vehicles. This is higher than the daily traffic volumes inferred from the traffic surveys. However, the traffic station also accounts for northbound vehicle trips attracted from Tamworth.

Additionally 2007 RMS traffic count data from Count Station 92.737 on the Tamworth-Nundle Road south of Nemingha, indicates annual daily traffic volumes of 1,596 vehicles, corresponding approximately to 160 two-way vehicles in the peak hour.

2.3.3 Daily and Seasonal Traffic Flow Distribution

There is no data available from the RMS publication for the daily variation in traffic flows at this location.

The traffic survey data indicates the peak hour traffic volumes on the New England Highway in the vicinity of the subject site is tidal, with heavier southbound flows in the AM peak period.

There is expected to be some seasonal variation with increased traffic volumes on the New England Highway and other roads in proximity to the subject site during summer holiday periods. The Tamworth Country Music Festival is an annual event that is held in Tamworth in January. During this period it is expected that the traffic flows on the New England Highway will be significantly higher than the average daily traffic flows.

2.3.4 Vehicle Speeds

No vehicle speed measurements have been taken as part of the study. Observations on site would indicate that traffic appears to travel within the posted speed limits, with no obvious signs of excessive speed.

2.3.5 Existing Site Flows

The existing site flows associated with the typical operation of Chaffey Dam on the Tamworth Nundle Road and the other roads in the vicinity of the subject site are negligible as dams are not major trip generators.

The current activity associated with the dam is associated with its routine maintenance, which is in the order of 2 – 3 trips per day.

There is also some recreational activity associated with the dam, namely fishing, camping and boating activity.

The Bowling Alley Point Recreational Reserve Trust manages a campsite on the foreshore of the Chaffey Dam. Discussions with a trust member indicates that peak activity at the camp site occurs during school holiday periods. Additionally, the campsite is significantly busier on the weekends than during the week.

Accordingly, the peak activity associated with the recreational use of the dam does not coincide with road network peak hours.

2.3.6 Heavy Vehicle Flows

The surveys data indicates that 20% of the traffic on New England Highway and 12% of traffic on Lindsays Gap Road consisted of heavy goods vehicles.

For the traffic movements along the New England Highway, it can be seen that there is a reasonably high percentage of heavy goods vehicles, including B-doubles, associated with interstate movements of products. The New England Highway forms part of the State Highway and carries traffic between Queensland and New South Wales.

2.3.7 Current Road Network Operation

Observations on site show that there are little if any delays for through traffic movements along the New England Highway at its intersection with Lindsays Gap Road. Traffic entering or exiting the side road also experience little delay, with the majority of the delay only caused by drivers having to slow down and negotiate the intersection.

Table 2.1 reproduced below from Austroads Part 5 Intersections at Grade provides advice on intersection operation. Where these limits are not reached, traffic effectively does not suffer from any delay.

- *Table 2-1 Intersection Operation*

Major Road Type	Major Road Flow (vph)	Minor Road Flow (vph)
Two Lane	400	250
	500	200
	650	100
Four Lane	1,000	100
	1,500	50
	2,000	25

Source: Table 4.1 Austroads Part 5 Intersection at Grade

It can be seen that for the current traffic flows, the limits shown in Table 2-1 are not reached; therefore, capacity modelling is not required at the intersection of the New England Highway and Lindsays Gap Road nor the other intersections in proximity to the subject site.

Furthermore, the RTA Guide to Traffic Generating Developments (Table 4.5 - Peak Hour Flow on Two-Lane Rural Roads) indicates that the two-way capacity for rural roads with 10% heavy vehicle flows is 560 vehicles per hour.

Hence the traffic flows on Lindsays Gap Road and the other rural roads in the vicinity of the subject site operate within acceptable limits.

2.4 Traffic Safety and Accident History

The New England Highway in the vicinity of Lindsays Gap Road and Garoo Road provides a straight alignment, allowing good visibility for drivers in all directions. The overall width of the New England Highway has allowed for a sheltered right turn lane and left turn lane into Lindsays Gap Road, allowing through traffic movements to pass any vehicles waiting to turn left or right into the side road.

Similarly, the intersection of the New England Highway and Garoo Road has sheltered left turn and right turn lanes. Table 3.1 of the Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections identifies the safe Approach Site Distance (ASD) for trucks on intersection approaches. For roads with a design speed of 100km/hour the guide identifies minimum sight distances of 151m and desirable sight distances of 179m.

During the site visits, the sights distances at the following intersections were measured:

- New England Highway and Garoo Road;
- New England Highway and Lindsays Gap Road;
- Garoo Road and Lindsays Gap Road;
- Lindsays Gap Road and Tamworth-Nundle Road; and
- Tamworth-Nundle Road and River Road.

In each circumstance sight distances in excess of 200m were achieved, facilitating their safe operation.

■ *Photo 8 Left Turn Lane from the New England Highway to Lindsays Gap Road*

The RMS has provided accident data in the last five year at the following locations:

- The intersection of New England Highway and Lindsays Gap Road;
- The intersection of New England Highway and Garoo Road; and
- The intersection of New England Highway and Tamworth-Nundle Road (at Nemingah).

The data indicates that in 2009, two accidents were recorded at the intersection of the New England Highway and Lindsays Gap Road. Both these accidents involved vehicles driving off the road and hitting an object. No injuries were caused in either of these accidents.

Additionally, four accidents have been recorded at the intersection of the New England Highway and Tamworth-Nundle Road, two of which occurred in 2007 and two of which occurred in 2009. The types of accidents that occurred were as follows:

- A head on collision;
- A side swipe accident involving vehicles changing lanes;
- A rear end collision; and
- Two vehicles on adjacent approaches colliding.

No accidents, however, have occurred at either intersection in the last three years.

No accidents have been recorded at the intersection of New England Highway and Garoo Road.

The RMS traffic accident data is included in Appendix C.

2.5 Parking Supply and Demand

2.5.1 On-street Parking Provision

There is no on street parking in the vicinity of the subject site.

2.5.2 Off-Street Parking Provision

A scenic look out area providing approximately 40 parking bays is located adjacent to Chaffey Dam, with access to the parking area provided from the Tamworth-Nundle Road.

2.5.3 Parking Demand and Utilisation

There was no on-street parking noted in the general vicinity of the site. During site visits no vehicles were observed to park at the scenic lookout car park. Parking activity at the Chaffey Dam lookout is expected to be associated with recreational users of the dam and typically occur on the weekends.

2.5.4 Set Down or Pick Up Areas

There are no set down or pick up areas in the locality of the site.

2.6 Public Transport

In keeping with its remote location there are no public transport facilities in the vicinity of the subject site.

Peel Valley Coaches provide four school buses that utilise the Tamworth-Nundle Road as part of their route, these are:

- Tamworth to Woolomin;
- Tamworth to Dungowan;
- Tamworth to Ogunbil; and
- Tamworth to Nundle.

Each of these school bus routes operate once in the morning departing to Tamworth between 7:00am – 7:30am and arriving from Tamworth between 4:30pm – 5:00pm.

2.7 Other Proposed Developments

There are no other developments of significance in the general locality of the subject site.

3 Proposed Development

3.1 The Development

State Water Corporation is proposing to augment and upgrade Chaffey Dam. The existing dam wall is a 54 metre high, 430 metre long, clay cored rockfill embankment with a combined spillway and outlet works. The dam currently has a reservoir storage capacity of 62 GL and a maximum depth of 30m.

The proposed upgrade and augmentation of Chaffey Dam will increase its capacity to 100 GL and ensure it can withstand extreme flooding. Increasing the capacity will require the dam wall to be raised 8.4m and increase the full supply level (FSL) of the dam by 6.5m.

Construction of the Project comprises 4 key elements: raising the dam wall, raising the Morning Glory spillway, reconfiguration of the auxiliary spillway fuseplug and realignment of roads and bridges.

The 35m auxiliary spillway was recently constructed at Chaffey Dam in order to increase the capacity of the dam to discharge flood waters. The construction of the spillway was completed in 2011. It is proposed to modify the existing fuseplug at the auxiliary spill, in order that it can accommodate staged release of water volumes associated with a 1 in 10,000 and 1 in 20,000 year flood events.

The project also includes the raising of the Morning Glory spillway by 6.5m.

The increase in the water level associated with the augmentation project will result in the inundation of some of the roads and bridges in proximity to the dam. Therefore, the scope of works comprises some local road upgrades.

This includes the realignment of the Tamworth-Nundle Road and River Road intersection. This intersection will be raised and modified and vehicles on River Road will be required to give way to vehicles on the Tamworth-Nundle Road.

The current intersection of Tamworth-Nundle Road and River Road will be operational during the construction of this road upgrade. This existing intersection will be closed upon completion of the realignment, which will occur prior to the raising of the dam's FSL and the inundation of the surrounding area.

Approximately 3.2km of the Western Foreshore Road will also require raising and realignment. The alignment will shift the existing road approximately 20m to the west of its current location.

During the realignment some sections of the Western Foreshore Road will be closed to general traffic. However, access to the rural properties on the Western Foreshore Road will be maintained throughout the construction period.

3.1.1 Phasing and Timing

It is understood that the construction of the Chaffey Dam upgrade is expected to take two years, with four construction phases as follows:

- Week 1 to 12 – Construction documentation, approvals and site establishment (up to 20 personnel on site);
- Weeks 13 to 60 – Raising of the dam wall and the realignment of roads and bridges (up to 50 personnel on site);
- Weeks 61 to 90 – Raising of the spillway (up to 40 personnel on site); and
- 90 to 104 weeks -Commissioning and site disestablishment (to up to 20 personnel on site).

The majority of works will occur on site with details of the types and volumes of service vehicles expected for each of the project four key elements as provided by Worley Parsons in consultation with the State Water Corporation included in Appendix D.

3.1.2 Access and Circulation Requirements

During the construction phase the development will need to accommodate both light vehicles and heavy vehicles.

3.2 Access

3.2.1 Driveway Location

During the construction of the auxiliary spillway an unsealed road was constructed to the north-east of the dam from the Tamworth-Nundle Road to provide access to the construction site. It is proposed to utilise this road to provide access to the construction site for works associated with the proposed augmentation project. The location of the construction access road is displayed in Figure 3-1.

Source: Googlemaps

▪ *Figure 3-1 Location of Construction Access Road*

▪ *Photo 9 Access Road to the Proposed Construction Site*

3.2.2 Service Vehicle Access

A large variety of heavy goods vehicles will be utilised during the construction phases of the augmentation of Chaffey Dam, including:

- Mobile cranes;
- Dump trucks;
- Flatbed trucks;
- Excavators;
- Compactors; and
- Semitrailers.

Access to service vehicles will be along the New England Highway, Lindsays Gap Road and along a short length of the Tamworth-Nundle Road to access point to the north of Chaffey Dam, as described in section 3.2.

3.2.3 Access to Public Transport

There will be no need for public transport to access the site.

3.3 Circulation

3.3.1 Pattern of Circulation

The design of the construction site will allow for all vehicles to enter the site, manoeuvre internally and exit the site in a forward direction.

3.3.2 Road Width

The width of the access road will be in accordance with Tamworth Regional Council and Australian Standard specifications.

3.3.3 Internal Bus Movements

It is considered that there will be no internal bus movements as there is no requirement for a bus to travel within the development site.

3.3.4 Service Area Layout

The internal service vehicle loading areas will be specified in the detailed design process for the construction phase of the proposed augmentation of the dam. They will be designed in accordance with Australian Standard and Council specifications in order to accommodate the largest service vehicle expected to access/egress the site during the construction phases.

As part of the detailed design process for the project, a Construction Traffic Management Plan will be required.

3.4 Parking

3.4.1 Proposed Supply

During the construction phase of the Chaffey Dam augmentation all parking will be contained within the construction site. Parking will be provided on "at grade" designated unsealed areas and will be designed to accommodate the volumes of cars utilised by personnel during the construction phase of the project.

Parking for up to 25 light vehicles will be required on site.

3.4.2 Parking Layout

The site layout will allow for the safe parking of vehicles within the construction site.

3.4.3 Service Vehicle Parking

The construction site will provide designated stand over areas for trucks waiting to deliver or collect their loads.

3.4.4 Pedestrian and Bicycle Facilities

There are no specific bicycle facilities proposed on site during the construction phase of the project. Internal paths will be designated on the construction site to ensure the safe pedestrian movement of onsite personnel.

3.5 Construction Traffic Management Plan

As stated in Section 3.3.4 as part of the detailed design process for the proposed augmentation and upgrade of the Chaffey Dam, a Construction Traffic Management Plan will be required.

The overall principles of construction traffic management are as follows:

- minimise effects on pedestrian movements and amenity;
- manage and control vehicular movements to and from the site;
- maintain traffic capacity at intersections and mid-block in the vicinity of the site;
- restrict vehicle activity to designated truck routes through the area;
- maintain safety for workers;
- provide appropriate access to the site for excavation and construction traffic; and
- manage and control vehicle activity in the vicinity of the site.

The Construction Traffic Management Plan will identify key mechanisms during the construction phase of the project by which the safety of workers and the general public will be maintained, both on site and on the adjoining road network.

It is recommended that as part of the Construction Traffic Management Plan, that the prescribed route for service vehicles to and from the subject site include the New England Highway and Lindsays Gap Road. These roads (as described in Section 4.2) are designated by the RMS as being capable of accommodating vehicles up to the size of a 26m B-double truck.

The Tamworth-Nundle Road is significantly more constrained with a narrower road reserve than the New England Highway and site observations indicate that the quality of the Tamworth-Nundle Road is variable with some sections having been recently sealed and other sections with uneven surfaces and patched pot holes.

Accordingly, it is recommended that the use of Tamworth-Nundle Road for service vehicles accessing the site from Tamworth be restricted to its connection between the site access and Lindsays Gap Road. Additionally, it is noted that as school buses utilise the Tamworth-Nundle Road as part of their route, this will minimise the potential interaction of school buses and service vehicles.

The design and operation of the construction site will be specified in the Construction Traffic Management Plan, which will require concurrence and approval from Tamworth Council. As the proposed development is "State Significant Infrastructure", the provisions of Section 115ZU of the *Environmental Planning and Assessment Act, 1979*, provide guidelines relating to appeals and approvals.

4 Transportation Analysis

4.1 Traffic Generation

The trip generation for the proposed augmentation program has been undertaken on a first principle basis accounting for the movement of service vehicles and personnel during the construction phase of the project.

The maximum volume of 50 personnel on site will occur during the raising of the dam wall, realignment of the roads and bridges and the reconfiguration of the fuseplug of the auxiliary spillway. The working hours of the personnel will be documented in the Environmental Impact Statement for the project and will consider the Environment Protection Authority and Council guidelines. It is expected that work will be undertaken on site Monday to Saturday and the typical period of work will be Monday to Friday 7:00am to 6:00pm, Saturday 8:00am to 1:00pm and no work on Sundays or public holidays.

The study team has indicated that onsite personnel are likely to be based in Tamworth. Consequently, there will be significant opportunities for shared trips for construction workers.

For the purpose of analysis it has been assumed that there will be vehicle occupancy of two during the construction phases of the augmentation of Chaffey Dam. Hence, during the periods of maximum activity associated with the raising of the dam wall, 25 light vehicle trips will be generated in the morning and evening peak hour associated with the movement of workers.

It is expected that the movement of on-site personnel to the site will predominantly consist of an inbound trip in the morning and an outbound trip in the evening.

The volumes of delivery vehicles required on site will fluctuate over the different phases of construction. At the start of each construction phase trucks will mobilise, and demobilise at the end of each construction phase. All movements between mobilisation and demobilisation will be internal to the site.

It is noted that there will likely be a requirement for a concrete batching plant on site as part of construction activities for the Project. The concrete batching plant has been excluded from this assessment as responsibility for any relevant approvals and licensing of the concrete batching plant will lie with the Construction Contractor. As a worst case scenario, therefore, traffic generation has been based on the need to deliver concrete by trucks from the supplier external to the site.

The maximum number of delivery vehicles on site is expected to occur during concrete pours associated with the raising of the Morning Glory spillway. During this phase, approximately 2,500m^3 of concrete will be required and the onsite concrete pump will have a capacity of 80m^3 per hour. Large concrete trucks with a capacity of approximately 7m^3 would most likely deliver to the site with the number of trips limited by the capacity of the concrete pump with limited waiting time desired on-site.

The capacity of the pump of 80m^3 allows for a maximum of 11 large concrete trucks to be emptied in one hour. This gives a two-way flow of 22 concrete trucks per hour between the concrete supplier and the site. These movements could occur over the full working day, so to complete a concrete pour of 2,500m^3 at this rate would only involve 4 days of 8 hours.

It is noted that there is a hard rock stockpile from the auxiliary spillway construction that will be utilised in the raising of the dam wall. During this period twelve 45 tonne articulated dump trucks are expected to arrive at the start of the work phase and depart at the end of the phase. During the working day all movements of these vehicles will be internal to the site.

Other service vehicles used during this phase such as excavators, cranes and compactors will remain on site during construction, and will not access and egress the site on a daily basis. Thus their impact on the adjoining road network will be minimal.

During other phases of construction relating to the work on the spillways and the realignment of roads which do not require the bulk movement of clay and rock fill, the impact of the heavy goods vehicles on the adjoining road network will be significantly reduced.

A summary of the anticipated maximum traffic generation is shown below in Table 4-1.

■ *Table 4-1 Daily Light and Heavy Traffic Generation by Construction Phase*

Phase	Light vehicle movements*	Maximum movement of delivery vehicles per hour
Phase 1 - Construction documentation, approvals and establishment - up to 20 personnel on site	10 inbound in AM peak and 10 outbound in PM peak	Less than 10
Phase 2 - Raising of dam wall, realignment of roads and bridges and reconfiguration of auxiliary spillway - up to 50 personnel on site	25 inbound in AM peak and 25 outbound in PM peak	
Phase 3 -Raising of morning glory spillway - up to 40 personnel on site	20 inbound in AM peak and 20 outbound in PM peak	11 concrete trucks per hour
Phase 4 -Commissioning and site disestablishment -up to 20 personnel on site	10 inbound in AM peak and 10 outbound in PM peak	Less than 10

** Assumes car occupancy of 2 workers per vehicle*

Therefore, the largest impact on the adjoining road network during the construction phases of the augmentation of the Chaffey Dam is expected to entail:

- The movement of 25 light vehicles for onsite personnel which will occur in the AM and PM peak hour during the raising of the dam wall; and
- The movement of a maximum number of 22 concrete trucks movements to and from the site per hour during the raising of the Morning Glory spillway (Phase 3). This assumes a worst case scenario of concrete being supplied external to the site.

Accordingly, the trips generated by the construction phase of the proposed augmentation of Chaffey Dam are minimal; in the case of the concrete pours only for a very short, concentrated period, and in all will have an acceptable impact upon the adjoining road network.

The proposed augmentation is expected to generate two oversized vehicle trips as follows:

- The delivery of a precast component of the spillway; and
- The delivery of a barge crane to the subject site.

Both of these will consist of a single inbound and outbound movement to/from the subject site.

The RTA Guide "Operating Conditions: Specific permits for oversize and overmass vehicles and loads RTA 2007" specifies that an oversize permit is required when:

- the height, width or length of an oversize vehicle (including any load) exceeds any of the maximum dimension limits specified in the General Class 1 Oversize Notice (see Tables 2, 3 and 4 of the RTA Guide); or
- travel by a vehicle operating under the General Class 1 Oversize Notice is
  - proposed on a restricted road.
  - If an oversize permit is required, it must be carried in the vehicle at all times, in
  - addition to these Operating Conditions and the General Class 1 Oversize Notice.

and specifies the criteria and operating conditions for the permit.

An oversize vehicle permit will be obtained pursuant to these guidelines.

4.1.1 Daily and Seasonal Factors

The construction phase of the augmentation of Chaffey Dam will lead to typical morning and evening peak hour traffic generation associated with the movement of onsite personnel.

At the start of each construction phase trucks will mobilise, and demobilise at the end of each construction phase. All movements between mobilisation and demobilisation will be internal to the site.

During the raising of the Morning Glory spillway, it is expected that the movement of up to 22 concrete trucks to and from the site could occur over the full working day for a period of 4 days.

On-site activity is expected to be unaffected by seasonal variations.

4.1.2 Sight Distances from Access Road

In the vicinity of Chaffey Dam the Tamworth-Nundle Road provides a constant curve alignment, ensuring good visibility for all drivers entering and exiting the construction site.

For the indicative speed limit of 100 km/h, the required visibility splay is 139 metres (source: AS2890.2). The visibility at the construction access road has been checked on site and it exceeds 150 metres in both directions.

■ *Photo 10 Sight Distances to the South of the Construction Access Road*

■ *Photo 11Sight Distances to the North of the Construction Access Road*

4.1.3 Queuing at Entrance to Site

Given the expected low traffic flows associated with the construction of the proposed development, it is considered that there will be no queues at the construction site access road.

4.1.4 Comparison with Existing Site Access

Access to the development's construction site is provided via an unsealed road that intersects the Tamworth-Nundle Road at a priority controlled intersection. This road was constructed for works associated with the auxiliary spillway and is not currently in use. However, it will be utilised during the construction phases of the proposed augmentation project.

4.1.5 Pedestrian Movements

In keeping with the remote location of the subject site it is considered that there will be little if any pedestrian demand to and from the subject site during the construction phase of the development.

4.2 Traffic Distribution and Assignments

4.2.1 Origin / Destinations Assignment

The study team has indicated that the majority of personnel associated with the construction are likely to be based in Tamworth and accordingly will access and egress the construction site to/from the north. In this respect both the New England Highway and the Tamworth-Nundle Road can be utilised as the north/south route to access and egress the construction site.

With regards to construction vehicles, the New England Highway would be considered the preferred route. It is the major arterial road in the region and it is heavily used as regional route by heavy goods vehicles. Peak hour surveys indicate that currently heavy goods vehicles constitute 20% of the total traffic volumes utilising the New England Highway. Unlike the Tamworth-Nundle and Garoo Roads, both the New England Highway and Lindsays Gap Road are designated by the Roads and Maritime Services (RMS) as being part of a restricted access vehicle route, capable of accommodating vehicles up to the size of a 26m B-double truck.

As described in Section 3.5, it is recommended as part of the construction management plan, that the prescribed route for service vehicles to and from the subject site include the New England Highway and Lindsays Gap Road.

During the raising of Morning Glory spillway the impact of supply of pre-mixed concrete, prepared in Tamworth, has been assessed. Tamworth contains a number of large concrete producers such as Boral. The recommended route along the New England Highway would be suitable for these movements.

4.3 Modal Split

Based upon the remote location of the subject site and the lack of regular public transport it is expected that all the trips generated by the proposed augmentation of Chaffey Dam will be via private light and heavy vehicles.

4.4 Impact of Generated Construction Traffic

4.4.1 Impact on Daily Traffic Flows

RTA Guide to Traffic Generating Developments (Table 4.5 Peak Hour Flow on Two-Lane Rural Roads) indicates that the two-way capacity for rural roads with 10% heavy vehicle flows is 560 vehicles per hour.

In accordance with the low existing traffic volumes on Lindsays Gap Road, Garoo Road and the Tamworth-Nundle Road the impact of the low vehicle trips generated throughout the construction phase of the proposed augmentation of Chaffey Dam will be acceptable. This includes the impact upon the recreational users of Chaffey Dam which is primarily during holiday and weekend periods as well as on the increased traffic volumes associated with the Tamworth Music Festival during January.

The most significant impact will be during periods of concrete provisioning which may be completed over two 4-5 day periods based on the capacity of the concrete pumps on site.

All works on site will be governed by the relevant legislative requirements, including any conditions of consent for the State Significant Infrastructure project.

4.4.2 Peak Hour Impacts on Intersections

The largest impact on the adjoining road network during the construction phases of the augmentation of the Chaffey Dam will entail;

- Phase 2 - The movement of 25 light vehicles for onsite personnel which will occur in the AM and PM peak hour during the raising of the dam wall; as well as, 12 dump trucks arriving at the commencement of this phase of construction and departing at the end of this phase of work;
- Phase 3 - The movement of 20 light vehicles for onsite personnel which will occur in the AM and PM peak hour during the spillway. The movement of a maximum number of 22 concrete trucks per hour between the site and the concrete supplier and the movement of concrete trucks during the raising of the Morning Glory spillway; which could occur over a full working day for a concentrated 4 day period.

The volume of these construction trips in the context of the road network volumes identified in the surveys of 15th May 2012 indicate that during construction phases the Austroads limits (See Figure 2-3) will not be met and therefore, capacity modelling will not be required on the New England Highway or other roads in proximity to the subject site.

Therefore, the trips generated during the construction phase are expected to be acceptable and the key intersections associated with the development are expected to continue to operate with good levels of service.

4.4.3 Impact of Operational Traffic

The operation of the Chaffey Dam currently generates in the order of 2 and 3 trips per day. The augmentation of the dam, once complete will not impact on this. Dams in their own right are not significant traffic generators and as there are no proposed changes to the existing tourist facilities within the site there is no reason to anticipate an impact of Operational Traffic in the future.

4.5 Impact on Road Safety

The additional traffic flows associated with the construction phase of the proposed works will have a minimal impact upon traffic safety.

For the key intersection of the construction site access road and the Tamworth-Nundle Road the sight lines are very good allowing for good visibility for traffic turning both into and out of the access road.

It is considered that the intersections in the vicinity of the study area, namely:

- New England Highway and Lindsays Gap Road
- New England Highway and Garoo Road and
- New England Highway and Tamworth-Nundle Road

will be able to operate in a safe and acceptable manner with the traffic associated with the proposed development.

Additionally no accidents have occurred at theses intersections in the previous 3 years.

At the intersection of New England Highway with the Tamworth-Nundle Road, Garoo Road and Lindsays Gap right and left turn storage lanes are provided. The provision of these turning lanes improves safety by allowing the physical separation of turning vehicles and through vehicles.

4.6 Parking Analysis

Adequate parking will be provided on the Chaffey Dam construction site to accommodate light and heavy vehicles. During peak periods of construction activity parking will be provided for up to 25 light vehicles utilised by on-site personnel.

4.7 Public Transport

No demand for public transport will be generated during the construction phase of the proposed development.

The existing school bus operation does not coincide with the road network peak hour and consequently, the movement of onsite personnel to and from the subject site.

As it is recommended that the heavy service vehicles utilise the New England Highway to access and egress the Chaffey Dam construction site, while the school bus service currently utilises the Tamworth-Nundle Road the movement of heavy vehicles is not expected to have any detrimental on the public transport facilities in the vicinity of the subject site.

4.8 Pedestrian and Cyclists

There are no specific bicycle facilities proposed on site during the construction phase of the project. Internal paths will be designated on the construction site to ensure the safe pedestrian movement of onsite personnel.

5 Improvement Analysis

5.1 Improvements to Accommodate Existing Traffic

It is considered no improvements are required to accommodate the existing traffic.

5.2 Additional Improvements to Accommodate Development Traffic

No other external road works are required to accommodate the construction trips generated by the proposed development. Proposed changes to the road network are designed to facilitate changes to the Dam layout rather than accommodate traffic impacts.

5.3 Alternative Improvements

It is considered that the proposed works will not have any impact on the rural areas or small towns such as Nundle in the general locality of the subject site.

5.4 Evaluation

It is considered that no mitigation measures are required to accommodate the trips generated by the construction phase of the proposed augmentation of Chaffey Dam.

The increase in the water level associated with augmentation project will result in the inundation of some of the roads and bridges in proximity to the dam. Consequently, the scope of works comprises some local road upgrades.

This includes the realignment of the Tamworth-Nundle Road and River Road intersection. This intersection will be raised and modified with vehicles on River Road required to give way to vehicles on the Tamworth-Nundle Road. This road and intersection upgrade will be designed and constructed in accordance with current road standards. The change in priority at the intersection will not have an adverse impact upon road safety in the location.

The current intersection of Tamworth-Nundle Road and River Road will be operational during the construction of this road upgrade.

It is noted that as part of the detailed design process of the project, a Construction Traffic Management Plan will be required.

6 Summary and Recommendations

6.1 Summary

The following conclusions are drawn from the investigations into the construction phases of the proposed augmentation of Chaffey Dam:

1. The proposed development consists of increasing the current capacity of Chaffey Dam from 62 GL to 100 GL. This necessitates the raising of the dam wall by an additional 8.4m.
2. The subject site is located on the Peel River in Woolomin, south of Tamworth. The study area has frontage to the Tamworth-Nundle Road, which intersects the New England Highway south east of Tamworth at Nemingha. The Tamworth-Nundle Road can also be accessed from Garoo Road and Lindsays Gap Road both of which intersect the New England Highway to the west of the subject site south of Tamworth.
3. As part of the development, peak hour traffic survey data has been collected at the intersection of the New England Highway and Lindsays Gap Road. The traffic volumes identified in the surveys are minimal and capacity modelling is not required at the intersections on the New England Highway or the other roads in proximity to the subject site including Lindsays Gap Road, Garoo Road and Tamworth-Nundle Road.
4. The construction of the Chaffey Dam upgrades is expected to take 2 years, with 4 construction phases as follows:
   - Week 1 to 12 – Construction documentation, approvals and site establishment (up to 20 personnel on site);
   - Weeks 13 to 60 – Raising of the dam wall and the realignment of roads and bridges (up to 50 personnel on site);
   - Weeks 61 to 90 – Raising of the spillway (up to 40 personnel on site); and
   - Weeks 90 to 104 - Commissioning and site disestablishment (up to 20 personnel on site).
5. The volumes of delivery vehicles required on site will fluctuate over the different phases of construction. At the start of each construction phase trucks will mobilise, and demobilise at the end of each construction phase. All movements between mobilisation and demobilisation will be internal to the site.
6. The largest impact on the adjoining road network during the construction phases of the augmentation of the Chaffey Dam will entail;
   - The movement of 25 light vehicles for onsite personnel which will occur in the AM and PM peak hour during the raising of the dam wall with 20 light vehicles expected for onsite personnel during the raising of the Morning Glory spillway (Phase 3)
   - During the raising of the Morning Glory spillway there will be a maximum number of 22 concrete trucks per hour between the site and the concrete supplier, which could occur over the course of a full working day for a period of 4days.
7. The trips generated by the construction phase of the proposed augmentation of the dam are minimal with the most intense periods being for very short lengths of time and will have an acceptable impact upon the adjoining road network.
8. It is expected that the majority of staff and service vehicles will access and egress the development to/from Tamworth to the north via the New England Highway as opposed to the Tamworth-Nundle Road at Nemingha. During the construction phases associated with raising the dam wall and the spillway the majority of heavy goods vehicles are also expected to access and egress the construction subject site via the New England Highway and Lindsays Gap Road.
9. All parking will be accommodated within the proposed site.
10. Once completed the operational traffic associated with Chaffey Dam will continue at its current level.

6.2 Recommendations

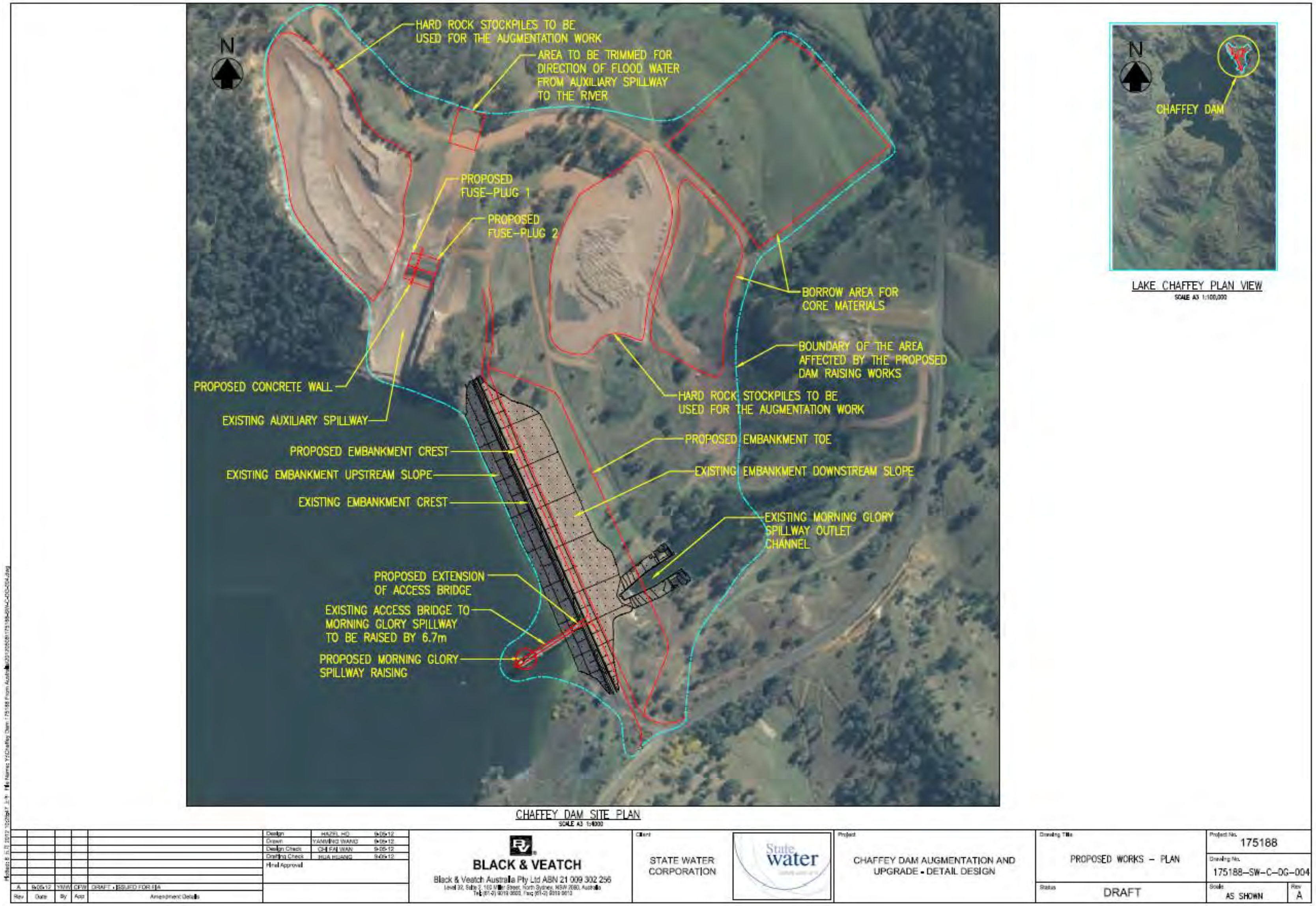
It is recommend that a Construction Traffic Management Plan be prepared for the construction works associated with the proposed augmentation and safety upgrade of Chaffey Dam.

It is recommended that as part of the construction management plan, a prescribed route for service vehicles to and from the subject site include the New England Highway and Lindsays Gap Road.

It is recommended that the use of Tamworth-Nundle Road for service vehicles accessing the site from Tamworth be prohibited. Additionally, it is noted that as school buses utilise the Tamworth-Nundle Road as part of their route, this will minimise the interaction of school buses and service vehicles.

The overall conclusion from the investigations is that traffic arrangements for the construction phase of the development proposal are satisfactory and that there is no traffic or parking impediments to the development.

Appendix A. Proposed Development Layout

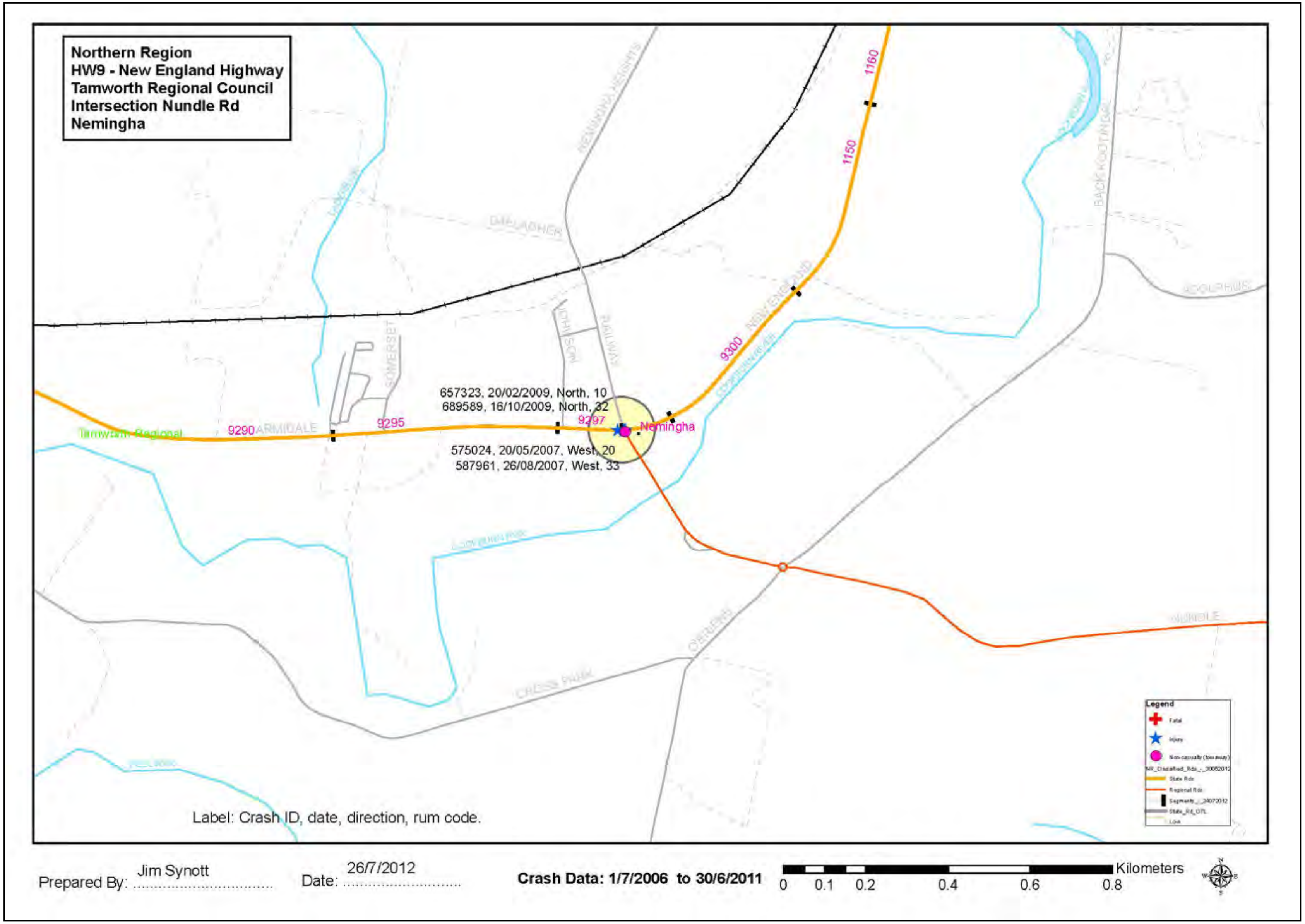


Appendix B. Road Classification

<table>
<tr><th>Road Class</th><th>Role</th><th>Existing/New</th><th>Traffic Management Guidelines</th></tr>
<tr><td>Freeways/ Motorways</td><td>▪ Freeways/Motorways are a particular form of arterial road in a hierarchical sense, but are considered separately in Part 4 of the Guide because of their distinctive operating characteristics.
▪ Provide for major regional and inter-regional traffic movement in a safe and operationally efficient manner.
▪ The prime traffic movement function dominates entirely and full access control ensures there are no competing access issues.</td><td>Existing And New</td><td>▪ Freeways and motorways do not have direct access to abutting land. There is thus effectively no access function and traffic management is directed entirely at the traffic movement function and associated aspects of capacity, congestion and speed.</td></tr>
<tr><td rowspan="2">Arterial Roads</td><td rowspan="2">▪ Provide for major regional and inter-regional traffic movement in a safe and operationally efficient manner.
▪ Commercial or industrial access requirements or local public transport priorities may need to be given significant weight in developing suitable traffic management strategies.</td><td>Existing</td><td>▪ Aim to obtain a balance between providing for traffic and providing for activities which occur, or are desired to occur, beside and across the road. The balance will generally favour traffic movement rather than the abutting access function with a focus on capacity and congestion management.
▪ Obtaining this balance will involve negotiations with affected parties including councils.</td></tr>
<tr><td>New</td><td>▪ Planning and design of new arterial roads (other than freeways and motorways) need not necessarily seek to entirely eliminate access to abutting land. However, it is desirable to have substantial control of access for these roads.
▪ Opportunity to plan for the desired balance between traffic and other activities beside and across the road. The planning of that 'balance' should consider:
– Type of land use allowed to locate beside the road
– Interactions between land uses on either side of the road
– Degree of access control for the arterial road, recognising that design and traffic management objectives on arterial roads should be biased towards the needs of through traffic.
▪ Coordinate the planning and design of new arterial roads with the land use development and amending of town planning schemes.
▪ Encourage roadside developments and access arrangements that are compatible with arterial road traffic conditions</td></tr>
</table>

Distributor/ Collector Roads	▪ Streets which do not easily fall into either the arterial or the local road category. ▪ Distribute traffic and bus services within the main residential, commercial and industrial built-up areas and link traffic on local roads to the arterial road network. ▪ may be streets which have been designed as local streets, but which have additional traffic functions, usually serving major traffic generators or providing for some non-local traffic movements. ▪ problems often arise with intermediate streets, as their design usually promotes the traffic movement function, while the residents and sometimes the local council, consider the street to be a local street with emphasis on the need for low traffic speed and restricted width ▪ Alternatively, in newer growth areas they may sometimes be under-designed in response to a desired emphasis on local road functions, resulting in operational and safety problems for the higher traffic volume that must use them.	Existing	▪ Traffic management principles are less well-defined than for arterial roads and local streets. ▪ As a consequence actions which result in the traffic function or roadside factors dominating the road environment will not normally be able to be implemented. ▪ Traffic management will normally be aimed at managing relatively high levels of conflict between: – Traffic movement activities generated by abutting land use – The desire of residents for local street functions to dominate, with severe restrictions on traffic speed and the width allocated to traffic movement. ▪ The extent of these conflicting demands may vary considerably throughout the day and a balance needs to be made to achieve traffic operations acceptable to the needs of both motorists and abutting residents.
		New	▪ In new street and road networks, the length of intermediate street classed as distributor/ collector should be minimised as far as possible. ▪ Where these streets are included, they should have complementary abutting land uses which generate a low degree of non-motorised traffic demands or incorporate a degree of access control, or include appropriate treatments to reduce traffic speed and other adverse impacts.
Local Roads and Streets	▪ May serve several functions to a greater or lesser degree. Some of the functions are at least partially incompatible. Typical functions include: – providing vehicular access to abutting property – providing vehicular access to other properties within a local area – providing access for emergency and service vehicles – providing a network for the movement of pedestrians and cyclists – providing a means to enable social interaction within a neighbourhood, e.g. serving as a play area or community open space – contributing visually to the "living" environment. ▪ The extent of each of these functions will vary within a local street network. For example, a street which provides access to several other streets, will have a more prominent vehicle movement role than a small cul-de-sac.	Existing And New	▪ Convey to motorists the impression that they are operating in a space or area which has not been designed soley for motor traffic. ▪ In many instances with residential streets, this desirably requires the road reservation to be constructed in such as way as to eliminate cleer, visual impressions of separate vehicle and pedestrian space. ▪ Detailed guidance can be found in *Part 8:Local Area Traffic Management*

Appendix C. Accident Data



BETTER TRANSPORT FUTURES

Transport
Centre for Road Safety

Summary Crash Report

# Crash Type		
Car Crash	3	75.0%
Light Truck Crash	2	50.0%
Rigid Truck Crash	0	0.0%
Articulated Truck Crash	0	0.0%
'Heavy Truck Crash	(0)	(0.0%)
Bus Crash	0	0.0%
"Heavy Vehicle Crash	(0)	(0.0%)
Emergency Vehicle Crash	0	0.0%
Motorcycle Crash	0	0.0%
Pedal Cycle Crash	1	25.0%
Pedestrian Crash	0	0.0%

' Rigid or Artic. Truck " Heavy Truck or Heavy Bus
These categories are NOT mutually exclusive

Location Type		
*Intersection	3	75.0%
Non intersection	1	25.0%

* Up to 10 metres from an intersection
~ 07:30-09:30 or 14:30-17:00 on school days

Collision Type		
Single Vehicle	0	0.0%
Multi Vehicle	4	100.0%

Road Classification		
Freeway/Motorway	0	0.0%
State Highway	4	100.0%
Other Classified Road	0	0.0%
Unclassified Road	0	0.0%

Contributing Factors		
Speeding	0	0.0%
Fatigue	0	0.0%
Alcohol	0	0.0%

Weather		
Fine	4	100.0%
Rain	0	0.0%
Overcast	0	0.0%
Fog or mist	0	0.0%
Other	0	0.0%

Road Surface Condition		
Wet	0	0.0%
Dry	4	100.0%
Snow or ice	0	0.0%

Natural Lighting		
Dawn	0	0.0%
Daylight	4	100.0%
Dusk	0	0.0%
Darkness	0	0.0%

Crash Movement		
Intersection, adjacent approaches	1	25.0%
Head-on (not overtaking)	1	25.0%
Opposing vehicles; turning	0	0.0%
U-turn	0	0.0%
Rear-end	1	25.0%
Lane change	1	25.0%
Parallel lanes; turning	0	0.0%
Vehicle leaving driveway	0	0.0%
Overtaking; same direction	0	0.0%
Hit parked vehicle	0	0.0%
Hit railway train	0	0.0%
Hit pedestrian	0	0.0%
Permanent obstruction on road	0	0.0%
Hit animal	0	0.0%
Off road, on straight	0	0.0%
Off road on straight, hit object	0	0.0%
Out of control on straight	0	0.0%
Off road, on curve	0	0.0%
Off road on curve, hit object	0	0.0%
Out of control on curve	0	0.0%
Other crash type	0	0.0%

Speed Limit					
			~ 40km/h or less	0	0.0%
40 km/h or less	0	0.0%	80 km/h zone	1	25.0%
50 km/h zone	0	0.0%	90 km/h zone	0	0.0%
60 km/h zone	3	75.0%	100 km/h zone	0	0.0%
70 km/h zone	0	0.0%	110 km/h zone	0	0.0%

CRASHES		4
Fatal crash	0	0.0%
Injury crash	3	75.0%
Non-casualty crash	1	25.0%

CASUALTIES		3
Killed	0	0.0%
Injured	3	100.0%
^ Unrestrained	1	33.3%

^ Belt fitted but not worn, No restraint fitted to position OR No helmet worn

Time Group			% of Day
00:01 - 02:59	0	0.0%	12.5%
03:00 - 04:59	0	0.0%	8.3%
05:00 - 05:59	0	0.0%	4.2%
06:00 - 06:59	0	0.0%	4.2%
07:00 - 07:59	0	0.0%	4.2%
08:00 - 08:59	0	0.0%	4.2%
09:00 - 09:59	0	0.0%	4.2%
10:00 - 10:59	1	25.0%	4.2%
11:00 - 11:59	1	25.0%	4.2%
12:00 - 12:59	0	0.0%	4.2%
13:00 - 13:59	1	25.0%	4.2%
14:00 - 14:59	1	25.0%	4.2%
15:00 - 15:59	0	0.0%	4.2%
16:00 - 16:59	0	0.0%	4.2%
17:00 - 17:59	0	0.0%	4.2%
18:00 - 18:59	0	0.0%	4.2%
19:00 - 19:59	0	0.0%	4.2%
20:00 - 21:59	0	0.0%	8.3%
22:00 - 24:00	0	0.0%	8.3%

Street Lighting Off/Nil		% of Dark	
0	of	0 in Dark	0.0%

Crashes		Casualties
2	2009	1
2	2007	2

~ School Travel Time		
Involvement	0	0.0%

McLean Periods			% Week
A	0	0.0%	17.9%
B	0	0.0%	7.1%
C	2	50.0%	17.9%
D	0	0.0%	3.5%
E	2	50.0%	3.6%
F	0	0.0%	10.7%
G	0	0.0%	7.1%
H	0	0.0%	7.1%
I	0	0.0%	12.5%
J	0	0.0%	10.7%

Day of the Week								
Monday	0	0.0%	Thursday	0	0.0%	Sunday	2	50.0%
Tuesday	0	0.0%	Friday	2	50.0%	WEEKDAY	2	50.0%
Wednesday	0	0.0%	Saturday	0	0.0%	WEEKEND	2	50.0%

# Holiday Periods								
New Year	0	0.0%	Queen's BD	0	0.0%	Easter SH	0	0.0%
Aust. Day	0	0.0%	Labour Day	0	0.0%	June/July SH	0	0.0%
Easter	0	0.0%	Christmas	0	0.0%	Sept./Oct. SH	1	25.0%
Anzac Day	0	0.0%	January SH	0	0.0%	December SH	0	0.0%

Crashid dataset HW9 - Nundle Rd, Nemingha   Crash Data 1/1/2007 to 31/12/2011

Note: Data for the 9 month period prior to the generated date of this report are incomplete and are subject to change.

Percentages are percentages of all crashes. Unknown values for each category are not shown on this report.

Rep ID: REG01 **Office:** Grafton **User ID:** synottj   Page 1 of 1   Generated: 26/07/2012 09:07

Detailed Crash Report

Transport Centre for Road Safety

Crash No.	Date	Day of Week	Time	Distance	ID Feature	Loc Type	Alignment	Weather	Surface Condition	Speed Limit	No. of Tus	Tu Type/Obj	Age/Sex	Street Travelling	Speed Travelling	Manoeuvre	Degree of Crash	Killed	Injured	Factors SF
Northern Region																				
Tamworth City LGA																				
Nemingha																				
New England Hwy																				
657323	20/02/2009	Fri	14:16	at	NUNDLE RD	XJN	STR	Fine	Dry	80	2	CAR	M83	N in NUNDLE RD	Unk	Proceeding in lane	I	0	1	
E215091092						RUM:	10	Cross traffic				4WD	F57	W in NEW ENGLAND HWY	Unk	Proceeding in lane				
587961	26/08/2007	Sun	13:30	50 m W	NUNDLE RD	2WY	STR	Fine	Dry	60	2	OMV	U U	W in NEW ENGLAND HWY	Unk	Proceeding in lane	I	0	1	
E33014185						RUM:	33	Lane sideswipe				P/C	M13	W in NEW ENGLAND HWY		Proceeding in lane				
575024	20/05/2007	Sun	10:12	at	RAILWAY ST	XJN	CRV	Fine	Dry	60	2	TRK	F67	W in NEW ENGLAND HWY	40	Incorrect side	I	0	1	
E30713974						RUM:	20	Head on				UTE	M27	E in NEW ENGLAND HWY	0	Wait turn right				
Nundle Rd																				
689589	16/10/2009	Fri	11:00	5 m S	NEW ENGLAND HWY	XJN	STR	Fine	Dry	60	2	CAR	F25	N in NUNDLE RD	Unk	Proceeding in lane	N	0	0	
E39312163						RUM:	32	Right rear				TRK	M72	N in NUNDLE RD	0	Wait turn right				

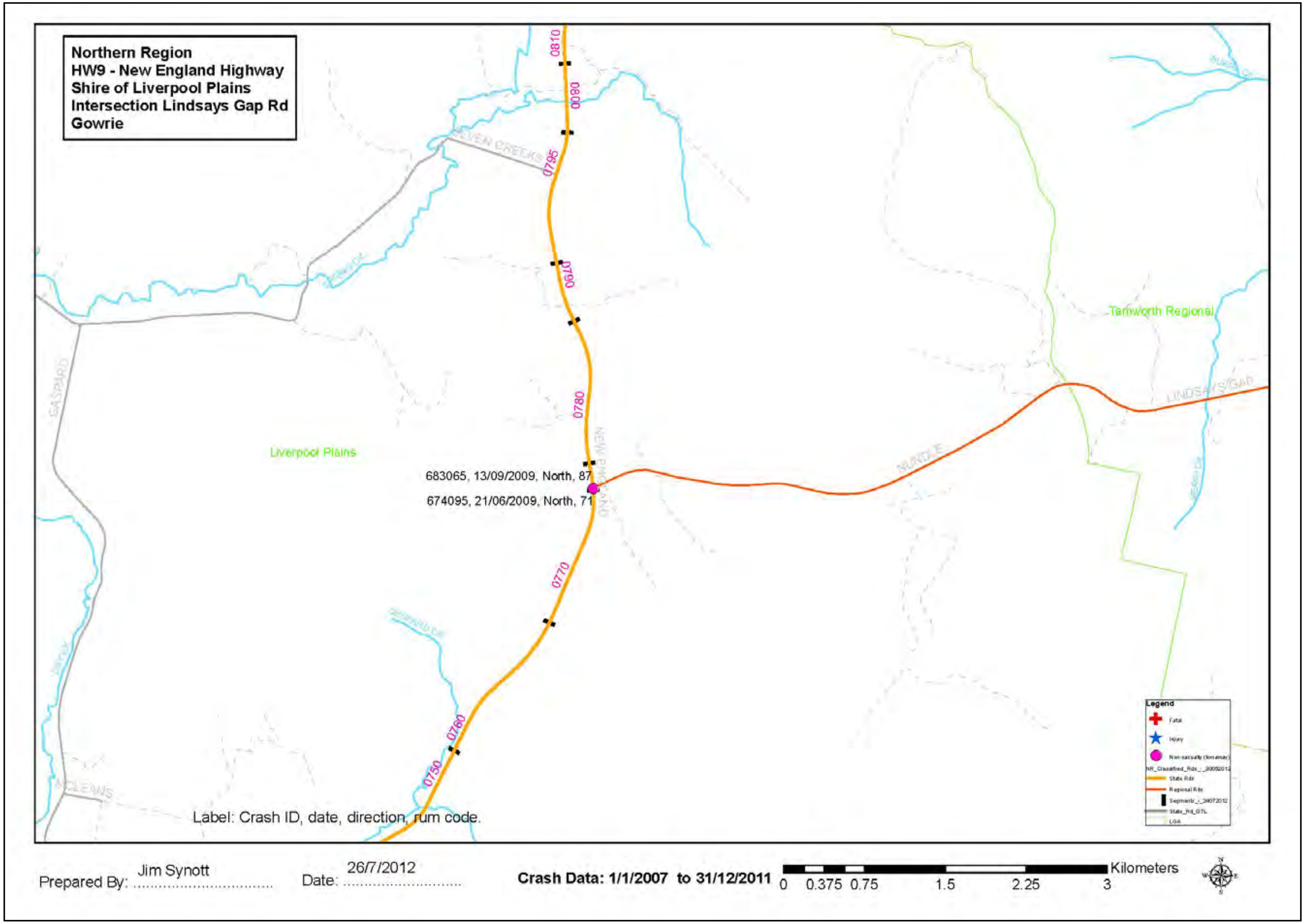
Report Totals: Total Crashes: 4 Fatal Crashes: 0 Injury Crashes: 3 Killed: 0 Injured: 3

Crashid dataset HW9 - Nundle Rd, Nemingha Crash Data 1/1/2007 to 31/12/2011

Note: Data for the 9 month period prior to the generated date of this report are incomplete and are subject to change.

Rep ID: DCR01 **Office:** Grafton **User ID:** synottj

Generated: 26/07/2012 09:07


Northern Region
HW9 - New England Highway
Shire of Liverpool Plains
Intersection Lindsays Gap Rd
Gowrie
0810
0800
0795
0790
0780
0770
0760
0750
SEVEN CREEKS
GASPARD
MCLEANS
NEW ENGLAND
NUNDLE
LINDSAYS GAP
Liverpool Plains
Tamworth Regional
683065, 13/09/2009, North, 87
674095, 21/06/2009, North, 71
Label: Crash ID, date, direction, rum code.
Legend
Prepared By: Jim Synott
Date: 26/7/2012
Crash Data: 1/1/2007 to 31/12/2011
0 0.375 0.75 1.5 2.25 3
Kilometers

Summary Crash Report

Transport Centre for Road Safety

# Crash Type		
Car Crash	2	100.0%
Light Truck Crash	0	0.0%
Rigid Truck Crash	0	0.0%
Articulated Truck Crash	0	0.0%
'Heavy Truck Crash	(0)	(0.0%)
Bus Crash	0	0.0%
"Heavy Vehicle Crash	(0)	(0.0%)
Emergency Vehicle Crash	0	0.0%
Motorcycle Crash	0	0.0%
Pedal Cycle Crash	0	0.0%
Pedestrian Crash	0	0.0%

' Rigid or Artic. Truck " Heavy Truck or Heavy Bus
These categories are NOT mutually exclusive

Location Type		
*Intersection	2	100.0%
Non intersection	0	0.0%

* Up to 10 metres from an intersection
~ 07:30-09:30 or 14:30-17:00 on school days

Collision Type		
Single Vehicle	2	100.0%
Multi Vehicle	0	0.0%

Road Classification		
Freeway/Motorway	0	0.0%
State Highway	2	100.0%
Other Classified Road	0	0.0%
Unclassified Road	0	0.0%

Contributing Factors		
Speeding	1	50.0%
Fatigue	0	0.0%

Weather		
Fine	1	50.0%
Rain	1	50.0%
Overcast	0	0.0%
Fog or mist	0	0.0%
Other	0	0.0%

Road Surface Condition		
Wet	1	50.0%
Dry	1	50.0%
Snow or ice	0	0.0%

Natural Lighting		
Dawn	0	0.0%
Daylight	1	50.0%
Dusk	0	0.0%
Darkness	1	50.0%

Crash Movement		
Intersection, adjacent approaches	0	0.0%
Head-on (not overtaking)	0	0.0%
Opposing vehicles; turning	0	0.0%
U-turn	0	0.0%
Rear-end	0	0.0%
Lane change	0	0.0%
Parallel lanes; turning	0	0.0%
Vehicle leaving driveway	0	0.0%
Overtaking; same direction	0	0.0%
Hit parked vehicle	0	0.0%
Hit railway train	0	0.0%
Hit pedestrian	0	0.0%
Permanent obstruction on road	0	0.0%
Hit animal	0	0.0%
Off road, on straight	0	0.0%
Off road on straight, hit object	1	50.0%
Out of control on straight	0	0.0%
Off road, on curve	0	0.0%
Off road on curve, hit object	1	50.0%
Out of control on curve	0	0.0%
Other crash type	0	0.0%

CRASHES	2	
Fatal crash	0	0.0%
Injury crash	0	0.0%
Non-casualty crash	2	100.0%

CASUALTIES	0	
Killed	0	0.0%
Injured	0	0.0%
^ Unrestrained	0	0.0%

^ Belt fitted but not worn, No restraint fitted to position OR No helmet worn

Time Group			% of Day
00:01 - 02:59	0	0.0%	12.5%
03:00 - 04:59	0	0.0%	8.3%
05:00 - 05:59	0	0.0%	4.2%
06:00 - 06:59	0	0.0%	4.2%
07:00 - 07:59	0	0.0%	4.2%
08:00 - 08:59	0	0.0%	4.2%
09:00 - 09:59	0	0.0%	4.2%
10:00 - 10:59	0	0.0%	4.2%
11:00 - 11:59	0	0.0%	4.2%
12:00 - 12:59	1	50.0%	4.2%
13:00 - 13:59	0	0.0%	4.2%
14:00 - 14:59	0	0.0%	4.2%
15:00 - 15:59	0	0.0%	4.2%
16:00 - 16:59	0	0.0%	4.2%
17:00 - 17:59	0	0.0%	4.2%
18:00 - 18:59	0	0.0%	4.2%
19:00 - 19:59	1	50.0%	4.2%
20:00 - 21:59	0	0.0%	8.3%
22:00 - 24:00	0	0.0%	8.3%

Crashes		Casualties
2	2009	0

~ School Travel Time		
Involvement	0	0.0%

McLean Periods			% Week
A	0	0.0%	17.9%
B	0	0.0%	7.1%
C	0	0.0%	17.9%
D	0	0.0%	3.5%
E	1	50.0%	3.6%
F	0	0.0%	10.7%
G	0	0.0%	7.1%
H	1	50.0%	7.1%
I	0	0.0%	12.5%
J	0	0.0%	10.7%

Speed Limit					
			~ 40km/h or less	0	0.0%
40 km/h or less	0	0.0%	80 km/h zone	0	0.0%
50 km/h zone	0	0.0%	90 km/h zone	0	0.0%
60 km/h zone	0	0.0%	100 km/h zone	2	100.0%
70 km/h zone	0	0.0%	110 km/h zone	0	0.0%

Street Lighting Off/Nil			% of Dark
1	of	1 in Dark	100.0%

Day of the Week								
Monday	0	0.0%	Thursday	0	0.0%	Sunday	2	100.0%
Tuesday	0	0.0%	Friday	0	0.0%	WEEKDAY	0	0.0%
Wednesday	0	0.0%	Saturday	0	0.0%	WEEKEND	2	100.0%

# Holiday Periods								
New Year	0	0.0%	Queen's BD	0	0.0%	Easter SH	0	0.0%
Aust. Day	0	0.0%	Labour Day	0	0.0%	June/July SH	0	0.0%
Easter	0	0.0%	Christmas	0	0.0%	Sept./Oct. SH	0	0.0%
Anzac Day	0	0.0%	January SH	0	0.0%	December SH	0	0.0%

Crashid dataset HW9 - Lindsays Gap Rd Crash Data 1/1/2007 to 31/12/2011

Note: Data for the 9 month period prior to the generated date of this report are incomplete and are subject to change.

Percentages are percentages of all crashes. Unknown values for each category are not shown on this report.

Rep ID: REG01 **Office:** Grafton **User ID:** synottj Page 1 of 1 Generated: 26/07/2012 09:19

BETTER TRANSPORT FUTURES

Detailed Crash Report

Transport for NSW Centre for Road Safety

Crash No.	Date	Day of Week	Time	Distance	ID Feature	Loc Type	Alignment	Weather	Surface Condition	Speed Limit	No. of Tus	Tu Type/Obj	Age/Sex	Street Travelling	Speed Travelling	Manoeuvre	Degree of Crash	Killed	Injured	Factors S F
Northern Region																				
Quirindi LGA																				
Wallabadah																				
New England Hwy																				
674095	21/06/2009	Sun	19:00	at	LINDSAYS GAP RD	TJN	STR	Raining	Wet	100	1	CAR	M21	N in NEW ENGLAND HWY	90	Proceeding in lane	N	0	0	
E39446887						RUM:	71	Off rd left => obj				Guide Post								
683065	13/09/2009	Sun	12:47	at	LINDSAYS GAP RD	TJN	CRV	Fine	Dry	100	1	CAR	M18	N in NEW ENGLAND HWY	90	Proceeding in lane	N	0	0	S
E40843481						RUM:	87	Off lft/lft bnd=>obj				Embankment								

Report Totals: Total Crashes: 2 Fatal Crashes: 0 Injury Crashes: 0 Killed: 0 Injured: 0

Crashid dataset HW9 - Lindsays Gap Rd Crash Data 1/1/2007 to 31/12/2011

Note: Data for the 9 month period prior to the generated date of this report are incomplete and are subject to change.

Rep ID: DCR01 **Office:** Grafton **User ID:** synottj Page 1 of 1 Generated: 26/07/2012 09:19

Appendix D. Project Construction Activity

Methodology	Volume	Equipment	Facilities
Raising the Dam Wall			
Remove and stockpile parapet wall for reuse. Some wall units will require excavation for removal	380 pre-cast concrete units	20 tonne (t) rough terrain crane 10 t flatbed truck 5 t backhoe	Works and stockpile area is located downstream of dam wall with direct access across the Peel River from Nundle Road
Excavate and stockpile deposited material at toe of for reuse at toe of new embankment	160,000 m^3	80 t excavator 45 t articulated dump trucks (12 loads per hour) D10 dozer	
Excavation of dam crest to expose existing crest embankment zones	30,000 m^3	30 t excavator 30 t dump trucks (12 loads per hour) Water cart Cat 140H grader	
Haul and place rock from Hard Rock Stockpile and clay from Borrow Area for dam wall raising	200,000 m^3	80 t excavators 50 t dump trucks (assume 9 loads per hour) 20 t vibrating roller 25 t compactor Water cart Cat 140H grader Cat D10N dozer	
Construction of road pavement and reinstalling the parapet wall	3,740 m^2 380 pre-cast concrete units	30 t articulated dump trucks 16 t vibrating roller Water Cart Truck (8 m^3 body) (assume 94 loads at one hour per round trip) Cat 140H grader	
Raising the Morning Glory Spillway			
Decommission and remove all mechanical and electrical equipment from bridge deck	N/A	5 t crane 5 t flatbed truck	Works and stockpile area is located downstream of dam wall with direct access across the Peel River from Nundle Road
Remove and store access bridge for reinstallation after dam wall and spillway raising	N/A	180 t barge crane 180 t mobile crane 30 x 15 m barge 25 t rough terrain crane 25 t semi-trailer Truck 18 m work boat	
Raise Morning Glory spillway and piers	2,500 m^3 (concrete)	180 t crane barge 180 t mobile crane 30 x 15 m barge 80 m^3/hr concrete pump	
Reinstall access bridge and gantry crane to bridge deck	N/A	180 t crane barge 180 t mobile crane 30 x 15 m barge	
Install new mechanical and electrical equipment to bridge deck	N/A	5 t crane 5 t flatbed truck	

Methodology	Volume	Equipment	Facilities
Reconfiguration of Auxiliary Spillway Fuseplug			
Construction of dividing wall between the two bays	70 m^3	Rock drill 5 t concrete truck 50 t mobile crane	Works and stockpile area is located downstream of dam wall with direct access across the Peel River from Nundle Road
Raise fuseplug embankment	2,000 m^3	30 t articulated truck 30 t excavator D8 dozer Cat 140H grader 5 t smooth roller 5 t pad foot roller 20,000 L water cart	
Realignment of Roads and Bridges			
Construction of new, and raising of existing, roads on the Western Foreshore Road	10,000 m^3 from cut in current alignment	20 t articulated dump truck 50 t excavator D10N dozer Cat 140H grader 20,000 L water cart 15 t smooth roller 15 t pad foot roller	Realigned road will be as per design plan
Construction of approaches and new section of road near Bowling Alley Point Road	10,000 m^3 from cut in current alignment	20 t articulated dump truck 50 t excavator D10N dozer Cat 140H grader 20,000 L water cart 15 t smooth roller 15 t pad foot roller	
Construction of a 6-span, 2 lane bridge at Bowling Alley Point with total length of 174 m	Drilling required for foundations	50 t rough terrain mobile crane 25 m^3/hr concrete pump 20 t piling rig on crawler tracks 10 t auger drill rig truck mounted 10 t flatbed truck 20 t semi-trailer	
Construction of a 2-span single lane bridge on Hyde's Creek with a total length of 58 m	Drilling required for foundations	50 t rough terrain mobile crane 25 m^3/hr concrete pump 20 t piling rig on crawler tracks 10 t auger drill rig truck mounted 10 t flatbed truck 20 t semi-trailer	

Appendix 12: Noise and Vibration Impact Assessment

global environmental solutions

Chaffey Dam Augmentation and Safety Upgrade

Noise and Vibration Impact Assessment

(301015-02980-REP-0009)

Report Number 630.10359R1

3 October 2012

WorleyParsons
PO Box 1812
North Sydney NSW 2059

Version: Revision 1

Chaffey Dam Augmentation and Safety Upgrade

Noise and Vibration Impact Assessment

(301015-02980-REP-0009)

PREPARED BY:

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 1, 14 Watt Street Newcastle NSW 2300 Australia

(PO Box 1768 Newcastle NSW 2300 Australia)
T: 61 2 4908 4500 F: 61 2 4908 4501
E: newcastleau@slrconsulting.com www.slrconsulting.com

DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
630.10359R1R1	Revision 1	3 October 2012	Martin Davenport	John Cotterill	John Cotterill
630.10359R1	Revision 0	25 September 2012	Martin Davenport	John Cotterill	John Cotterill

Table of Contents

Table of Contents

TABLES

Table of Contents

FIGURES

APPENDICES

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR Consulting) has been commissioned by WorleyParsons Services Pty Ltd (WorleyParsons) on behalf of State Water Corporation to conduct a Noise and Vibration Impact Assessment for the proposed augmentation and safety upgrade of Chaffey Dam.

The noise assessment has been prepared with reference to Australian Standards AS 1055:1997 *Description and Measurement of Environmental Noise* Parts 1, 2 and 3 and in accordance with the NSW Environment Protection Authority (EPA) *NSW Industrial Noise Policy* (INP), *NSW Interim Construction Noise Guideline* (ICNG) and *NSW Road Noise Policy* (RNP).

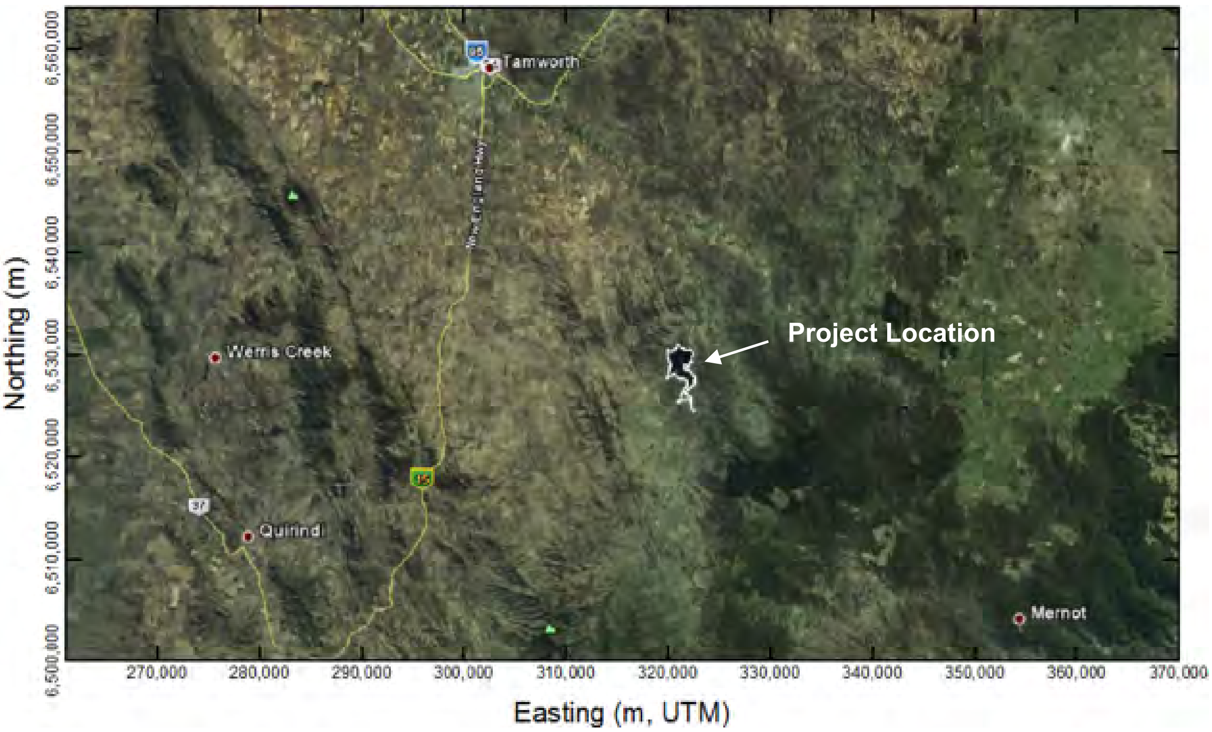
2 PROJECT DESCRIPTION

2.1 Project Setting

Chaffey Dam is located on the Peel River, approximately 30 km southeast of Tamworth (**Figure 1**). The existing dam wall structure was constructed between 1976 and 1979, and comprises a 54 m high earth and rockfill embankment with a crest length of approximately 430 m. A morning glory spillway is in place which enables excess water to pass through the dam downstream to the Peel River. There is an auxiliary spillway on the left abutment which enables extreme flood flows to pass around the dam wall.

Chaffey Dam has a storage volume of 62 gigalitres (GL), a reservoir surface area of 542 hectares and has a catchment area of approximately 420 km^2. Each year it supplies approximately 9 GL of potable town water to Tamworth and approximately 6.6 GL of irrigation water to local landholders downstream.

Figure 1 Project Location



2.2 Project Construction Overview

The project comprises the augmentation and safety upgrade of the existing Chaffey Dam (the Project) located on the Tamworth-Nundle Road approximately 4.5 km south of Woolomin, NSW. The Project will result in an increase in the Full Supply Level (FSL) of 6.5 m and an increase in storage capacity from 62 GL to 100 GL. To achieve the required outcomes the Project broadly encompasses the raising of the dam wall and the morning glory spillway and reconfiguration of the existing auxiliary spillway fuseplug. Realignment of some roads and bridges, as well as modification to other surrounding land uses, is also required due to inundation from the increased FSL. **Figure 2** provides an overview of the major construction areas for the project and **Figure 3** provides further detail for construction activities at the dam wall.

It is noted that there will likely be a requirement for a concrete batching plant on site as part of construction activities for the Project. The concrete batching plant has been excluded from this assessment as responsibility for any relevant approvals and licensing of the concrete batching plant will lie with the construction contractor.

Figure 2 Project Overview

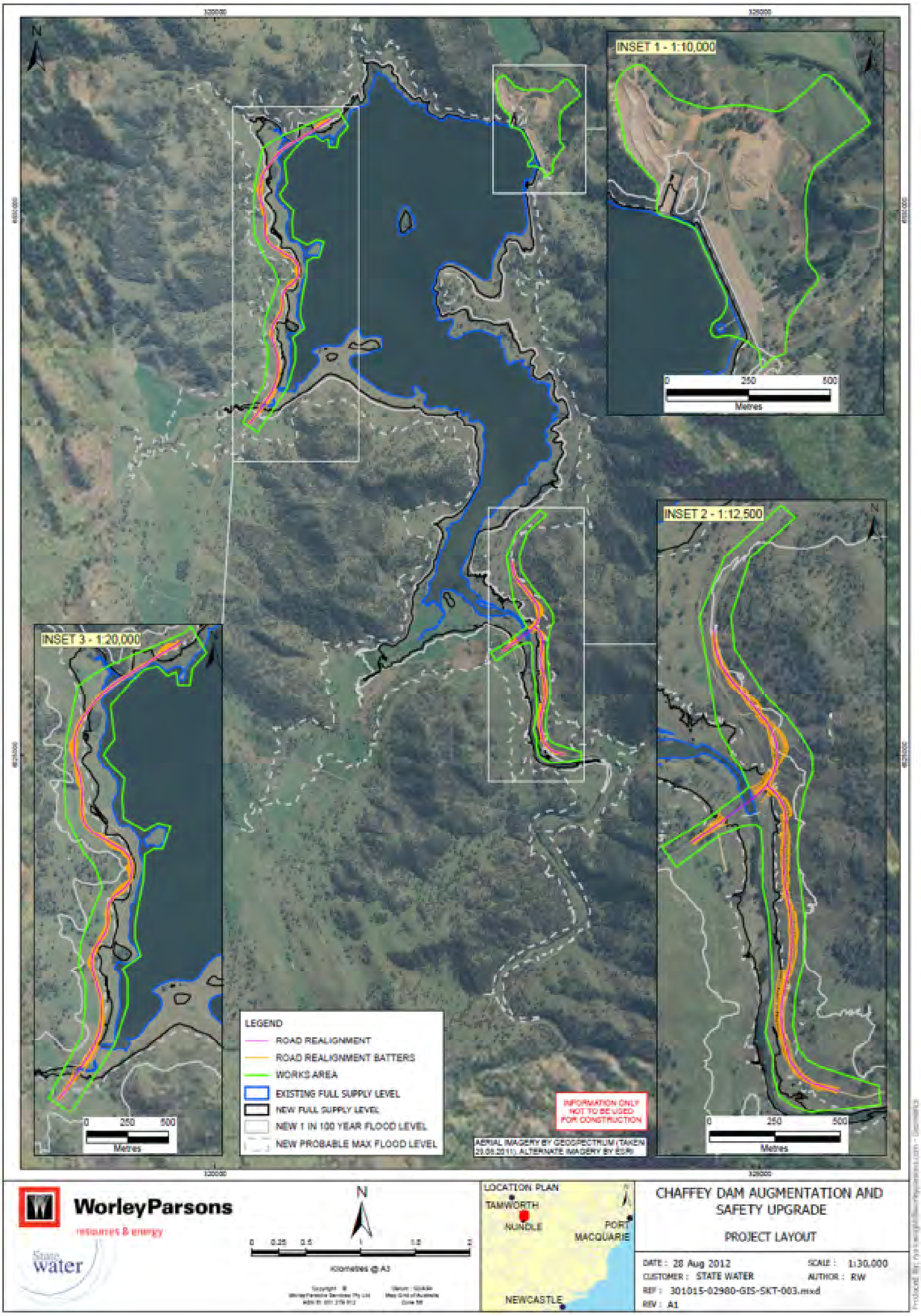


Figure 3 Dam Wall Construction Area

2.2.1 Dam Wall Construction Area

Dam Wall

The crest of the existing dam wall will be raised by 8.4 m to 542.1 m AHD. This will be achieved by placement of rockfill on the upstream and downstream sides of the embankment. The additional rockfill will be placed on the existing embankment faces to steepen the slope and thus widen the crest. Existing hard rock stockpiled on site, sourced from previous construction of the auxiliary spillway, will be utilised as rockfill for the embankment.

The existing waste dump at the downstream toe of the embankment will be excavated and stockpiled to allow the placement of rockfill on a sound soil/rock foundation. The stockpiled material will then be returned to the new embankment toe.

Excavation of the top part of the existing embankment will be undertaken for extension of the core and filter zones in the dam raising process. Vertical wall raising by the construction of reinforced earth vertical blocks above the existing dam crest will also be carried out, if required.

The existing 1.8 m high concrete parapet wall will be removed to enable the raising of the dam wall. This wall will be reinstated along the raised embankment crest to provide a 0.6 m freeboard when the reservoir reaches its maximum level during the Probable Maximum Flood (PMF).

Two borrow areas downstream of the dam wall will be utilised to source clay for use in the dam wall raising as core material.

Morning Glory Spillway

The existing morning glory spillway will be raised by 6.5 m. No changes are proposed to the existing morning glory spillway outlet channel.

The existing 56.4 m long single span steel truss bridge providing access to the morning glory spillway structure will be raised vertically by approximately 6.8 m, along with the dam intake and embankment infrastructure.

Auxiliary Spillway

The same materials to be used for raising the core of the embankment dam will be used for reconfiguration of the existing auxiliary spillway fuseplug. These materials will be sourced from two borrow areas downstream of the dam wall. Grouting along the foundation of the proposed fuseplug embankments may not be required considering the good quality of the existing foundation, though dental concrete may need to be applied to the rock surface before placing the embankment fill materials.

2.2.2 Roads, Bridges and Infrastructure Realignment

The Project will result in the inundation of some existing roads and bridges, as such the following works are proposed:

- Realignment of the intersection of Tamworth-Nundle Road and River Road and the relocation of power and telecommunications infrastructure.
- Realignment of sections of Tamworth-Nundle Road and River Road and the relocation of power and telecommunications infrastructure.
- Replacement of the Bowling Alley Point Bridge
- Realignment of Western Foreshore Road from Hyde's Creek to Silver Gully
- Modification to Hyde's Creek Bridge
- Modification to the existing culverted crossing at Silver Gully

2.3 Project Construction Program

The preliminary construction program for the Project is expected to comprise the following:

- Weeks 1 to 12 - Construction documentation, approvals and establishment (up to 20 personnel on site)
- Weeks 13 to 60 - Raising of dam wall, realignment of roads and bridges and reconfiguration of auxiliary spillway (up to 50 personnel on site)
- Weeks 61 to 90 - Raising of morning glory spillway (up to 40 personnel on site)
- Weeks 90 to 104 - Commissioning and site disestablishment (up to 20 personnel on site)

Construction activities are envisaged to occur between the hours of 7.00 am to 6.00 pm Monday to Friday and 8.00 am to 1.00 pm on Saturdays with no work on Sundays or public holidays.

2.4 Noise Sensitive Receivers

Land uses in the vicinity of the Project include livestock grazing, recreation (camping, boating, fishing, bird watching etc.) as well as rural dwellings. The nearest most potentially affected noise sensitive receivers to the Project are provided in **Table 1**, and are shown in **Figure 4**.

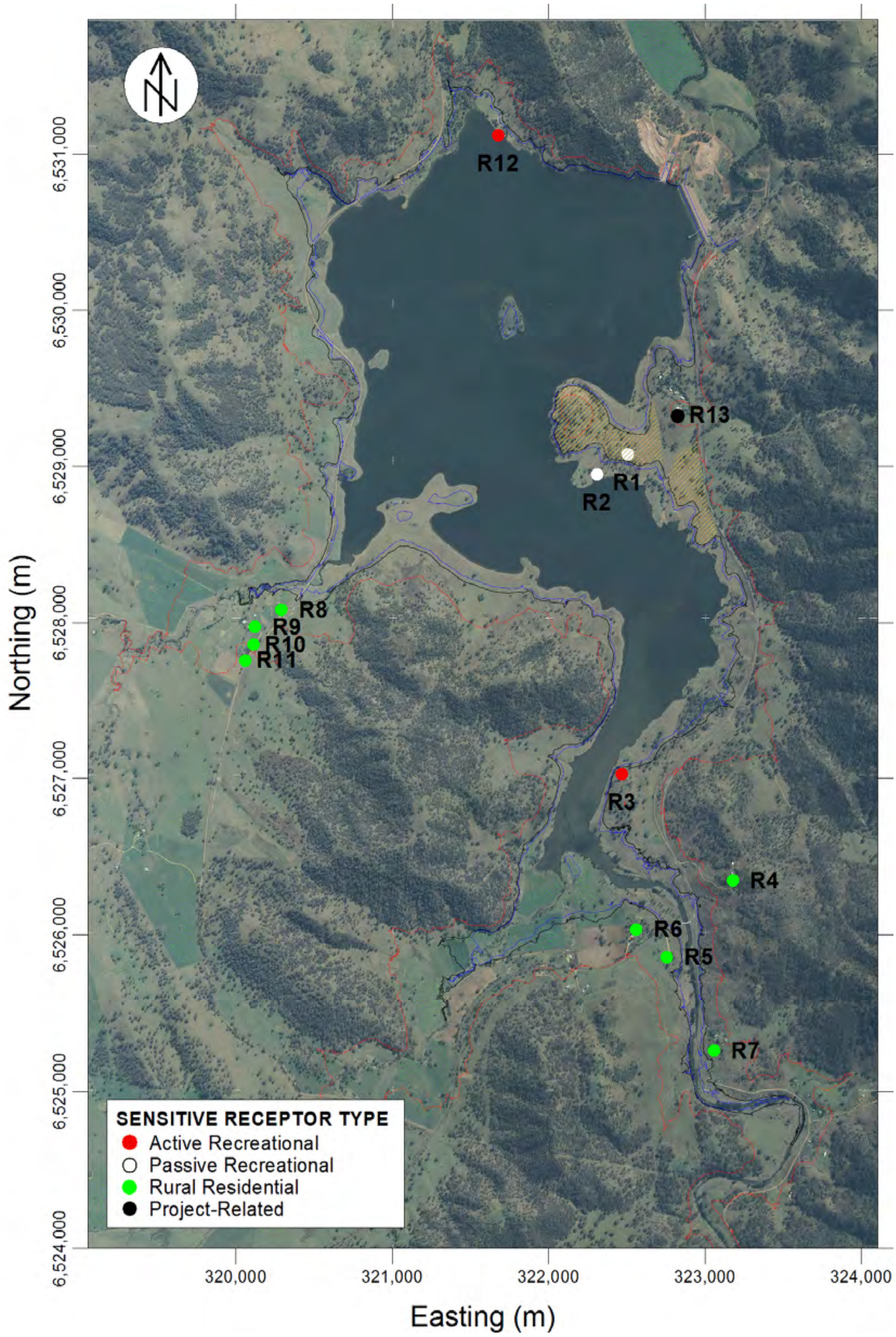
Table 1 Noise Sensitive Receivers

Receiver ID	Receiver	Receiver Type	Receiver Location	
			Easting	Northing
R1	Bowling Alley Point Recreation Area – Amenities Building	Passive Recreational	322503.0	6529076.8
R2	Bowling Alley Point Recreation Area – Camping Area	Passive Recreational	322307.9	6528947.5
R3	Nundle Fishing Clubhouse	Active Recreational	322467.7	6527028.9
R4	Bowling Alley Point Receiver	Rural Residential	323176.0	6526346.5
R5	Bowling Alley Point Receiver	Rural Residential	322754.2	6525856.8
R6	Bowling Alley Point Receiver	Rural Residential	322558.3	6526035.3
R7	Bowling Alley Point Receiver	Rural Residential	323055.3	6525258.0
R8	Western Foreshore Receiver	Rural Residential	320291.3	6528081.1
R9	Western Foreshore Receiver	Rural Residential	320119.0	6527971.6
R10	Western Foreshore Receiver	Rural Residential	320112.4	6527857.5
R11	Western Foreshore Receiver	Rural Residential	320057.2	6527758.5
R12	South Bowlo Fishing Club Tamworth	Active Recreational	321675.8	6531119.5
R13	Storage Custodian’s residence	Project-Related	322,825.2	6,529,325.5

Table 1 describes the location of land uses within the vicinity of the Project; however it should be noted that any of the roads or tracks within the vicinity of the Project could potentially be used for recreational purposes.

It should also be noted that R13 is a State Water employee’s residence and directly related to the operation of Chaffey Dam and as such has not been considered as part of this assessment.

Figure 4 Noise Sensitive Receivers



3 IMPACT ASSESSMENT PROCEDURES

3.1 General Objectives

Responsibility for the control of noise emission in New South Wales is vested in Local Government and the EPA. The Industrial Noise Policy (INP) was released in January 2000 and provides a framework and process for deriving noise criteria for consents and licenses that will enable the EPA to regulate premises that are scheduled under the *Protection of the Environment Operations Act, 1997*.

The specific policy objectives are:

- To establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity for specific land uses.
- To use the criteria as the basis for deriving project specific noise levels.
- To promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects.
- To outline a range of mitigation measures that could be used to minimise noise impacts.
- To provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of industrial development.
- To carry out functions relating to the prevention, minimisation and control of noise from the premises scheduled under the *Protection of the Environment Operations Act, 1997*.

The INP provides two forms of noise criteria with the aim of achieving environmental noise objectives; one to account for intrusive noise which involves setting a noise goal objective relative to the existing acoustic environment and the other to protect the amenity of particular land uses.

3.2 Assessing Intrusiveness

For assessing intrusiveness, the background noise level must be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source should not be more than five decibels above the measured background level (L_{A90}).

3.3 Assessing Amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. The existing noise level from industry is measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion. For high-traffic areas there is a separate amenity criterion.

An extract from the INP that relates to the amenity criteria is given in **Table 2**.

Table 2 Amenity Criteria – Recommended LAeq Noise levels from industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended $L_{Aeq(Period)}$ Noise Level (dBA)	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface (for existing situations only)	Day	65	70
		Evening	55	60
		Night	50	55
School classrooms - internal	All	Noisiest 1 hour period when in use	35	40
Hospital wards - internal - external	All	Noisiest 1 hour period	 35 50	 40 55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (eg National Park)	All	When in use	50	55
Active recreation area (eg school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Note: Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am, On Sundays and Public Holidays, Daytime 8.00 am -6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

Table 3 Modification to Acceptable Noise level (ANL)* to Account for Existing Levels of industrial Noise

Total Existing L_{Aeq} noise level from Industrial Noise Sources	Maximum L_{Aeq} Noise Level for Noise from New Sources Alone, dBA
≥ Acceptable noise level plus 2 dBA	If existing noise level is *likely to decrease* in future acceptable noise level minus 10 dBA If existing noise level is *unlikely to decrease* in future existing noise level minus 10 dBA
Acceptable noise level plus 1 dBA	Acceptable noise level minus 8 dBA
Acceptable noise level	Acceptable noise level minus 8 dBA
Acceptable noise level minus 1 dBA	Acceptable noise level minus 6 dBA
Acceptable noise level minus 2 dBA	Acceptable noise level minus 4 dBA
Acceptable noise level minus 3 dBA	Acceptable noise level minus 3 dBA
Acceptable noise level minus 4 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 5 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 6 dBA	Acceptable noise level minus 1 dBA
< Acceptable noise level minus 6 dBA	Acceptable noise level

* ANL = recommended acceptable L_{Aeq} noise level for the specific receiver, area and time of day from **Table 2.**

3.4 INP Project Specific Criteria

The INP Project Specific Noise Criteria are the more stringent of either the amenity or intrusive criteria. The INP states that these criteria have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

3.5 Construction Noise

The EPA has prepared an interim guideline covering construction noise. The ICNG sets out noise criteria applicable to construction site noise for the purpose of defining intrusive noise impacts. **Table 4** and **Table 5** sets out the noise management levels and how they are to be applied. The approach is intended to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

Table 4 Construction Noise Goals

Time of Day	Management Level	How to apply
Recommended standard hours : Monday to Friday 7:00am to 6:00pm Saturday 8:00am to 1:00pm No work on Sundays or public holidays	Noise affected RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq,(15mins)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly affected noise level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise levels of the works, and by describing any respite periods that will be provided.
Outside recommended standard hours	Noise affected RBL + 5 dBA	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

Table 5 Interim Construction Noise Guideline at Sensitive Land Uses (other than residences)

Land Use	Management Level $L_{Aeq(15minute)}$
Active Recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion).	External Noise Level 65 dBA When in use
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation).	External Noise Level 60 dBA When in use

3.6 Road Traffic Noise

The RNP presents guidelines for road traffic noise assessment. The policy document provides road traffic noise criteria for proposed road, residential and industrial developments, as well as criteria for other sensitive land uses.

Table 6 presents the most relevant RNP criteria for the Project that has the potential to increase road traffic noise levels during construction on the Tamworth-Nundle Road and the New England Highway, Garoo Rd, Lindsays Gap Road then Tamworth-Nundle Road.

Table 6 Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Project/Land Use	Assessment Criteria	
		Day	Night
Freeway/arterial/Sub-arterial Roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 dBA (external)	$L_{Aeq(9hour)}$ 55 dBA (external)

Day 7:00 am to 10:00 pm, Night 10:00 pm to 7:00 am

4 EXISTING ACOUSTICAL AND METEOROLOGICAL ENVIRONMENT

4.1 Noise Environment

In the absence of background noise monitoring at the subject site and surrounding locality, a Rating Background Level (RBL) of 30 dBA has been adopted at the nearest potentially affected residences during the daytime, evening and night-time periods. The INP provides detailed methodology to determine the RBL and in cases where the RBL is found to be less than 30 dBA states the following:

> *Where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A).*

It is expected that the background noise environment in the vicinity of the nearest residential receivers is typically rural in nature, with little contributed noise from man-made sources. Such an acoustical environment would typically have an RBL in the order of 30 dBA or less.

Therefore the use of an RBL of 30 dBA will result in the application of the minimum intrusive noise criteria set in the INP and ICNG.

4.2 INP Assessment of Prevailing Weather Conditions

Wind

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the noise source. As the strength of the wind increases the noise produced by the wind will obscure noise from most industrial and transport sources.

Wind effects need to be considered when wind is a feature of the area under consideration. Where wind blows from the source to the receiver at speeds up to 3 m/s for more than 30% of the time in any seasonal assessment period (ie day, evening or night), then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

In order to determine the prevailing conditions for the subject site, 12 months of weather data from the calendar year of 2011 was obtained from a Bureau of Meteorology automatic weather station located at Tamworth Airport approximately 38 km north west of the subject site. As the Tamworth Airport automatic weather station is located a significant distance from the Chaffey Dam site synthetically generated meteorological data has been produced for the site using the The Air Pollution Model (TAPM) meteorological model as part of the project (refer SLR Consulting report *630.10359-R2 Chaffey Dam Augmentation and Safety Upgrade Air Quality Impact Assessment*). The modelling process has provided a meteorological dataset for the 2011 calendar year, over the Chaffey Dam site.

This data was analysed to determine the frequency of occurrence of winds of speeds up to 3 m/s in each season during the day, evening and night time periods. The results of the wind analysis for daytime, evening, and night-time winds for Tamworth Airport are presented in **Table 7, Table 8** and **Table 9**, respectively. The results of the wind analysis for daytime, evening, and night-time winds for the synthetically generated TAPM data are presented in **Table 10**, **Table 11** and **Table 12,** respectively. In each table, the wind directions and percentage occurrence are those dominant during each season.

Table 7 Seasonal Frequency of Occurrence of Wind Speed Intervals – Daytime – Tamworth Airport

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	1.7%	SE±45	2.0%	5.4%	7.4%
Autumn	5.3%	SE±45	3.4%	8.1%	11.5%
Winter	6.7%	NNW±45	3.9%	9.1%	13.1%
Spring	4.3%	SSE±45	2.4%	5.7%	8.1%

Table 8 Seasonal Frequency of Occurrence of Wind Speed Intervals – Evening – Tamworth Airport

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	9.5%	S±45	1.0%	6.0%	7.0%
Autumn	7.1%	SE±45	1.4%	7.2%	8.6%
Winter	12.3%	SSE±45	1.9%	8.9%	10.8%
Spring	18.5%	NNW±45	4.5%	5.5%	10.1%

Table 9 Seasonal Frequency of Occurrence of Wind Speed Intervals – Night – Tamworth Airport

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	10.6%	SSE±45	3.6%	10.9%	14.5%
Autumn	13.7%	SSE±45	6.4%	16.8%	23.2%
Winter	20.1%	SSE±45	7.3%	15.7%	23.0%
Spring	14.8%	SSE±45	7.5%	16.2%	23.7%

Table 10 Seasonal Frequency of Occurrence of Wind Speed Intervals – Daytime - TAPM

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	1.3%	NE±45	5.6%	6.3%	11.9%
Autumn	1.9%	NE±45	7.8%	5.8%	13.6%
Winter	6.2%	W±45	14.5%	10.3%	24.9%
Spring	2.3%	NE±45	6.7%	11.8%	18.5%

Table 11 Seasonal Frequency of Occurrence of Wind Speed Intervals – Evening - TAPM

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	0.3%	ESE±45	10.4%	25.2%	**35.7%**
Autumn	1.1%	ESE±45	26.0%	24.1%	**50.1%**
Winter	3.8%	ESE±45	28.1%	14.6%	**42.6%**
Spring	1.4%	ESE±45	18.2%	19.1%	**37.3%**

Table 12 Seasonal Frequency of Occurrence of Wind Speed Intervals – Night – TAPM

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	1.6%	E±45	29.4%	40.0%	**69.4%**
Autumn	3.0%	ESE±45	40.9%	17.0%	**57.9%**
Winter	9.4%	E±45	33.2%	12.9%	**46.1%**
Spring	2.8%	E±45	27.6%	37.3%	**64.9%**

Seasonal wind records indicate that significant winds (of up to 3 m/s) are not a feature of the area during the daytime period since the 30% threshold is not exceeded during any seasonal period, and therefore, prevailing winds have not been considered as part of this assessment.

Temperature Inversion

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions occur predominantly at night during the winter months. For a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30% of the total night-time during winter or about two nights per week. The INP states the following with regard to temperature inversions

> *The night-time period for determining inversion frequency is from 1 hour before sunset to 1 hour after sunrise (taken to be 6 pm to 7 am), which is the time period during which inversions are most likely.*

The proposed hours of construction for the site are 7.00 am to 6.00 pm, and therefore there is little or no potential for impact from temperature inversions and as such have not been considered as part of this assessment.

5 PROJECT SPECIFIC NOISE EMISSION CRITERIA

5.1 Operational Noise Design Criteria

The noise emission design criteria for the proposed development have been established with reference to the INP outlined in **Section 3** of this report.

The INP prescribes detailed calculation routines for establishing project specific $L_{Aeq(15minute)}$ intrusive criteria and $L_{Aeq(period)}$ amenity criteria for a development at potentially affected residences or receivers.

The existing ambient L_{Aeq} noise level in the area surrounding the project site is expected to be controlled by rural sources. The residences in the vicinity of the project site are best described by the rural receiver type. Therefore the amenity criteria have been set using the $L_{Aeq(period)}$ contribution from industrial noise in conjunction with Table 2.1 of the INP.

The intrusive and amenity noise assessment criteria in the vicinity of the project site are presented in **Table 13**. These criteria are nominated for the purposes of assessing the potential noise impacts from the development. For this project the $L_{Aeq(15minute)}$ intrusive criteria is the controlling noise criteria at all residential receivers.

Table 13 Project Specific Operational Noise Criteria – Residential Receivers

Location	Period	Intrusiveness Criteria LAeq(15minute)	EPA Acceptable Amenity Criteria LAeq(Period)	Project Specific Noise Criteria
R4-R10 Residential Receivers	Day	35 dBA	50 dBA	**35 dBA LAeq(15minute)**
	Evening	35 dBA	45 dBA	**35 dBA LAeq(15minute)**
	Night	35 dBA	40 dBA	**35 dBA LAeq(15minute)**
R1, R2 Passive Recreational	When in use	n/a	50 dBA	**50 dBA LAeq(period)**
R3, R11 Active Recreational	When in use	n/a	55 dBA	**55 dBA LAeq(period)**

5.2 Construction Noise Goals

The project specific construction noise goals, presented in **Table 14** and **Table 15** are applicable for the proposed development.

Table 14 Project Specific Construction Noise Criteria – Recreational Receivers

Receiver ID	Receiver Type	Management Level LAeq(15minute)
R1, R2	Passive Recreational	60 dBA When in use
R3, R12	Active Recreational	65 dBA When in use

Table 15 Project Specific Construction Noise Criteria – Residential Receivers

Receiver ID	Receiver Type	Recommended Hours Construction Noise Goal LAeq(15minute)	
		Noise Affected	Highly Noise Affected
R4-R11	Residential	40 dBA	75 dBA

5.3 Road Traffic Noise Goals

It has been assumed that construction personnel would access the site from the Tamworth-Nundle Road (via Woolomin) or the New England Highway, Garoo Rd, Lindsays Gap Road then Tamworth-Nundle Road. For heavy construction vehicles it is expected that access to the site would be via the New England Highway, Garoo Rd, Lindsays Gap Road then Tamworth-Nundle Road. As described in **Section 3.6** these roads fall into the category of arterial/sub-arterial roads and therefore the noise criteria outlined in **Table 6** has been adopted.

6 ASSESSMENT OF NOISE IMPACTS

6.1 Noise Modelling

A computer model was used to predict noise emissions from the subject development. The Environmental Noise Model (ENM) used has been produced in conjunction with the EPA. A three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process. The model used this map, together with noise source data, ground cover, shielding by barriers and/or adjacent buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers.

Noise levels were predicted at the residences which represent the nearest, most potentially affected locations.

The predicted noise emission levels for the construction and operation of the Project have been calculated under the meteorological parameters shown in **Table 16**.

Table 16 Noise Modelling Parameters

Assessment Condition	Temperature	Wind Speed / Direction	Relative Humidity	Temperature Gradient
All periods	20°C	n/a	65%	n/a

6.2 Operational Noise Impact Assessment

Given that no changes to the operation of the morning glory spillway is associated with the Project and the significant distance between any noise sensitive receiver, no noise impact is predicted from the continued operation of the Project.

6.3 Construction Noise Assessment

Potential worst case construction scenarios have been modelled for the Project and are provided in **Table 17**. Potential construction scenarios have been selected based on the equipment proposed for use.

Table 17 Potential Construction Scenarios

Scenario	Construction Area	Methodology	Anticipated Construction Equipment
Scenario 1	Dam Wall	Haul and place rock from Hard Rock Stockpile and clay from Borrow Area for dam wall raising	2 x 80t excavators 3 x 50 t dump trucks 1 x 20 t vibrating roller 1 x 25 t compactor 1 x water cart 1 x Cat 140H grader 1 x cat D10N dozer
Scenario 2	Morning Glory Spillway	Raise Morning Glory Spillway	1 x 180 t barge crane 1 x 180 t mobile crane 1 x barge 1 x concrete pump
Scenario 3	Auxiliary Spillway	Reconfigure fuseplug embankment	1 x 30 t articulated truck 1 x 30 t excavator 1 x D8 dozer 1 x Cat 140H grader 1 x 5 t smooth roller 1 x 5 t pad food roller 1 x watercart
Scenario 4	Bowling Alley Point	Bowling Alley Point Bridge Construction	1 x 50 t rough terrain mobile crane 1 x concrete pump 1 x 20 t piling rig 1 x 10 t auger drill rig 1 x 10 t flatbed truck 1 x 20 t semi trailer
Scenario 5	Western Foreshore	Hyde's Creek Bridge Construction	1 x 50 t rough terrain mobile crane 1 x concrete pump 1 x 20 t piling rig 1 x 10 t auger drill rig 1 x 10 t flatbed truck 1 x 20 t semi trailer
Scenario 6	Bowling Alley Point and Western Foreshore	Road realignment construction	1 x 20 t articulated truck 1 x 50 t excavator 1 x D10N dozer 1 x Cat 140H grader 1 x 15 t vibrating roller 1 x 15 t pad food roller 1 x watercart

The scenarios provided in **Table 17** assume that all construction equipment considered in each scenario is operating simultaneously over a 15 minute period. Scenario 6 assumes that road realignment construction is being conducted at the nearest construction area to each individual receiver. The details of the sound power levels of the equipment used are provided in **Appendix A.**

6.4 Predicted Construction Noise Levels

Table 18 and **Table 19** details the potential predicted noise levels of each construction scenario and associated activity. Predicted noise levels in bold indicate an exceedance of the ICNG noise affected criterion.

Table 18 Predicted Construction Noise Levels – Recreational Receivers

Receptor ID	Predicted Noise Level LAeq(15minute) dBA							Management Level LAeq(15minute) dBA
	Scenario						All Scenarios	
	1	2	3	4	5	6[1]		
R1	39	34	39	32	<30	33	44	60
R2	32	<30	33	33	<30	32	39	60
R3	<30	<30	<30	<30	38	36	40	65
R12	<30	<30	<30	<30	<30	52	52	65

[1]Construction equipment is operating at the nearest section of road to the receiver to be aligned.

Table 19 Predicted Construction Noise Levels – Residential Recievers

Receptor ID	Predicted Noise Level LAeq(15minute) dBA							Recommended Hours Construction Noise Goal LAeq(15minute) dBA	
	Scenario						All Scenarios	Noise Affected	Highly Noise Affected
	1	2	3	4	5	6[1]			
R4	<30	<30	<30	<30	**46**	**45**	**48**	40	75
R5	<30	<30	<30	<30	**63**	**66**	**68**	40	75
R6	<30	<30	<30	<30	**61**	**65**	**67**	40	75
R7	<30	<30	<30	<30	**48**	**71**	**71**	40	75
R8	<30	<30	<30	**63**	<30	**61**	**65**	40	75
R9	<30	<30	<30	**48**	<30	**48**	**51**	40	75
R10	<30	<30	<30	**50**	<30	**49**	**53**	40	75
R11	<30	<30	<30	**47**	<30	**46**	**50**	40	75

[1]Construction equipment is operating at the nearest section of road to the receiver to be aligned.

A review of **Table 18** shows that at all passive and active recreational areas (R1, R2, R3 and R12) construction noise levels are predicted to be within the relevant construction noise goals of 60 dBA and 65 dBA respectively.

Table 19 shows that at the nearest residential receptors (R4 to R11) LAeq(15minute) construction noise levels are predicted to exceed the noise affected criterion. All locations are predicted to be below the highly noise affected construction noise goal. The main contributor to noise levels at these locations is due to the road realignment and bridge construction. Works at the dam wall are predicted to have a negligible impact on residential receivers.

It is noted that although the estimated construction time for the road and bridge realignment is approximately one (1) year, the predicted noise levels reflect peak construction activities at the closest proximity to the receiver. As such noise levels are likely to be lower than those presented in **Table 18** and **Table 19** for the majority of the construction period.

In accordance with the ICNG all feasible and reasonable work practices are to be implemented with the aim of achieving the proposed acceptable noise affected criterion and all potentially affected residents should be informed of the following:

- The nature and duration of the works to be carried out (a schedule would be provided outlining each principle activity and what would be involved in that activity).
- The expected overall noise levels and the relative level of each noise for each activity.
- Relevant contact details for site personnel.

Noise mitigation and management measures to minimise noise levels and associated construction noise impacts as much as possible are provided in **Section 6.5.**

6.5 Construction Noise Mitigation and Management

Exceedance of construction noise goals is typical for construction sites in close proximity to receivers and highlights the need for appropriate noise management and planning.

The following recommendations are made with the aim of minimising construction noise impacts at nearby noise sensitive receivers.

- An important aspect of the mitigation of noise impacts during all construction phases will be adherence to the standard daytime construction hours.
- Noisy plant operating simultaneously to be avoided wherever possible.
- Maintenance work on all construction plant to be carried out away from noise sensitive areas and confined to standard daytime construction hours, where practicable.
- Position noisy equipment behind structures that act as barriers or at the greatest distance from the noise sensitive area or orient the equipment so that noise emissions are directed away from any noise sensitive areas.
- Keep equipment well maintained.
- Employ “quiet” practices when operating equipment (eg positioning and unloading of trucks in appropriate areas). This is particularly important to ensure that plant and equipment are not operated or left idling when not positioned appropriately.
- Implementation of an effective complaints handling system.

However, even with these measures in place it would generally not be possible to reduce noise levels to below the Noise Affected CNML. Therefore, consideration is given to AS 2436:1981 “Guide to noise control on construction, maintenance and demolition sites” which provides the following with regard to potentially offensive noise events associated with construction activities.

> *If noisy operations must be carried out, then a responsible person should maintain liaison between the neighbouring community and the contractor. This person should inform the public at what time to expect noisy operations and also inform the contractor of any special needs of the public. Consultation and cooperation between the contractor and his neighbours and the removal of uncertainty and rumour can help to reduce the adverse reaction to noise.*

6.6 Road Traffic Noise

Existing and Predicted Traffic Movements

The Project is expected to generate 50 light vehicle movements per day during the peak construction phase (i.e. 25 movements to site and 25 movements from site).

There is potential for the Project to require the sourcing of construction material from two (2) nearby quarries. Maximum movements expected from the haulage of material would comprise 12 x 45 t articulated dump trucks undertaking one inbound and one out-bound journey per hour over a 10 hour working day. This would generate a maximum of 240 additional heavy vehicle movements on Lindsays Gap Road and Garoo Road.

Estimated existing traffic levels on Lindsays Gap Road and Garoo Road are 170 vehicles per day, and the Tamworth-Nundle Road between Woolomin and Dungowan of 450 vehicles per day. It is estimated that 10% of the existing vehicular traffic on these roads is comprised of heavy vehicles. Road traffic noise levels predicted at the closest receivers from each roadway are provided in **Table 20**.

Table 20 Predicted Road Traffic Noise Levels

Location	Distance From Roadway	Assessment Period	Non-Project Related Traffic	Project Related Traffic	Total Road Traffic Noise
Lindsays Gap Road/Garoo Road	39 m	Day LAeq(15hour)	49.4 dBA LAeq(15hour)	57.6 dBA LAeq(15hour)	58.2 dBA LAeq(15hour)
Woolomin Township	13 m		53.2 dBA LAeq(15hour)	38.5 dBA LAeq(15hour)	53.3 dBA LAeq(15hour)
Tamworth-Nundle Road Between Woolomin and Dungowan	14 m		**60.4 dBA LAeq(15hour)**	48.5 dBA LAeq(15hour)	**60.7 dBA LAeq(15hour)**

Note: RNP road traffic noise assessment criteria LAeq(15hour) 60 dBA. Bolded items indicate and exceedance.

As shown in **Table 20** road traffic noise levels are predicted to meet the relevant criteria on Lindsays Gap Road, Garoo Road and within the township of Woolomin. On the Tamworth-Nundle between Woolomin and Dungowan existing noise levels are predicted to marginally exceed road traffic noise assessment criteria at the closest receiver to the roadway. A marginal increase in road traffic noise levels with the addition of Project related traffic during peak construction periods of 0.3 dB is predicted at the closest receiver to the roadway. An increase of up to 2 dB represents a minor impact that is barely perceptible for an average person. On this basis, the predicted increase of 0.3 dB is considered to be imperceptible.

It is also noted that initial movement of construction vehicles to the site at the commencement of each stage of the project and the final movement of construction vehicles away from the site at completion of each stage is also expected to occur. However, given the limited number of vehicles required for this function and the intermittent scheduling of such movements impacts are expected to be minimal.

7 VIBRATION

7.1 Assessment Criteria

German Standard DIN 4150-3 1999 "*Structural Vibration Part 3: Effects of Vibration on Structures*" provides guideline criteria for evaluating the short and long-term effects of vibration on structures. In addition, the NSW EPA has recently released an interim guideline "*Assessing Vibration: A Technical Guideline"* provides guideline building vibration levels associated with a low probability of annoyance from occupants. The range of applicable damage and annoyance risk vibration velocity criteria are summarised in **Table 21**.

Table 21 Vibration Velocity Damage and Annoyance Risk Criteria (mm/s)

Receiver Area/Type	Damage Risk (mm/s)		Annoyance Risk (mm/s)	
	Horizontal	Vertical	Horizontal	Vertical
Residential/Dwellings	15	5	1.2	0.45
Industrial/Workshops	40	20	3.2	1.2
Subsurface/Pipework	50-100	50-100	n/a	n/a

7.2 Construction Impact Assessment

Energy from construction equipment is transmitted into the ground and transformed into vibration, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- The efficiency of the energy transfer mechanism of the equipment (i.e. impulsive; reciprocating, rolling or rotating equipment).
- The frequency content.
- The stiffness of the medium (ground).
- The type of wave (surface or body).
- The ground type and topography.

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data.

Bridge Construction Activities

Impact piling rigs are anticipated for use during the construction of the Bowling Alley Point Bridge and Hyde's Creek Bridge. Piling has the potential to generate the highest vibration levels from all proposed bridge construction activities. Buffer distances predicted to achieve compliance with the range of damage and annoyance risk criteria are presented in **Table 22**. The safe distances are based on the operation of a single hydraulic hammer rated at 5 tonne-metres (t-m) driving 450 mm concrete piles at both 50% and 100% piling capacity. As the vertical criterion is equal to or lower than the horizontal criterion in all cases, buffer distances are provided in **Table 22** with respect to the vertical criterion only.

Table 22 Predicted Buffer Distance from Impact Piling (m)

Receiver Area/Type	Damage Risk (m)		Annoyance Risk (m)	
	50% Capacity	100% Capacity	50% Capacity	100% Capacity
Residential/Dwellings	80	100	150	180
Industrial/Workshops	9	12	100	120
Subsurface/Pipework	2	3	n/a	n/a

Based on the predicted buffer distances, vibration levels would be within the relevant damage and annoyance risk criteria at all residential receivers as the closest residential receiver (R5) is located approximately 200 metres from impact piling activities. Given that impact piling would generate the highest vibration levels from bridge construction other bridge construction activities within the buffer distances provided in **Table 22** are also predicted to be within the relevant damage and annoyance risk criteria.

Road Construction Activities

Vibratory rollers are anticipated to be used during the re-alignment of roads inundated by the Project. Vibratory rolling has the potential to generate the highest vibration levels from all proposed road construction activities. Buffer distances predicted to achieve compliance with the range of vertical vibration level damage and annoyance risk criteria are presented in **Table 23**.

Table 23 Predicted Buffer Distance Vibratory Rolling (m)

Receiver Area/Type	Damage Risk (m)	Annoyance Risk (m)

Residential/Dwellings	18	43
Industrial/Workshops	1	37
Subsurface/Pipework	<1	n/a

Based on the predicted buffer distances, vibration levels would be within the relevant damage and annoyance risk criteria at all residential receivers as the closest residential receiver (R7) is located approximately 65 metres from vibratory rolling activities. Given that vibratory rolling would generate the highest vibration levels from road construction other road construction activities within the buffer distances provided in **Table 23** are also predicted to be within the relevant damage and annoyance risk criteria.

Dam Wall Construction Activities

Given the significant distance from construction activities proposed at the dam wall the risk of vibration related impacts is negligible.

7.3 Vibration Monitoring

It is recommended that attended vibration monitoring be conducted at the commencement of any significant construction activities for bridge and road construction (i.e. impact piling and vibratory rolling) at the nearest vibration sensitive receiver. In the event that construction vibration is found to be significantly below construction vibration criteria, it is envisaged that no subsequent monitoring of that activity would be required. If monitored vibration levels are considered to be high-risk or close to the vibration criteria it is recommended that unattended vibration monitoring be carried out on a continuous basis at the nearest vibration sensitive receiver.

7.4 Blasting Vibration

The use of explosives may be required as part of the Project to dislodge and fracture rock structure in the vicinity of the auxiliary spillway to enable its extraction for use in raising the dam wall. To achieve this, holes would be drilled into the rock in a designed pattern giving strict attention to their angle, depth and spacing. These holes are then filled with an explosive charge which is then initiated with the aid of primers and detonators. The detonation of holes would be delayed in a pre-designed sequence to ensure that holes are fired in quick succession. A delayed firing technique improves the efficiency of the blast and also reduces its environmental impacts.

Blast Emission Criteria – Residential Disturbance

The Australian and New Zealand Environment Conservation Council (ANZECC) guidelines are the most commonly used guideline for assessing potential residential disturbance arising from blast emissions. The ANZECC guidelines provide assessment criteria with the aim of minimising annoyance from noise and vibrations caused by blasting activities and are as follows:

- The recommended maximum level for airblast is 115 dB Linear. This level may be exceeded for up to 5% of the total number of blasts over a 12 month period but should not exceed 120 dB Linear at any time.
- The recommended maximum for ground vibration is a Peak Vector Sum (PVS) vibration velocity of 5 millimetres per second (mm/s). This level may be exceeded for up to 5% of the total number of blasts over a 12 month period but should not exceed 10 mm/s at any time.
- Blasting should generally only be permitted during the hours of 9.00 am to 5.00 pm Monday to Saturday. Blasting should not take place on Sundays and public holidays.
- Blasting should generally take place no more than once per day.

The ground vibration and airblast levels which cause concern or discomfort to residents are generally lower than the relevant building damage limits.

Blasting Impacts

Blasting was conducted during the construction of the existing Chaffey Dam auxiliary spillway. Monitoring for both ground vibration and airblast was conducted at the nearest residential location to the site. A summary of the blast monitoring is provided in **Table 24**.

Table 24 Auxiliary Spillway Blasting Results – Nearest Residential Receiver

Blast Number	Blast Date	MIC (kg)[1]	Vibration (PVS mm/s)	Airblast (dBL)
1	13/5/2010	187	0.05	111.4
2	7/9/2010	160	No Data	No Data
3	24/9/2010	209	<0.19[2]	<115[2]
4	15/10/2010	166	0.22	112.3
5	22/10/2010	173	<0.19[2]	<115[2]
6	29/10/2010	133	0.29	111.3
7	5/11/2010	138	No Data	No Data
8	12/11/2010	196	0.27	104.9
9	19/11/2010	131	0.36	96.1
10	26/11/2010	135	0.34	86.7
11	30/11/2010	131	0.38	111.8
12	10/12/2010	130	<0.19[2]	<115[2]

[1]Maximum Instantaneous Charge – Maximum explosive mass to be detonated in any 8 millisecond interval

[2]Blast failed to trigger monitoring equipment. Actual blast vibration and airblast levels are below those presented.

Results from previous blasts conducted at the site indicate there has been compliance with the ANZECC guidelines. Should blasting be required as part of the Project it is recommended that similar blast designs and MIC (i.e. less than 209 kg) to those carried out during the construction of the existing auxiliary spillway be implemented. Should blasting be required for the Project, monitoring would be conducted to ensure compliance with relevant criteria.

8 CONCLUSION

SLR Consulting has conducted a noise and vibration impact assessment for the proposed augmentation and safety upgrade of Chaffey Dam.

Noise modelling has indicated that the impact of noise emissions from the operation of the Project is expected to be negligible.

Construction noise levels are predicted to be met at all assessed passive and active recreational areas surrounding the Project. Construction noise levels are predicted to be within the highly noise affected criterion at all residential receiver locations. Various noise management techniques have been presented in this report to reduce the impact of construction noise on nearby residential receivers and include:

- Adherence to the standard daytime construction hours.
- Noisy plant operating simultaneously to be avoided wherever possible.

- Maintenance work on all construction plant to be carried out away from noise sensitive areas and confined to standard daytime construction hours, where practicable.
- Position noisy equipment behind structures that act as barriers or at the greatest distance from the noise sensitive area or orient the equipment so that noise emissions are directed away from any noise sensitive areas.
- Keep equipment well maintained.
- Employ "quiet" practices when operating equipment.
- Implementation of an effective complaints handling system.
- Liaise with potentially affected receivers regarding the nature and duration of the works to be carried out, expected noise levels and any relevant contact details.

Traffic generated by the Project is predicted to be within the traffic noise goals, with the exception of the Tamworth-Nundle Road between Woolomin and Dungowan where a marginal increase in road traffic noise levels with the addition of Project related traffic during peak construction periods of 0.3 dB is predicted at the closest receiver to the roadway. An increase of up to 2 dB represents a minor impact that is barely perceptible for an average person. On this basis, the predicted increase of 0.3 dB is considered to be imperceptible.

Construction vibration levels are predicted to be below the adopted damage and annoyance criteria.

Vibration and airblast associated with potential blasting to be carried out for the Project are predicted to be within the adopted criteria provided the blasts are of similar design to those carried out during the construction of the existing auxiliary spillway are implemented.

Equipment Sound Power Levels

Equipment Description	Octave Band Centre Frequency (Hz) – dB re 1pW									dB	dBA
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**		
Excavator	112	105	116	108	111	107	105	100	93	119	113
Articulated Dump Truck	112	120	112	112	108	105	103	98	91	122	111
Compactor	99	104	109	112	107	105	102	96	90	116	110
Roller	99	104	109	112	107	105	102	96	90	116	110
Watercart	97	103	105	106	102	100	95	90	77	111	105
Grader	112	123	118	117	109	111	107	103	93	126	115
Dozer	111	112	109	113	116	113	111	108	98	121	118
150t Crane	107	115	109	105	105	104	100	100	80	117	109
50t Crane	104	112	106	102	102	101	97	97	77	114	106
Heavy Lift Barge	107	111	126	109	107	106	104	97	92	126	113
Barge	96	104	106	99	100	98	92	85	77	110	102
Concrete Pump	104	102	102	104	106	106	100	91	84	112	109
Road Truck	96	104	106	99	100	98	92	85	77	110	102
Impact Piling Rig	115	119	117	116	116	116	118	113	112	126	123
Drill Rig	108	110	121	115	111	111	108	101	95	123	116

Appendix 13: Air Quality Impact Assessment

Chaffey Dam Augmentation and Safety Upgrade

Air Quality Impact Assessment

(301015-02980-REP-0009)

Report Number 630.10359

25 September 2012

WorleyParsons Pty Ltd
PO Box 1812
North Sydney NSW 2059

Version: Revision 1

Chaffey Dam Augmentation and Safety Upgrade

Air Quality Impact Assessment

(301015-02980-REP-0009)

PREPARED BY:

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
2 Lincoln Street Lane Cove NSW 2066 Australia

(PO Box 176 Lane Cove NSW 1595 Australia)
T: 61 2 9428 8100 F: 61 2 9427 8200
E: sydney@slrconsulting.com www.slrconsulting.com

DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
630.10359	Revision 1	25 September 2012	Kirsten Lawrence	Gary Graham	John Cotterill
630.10359	Revision 0	20 September 2012	Kirsten Lawrence	Gary Graham	John Cotterill

Table of Contents

Table of Contents

Table of Contents

TABLES

FIGURES

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR Consulting) has been commissioned by WorleyParsons Services Pty Ltd (WorleyParsons) on behalf of State Water Corporation (State Water) to prepare an Air Quality Impact Assessment (AQIA) of activities associated with the Chaffey Dam Augmentation and Safety Upgrade. An AQIA is a required component of the Environmental Impact Assessment (EIA).

The proposed works include construction of:

- Raise the Dam Wall
- Modify the Existing Spillways
- Modification of Other Infrastructure

This assessment has focused on the quantification of worst case impacts on air quality from dust emissions for the construction phase of the Chaffey Dam Augmentation and Safety Upgrade. Emissions to air from operational and maintenance activities will be negligible and have not been considered further in this study.

The agreed scope of works for this study comprised the following:

- Visit the site to gather information on the project setting, including the locations of nearest sensitive receptors, local topography and land use.
- Review any available monitoring data and any relevant past studies, including any existing air quality monitoring data for the estimation of background concentrations of pollutants such as suspended and deposited particulate.
- Review the terrain and topography and identify surrounding sensitive receptors and land uses in all directions in relation to potential air quality impacts.
- Obtain available meteorological data from the closest Bureau of Meteorology weather station to the subject site and compile a meteorological data file (one full year of hourly observations) for input into a suitable atmospheric dispersion model.
- Identify all air pollutants likely to be generated by the Project and establish air quality goals for all relevant air emissions in accordance with the NSW OEH *"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales" (2005)* and other relevant legislation.
- Compile an emissions inventory for the construction phase of the Project based on data provided by the client on quantities, timelines, equipment inventory (both fixed and mobile), particulate control equipment, location of airborne pollutant generating activities, activity rates etc.
- Using an appropriate atmospheric dispersion model, conduct predictive modelling to estimate maximum off-site pollutant concentrations including residential receivers.
- On the basis of the compliance goals established for the project, assess predicted impacts and recommend mitigation treatments where appropriate.

1.1 Limitations

The key limitations of this study are associated with:

- The representativeness of the published emission rates used to estimate emissions from proposed activities at the site for the purposes of predicting dust impacts at the receptor locations; and

- The limitations inherent to the use of numerical modelling tools used in this study (TAPM, CALMET and CALPUFF). It is important to note that all numerical models that are based on approximating a governing set of equations will inherently be associated with some degree of error. The more complex the model, the greater the number of processes which must be parameterised. The accuracy of air dispersion modelling is discussed further in **Section 7.2**.

This study necessarily relies on the accuracy of the following data sets:

- Information including activity rates and operational practices provided by State Water;
- Ambient air quality monitoring data obtained from the regional monitoring network;
- Terrain and land use information for the region sourced from the databases described in **Section 7.5**.

Therefore, a number of assumptions have been applied and relied upon within this assessment. These include:

- Dust emission rates derived from published emission factors are representative of emissions from proposed activities at Chaffey Dam;
- PM_{10} concentrations measured at Tamworth are representative of background concentrations in the area surrounding Chaffey Dam;
- Default values of parameters used in the development of emission factors (e.g. silt and moisture contents) are representative of on-site conditions; and
- Simulated meteorology adequately represents local conditions.

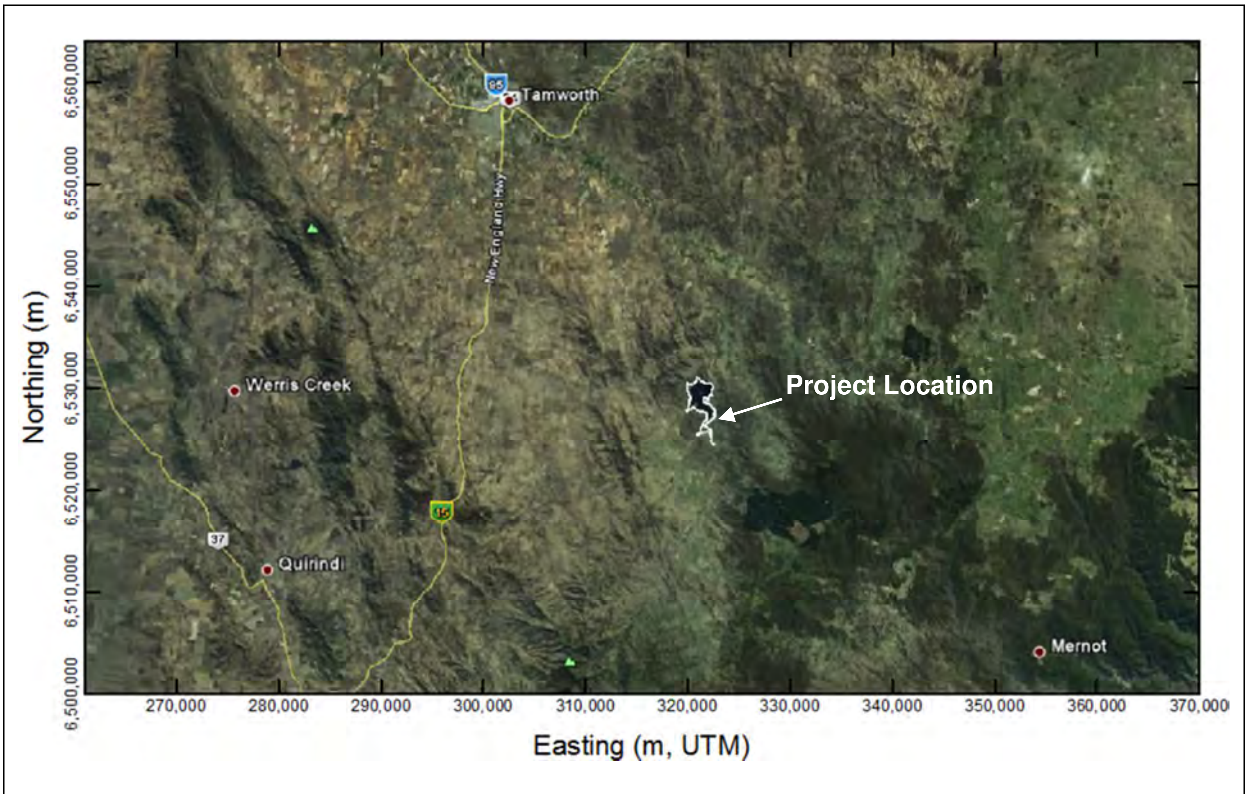
2 PROJECT DESCRIPTION

2.1 Project Setting

Chaffey Dam is located on the Peel River, approximately 30 km to the southeast of Tamworth (**Figure 1**) in the Tamworth Regional Local Government Area (LGA). The existing dam wall structure was constructed between 1976 and 1979, and comprises a 54 m high earth and rockfill embankment with a crest length of approximately 430 m. A morning glory spillway is in place which enables excess water to pass through the dam downstream to the Peel River. There is an auxiliary spillway on the left abutment which enables extreme flood flows to pass around the dam.

Chaffey Dam has a storage volume of 62 gigalitres (GL), a reservoir surface area of 542 hectares and has a catchment area of approximately 420 km^2. Each year it supplies approximately 9 GL of potable town water to Tamworth and approximately 6.6 GL of irrigation water to local landholders downstream.

Figure 1 Project Location



(Image courtesy GoogleEarth)

2.2 Project Overview

Chaffey Dam is classified as a high hazard dam due to the potential consequences of dam failure. To comply with the current Australian National Committee on Large Dams (ANCOLD) and NSW Dams Safety Committee safety standards for high hazard dams, Chaffey Dam needs to pass a probable maximum flood (PMF) if the reservoir were full at the commencement of flooding. At Chaffey Dam the PMF has an estimated annual exceedance probability (AEP) of 1 in 1,000,000 (Molino Stewart, 2011).

The morning glory spillway ensures that the dam provides some flood mitigation capacity. However, the maximum flood that the dam could withstand is quantified as the 1 in 100,000 AEP event (Molino Stewart, 2011). Recently, a precast concrete wall was built along the dam crest and an auxiliary spillway put in place to ensure that it meets the requirements for a 1 in 470,000 AEP event. The auxiliary spillway has an earth and rockfill fuse plug embankment which is designed to fail in the event of an extreme flood. This directs the flood waters back to the Peel River, avoiding overtopping of the dam wall.

State Water is proposing to increase the dam's storage capacity to provide more water security for town and irrigation supplies and the opportunity will be taken as part of those works to provide sufficient freeboard to the dam crest that the auxiliary spillway can safely pass a PMF. It is proposed to raise the full supply level by 6.5 m from 518.6 m to 525.1 m AHD. To ensure compliance with the Dams Safety Committee's requirements, the effective dam crest level will need to be raised by up to 8.4 m to 543.7m AHD. In addition the spillways will also need to be modified.

To complete the augmentation, three key tasks will need to be undertaken:

Raise the Dam Wall

Works include increasing the height of the dam wall by 8.4 m with additional compacted earth and rockfill material to be placed on the top and on the downstream face of the dam wall. This will shift the crest centreline and the toe of the dam downstream. Excavated rock from the recent auxiliary spillway construction will be utilised.

Key components of this task will include:

- Dismantling and removing the existing 1.8 m high concrete parapet wall panels.
- Reconstructing the top part of the existing embankment to extend the central impervious clay core and the filter zones to the new embankment crest level. The clay is to be sourced from an area adjacent to the existing stockpile area (shown in **Figure 2**).
- Placing rockfill materials on top of the existing embankment to increase the crest level of the embankment.
- Removing the existing unconsolidated fill materials along the downstream toe of the embankment to expose the buried part of the downstream toe and the original dam foundation.
- Treating and compacting the downstream toe and dam foundation.
- Placing new rockfill materials over the downstream and potentially the upstream face of the existing embankment. The rockfill material (excavated rock from the previous auxiliary spillway construction) is to be sourced from the existing stockpile areas shown in **Figure 2**.
- Disposing of unsuitable excavated materials in the existing stockpile area/spoil disposal area shown in **Figure 2**.

Modify the Existing Spillways

The morning glory spillway will need to be raised 6.5 m to align with the new full supply level. The existing auxiliary spillway will also need to be modified to provide for any likely staged release of flood flows given the increased water levels.

Key components of this task will include:

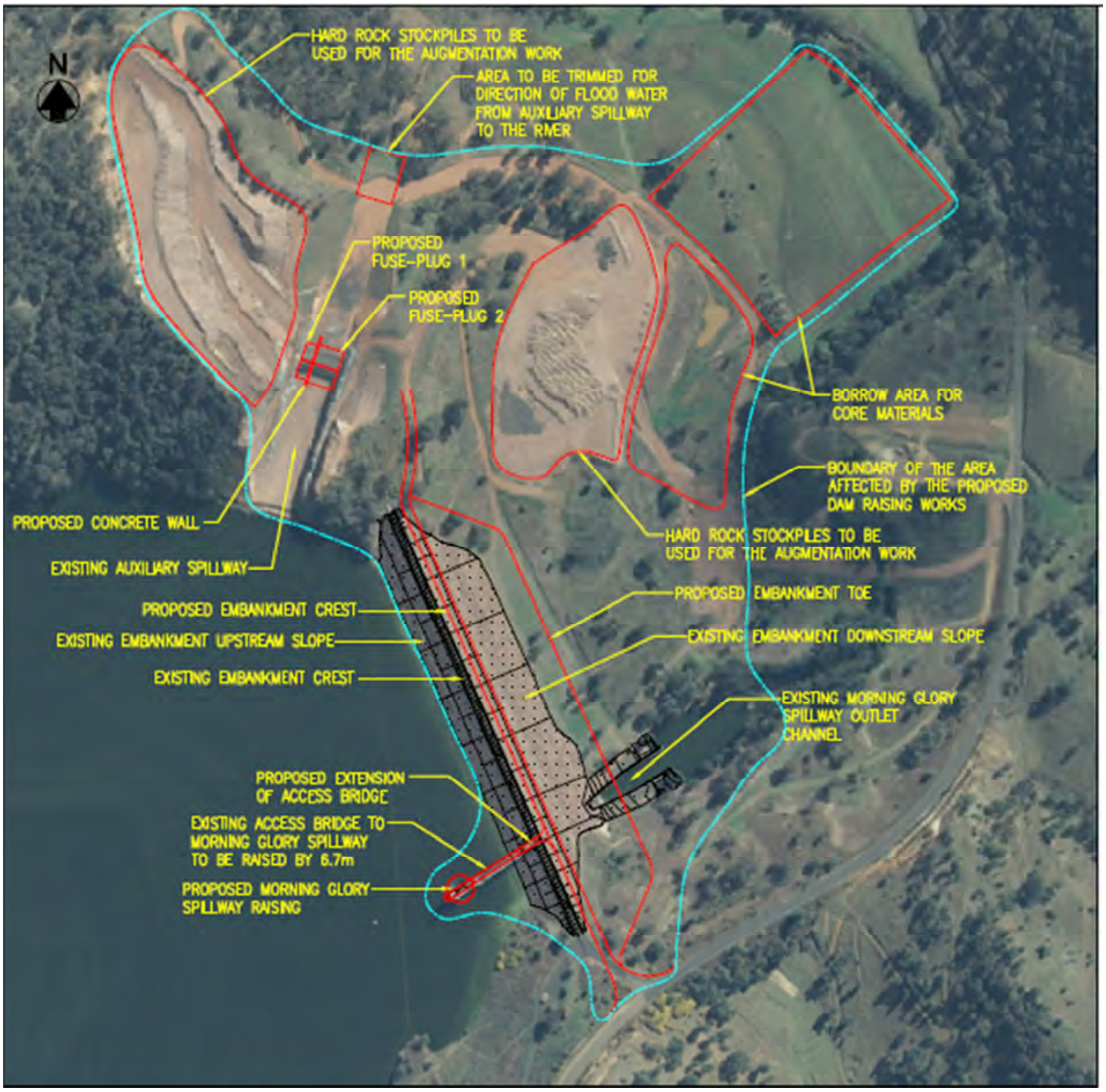
- Raising the sill level of the existing morning glory spillway from 518.6m AHD to 525.1 m AHD in order to augment the storage to 100 GL.
- Raising the height of the intake tower by 8.42 m to match the new crest level of the embankment dam.

- Modifying the access bridge for the intake tower by raising it by 8.42 m to 541.92 m AHD to match the raised entrance level of the intake tower and the new embankment crest level.
- Constructing an 18 m long extension bridge to connect the existing bridge to the raised embankment crest.
- Installing a flood gate across the concrete parapet wall to provide access to the raised bridge.
- Extending the outlet tunnel of the intake tower by 9 m.
- Constructing a new two bay fuse plug embankment within the existing auxiliary spillway, with a sill level at 525.5 m AHD at the current fuse plug location.

Modification of Other Infrastructure

Tamworth-Nundle Road (and Bowling Alley Point Bridge) and Western Foreshore Road will need to be realigned and/or raised to ensure they are not impacted by the increased full supply level. South Bowlo Fishing Club Tamworth facilities and the Bowling Alley Point Recreation Area will also need to be relocated.

Figure 2 Chaffey Dam Augmentation and Safety Upgrade – Site Layout



2.3 Construction Methodology

Conventional land-based construction methods are anticipated to be used, except for works to the morning glory spillway, which will require some access via water. The construction methodology, facilities and equipment for each of these elements is described in **Table 1** and the overall layout of the construction areas is shown in **Figure 3**.

It is noted that there will likely be a requirement for a concrete batching plant on site as part of construction activities for the Project. The concrete batching plant has been excluded from this assessment as responsibility for any relevant approvals and licensing of the concrete batching plant will lie with the Construction Contractor.

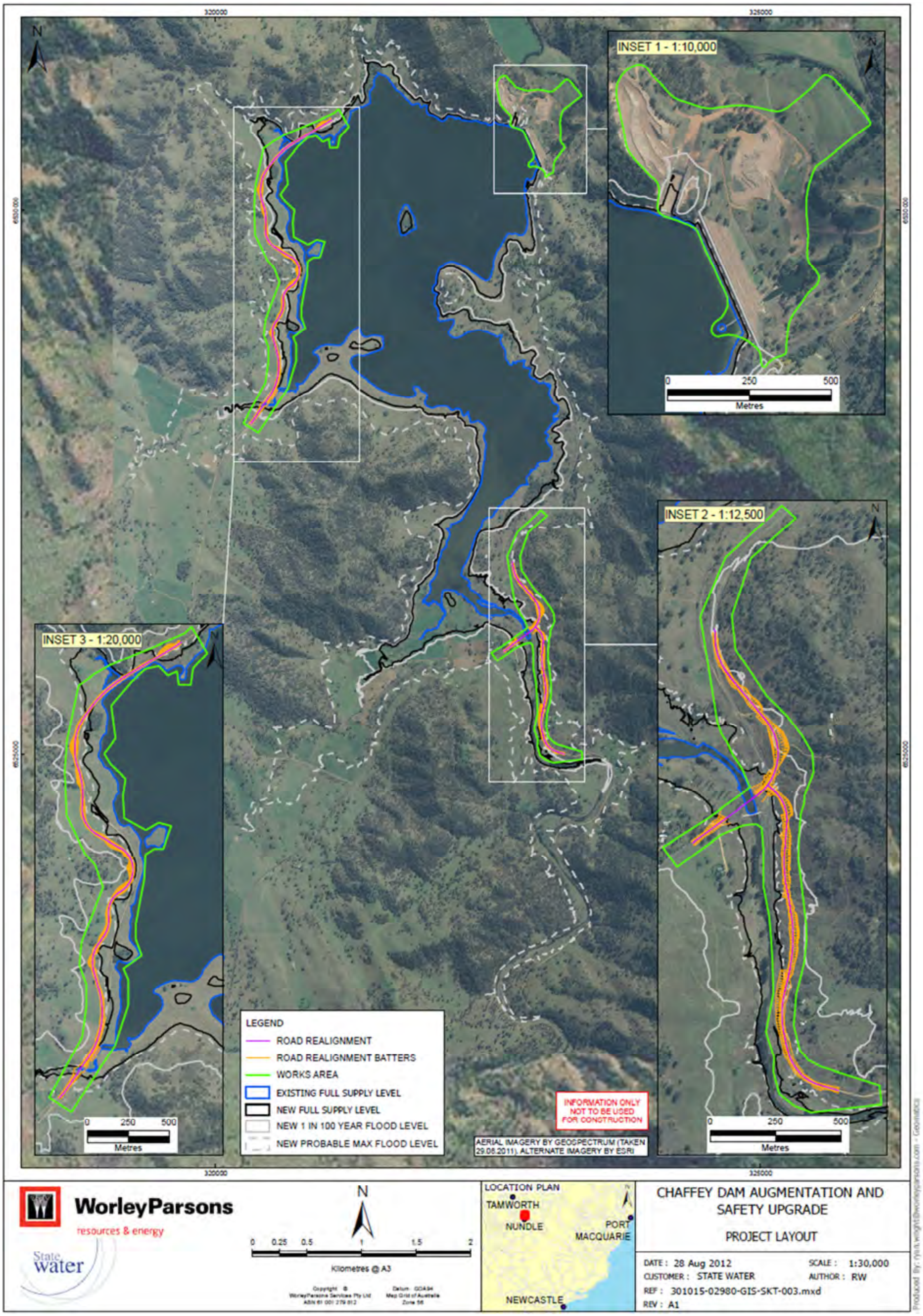
Access to the site for construction will primarily be via Tamworth-Nundle Road.

Table 1 Project Construction Methodology, Facilities and Equipment

Methodology		Volume	Typical Equipment	Facilities
1	**Raising the Dam Wall**			
1.1	Remove and stockpile parapet wall for reuse. Some wall units will require excavation for removal	380 pre-cast concrete units	20 tonne (t) rough terrain crane 10 t flatbed truck 5 t backhoe	Works and stockpile area is located downstream of dam wall with direct access across the Peel River from Tamworth-Nundle Road (refer **Figure 3**)
1.2	Excavate and stockpile deposited material at toe for reuse at toe of new embankment	160,000 m^3	80 t excavator 45 t articulated dump trucks (12 loads per hour) D10 dozer	
1.3	Excavation of dam crest to expose existing crest embankment zones	30,000 m^3	30 t excavator 30 t dump trucks (12 loads per hour) Water cart Cat 140H grader	
1.4	Haul and place rock from Hard Rock Stockpile and clay from Borrow Area for dam wall raising	200,000 m^3	80 t excavators 50 t dump trucks (assume 9 loads per hour) 20 t vibrating roller 25 t compactor Water cart Cat 140H grader Cat D10N dozer	
1.5	Construction of road pavement and reinstalling the parapet wall	3,740 m^2 380 pre-cast concrete units	30 t articulated dump trucks 16 t vibrating roller Water Cart Truck (8 m^3 body) (assume 94 loads at one hour per round trip) Cat 140H grader	
2	**Raising the Morning Glory Spillway**			
2.1	Decommission and remove all mechanical and electrical equipment from bridge deck	N/A	5 t crane 5 t flatbed truck	Works and stockpile area is located downstream of dam wall with direct access across the Peel River from Tamworth-Nundle Road (refer **Figure 3**)
2.2	Remove and store access bridge for reinstallation after dam wall and spillway raising	N/A	180 t barge crane 180 t mobile crane 30 x 15 m barge 25 t rough terrain crane 25 t semi-trailer truck 18 m work boat	
2.3	Raise morning glory spillway and piers	2,500 m^3 (concrete)	180 t crane barge 180 t mobile crane 30 x 15 m barge 80 m^3/hr concrete pump	
2.4	Reinstall access bridge and gantry crane to bridge deck	N/A	180 t crane barge 180 t mobile crane 30 x 15 m barge	
2.5	Install new mechanical and electrical equipment to bridge deck	N/A	5 t crane 5 t flatbed truck	
3	**Reconfiguration of Auxiliary Spillway Fuseplug**			
3.1	Construction of dividing wall between the two bays	70 m^3	Rock drill 5 t concrete truck 50 t mobile crane	Works and stockpile area is located downstream of dam

Methodology		Volume	Typical Equipment	Facilities
3.2	Raise fuseplug embankment	2,000 m^3	30 t articulated truck 30 t excavator D8 dozer Cat 140H grader 5 t smooth roller 5 t pad foot roller 20,000 L water cart	wall with direct access across the Peel River from Nundle Road (refer **Figure 3**)
4	**Realignment of Roads and Bridges**			
4.1	Construction of new, and raising of existing, roads on the Western Foreshore Road	10,000 m^3 from cut in current alignment	20 t articulated dump truck 50 t excavator D10N dozer Cat 140H grader 20,000 L water cart 15 t smooth roller 15 t pad foot roller	Realigned road will be as per design plan
4.2	Construction of approaches and new section of road near Bowling Alley Point Bridge	10,000 m^3 from cut in current alignment	20 t articulated dump truck 50 t excavator D10N dozer Cat 140H grader 20,000 L water cart 15 t smooth roller 15 t pad foot roller	
4.3	Construction of a 6-span, 2 lane bridge at Bowling Alley Point with total length of 174 m	Drilling required for foundations	50 t rough terrain mobile crane 25 m^3/hr concrete pump 20 t piling rig on crawler tracks 10 t auger drill rig truck mounted 10 t flatbed truck 20 t semi-trailer	
4.4	Construction of a 2-span single lane bridge on Hyde's Creek (Western Foreshore Road) with a total length of 58 m	Drilling required for foundations	50 t rough terrain mobile crane 25 m^3/hr concrete pump 20 t piling rig on crawler tracks 10 t auger drill rig truck mounted 10 t flatbed truck 20 t semi-trailer	

Figure 3 Overall Project Layout



2.4 Construction Schedule

The program for construction and operation of the Project will be dependent on the selected contractor and dam safety requirements. However, the preliminary program is expected to comprise the following:

- Weeks 1 to 12 Construction documentation, approvals and establishment (up to 20 personnel on site)
- Weeks 13 to 60 Raising of dam wall, realignment of roads and bridges and reconfiguration of auxiliary spillway (up to 50 personnel on site)
- Weeks 61 to 90 Raising of Morning Glory spillway (up to 40 personnel on site)
- Weeks 90 to 104 Commissioning and site disestablishment (up to 20 personnel on site)

This schedule indicates that the major earthworks and other construction activities with the potential for significant dust emissions are expected to occur over a period of approximately 18 months.

Construction activities are envisaged to occur between the hours of 7:00 AM to 6:00 PM Monday to Friday and 8.00 am to 1.00 pm on Saturdays with no work on Sundays or public holidays.

3 SURROUNDING LAND USE AND SENSITIVE RECEPTORS

Existing land uses around the dam include:

- Recreational and open space areas, including:
  - Bowling Alley Point Recreation Area managed by the Bowling Alley Point Recreation Reserve Trust;
  - Boating facilities;
  - South Bowlo Fishing Club Tamworth
  - Nundle Fishing Club
- Roads and bridges;
- Land under private ownership and leasehold, including rural residential properties and land used for grazing and dairy farming; and
- State Water administration and maintenance facilities.

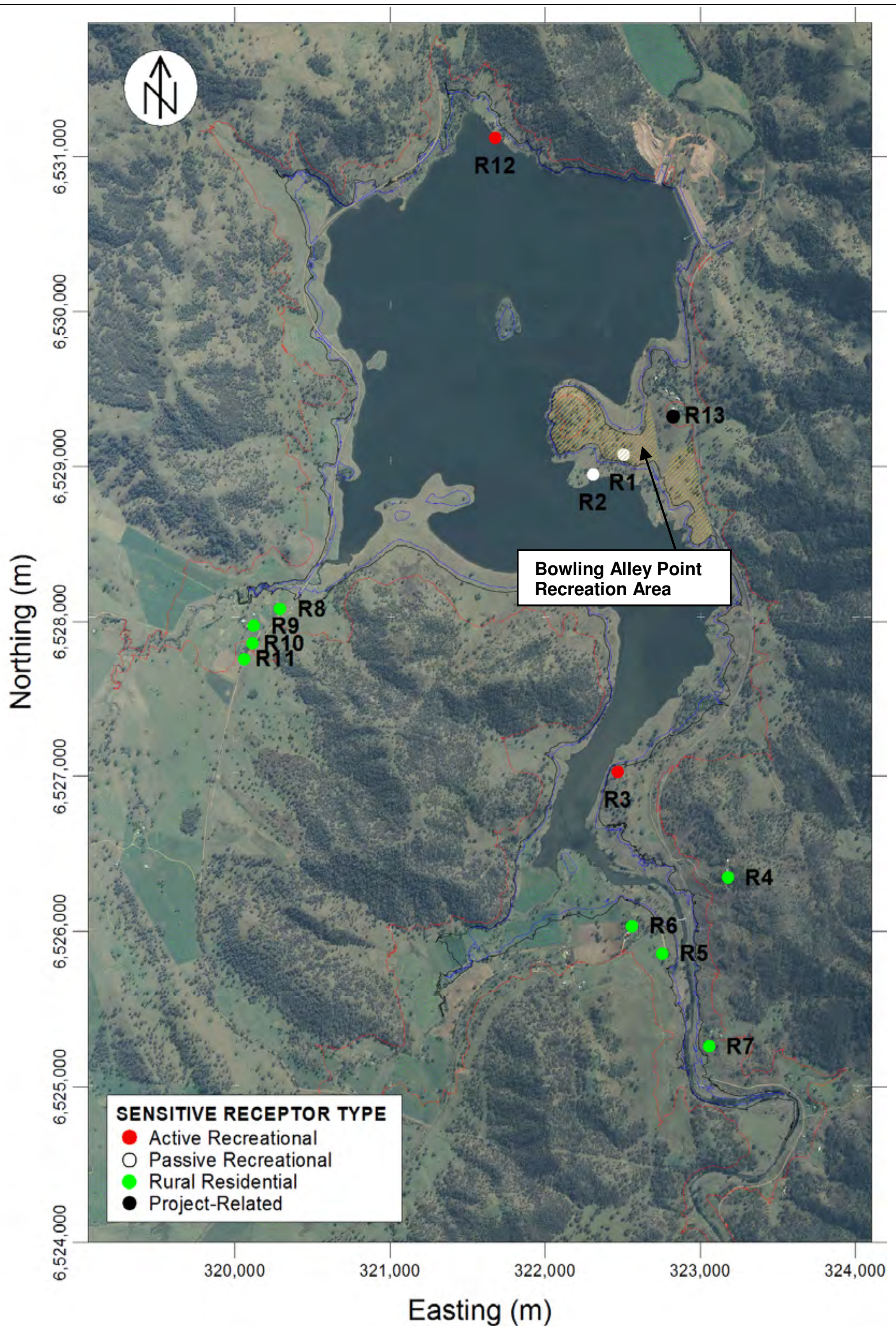
The nearest most potentially affected sensitive receivers to the Project are provided in **Table 2** and **Figure 4**. It is noted that while **Table 2** lists the position of sensitive land uses within the vicinity of the Project, any of the roads or tracks within the vicinity of the Project could potentially be used for recreational purposes.

Table 2 Identified Sensitive Receivers

ID	Receiver	Type	Location	
			Easting	Northing
R1	Bowling Alley Point Recreation Area – Amenities Building	Passive Recreational	322,503.0	6,529,076.8
R2	Bowling Alley Point Recreation Area – Camping Area	Passive Recreational	322,307.9	6,528,947.5
R3	Nundle Fishing Clubhouse	Active Recreational	322,467.7	6,527,028.9
R4	Bowling Alley Point	Rural Residential	323,176.0	6,526,346.5
R5	Bowling Alley Point	Rural Residential	322,754.2	6,525,856.8
R6	Bowling Alley Point	Rural Residential	322,558.3	6,526,035.3
R7	Bowling Alley Point	Rural Residential	323,055.3	6,525,258.0
R8	Western Foreshore	Rural Residential	320,291.3	6,528,081.1
R9	Western Foreshore	Rural Residential	320,119.0	6,527,971.6
R10	Western Foreshore	Rural Residential	320,112.4	6,527,857.5
R11	Western Foreshore	Rural Residential	320,057.2	6,527,758.5
R12	South Bowlo Fishing Club Tamworth Clubhouse	Active Recreational	321,675.8	6,531,119.5
R13	Storage Custodian's residence	Project-Related	322,825.2	6,529,325.5

Note: R13 is a State Water employee's residence and directly related to the operation of Chaffey Dam.

Figure 4 Locations of Sensitive Receptors



4 REGULATORY FRAMEWORK

The *Protection of the Environment Operations (Clean Air) Regulation 2010* remade the Protection of the Environment Operations (Clean Air) Regulation 2002. The Regulation is the core legislative and regulatory instrument for air quality issues in NSW. It includes regulatory measures for a number of issues, including domestic solid fuel heaters, control of burning, motor vehicles and motor vehicle fuels, and emissions from industry.

Part 5 (*Air impurities from emitted activities and plant*) of the POEO (Clean Air) Regulation 2010 refers to the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2005) (hereafter the "Approved Methods") for assessment of impacts of air pollutants.

The Approved Methods:

- Lists the statutory methods for modelling and assessing air pollutants from stationary sources in NSW.
- Specifies assessment criteria which reflect the environmental outcomes adopted by DECC.

The assessment criteria set out in the Approved Methods relevant to the Chaffey Dam Augmentation and Safety Upgrade are discussed below.

4.1 Assessment Criteria

4.1.1 Pollutants of Interest

The most significant emissions associated with the proposed activities will be emissions of particulate matter from the excavation, handling and transport of soil and rocks, as well as from wind erosion of disturbed soils.

The proposed construction activities will also give rise to emissions of products of fuel combustion in mobile equipment including excavators, dozers and haul trucks. These emissions include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), volatile organic compounds (VOCs) and fine particulate matter. These emissions will occur over large areas and will vary spatially and temporally during the course of the works. Based on the equipment numbers and activity rates proposed in **Table 1**, there is no potential for exceedances of air quality criteria for SO_2, NO_2, CO or VOCs to occur at the identified sensitive receptor locations and these emissions have not been considered further. Emissions of particulate matter from the vehicle exhausts have been included in the assessment of particulate emissions from construction activities noted above.

4.1.2 Ambient Air Quality Criteria for Particulate Matter

Airborne contaminants that can be inhaled directly into the lungs can be classified on the basis of their physical properties as gases, vapours or particulate matter. In common usage, the terms "dust" and "particulates" are often used interchangeably. The term "particulate matter" refers to a category of airborne particles, typically less than 30 microns (µm) in diameter and ranging down to 0.1 µm and is termed total suspended particulate (TSP).

Emissions of particulate matter less than 10 and 2.5 microns (µm) in diameter (referred to as PM_{10} and $PM_{2.5}$ respectively) are considered important pollutants due to their ability to penetrate into the respiratory system. In the case of the $PM_{2.5}$ category, recent health research has shown that this penetration can occur deep into the lungs. Potential adverse health impacts associated with exposure to PM_{10} and $PM_{2.5}$ include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

Suspended Particulate Matter

The annual goal for Total Suspended Particulate (or TSP) recommended by OEH is 90 µg/m^3. It was developed before the more recent results of epidemiological studies suggested a relationship between health impacts and exposure to concentrations of finer particulate matter.

The NSW Office of Environment and Heritage (OEH) PM_{10} assessment goals as expressed in the Approved Methods are as follows:

- A 24-hour maximum of 50 µg/m^3; and
- An annual average of 30 µg/m^3.

The 24-hour PM_{10} reporting standard of 50 µg/m^3 is numerically identical to the 24-hour average National Environment Protection Measure (NEPM) reporting standard for PM_{10}, except that the NEPM reporting standard allows for five exceedances per year. These NEPM goals were developed by the National Environmental Protection Council (NEPC) in 1998 to be achieved within 10 years of commencement (i.e. by 2008).

In December 2000, the NEPC initiated a review to determine whether a new ambient air quality criterion for $PM_{2.5}$ was required in Australia, and the feasibility of developing such a criterion. The review found that:

- There are health effects associated with these fine particles;
- The health effects observed overseas are supported by Australian studies; and
- Fine particle standards have been set in Canada and the USA, and an interim criterion is proposed for New Zealand.

The review concluded that there is sufficient community concern regarding $PM_{2.5}$ to consider it an entity separate from PM_{10}. As such, in July 2003, a variation to the Ambient Air Quality National Environment Protection Measure (NEPM) was made to extend its coverage to $PM_{2.5}$. This document references the following interim advisory reporting standards for $PM_{2.5}$:

- A 24-hour average concentration of 25 µg/m^3; and
- An annual average concentration of 8 µg/m^3.

It is noted that the advisory reporting standards relating to $PM_{2.5}$ particles are at the present time reporting guidelines only and not intended to represent air quality criteria.

Deposited Particulate Matter

The preceding sections are concerned in large part with the health impacts of particulate matter. Nuisance impacts need also to be considered, mainly in relation to deposited dust (i.e. dust settling out of the air onto surfaces such as cars, washing, windowsills etc.).

In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4 g/m^2/month. **Table 3** presents the OEH impact assessment goals for dust deposition, showing the allowable increase in dust deposition level over the ambient (background) level which would be acceptable so that dust nuisance could be avoided.

Table 3 OEH Goals for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 g/m^2/month	4 g/m^2/month

Source: Approved Methods, OEH 2005.

4.1.3 Project Air Quality Goals

Based on the above, the air quality goals adopted for this assessment, which conform to current OEH air quality criteria, are summarised below in **Table 4**.

Table 4 Project Air Quality Goals

Pollutant	Averaging Time	Goal
TSP	Annual	90 µg/m^3
PM_{10}	24 hours Annual	50 µg/m^3 30 µg/m^3
$PM_{2.5}$	24 hours Annual	25 µg/m^3 8 µg/m^3
Dust Deposition	Annual	Maximum incremental (Project only) increase of 2 g/m^2/month Maximum Total of 4 g/m^2/month (Project and other sources)

Source: Approved Methods, OEH 2005.

5 EXISTING ENVIRONEMNT

5.1 Meteorology and Climatology

The nearest available meteorological monitoring stations operated by the Bureau of Meteorology (BoM) collecting data suitable for use in a quantitative air dispersion modelling study is located at Tamworth Airport (Station 55325), 34 km northwest of Chaffey Dam. Rainfall, temperature and relative humidity statistics from the BoM's Tamworth Airport weather station for the period 1992 to 2012 are presented and discussed below.

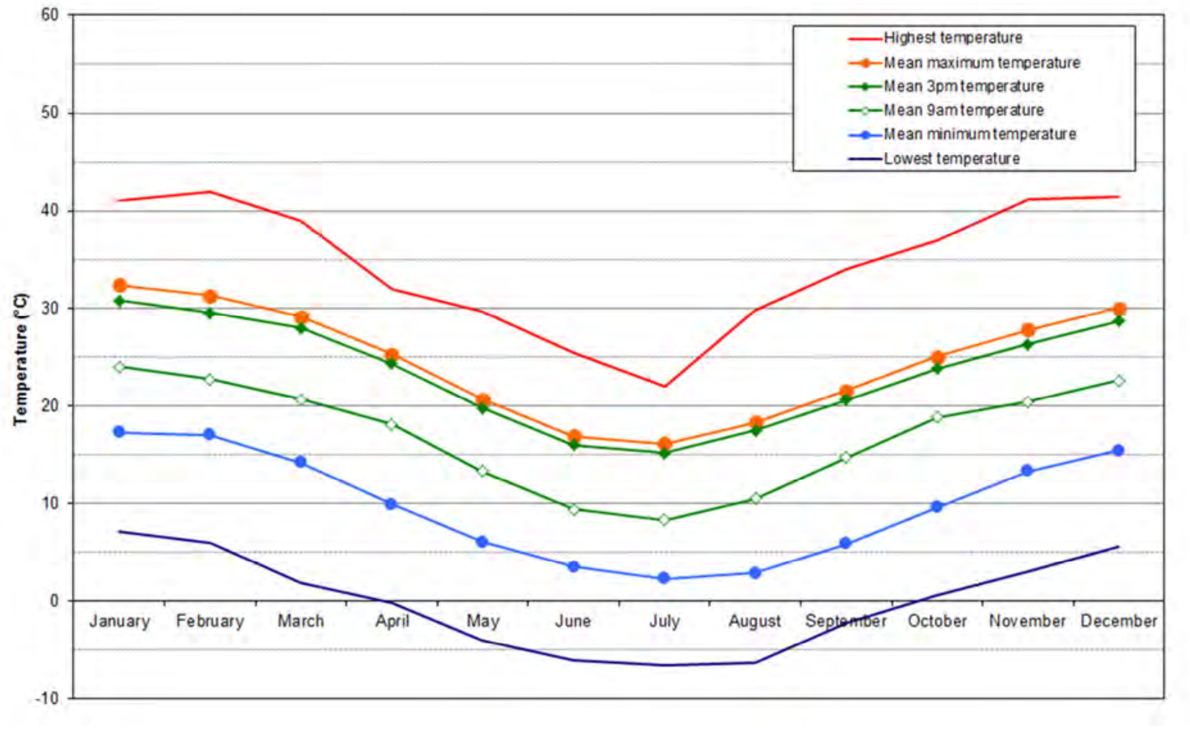
Monthly mean maximum and minimum temperatures recorded at Tamworth (1992 – 2012) are presented in **Figure 5**. This data shows that average maximum temperatures in the region exceed 30℃ during summer. During the winter months, the average maximum temperature falls to about 22℃. Average minimum temperatures range from 17℃ in summer to 2℃ in winter.

Monthly average rainfall data recorded at Tamworth Airport (1993 – 2012) are presented in **Figure 6**. The average annual rainfall was 393 mm over the period. Higher monthly rainfall rates occur between November and February.

Monthly average 9:00 AM and 3:00 PM relative humidity data recorded at Tamworth Airport (1992 – 2012) are presented in **Figure 7**. The humidity levels are higher in the morning compared to the afternoon. Levels are highest in June and July (around 80% at 9:00 AM and 50% at 3:00 PM) and drop to their lowest levels in December and January (around 55% at 9:00 AM and 35% at 3:00 PM).

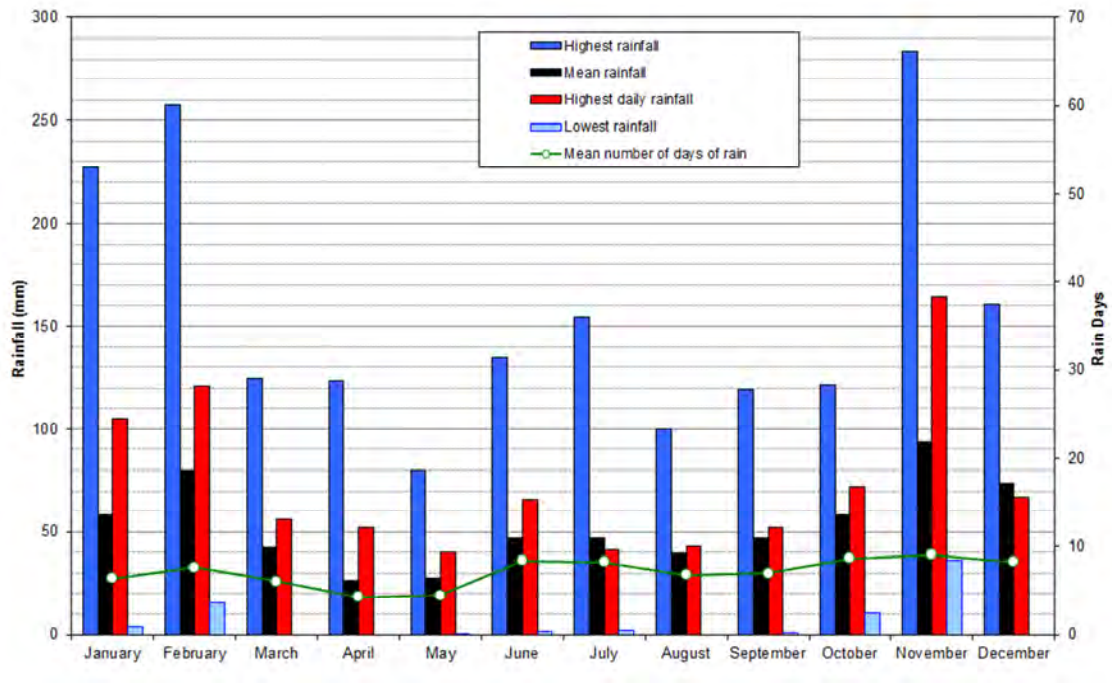
Further details of the meteorology at the Project site are provided in **Section 7.4**, based on meteorological modelling studies performed as part of this assessment.

Figure 5 Monthly Average Minimum and Maximum Temperatures



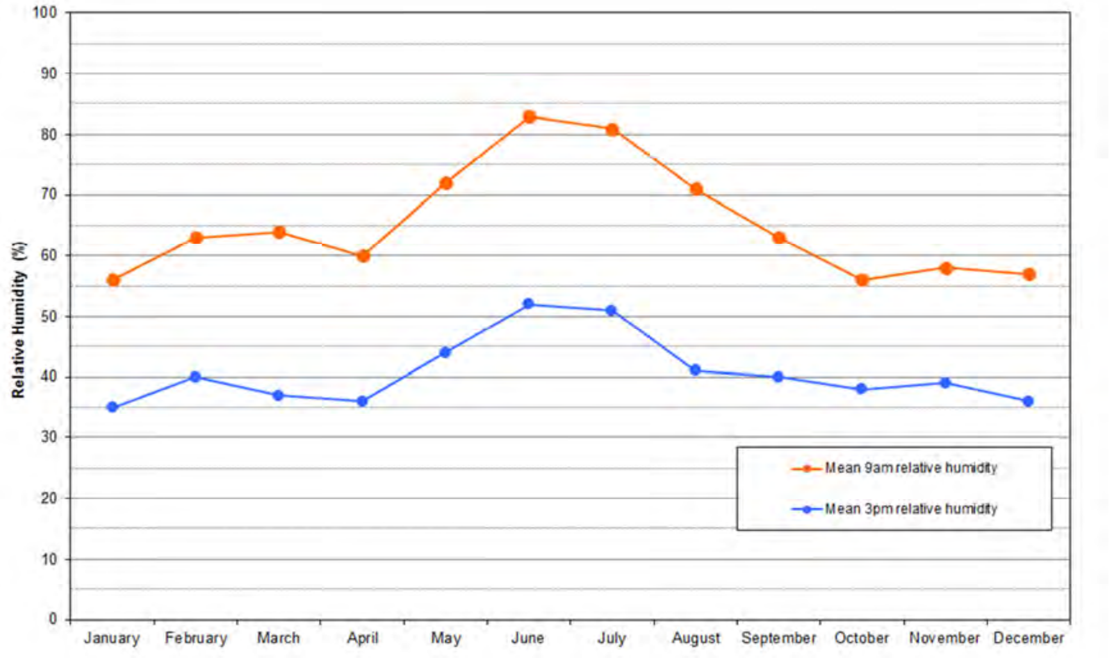
SOURCE: http://www.bom.gov.au/climate/averages/tables/cw_055325.shtml

Figure 6 Monthly Average Rainfall Data



SOURCE: http://www.bom.gov.au/climate/averages/tables/cw_055325.shtml

Figure 7 Monthly Average 9:00 AM and 3:00 PM Relative Humidity Data



SOURCE: http://www.bom.gov.au/climate/averages/tables/cw_055325.shtml

5.2 Existing Air Quality

Given the undeveloped nature and low population density of the surrounding area, the existing air quality at the Project site is expected to be good. There are no major industrial or commercial air emission sources in the area and domestic (e.g. wood burners) and vehicle emissions will also be minimal.

There is no site-specific air quality monitoring data available for the Project site, however the NSW OEH operates an ambient air quality monitoring station at Tamworth, 34 km northwest of Chaffey Dam, in collaboration with local council. The Tamworth air quality monitoring site is located in Hyman Park, off Robert Road and Vue Street. It is situated in a rural township on the north-west slopes and was commissioned in October 2000. The following air pollutants and meteorological variables are measured at Tamworth:

- Fine particles (PM_{10} using a tapered element oscillating microbalance (TEOM)); and
- Wind speed, wind direction and sigma theta (standard deviation of wind direction).

The 24-hour average PM_{10} concentrations measured at Tamworth over the last two years are presented in **Figure 8**. This plot shows that only one exceedance of the NEPM Guideline of 50 µg/m3 was measured during this period, occurring on 20 September 2011. The second highest 24-hour average concentration recorded by the station in 2011 was 37.8 µg/m^3 (19 September 2011).

Annual average PM_{10} concentrations measured from 2001 to 2011 are shown in **Figure 9**. The annual average PM_{10} concentration recorded in 2011 was 13.1 µg/m^3.

Figure 8 24-Hour Average PM_{10} Concentrations Measured at Tamworth (Aug 2010 – Aug 2012)

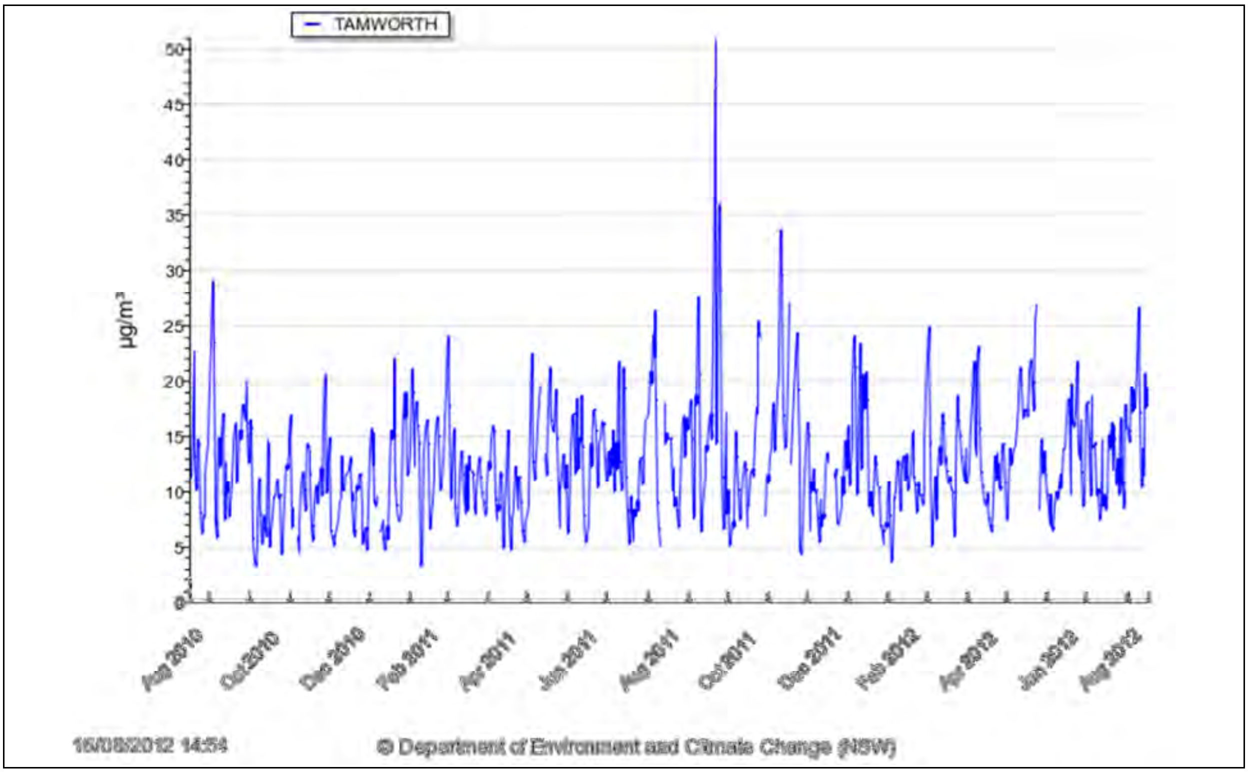
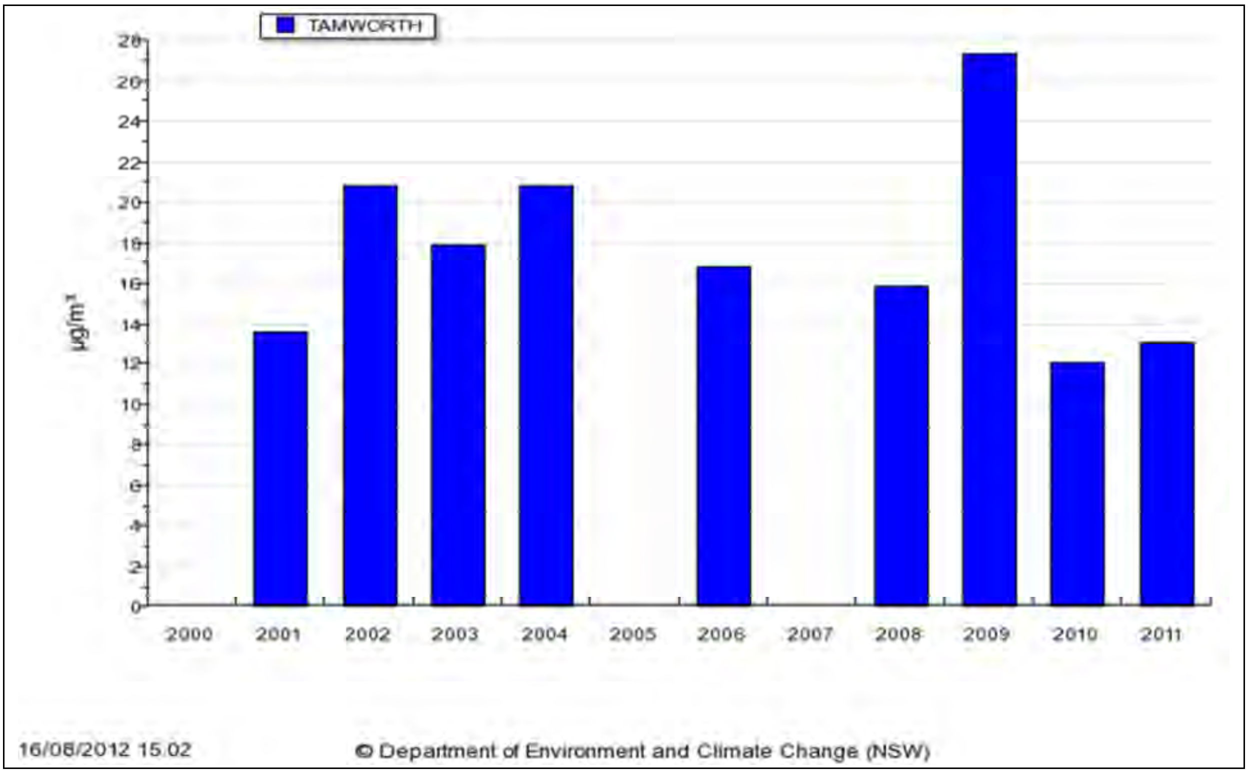


Figure 9 Annual Average PM_{10} Concentrations Measured at Tamworth (2001 – 2011)



Based on the monitoring data recorded at Tamworth in 2011, a daily-varying background PM_{10} data file has been compiled for use in the dispersion modelling study. This file is contemporaneous with the 2011 meteorological file used in the modelling. The 2011 dataset had 12 days missing and these data gaps were replaced with the annual average of 13.1 µg/m^3.

There are no local or regional monitoring data available for TSP or $PM_{2.5}$. A daily-varying background $PM_{2.5}$ data file was therefore compiled for use in the modelling based on the PM_{10} concentrations measured at Tamworth and assuming a $PM_{2.5}/PM_{10}$ ratio of 0.5. Similarly, a daily-varying background TSP file was compiled for use in the modelling assuming a PM_{10}/TSP ratio of 0.5.

The impacts of dust deposition were assessed using the NSW OEH's incremental impact criterion of 2 g/m^2/month, hence background levels are not required to be estimated.

6 ESTIMATION OF EMISSIONS

6.1 Emission Scenario

This assessment has been prepared based on a single proposed worst case construction scenario that has been compiled to give rise to maximum expected air quality impacts at the sensitive residences/properties identified in **Section 3**. In order to provide a worst case assessment of emissions from the construction stage, it has been assumed that the following activities could potentially be undertaken simultaneously:

- Excavation and stockpiling of material at toe of the dam wall for reuse at toe of new embankment (Task 1.2 in **Table 1**);
- Hauling and placement of rock from the Hard Rock Stockpile and clay from Borrow Area for dam wall raising (Task 1.4 in **Table 1**);
- Reconfiguration of fuseplug embankment at the auxiliary spillway (Task 3.2 in **Table 1**); and
- Road and bridge construction works at Western Foreshore Road (including at Hydes Creek) and Bowling Alley Point (Tasks 4.1 – 4.4 in **Table 1**).

Emissions of particulate from the initial preparation works and road paving activities at the dam wall and the auxiliary spillway (Tasks 1.1, 1.5 and 3.1 in **Table 1**) are expected to be significantly less than that generated during the main construction activities listed above and have therefore not been included in the worst case emission scenario.

Excavation of the dam crest to expose the existing crest embankment zones (Task 1.3 in **Table 1**) would be completed prior to the hauling of rock from the Hard Rock Stockpile for the dam wall raising (Task 1.4 in **Table 1**) with no overlap in these activities. As Task 1.4 involves larger quantities of soil and rock being moved, it has been included in the worst case scenario.

Works during Weeks 61 – 90 of the construction schedule associated with raising the morning glory spillway (Tasks 2.1 – 2.5 in **Table 1**) do not involve major excavation works and the potential for dust generation is considered to be significantly lower than for the activities listed above, hence these activities have also not been included in the worst case emission scenario.

This assessment has considered emissions of particulate matter from:

- Excavation and handling of soil and rocks (excavators, truck loading and unloading);
- Dozers and graders working on stockpiles and haul routes;
- Vehicle movements on unpaved roads; and
- Wind erosion of stockpiles and disturbed soils.

Emissions from drilling for preparation of bridge foundations have not been included in the emission estimates. Emissions of particulate from drilling will be minor compared to the other activities associated with the Project.

Worst case emission rates have been estimated as described in **Section 6.2** Due to the variable and short-term nature of the Project, emission rates are presented in kg/hour rather than kg/annum. In the modelling, those emissions associated with the use of equipment such as excavators, dozers and trucks were assumed to only occur during the hours of 7.00 am to 6.00 pm, while emissions from wind erosion were configured in the modelling to occur only when the wind speed in the meteorological file exceeded 5 m/s.

6.2 Emission Estimation Methodology

6.2.1 Emission Factors

Emission factors for TSP and PM_{10} have been sourced from the Commonwealth of Australia Document "*National Pollutant Inventory (NPI) for Mining*, Version 3.1 (2002)" and the US EPA's AP-42 Emission Factors where suitable factors do not exist within the NPI documentation. The emission factors used, and their source, are presented overleaf in **Table 6**.

While the National Pollutant Inventory for Mining, Version 3.1 (2002) and US EPA's AP-42 contain emission factors for TSP and PM_{10}, no factors are provided within these documents for $PM_{2.5}$. This is because there is little data available on the fraction of PM_{10} that is typically emitted as $PM_{2.5}$ from the wide range of sources involved.

Some limited research has been conducted by the Midwest Research Institute (MRI) on behalf of the Western Regional Air Partnership (WRAP) with findings published within the document entitled *'Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors'* (MRI, 2006). This document provides proposed $PM_{2.5}/PM_{10}$ ratios for a number of fugitive dust source categories, as presented in **Table 5**. The $PM_{2.5}$ / PM_{10} ratios presented in **Table 5** have been used within this assessment to calculate the emissions of $PM_{2.5}$. The most appropriate ratio has been applied to each emission source.

Table 5 Particle Size Ratios Proposed for Inclusion in US EPA AP-42

Fugitive Dust Source	AP-42 Section	Proposed $PM_{2.5}$ / PM_{10} Ratio
Paved Roads	13.2.1	0.15
Unpaved Roads	13.2.2	0.10
Aggregate Handling and Storage Piles	13.2.4	0.10
Industrial Wind Erosion	13.2.5	0.15
Open Area Wind Erosion	-	0.15

Table 6 Emission Factor Equations Used in this Assessment

Activity	Emission Factor Equation	Units	Source	Variables	Controls Applied*
Excavator / Front End Loader on waste rock / overburden	$EF_{TSP} = 0.025$ $EF_{PM10} = 0.012$	kg/t	NPI EETM v3.1 (p47)	N/A	None assumed
Trucks dumping waste rock / overburden	$EF_{TSP} = 0.012$ $EF_{PM10} = 0.0043$	kg/t	NPI EETM v3.1 (p51)	N/A	Water sprays - 70%
Dozer on material other than coal	$EF_{TSP} = 2.6 \times \left(\frac{s^{1.2}}{M^{1.4}}\right)$ $EF_{PM_{10}} = 0.34 \times \left(\frac{s^{1.5}}{M^{1.4}}\right)$	kg/hr	NPI EETM v3.1 (p50)	s=silt content (assumed 5%) M=Moisture content (assumed 10%)	None assumed
Grader	$EF_{TSP} = 0.0034 \times S^{2.5}$ $EF_{PM_{10}} = 0.0034 \times S^{2.0}$	kg/VKT	NPI EETM v3.1 (p58)	S=mean vehicle speed (assumed 5 km/h)	None assumed
Unpaved haul route wheel dust	$EF = k \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45}$	kg/VKT	NPI EETM v3.0 (p16)	k = 4.08 (TSP) k = 1.24 (PM_{10}) s = silt content (%), W = vehicle gross mass (tonnes)	Level 1 watering (2 $l/m^2/hr$) - 50%
Wind Erosion	$EF_{TSP} = 0.04$ $EF_{PM10} = 0.02$	kg/ha/hr	NPI EETM v3.1 (p60))	N/A	Water sprays - 50%

Note: VKT = Vehicle kilometres travelled

6.2.2 Activity Data

Quantities of Soil Excavated

The quantities of soil assumed to be excavated in each area in the emission calculations are provided in **Table 7**. These quantities are based on the payloads and number of loads per hour provided in **Table 1**.

Table 7 Assumed Quantities of Soil Excavated/Moved

Route	Payload (tonnes)	Trips (per hour)	Quantity (tonnes/hr)	Unloading Location
Dam Toe Excavator	45	12	540	Stockpile Area
Auxiliary Spillway Excavator	20	5	100	Auxiliary Spillway
Borrow Area 1 Excavator	50	4	200	Dam Crest
Borrow Area 2 Excavator	50	5	250	Auxiliary Spillway
Western Foreshore Road Excavator	20	5	100	Western Foreshore Road
Bowling Alley Point Excavator	20	5	100	Bowling Alley Point

Haulage Distances

The estimated haulage distances assumed in the dispersion modelling are provided in **Table 8**. These distances are based on the layout diagrams provided in **Tamworth-Nundle** Road (and Bowling Alley Point Bridge) and Western Foreshore Road will need to be realigned and/or raised to ensure they are not impacted by the increased full supply level. South Bowlo Fishing Club Tamworth facilities and the Bowling Alley Point Recreation Area will also need to be relocated.

Figure 2 and **Figure 3**. Unsealed haul roads used by the haul trucks have been assumed to contain 10% moisture and 5% silt.

Table 8 Estimated Haul Route Activity Data

Route	Haul Route Length (m)	Total Quantity to be Moved (m^3)	Number of Trips # (per Hour)	Vehicle Kilometres Travelled per Hour (VKT)
Dam Toe to Stockpile	150	160,000	24	3.6
Stockpile to Dam Wall	250	200,000	18	4.5
Stockpile to Auxiliary Spillway	400	2,000	10 *	4.0
Western Foreshore Road	100	10,000	10 *	1.0
Bowling Alley Point	100	10,000	10 *	1.0

Two-way traffic

* No data provided – assumed value

Open Areas

The disturbed areas assumed to be subject to wind erosion in each area are shown in **Table 9**.

Table 9 Areas Exposed to Wind Erosion

Area	Estimated Area of Disturbance (ha)
Dam Construction Area (includes Auxiliary Spillway)	31.9
Western Foreshore Road construction zone	12.1
Bowling Alley Point construction zone	3.9
Total	**47.9**

6.3 Estimated Emissions

Total calculated emissions of TSP, PM_{10} and $PM_{2.5}$ are presented in **Table 10**. **Table 10** shows that for the dam wall and auxiliary spillway areas, the greatest source of dust emissions is predicted to be the excavation and haulage of soils and rock. The excavators are also the most significant source of dust emissions for the road modifications at Western Foreshore Road and Bowling Alley Point.

Table 10 Estimated Particulate Emissions from Construction Activities

Area	Source	TSP (kg/hr)	PM_{10} (kg/hr)	$PM_{2.5}$ (kg/hr)
Dam wall and Auxiliary Spillway	Excavators	13.6	6.5	0.65
	Truck Unloading	3.6	1.3	0.13
	Dozers	2.0	0.3	0.03
	Graders	0.7	0.3	0.03
	Haul roads	28.4	7.6	0.76
	Wind erosion	6.4	3.2	0.48
	TOTAL	**54.7**	**19.3**	**2.1**
Western Foreshore Road	Excavators	1.3	0.6	0.06
	Truck Unloading	0.4	0.1	0.01
	Dozers	0.7	0.1	0.01
	Graders	0.4	0.2	0.02
	Haul roads	0.6	0.2	0.02
	Wind erosion	2.4	1.2	0.18
	TOTAL	**5.7**	**2.4**	**0.3**
Bowling Alley Point	Excavators	1.3	0.6	0.06
	Truck Unloading	0.4	0.1	0.01
	Dozers	0.7	0.1	0.01
	Graders	0.4	0.2	0.02
	Haul roads	0.6	0.2	0.02
	Wind erosion	0.8	0.4	0.06
	TOTAL	**4.1**	**1.6**	**0.2**

7 ATMOSPHERIC DISPERSION MODELLING

7.1 Model Selection

Emissions from the proposed construction activities have been modelled using the US EPA's CALPUFF (Version 6.267) modelling system. CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by a meteorological pre-processor CALMET, discussed further below. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

CALPUFF was selected for use in this study in preference to the widely used AUSPLUME model due to the complex terrian surrounding the project site. The NSW Approved Methods notes that AUSPLUME should not be used in the following applications: complex terrain, buoyant line plumes, coastal effects such as fumigation, high frequency of stable calm night-time conditions, and inversion break-up fumigation).

For this study, CALPUFF was run using a sub-domain of the CALMET domain (see **Section 7.3.2**) that had a southwest corner located at 361.468 km E and 6345.444 km S, extended 10 km east-west and 10 km north-south, and had a grid spacing of 200 m.

7.2 Accuracy of Modelling

Atmospheric dispersion models all represent a simplification of the many complex processes involved in the dispersion of pollutants in the atmosphere. To obtain good quality results it is important that the most appropriate model is used and the quality of the input data (meteorological, terrain, source characteristics) is adequate.

The main sources of uncertainty in dispersion models, and their effects, are discussed below.

- **Oversimplification of physics:** This can lead to both under-prediction and over-prediction of ground level pollutant concentrations. Errors are smaller in puff models such as CALPUFF, which include the effects of non-steady-state meteorology (i.e., spatially- and temporally-varying meteorology).
- **Errors in emission rates:** Ground level concentrations are proportional to the pollutant emission rate. In this study, the modelling is based on emission estimates derived from the use of published emission factors and estimated activity levels for worst case operational activities. In order to address the uncertainty associated with these estimates, conservative assumptions have been made so that the emissions are not under-predicted.
- **Errors in source parameters:** Plume rise is affected by source dimensions, temperature and exit velocity. Inaccuracies in these values will contribute to errors in the predicted height of the plume centreline and thus ground level pollutant concentrations. However, for ground-level fugitive sources such as those associated with this study, plume rise is not a significant factor.
- **Errors in wind direction and wind speed**: Wind direction affects the direction of plume travel, while wind speed affects plume rise and dilution of plume. Errors in these parameters can result in errors in the predicted distance from the source of the plume impact, and magnitude of that impact. In addition, aloft wind directions commonly differ from surface wind directions (referred to as "wind shear"). For ground-level fugitive sources such as those associated with this study, wind shear will not have a significant impact on plume behaviour.

- **Errors in mixing height:** If the plume elevation reaches 80% or more of the mixing height, more interaction will occur, and it becomes increasingly important to properly characterise the depth of the mixed layer as well as the strength of the upper air inversion. For ground-level fugitive sources such as those associated with this study, mixing height is not a significant factor
- **Errors in temperature:** Ambient temperature affects plume buoyancy, so inaccuracies in the temperature data can result in potential errors in the predicted distance from the source of the plume impact, and magnitude of that impact. For non-buoyant emission sources such as those associated with this study, ambient temperature is not a significant factor
- **Errors in stability estimates:** Gaussian plume models use estimates of stability class, and 3D models use explicit vertical profiles of temperature and wind (which are used directly or indirectly to estimate stability class for Gaussian models). In either case, errors in these parameters can cause either under-prediction or over-prediction of ground level concentrations. For example, if an error is made of one stability class, then the computed concentrations can be off by 50% or more.

The US EPA makes the following statement in its Modelling Guideline (US EPA, 2005) on the relative accuracy of models:

> *"Models are more reliable for estimating longer time-averaged concentrations than for estimating short-term concentrations at specific locations; and the models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of ± 10 to 40% are found to be typical, i.e., certainly well within the often quoted factor-of-two accuracy that has long been recognized for these models. However estimates of concentrations that occur at a specific time and site, are poorly correlated with actually observed concentrations and are much less reliable."*

In summary, modelling of air emissions is subject to a number of sources of uncertainty. The main source of uncertainty for the air dispersion modelling study performed for this Project relates to the pollutant emission rates, which are based on published emission factors and estimated activity data such as total expected quantities of soil moved and estimated haulage distances. There would be a large degree of variation in the activity levels that would occur during the Project – with regards to both location and time – which would affect the actual short-term hourly emission rates that would occur in any given location. For this reason, care has been taken to use conservative assumptions in estimating the emission rates.

7.3 Meteorological Modelling Methodology

7.3.1 TAPM

Meteorological modelling using The Air Pollution Model (TAPM) meteorological model (Version 4.3) was performed to provide suitable data for input into the dispersion model. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations.

The TAPM model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and historical synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

Additionally, the TAPM model may assimilate actual local wind observations so that they can optionally be included in a model solution. The wind speed and direction observations are used to realign the predicted solution towards the observation values. While the BOM's Tamworth meteorological station records hourly surface data suitable for assimilation into the TAPM model, it is located 35 km or so from the project site, which is located in relatively complex terrain. The TAPM user guide recommends that the radius of influence for observational data should be set at 5 to 30 km, with 20 km being a typical value in flat or gentle terrain. The Tamworth data would therefore need to be restricted to a radius of influence of around 10-15 km, which means that it would have had no impact on the meteorological data generated by the model at the project site. There was therefore no value in assimilating the Tamworth data into the model run, and TAPM was run without any observational data assimilation.

Table 11 details the parameters used in the TAPM meteorological modelling for this assessment. TAPM was run using synoptic scale meteorological data for the year 2011.

Table 11 Meteorological Parameters used for this Study (TAPM v 4.3)

Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grid points	25 x 25 x 25
Year of analysis	2011 (i.e. synoptic data for the year 2011 was used)
South-West Corner	309,155 m E, 6,516,852 m S
Data assimilation	No data assimilation

7.3.2 CALMET

CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final wind field thus reflects the influences of local topography and land uses.

CALTAPM was used to create three dimensional gridded data from the TAPM output to provide an initial guess field across the modelling domain for use by CALMET.

CALMET was configured using a 14 km x 14 km model domain with a 200 m grid spacing, with the southwest corner of the domain located at 314.659 km E and 6522.166 km S in Universal Transverse Mercator (UTM) zone 56.

7.4 Site-Representative Meteorological Data File Used in this Study

A description of the meteorological data derived for the study area for the year 2011 as described above and used in the assessment is provided below.

7.4.1 Atmospheric Stability Data

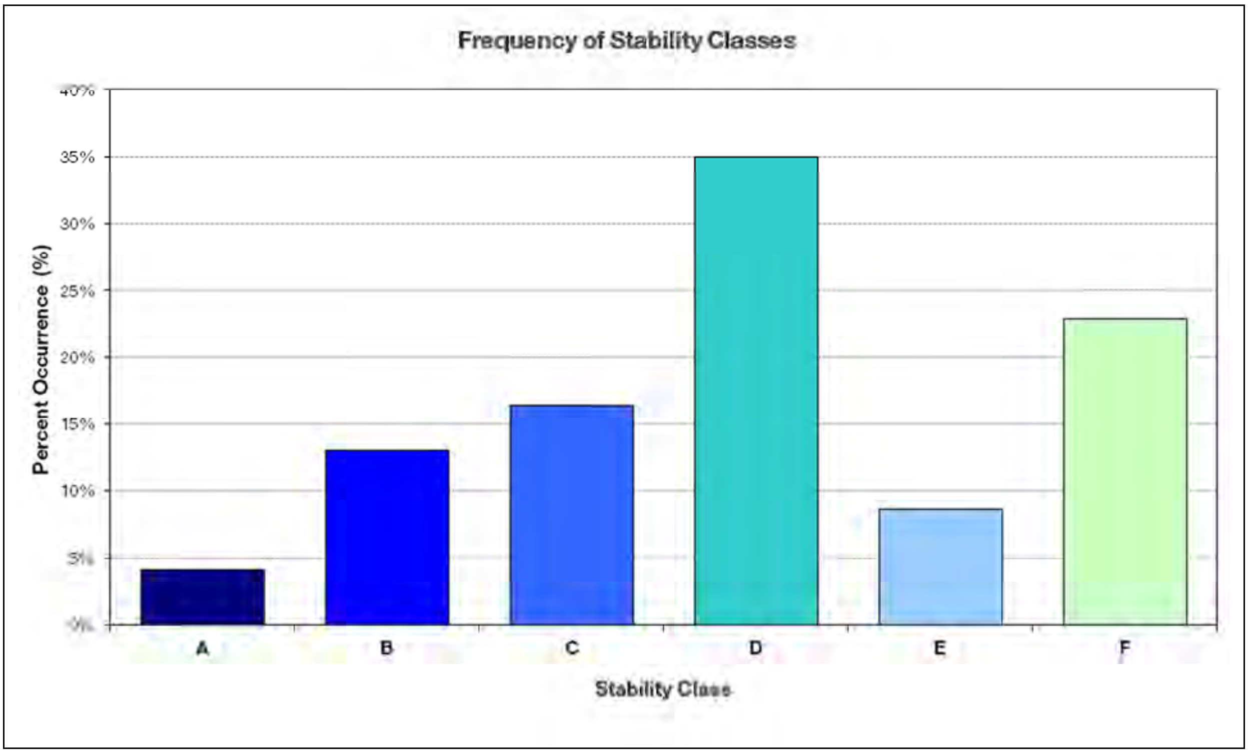
Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, A to F, to categorise the degree of atmospheric stability (see **Table 12**). These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models.

The frequency of each stability class predicted by TAPM at the project site during 2011 is presented in **Figure 10**. The results indicate a high frequency of conditions typical to Stability Class D and F. Stability Class D is indicative of neutral conditions, conducive to a moderate level of pollutant dispersion due to mechanical mixing with Stability Class F indicative of very stable conditions with low winds.

Table 12 Description of Atmospheric Stability Classes

Atmospheric Stability Class	Category Description
A	Very unstable Low wind, clear skies, hot daytime conditions
B	Unstable Clear skies, daytime conditions
C	Moderately unstable Moderate wind, slightly overcast daytime conditions
D	Neutral High winds or cloudy days and nights
E	Stable Moderate wind, slightly overcast night-time conditions
F	Very stable Low winds, clear skies, cold night-time conditions

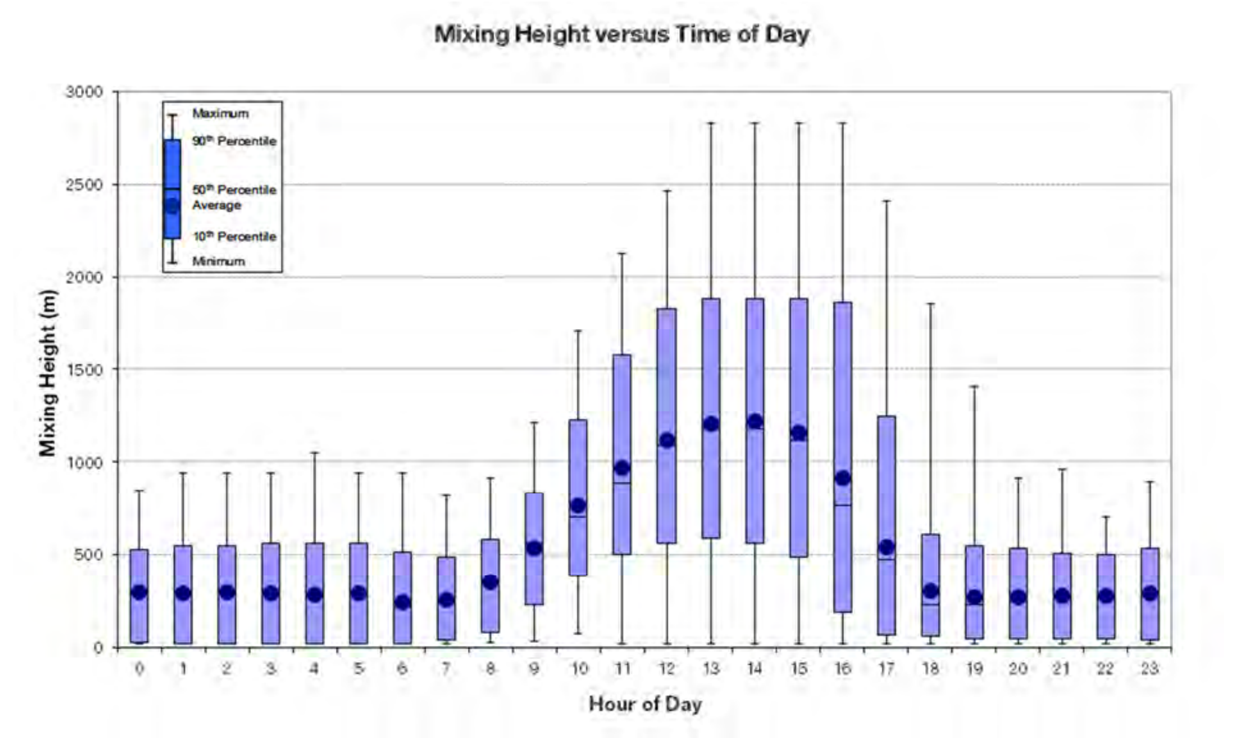
Figure 10 Stability Class Distribution Predicted by TAPM for Chaffey Dam (2011)



7.4.2 Mixing Height Data

Diurnal variations in maximum and average mixing depths predicted by TAPM at the project site during 2011 are illustrated in **Figure 11**. As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

Figure 11 Mixing Heights Predicted by TAPM for Chaffey Dam (2011)



7.4.3 Wind Speed and Direction Data

A summary of the annual wind behaviour predicted by TAPM for Chaffey Dam is presented as wind roses in **Figure 12**. **Figure 12** indicates that winds experienced at Chaffey Dam are predominantly light to moderate (between 1.5 m/s and 8 m/s) and from the east. Infrequent winds vary in direction. Calm wind conditions (wind speed less than 0.5 m/s) were predicted to occur just over 3.2% of the time throughout 2011. The annual average wind speed was 2.6 m/s.

Winds stronger than 5.4 m/s (the threshold for dust pick-up) were predicted to occur just over 5% of the time (518 hours/year). As shown by the wind roses, these stronger winds are generally associated with easterly winds during spring and summer.

It is noted that the terrain surrounding Chaffey Dam is relatively complex and the distances between the three main construction areas (Chaffey Dam, Bowling Alley Point and Western Foreshore Road) are significant. There is therefore potential for the predominant wind directions at each construction area to be affected by localised channelling effects due to nearby hills and valleys. Wind patterns predicted by the modelling at the Bowling Alley Point Road construction area were therefore also examined and the windroses for this location (see **Figure 13**) show a much wider spread in wind directions, with a predominance of westerly winds during the winter months.

Figure 12 Wind Roses for the Chaffey Dam Site, as Predicted by TAPM (2011)

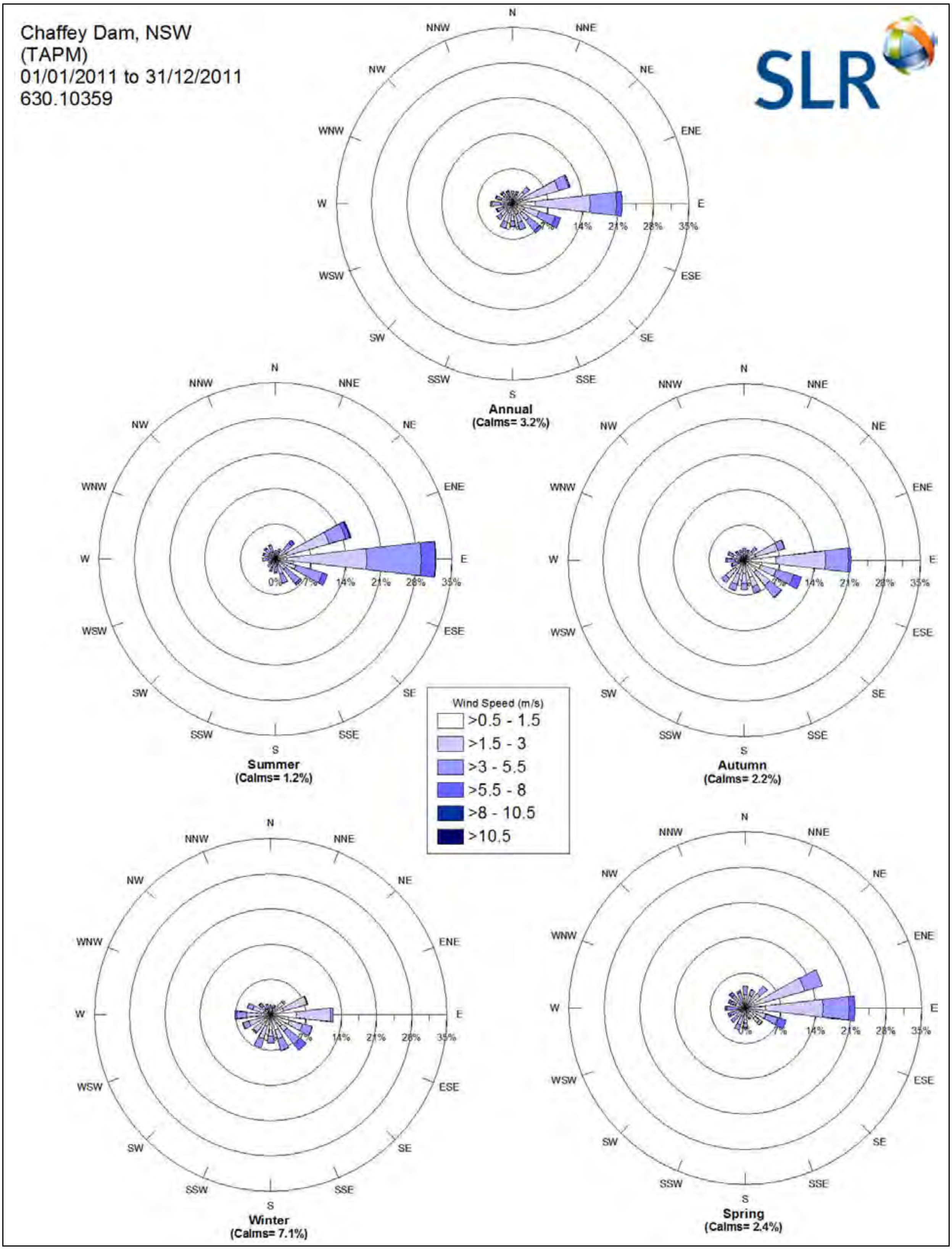
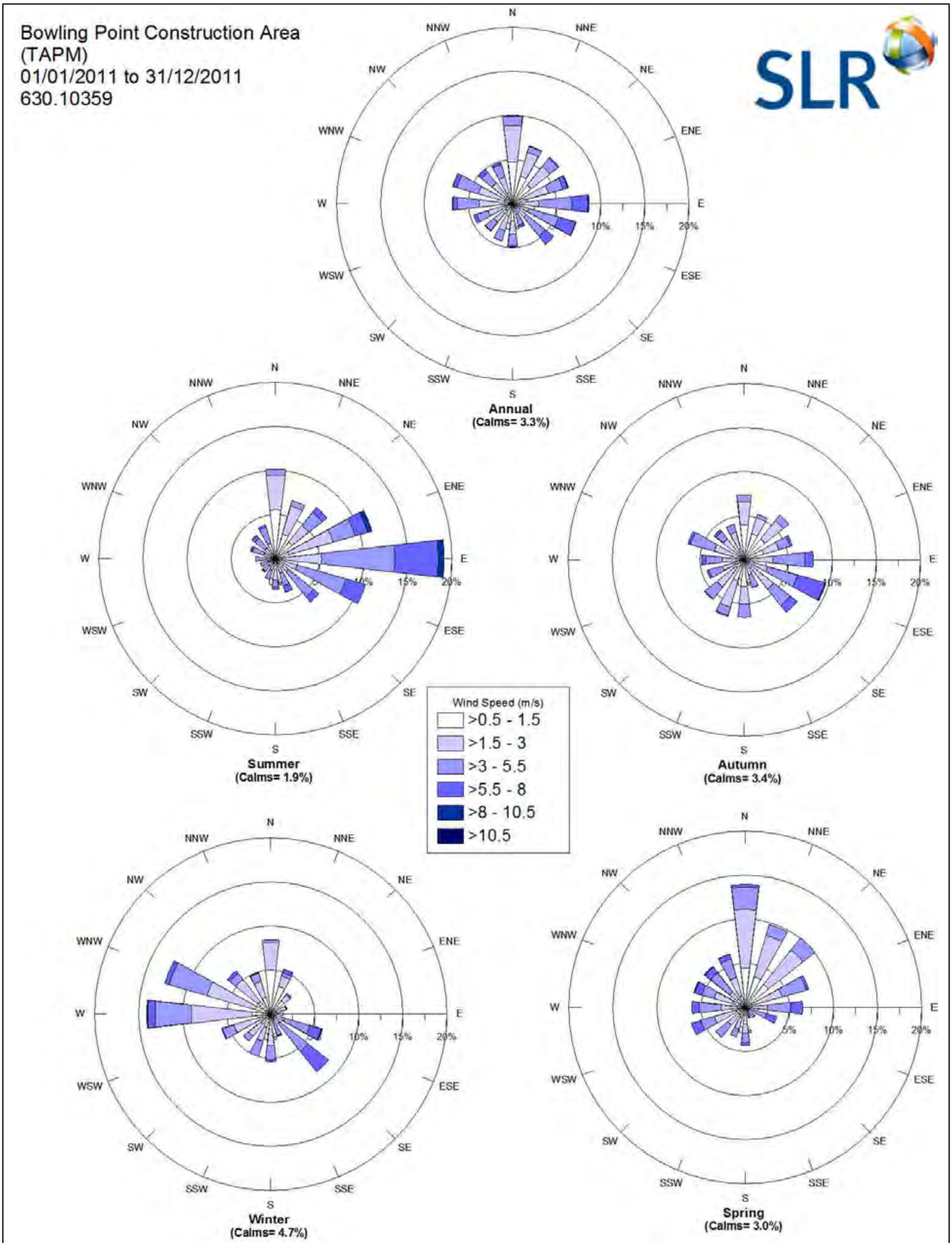


Figure 13 Wind Roses for the Bowling Alley Point Construction Site, as Predicted by TAPM (2011)



7.5 Topography and Land Use Data

The topographical data used in the model was sourced from the United States Geological Service's Shuttle Radar Topography Mission[1] database that has recorded topography across Australia with a 3 arc second (~90 m) spacing.

Land use data was generated using approximately 1 km resolution data sets taken from the providers of the CALPUFF software TRC (www.src.com, accessed 11/10/10).

7.6 Source and Emission Data

The source and emission data entered into the model was based on the emission inventory presented in **Section 6.3**.

CALPUFF requires particle distribution data (geometric mass mean diameter, standard deviation) to compute the dispersion of particulates. Alternatively, hourly varying deposition velocity data can be used. Deposition velocity data for TSP, PM_{10} and $PM_{2.5}$ have been taken from the VISTAS (2005) report (complied to provide guidance to US CALPUFF modellers when predicting pollutant concentrations in sensitive areas), with constant values of 1 m/min (0.0167 m/s) for TSP and PM_{10} and 1 cm/min (0.000167 m/s) for $PM_{2.5}$ used.

Emissions from truck haulage, excavators and other equipment were assumed to emit only during the hours of 7:00 AM to 6:00 PM. Emissions from wind erosion were configured in the model to vary according to the default wind speed categories set in the model, with emissions only occurring when the wind speed exceeded the default 5 m/s threshold.

7.7 Receptor Grids

The modelling was performed with a Cartesian Grid extending 4.8 km east-west and 7.6 km north-south, with a 200 m spacing centred over the study area.

Discrete receptor locations were also included to predict impacts at the sensitive receptors identified in **Section 3**.

[1] Sourced from http://www.src.com/datasets/datasets_terrain.html#SRTM_DATA

8 PREDICTED IMPACTS

8.1 Health-Related Impacts (PM_{10} and $PM_{2.5}$)

PM_{10}

The annual average and 24-hour average PM_{10} concentrations predicted at each of the nominated sensitive receptors using the emission rates calculated in **Section 6.3** are presented in **Table 13**. Contour plots of the predicted concentrations are presented in **Figure 14** (24-hour averages) and **Figure 15** (annual averages). It is noted that due to the complex terrain in the Project area, the contouring of the gridded receptor predictions (200 m spacing) results in some minor inconsistences between the contour plots and the more accurate discrete receptor results presented in **Table 13**.

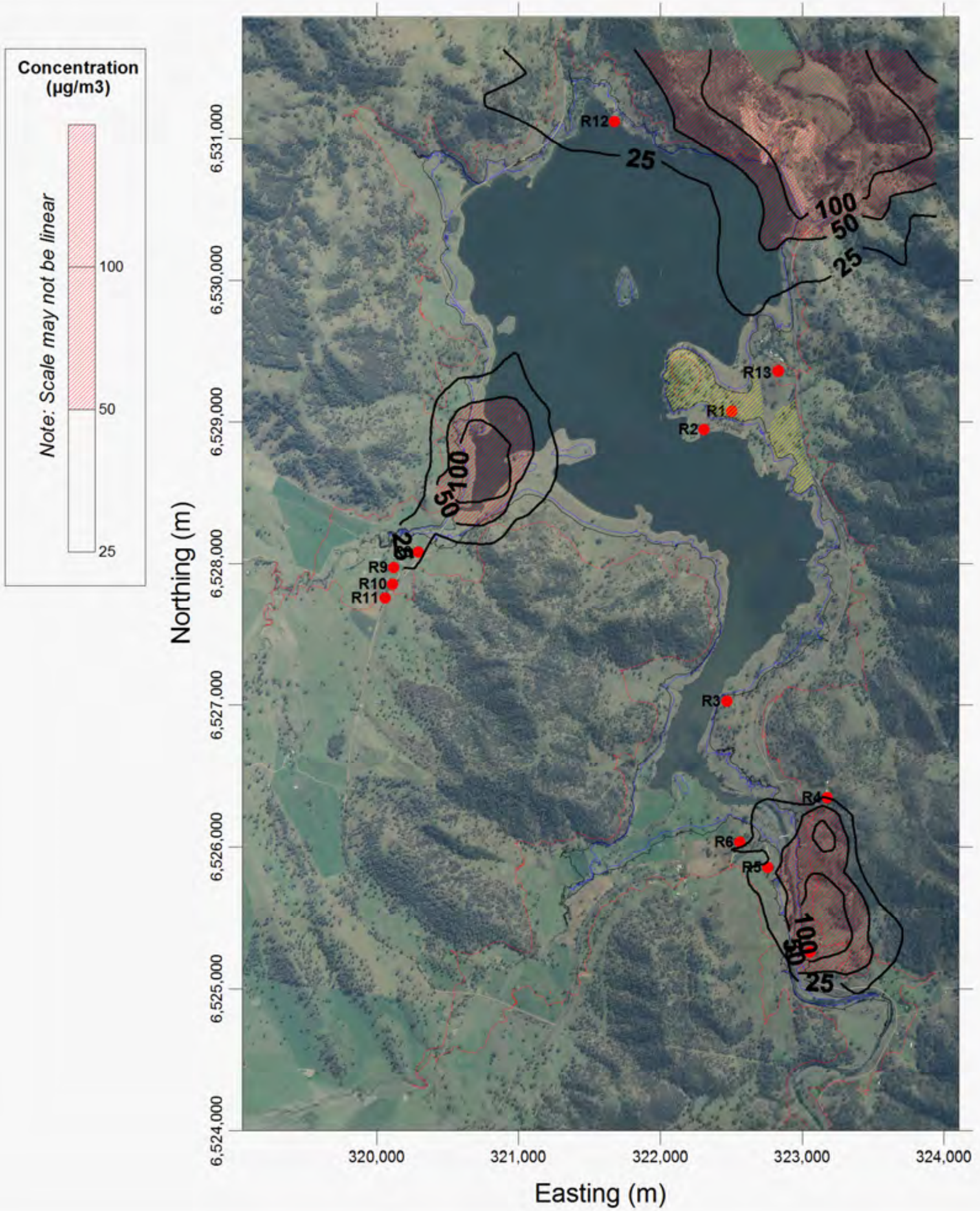
The numbers in brackets in the cumulative (including background) 24-hour average column in **Table 13** are the number of days per year predicted to exceed the NEPM Standard of 50 µg/m³. The results for receptors predicted to experience additional exceedances of the 24-hour guideline (i.e. in addition to the one exceedance included in the background file) are shown in bold text.

As the background file already includes one exceedance of the Standard, the modelling results suggest that the worst affected receptor (Receptor R7, located closest to Rivers Road), could experience an additional 15 exceedance days per annum. However the modelling of construction activities along Bowling Alley Point Road is based on a worst case scenario for this receptor, with all earthmoving equipment operating in the section of road immediately adjacent to this residence. As this scenario will not occur for an entire year, the number of exceedances predicted at this receptor would not be expected to occur in reality. It should also be remembered that when the earthmoving activities associated with the realignment of Tamworth-Nundle Road, Rivers Road and Bowling Alley Point Bridge are occurring further north, closer to Receptors R3 to R6, higher PM_{10} concentrations could occur at these receptors than shown in **Table 13**. However these receptors are located further from the road than Receptor R7, so would not be expected to experience peak concentrations as high as those shown in **Table 13** for Receptor R7.

Table 13 Predicted Annual Average PM_{10} Concentrations

ID	Description	24-Hour Average PM_{10} Concentrations		Annual Average PM_{10} Concentrations	
		Incremental (µg/m³)	Cumulative * (µg/m³)	Incremental (µg/m³)	Cumulative * (µg/m³)
R1	BAP Reserve – Amenities	17	52 (1)	0.7	14
R2	BAP Reserve – Camping Area	15	52 (1)	0.6	14
R3	Nundle Fishing Clubhouse	4	53 (1)	0.4	14
R4	Bowling Alley Point	11	51 (1)	0.4	14
R5	Bowling Alley Point	44	**57 (4)**	9.8	23
R6	Bowling Alley Point	31	51 (1)	4.6	18
R7	Bowling Alley Point	150	**155 (16)**	10.5	24
R8	Western Foreshore	46	**64 (6)**	9.0	22
R9	Western Foreshore	23	52 (1)	3.2	16
R10	Western Foreshore	12	54 (1)	1.4	14
R11	Western Foreshore	8	53 (1)	0.9	14
R12	Tamworth Fishing Clubhouse	39	51 (1)	7.8	21
R13	Storage Custodian's residence	15	52 (1)	0.7	14
Criteria		**-**	**50**	**-**	**30**

* Cumulative impacts derived using a daily-varying background file as discussed in **Section 5.2**.
Numbers in brackets are the number of days predicted to exceed the NEPM Standard of 50 µg/m³.



Maximum Predicted 24-Hour Average PM10 Concentrations

(Excluding Background)

NSW OEH Assessment Criterion = 50 µg/m3

LEGEND

Sensitive Receptor

Bowling Alley Point Recreation Area

NOTES

Dispersion Model: Calpuff V6.267
Meteorological Year: 2011
Modeller: KL

N

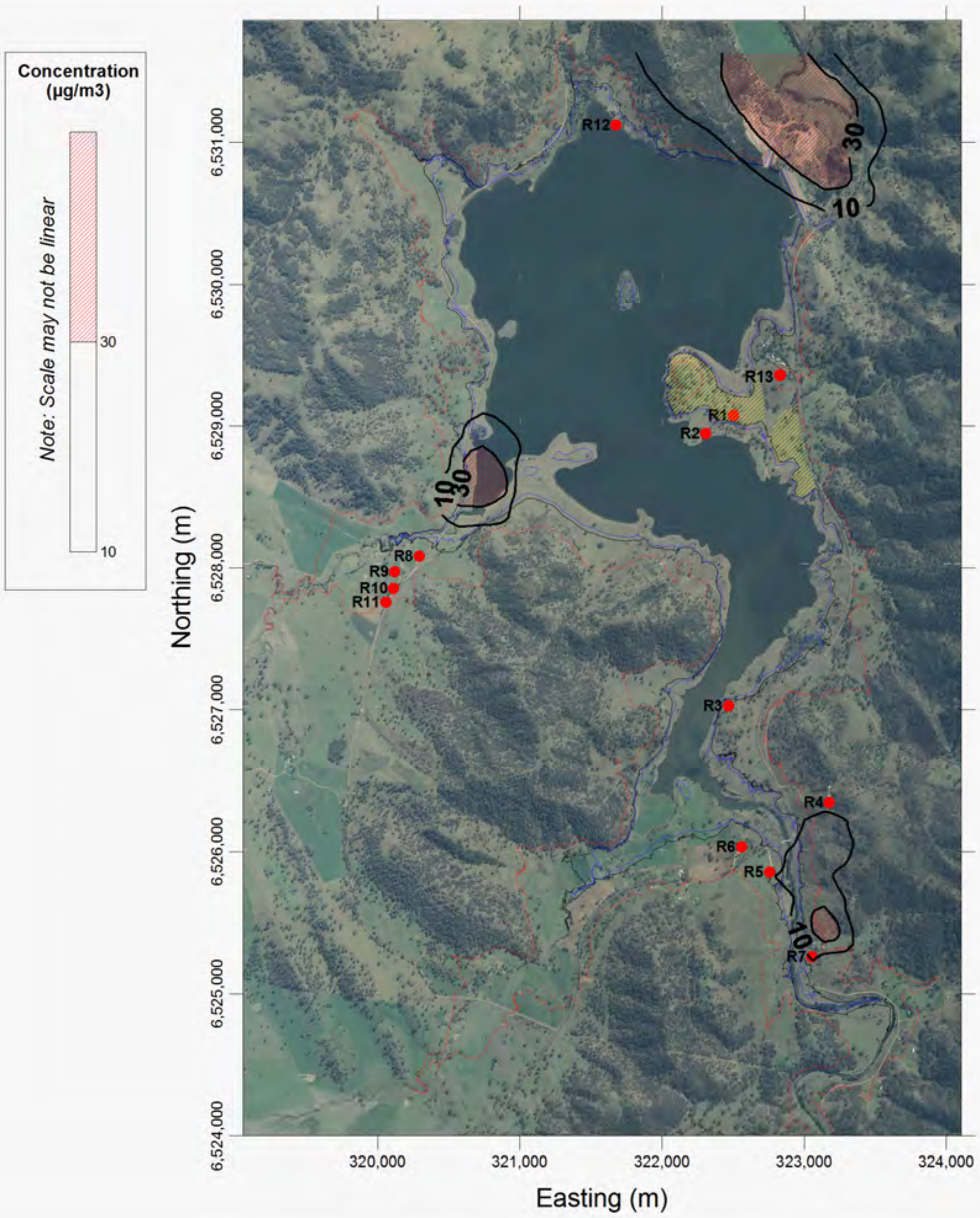
240 Waterworks Road
Ashgrove
QLD 4060
T: +61 7 3858 4800
F: +61 7 3858 4801
www.slrconsulting.com

Chaffey Dam Augmentation and Safety Upgrade

AIR QUALITY IMPACT ASSESSMENT

FIGURE 14

Project No. 630.10359 | Date 13/09/12



Predicted Annual Average PM10 Concentrations

(Excluding Background)

NSW OEH Assessment Criterion = 30 µg/m3

LEGEND

Sensitive Receptor

Bowling Alley Point Recreation Area

NOTES

Dispersion Model: Calpuff V6.267
Meteorological Year: 2011
Modeller: KL

N

SLR

240 Waterworks Road
Ashgrove
QLD 4060
T: +61 7 3858 4800
F: +61 7 3858 4801
www.slrconsulting.com

Chaffey Dam Augmentation and Safety Upgrade

AIR QUALITY IMPACT ASSESSMENT

FIGURE 15

Project No. 630.10359

Date 13/09/12

Receptor R8, located closest to the construction activities along Western Foreshore Road is also predicted to experience additional exceedances of the NEPM Standard of 50 µg/m³. Again, the modelling of construction activities along Western Foreshore Road is based on a worst case scenario for this receptor, with all road construction equipment operating in the section of road closest to this residence. As this scenario will not occur for an entire one-year period, the number of exceedances per year predicted at this receptor would not be expected to occur in reality.

The peak concentrations predicted as a result of construction activities along Rivers Road and Western Foreshore Road are shown in the contour plots to be predicted to occur to the east of the construction activities. As discussed in **Section 7.4.3**, while westerly winds at Chaffey Dam are predicted by the modelling to be very infrequent, the complex topography results in localised wind-channelling effects at Western Foreshore Road and Rivers Road and a higher frequency of westerly winds at these locations. The elevated terrain to the east of the River Road construction area will also contribute to the higher concentrations predicted in this area. In addition, the meteorological conditions giving rise to the highest PM_{10} predictions may be more frequently associated with westerly winds, resulting in a tendency for the peak concentrations to be predicted to the east of the construction areas. Finally, the majority of the emission sources within the model were configured to only occur during the daytime hours. An analysis of the wind directions predicted at River Road showed that while westerly winds (between 225° and 315°) occurred only 15% of the time annually, they occurred 25% of the time during daytime hours.

Figure 16, **Figure 17** and **Figure 18** present time-series plots of the predicted 24-Hour PM_{10} concentrations at Receptors R5, R7 and R8 respectively, showing the relative contribution of estimated background levels and the incremental impact predicted by the modelling. These plots show that maximum impacts are generally predicted to occur during winter and spring. These results suggest that if the works are performed during the summer months, exceedances of the guideline would be less likely to occur.

Figure 16 Time Series Plot of Predicted 24-Hour Average PM_{10} Concentrations at Receptor R5

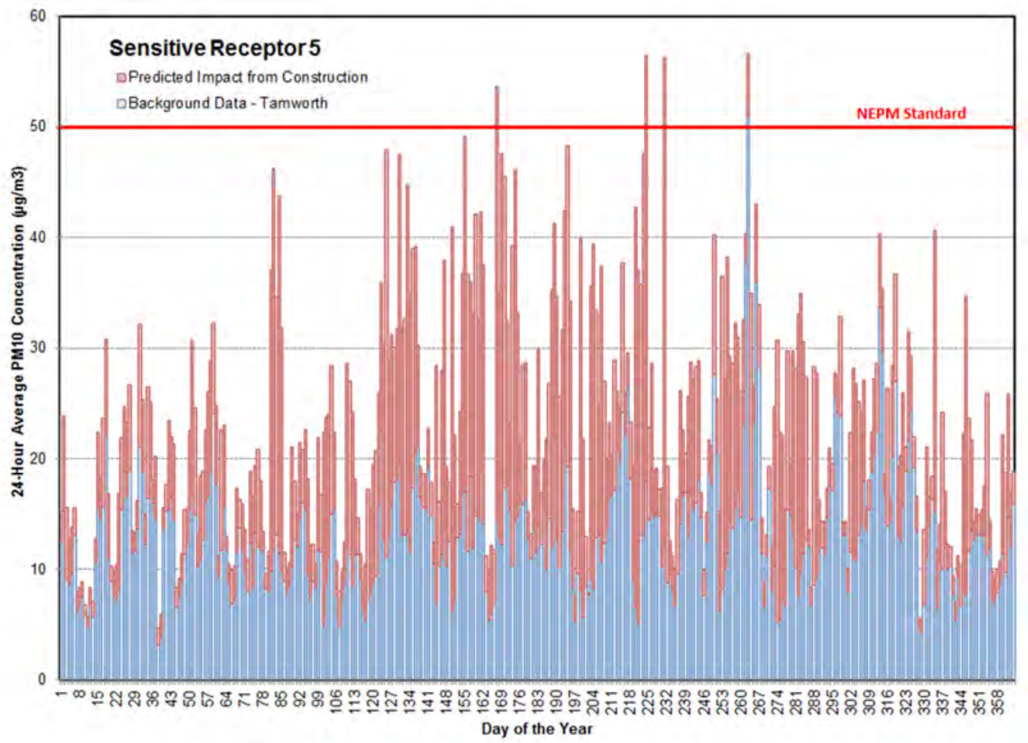


Figure 17 Time Series Plot of Predicted 24-Hour Average PM_{10} Concentrations at Receptor R7

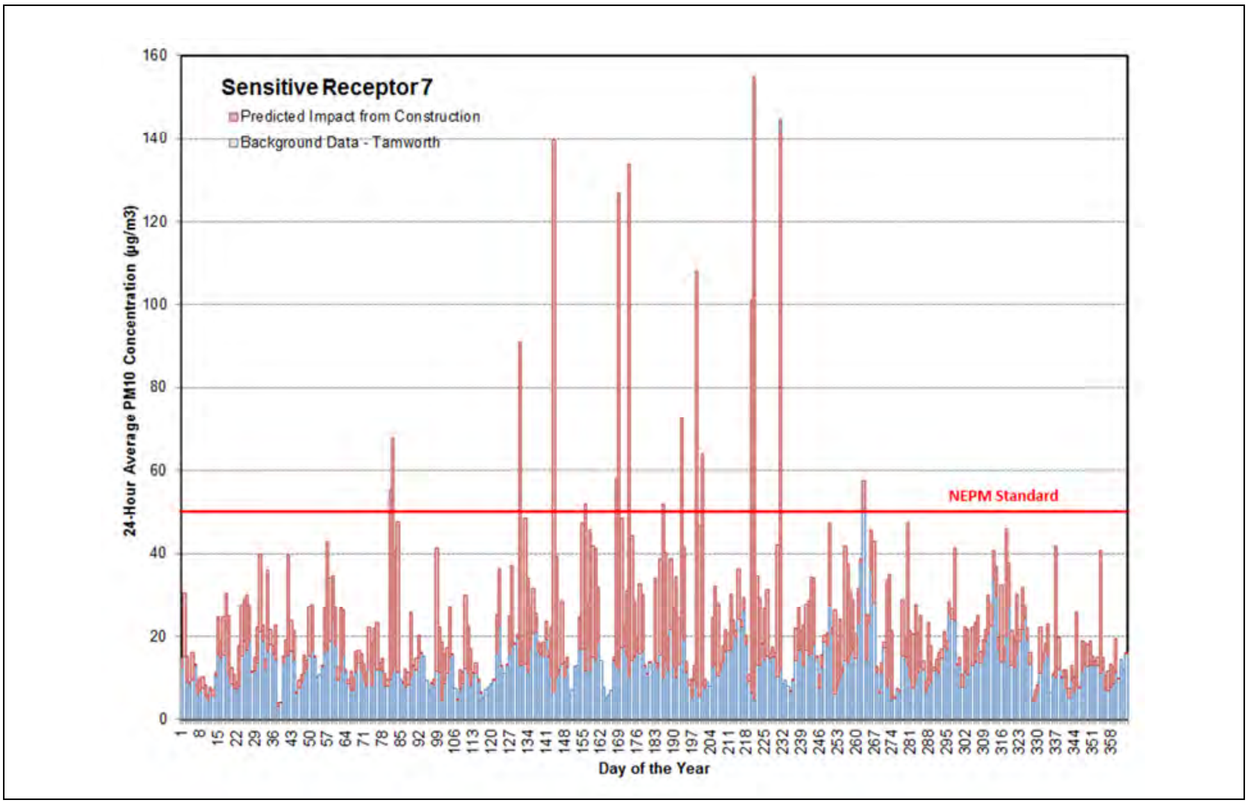
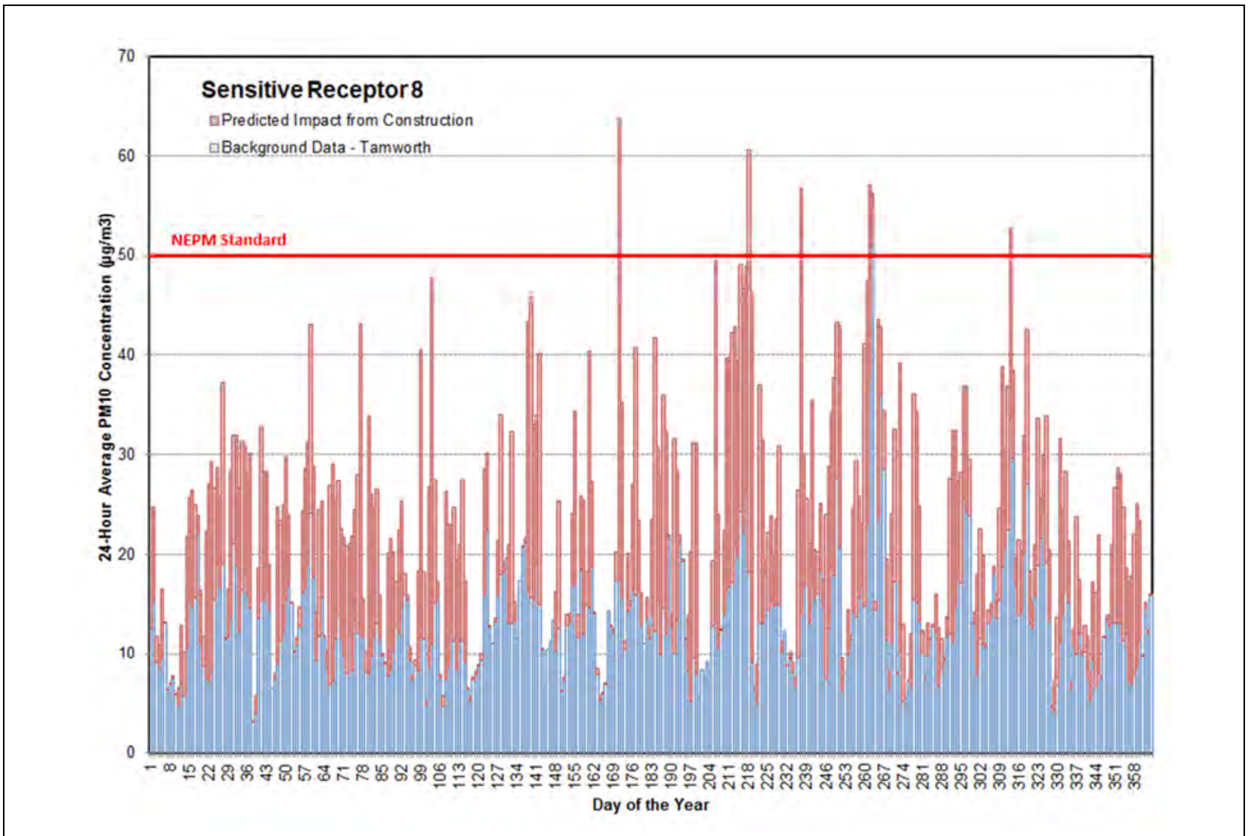


Figure 18 Time Series Plot of Predicted 24-Hour Average PM_{10} Concentrations at Receptor R8



$PM_{2.5}$

The annual average and 24-hour average PM_{10} concentrations predicted at each of the nominated sensitive receptors using the emission rates calculated in **Section 6.3** are presented in **Table 14**. The numbers in brackets in the cumulative (including background) 24-hour average column are the number of days per year predicted to exceed the NEPM Advisory Reporting Standard. The results for receptors predicted to experience additional exceedances of the 24-hour guideline (i.e. in addition to the one exceedance included in the background file) are shown in bold text. Contour plots of the predicted incremental concentrations are presented in **Figure 19** (24-hour averages) and **Figure 20** (annual averages).

It is noted that there is some uncertainty associated with the estimation of $PM_{2.5}$ emissions from PM_{10} estimates using broad ratios for ranges of sources. The background data are also based on an assumed 0.5 ratio of $PM_{2.5}/PM_{10}$ for a rural environment. The dispersion modelling predictions for $PM_{2.5}$ should therefore be viewed as indicative only, with an appropriate level of uncertainty attached.

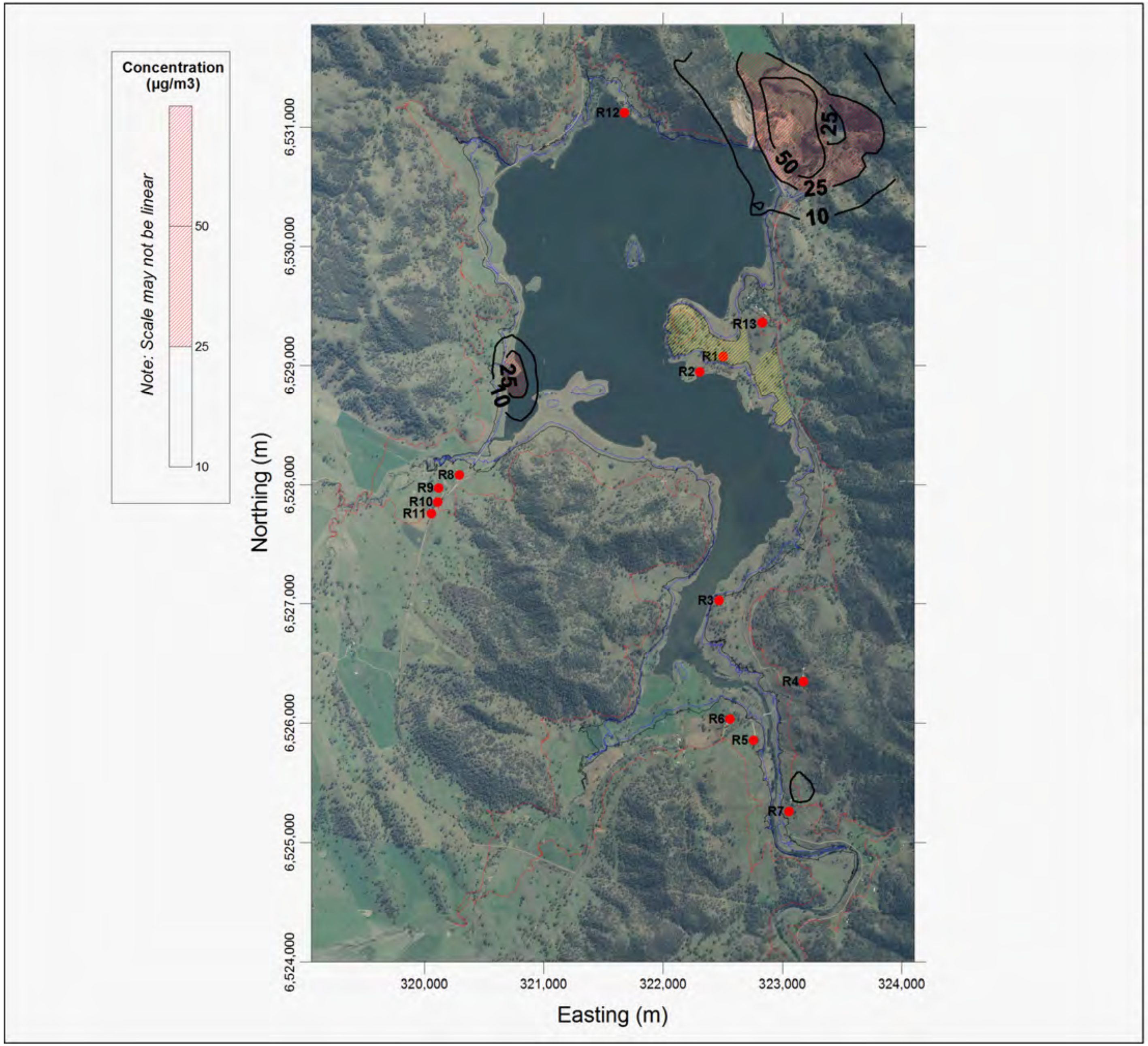
The incremental 24-hour $PM_{2.5}$ concentrations predicted by the modelling are low at all identified sensitive receptors surrounding the dam wall and Western Foreshore Road construction areas and no additional exceedances of the Advisory Reporting Standard of 25 µg/m³ are predicted at these receptors as a result of the proposed construction activities. No adverse health impacts from elevated $PM_{2.5}$ concentrations are therefore expected at these locations as a result of the proposed works.

Receptor R7, located adjacent to the Rivers Road realignment works, is predicted to experience an additional two exceedances of the Advisory Reporting Standard for 24-hour $PM_{2.5}$ concentrations, with a maximum predicted cumulative concentration of 30.5 µg/m³. It should be noted however, that as peak construction activities in this area will not occur for an entire one-year period, the likelihood of exceedances occurring in reality will be lower than that reported by the modelling. Nonetheless the modelling indicates that short-term elevated $PM_{2.5}$ concentrations could occur at nearby sensitive receptors when dust-producing construction activities are at their peak and when winds are blowing from the construction works towards the residences.

Table 14 Predicted Annual Average $PM_{2.5}$ Concentrations

ID	Description	24-Hour Average $PM_{2.5}$ Concentrations		Annual Average $PM_{2.5}$ Concentrations	
		Incremental (µg/m³)	Cumulative * (µg/m³)	Incremental (µg/m³)	Cumulative * (µg/m³)
R1	BAP Reserve – Amenities	2.7	25.6 (1)	0.1	6.7
R2	BAP Reserve – Camping Area	2.7	25.6 (1)	0.1	6.7
R3	Nundle Fishing Clubhouse	1.0	25.5 (1)	<0.1	6.6
R4	Bowling Alley Point	0.6	25.5 (1)	<0.1	6.6
R5	Bowling Alley Point	1.5	26.0 (1)	0.5	7.1
R6	Bowling Alley Point	1.1	25.5 (1)	0.3	6.9
R7	Bowling Alley Point	8.8	**30.5 (3)**	0.9	7.5
R8	Western Foreshore	3.6	26.0 (1)	0.6	7.1
R9	Western Foreshore	2.4	25.6 (1)	0.3	6.8
R10	Western Foreshore	1.8	25.8 (1)	0.2	6.7
R11	Western Foreshore	1.6	25.8 (1)	0.1	6.7
R12	Tamworth Fishing Clubhouse	5.2	25.5 (1)	1.1	7.7
R13	Storage Custodian's residence	2.7	25.6 (1)	0.1	6.7
Criteria		**-**	**25**	**-**	**8**

* Cumulative impacts derived using a daily-varying background file as discussed in **Section 5.2**. Numbers in brackets are the number of days predicted to exceed the Advisory Reporting Standard of 25 µg/m³.



**Maximum Predicted
24-Hour Average
PM2.5 Concentrations**

(Excluding Background)

NSW OEH Assessment Criterion = 25 µg/m3

LEGEND

- Sensitive Receptor
- Bowling Alley Point Recreation Area

NOTES

Dispersion Model: Calpuff V6.267
Meteorological Year: 2011
Modeller: KL

N

SLR

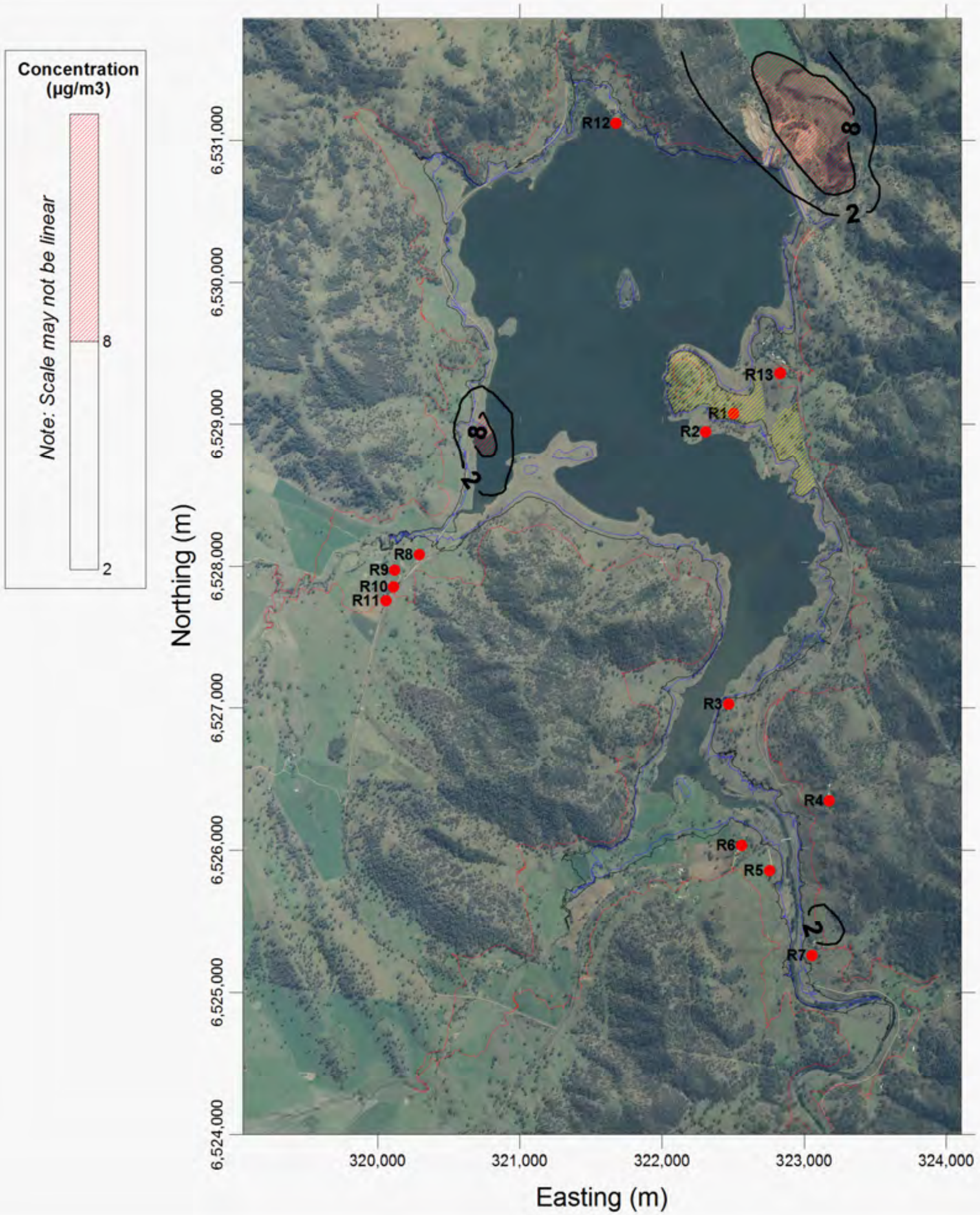
240 Waterworks Road
Ashgrove
QLD 4060
T: +61 7 3858 4800
F: +61 7 3858 4801
www.slrconsulting.com

**Chaffey Dam Augmentation
and Safety Upgrade**

**AIR QUALITY
IMPACT ASSESSMENT**

FIGURE 19

Project No. 630.10359	Date 13/09/12



Predicted Annual Average PM2.5 Concentrations

(Excluding Background)

NSW OEH Assessment Criterion = 8 µg/m3

LEGEND

- Sensitive Receptor
- Bowling Alley Point Recreation Area

NOTES

Dispersion Model: Calpuff V6.267
Meteorological Year: 2011
Modeller: KL

N

SLR
240 Waterworks Road
Ashgrove
QLD 4060
T: +61 7 3858 4800
F: +61 7 3858 4801
www.slrconsulting.com

Chaffey Dam Augmentation and Safety Upgrade

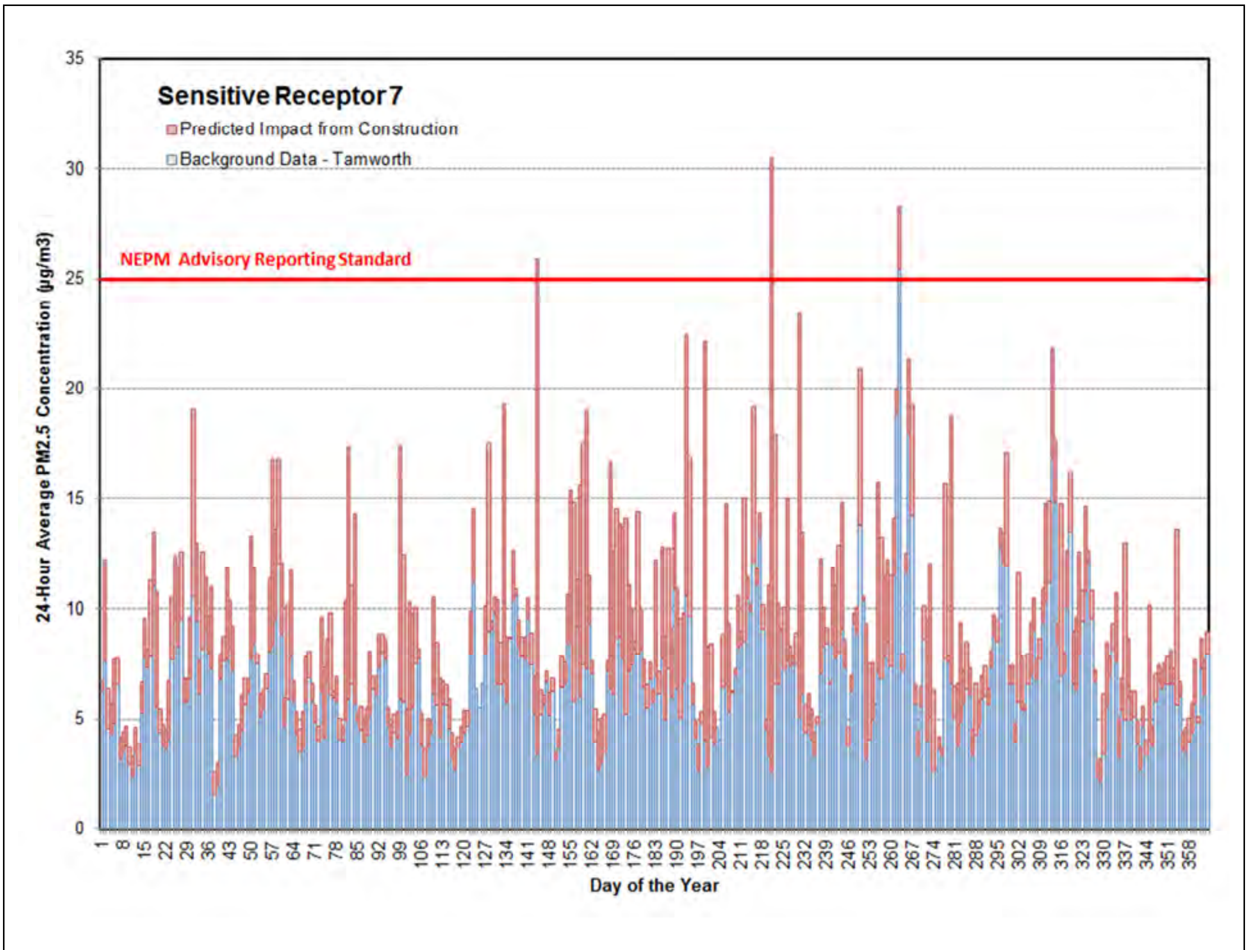
AIR QUALITY IMPACT ASSESSMENT

FIGURE 20

Project No. 630.10359 | Date 13/09/12

Figure 21 presents a time-series plot of the predicted concentrations at Receptor R7, showing the relative contribution of estimated background levels and the incremental impact predicted by the modelling to the worst case construction scenario modelled. This plot shows that again, maximum impacts are generally predicted to occur during winter and spring.

Figure 21 Time Series Plot of Predicted 24-Hour Average $PM_{2.5}$ Concentrations at Receptor R7



8.2 Nuisance Impacts (TSP and Dust Deposition)

The annual average TSP concentrations and dust deposition rates predicted at each of the nominated sensitive receptors using the emission rates calculated in **Section 6.3** are presented in **Table 15**. Contour plots of the predicted concentrations and deposition rates are presented in **Figure 22** (TSP) and **Figure 23** (dust deposition).

Table 15 Predicted Annual Average TSP Concentrations and Deposition Rates

ID	Description	24-Hour Average TSP Concentrations		Annual Average Dust Deposition Rates
		Incremental (µg/m³)	Cumulative * (µg/m³)	Incremental (g/m²/month)
R1	BAP Reserve – Amenities	0.7	27	0.1
R2	BAP Reserve – Camping Area	0.6	27	0.1
R3	Nundle Fishing Clubhouse	0.3	26	0.0
R4	Bowling Alley Point	0.3	27	0.0
R5	Bowling Alley Point	11.4	38	1.4
R6	Bowling Alley Point	4.0	30	0.4
R7	Bowling Alley Point	19.3	45	2.0
R8	Western Foreshore	7.3	33	0.6
R9	Western Foreshore	2.2	28	0.2
R10	Western Foreshore	0.9	27	0.1
R11	Western Foreshore	0.6	27	0.1
R12	Tamworth Fishing Clubhouse	7.2	33	0.9
R13	Storage Custodian's residence	0.7	27	0.1
Criteria		**-**	**90**	**2**

* Cumulative impacts derived using an annual average background value of 26.2 µg/m³ as discussed in **Section 5.2**.

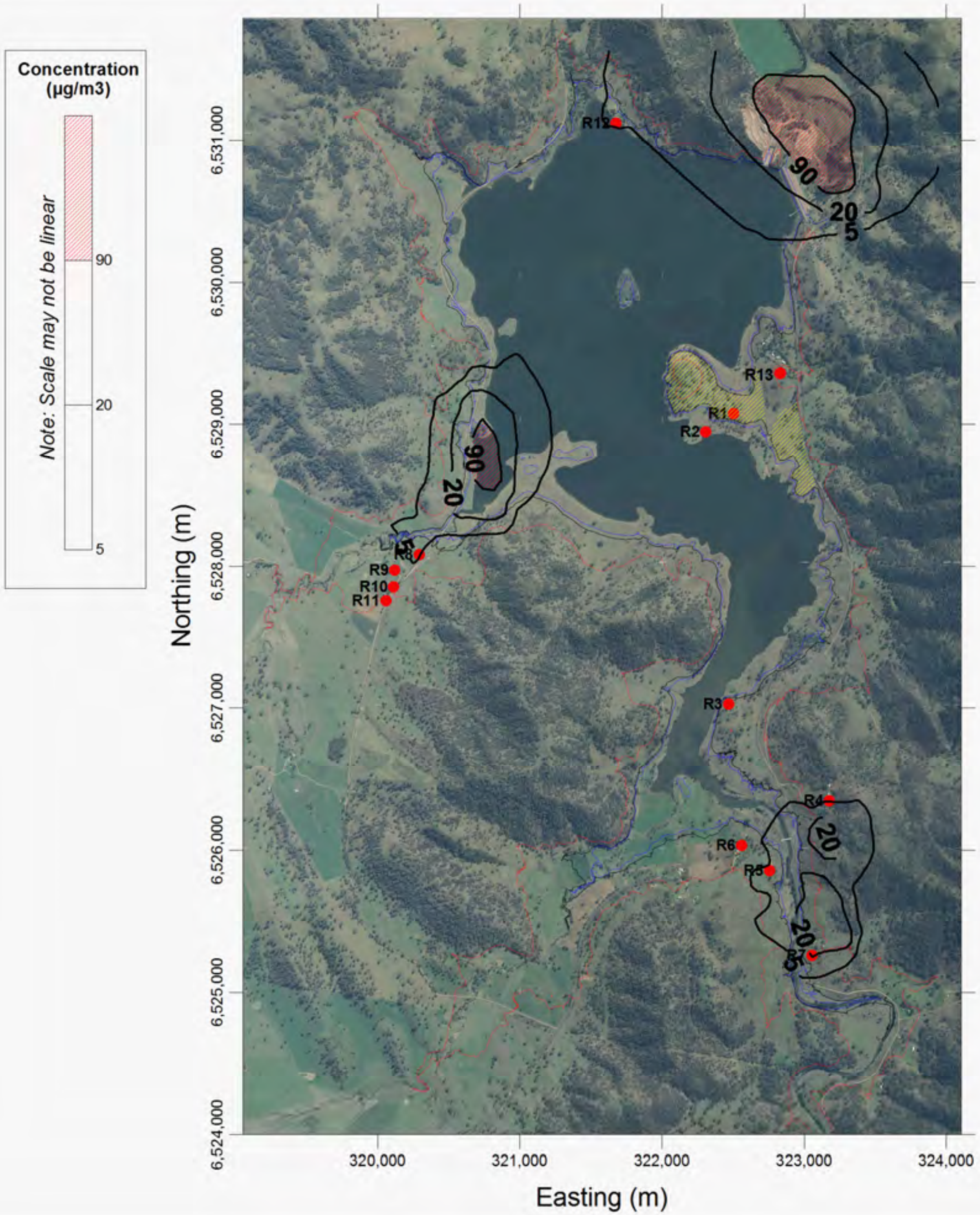
TSP

The annual average TSP concentrations predicted by the modelling are below the criterion at all nominated sensitive receptors surrounding the three main construction areas, even with background levels included. No adverse nuisance impacts from elevated TSP levels are therefore expected as a result of the proposed works.

Dust Deposition

The annual average dust deposition rates predicted by the modelling are below the incremental impact criterion at all nominated sensitive receptors surrounding the Dam Wall and Western Foreshore Rd construction areas. No nuisance impacts from dust deposition are therefore expected at these locations as a result of the proposed works.

Receptor R7, located adjacent to the Rivers Road realignment works, is predicted to experience dust deposition levels equivalent to the NSW OEH guideline level, however as peak construction activities in this area will not occur for an entire one-year period it is not expected that actual annual average dust levels would be as high as predicted. Nonetheless, it is possible given the short distance between the road and this residence that short-term elevated deposition levels could occur when dust-producing construction activities are at their peak near this location.



Predicted Annual Average TSP Concentrations

(Excluding Background)

NSW OEH Assessment Criterion = 90 µg/m3

LEGEND

- Sensitive Receptor
- Bowling Alley Point Recreation Area

NOTES

Dispersion Model: Calpuff V6.267
Meteorological Year: 2011
Modeller: KL

N

SLR

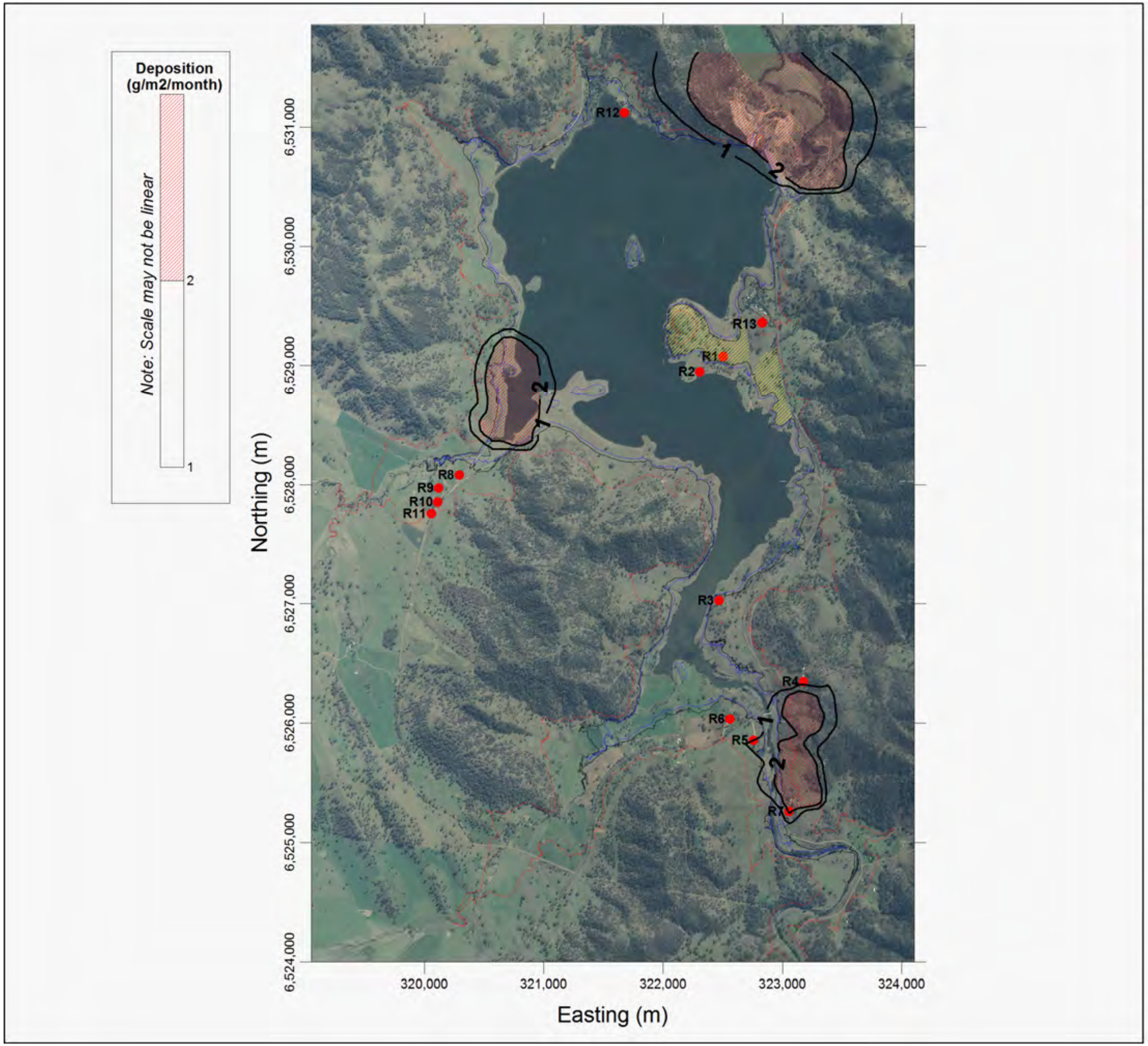
240 Waterworks Road
Ashgrove
QLD 4060
T: +61 7 3858 4800
F: +61 7 3858 4801
www.slrconsulting.com

Chaffey Dam Augmentation and Safety Upgrade

AIR QUALITY IMPACT ASSESSMENT

FIGURE 22

Project No. 630.10359 | Date 13/09/12



Predicted Annual Average Dust Depostion Rate

(Excluding Background)

NSW OEH Assessment Criterion = 2 g/m2/month (incremental impact)

LEGEND

Sensitive Receptor

Bowling Alley Point Recreation Area

NOTES

Dispersion Model: Calpuff V6.267
Meteorological Year: 2011
Modeller: KL

N

SLR

240 Waterworks Road
Ashgrove
QLD 4060
T: +61 7 3858 4800
F: +61 7 3858 4801
www.slrconsulting.com

Chaffey Dam Augmentation and Safety Upgrade

AIR QUALITY IMPACT ASSESSMENT

FIGURE 23

Project No. 630.10359

Date 13/09/12

9 CONTROL OF DUST EMISSIONS FROM CONSTRUCTION ACTIVITIES

The following control measures are recommended for the minimisation of particulate emissions from the proposed construction activities.

Haul Roads

- Minimisation of the distance travelled by taking the most direct route to the destination
- Optimise surface drainage, particularly at intersections
- Restrict vehicle speeds on unpaved roads to 40 km/hr or less
- Use larger trucks to minimise number of trips, where possible
- Watering of unpaved roads using water carts during dry, windy periods when visible dust emissions can be observed travelling offsite (although it is important to not allow haul roads to become saturated as this will increase emissions once they dry out)

The addition of chemical dust suppressants to the water used for dust suppression is not recommended as the works are to be performed within a catchment area.

Graders

- Watering of the work area during dry, windy periods when visible dust emissions can be observed travelling offsite

Wind Erosion

- Minimise disturbed areas by only clearing areas required for the works
- Rehabilitate disturbed areas as soon as possible after works are completed
- Stabilise stockpiles (e.g. by watering, covering, revegetating etc., as practical) and shield them from the prevailing wind using wind breaks or, if possible, by positioning them in sheltered areas so that the topography or existing trees screen them from the nearest sensitive receptors

Bulldozers

- Minimise travel speed and distance
- Keep travel routes and materials moist using water carts

Loading and Dumping of Soil

- Minimise dump height as far as practicable, particularly when dry, sandy materials are being handled
- Use of water carts to keep the material being handled moist, particularly when dry, sandy materials are being handled

Table 16 presents a modified version of the Beaufort Wind Scale, which is an empirical measure that relates wind speed to observed conditions at sea or on land. As shown in the chart, wind speeds above 5.4 m/s (the threshold for dust pickup) are characterised by the movement of small branches on leaves. This chart may be used as a practical guide for the need to implement additional dust controls (e.g. such as increased watering rates on unpaved roads and disturbed areas).

Table 16 Beaufort Wind Scale and Velocity Conversions

Description	Wind Speed		On Land
	(knots)	(m/s)	
Calm	< 1	<0.5	Smoke rises vertically
Very light breeze	1-3	0.5-1.5	Smoke drifts
Light breeze	4-6	2-3	Wind felt on face. Rustles leaves
Gentle breeze	7-10	3.5-5	Leaves and flags move
Moderate breeze	11-16	5.5-8	Paper blown about. Small branches move
Fresh breeze	17-21	8.5-10.5	Large branches sway
Strong breeze	22-27	11-13.5	Small trees sway
Near gale	28-33	14-16.5	Large trees sway. Difficult to walk
Gale	34-40	17-20	Small trees blown down
Strong gale	41-47	20.5-23.5	Structural damage. Chimney pots removed
Storm	48-55	24-27.5	Trees uprooted. Much structural damage
Violent storm	56-63	28-31.5	Widespread damage
Hurricane	> 64	>32	Widespread damage

As the construction activities will be short-term and variable in nature, the impacts on local air quality will also be short-term and will depend significantly upon the meteorological conditions during the construction period. Regular consultation with potentially affected receptors should be carried out to assess the effectiveness of the implemented dust mitigation measures and to identify whether additional controls (e.g. increased watering rates) are required.

10 CONCLUSIONS AND RECOMMENDATIONS

Atmospheric dispersion modelling of fugitive emissions of particulate matter (as TSP, PM_{10} and $PM_{2.5}$) from the site was undertaken using the CALPUFF dispersion model. Emissions from excavation, vehicle movements, wind erosion, and the handling of soils were addressed in the study. Local meteorological conditions were predicted using The Air Pollution Model (TAPM) for the year 2011. Topography and land use data were sourced from published databases. The site was visited to help inform an understanding of the complexity of the terrain, the location of settlement areas in relation to the site of the proposed development and to further inform the identification and assessment of impacts, if any.

The results of the dispersion modelling conducted for the Chaffey Dam Augmentation and Safety Upgrade indicate that TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates at sensitive receptors in the vicinity of the Dam Wall and Auxiliary Spillway construction area will comply with relevant OEH air quality guidelines.

The modelling does however, indicate a potential for elevated PM_{10} and $PM_{2.5}$ concentrations at residential receptors located close to the road construction activities along Western Foreshore Road and Bowling Alley Point. The greatest impacts are predicted at Receptor R7, located immediately east of the southern end of Rivers Road. This receptor is predicted to have the potential to be exposed to a worst case 24-hour average PM_{10} concentration of 150 µg/m^3 (compared to a guideline of 50 µg/m^3) and a worst case 24-hour average $PM_{2.5}$ concentration of 30.5 µg/m^3 (compared to a guideline of 25 µg/m^3). It is noted however, that the modelling is based on the peak, worst case construction scenarios occurring at the worst case locations for the full year of meteorological data used in the modelling, hence actual concentrations are likely to be lower than the predicted due to the transient and short-term nature of the Project.

The modelling does indicate, however, that care will need to be taken when the road construction activities are being undertaken in the vicinity of residences along these roads. A Construction Environmental Management Plan (CEMP) should be prepared detailing the control measures to be implemented, which may include:

- Regular communication and consultation with potentially affected residents
- Minimising disturbed areas by only clearing areas required for the works and by stabilising and rehabilitating disturbed areas as soon as possible after works are completed
- Minimising the distances travelled by trucks by taking the most direct route and using larger trucks to minimise number of trips, where possible
- Restricting vehicle speeds on unpaved roads to 40 km/hr or less
- Watering of roads and disturbed soils using water carts during dry, windy periods when visible dust emissions can be observed travelling off-site
- Stabilising stockpiles (e.g. by watering, covering, revegetating etc., as practical) and shielding them from the prevailing wind using wind breaks or, if possible, by positioning them in sheltered areas so that the topography or existing trees screen them from the nearest sensitive receptors
- Minimising the dump height for the unloading and loading of soils as far as practicable, particularly when dry, sandy materials are being handled
- If possible, ceasing or modifying activities on dry windy days, when visible dust emissions can be observed travelling off-site towards nearby sensitive receptors
- A complaints management system to record any complaints received regarding dust emissions, the findings of any investigations into the source of the dust emissions and the additional control measures implemented (if required)

11 REFERENCES

- *Approved Methods for the Modelling and Assessment of Air Pollutants in* New *South Wales,* August 2005, NSW Office of Environment and Heritage (formerly the Department of Environment and Conservation).
- *Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors,* prepared by Midwest Research Institute (MRI) for Western Governors' Association, Western Regional Air Partnership (WRAP), February 2006, http://www.epa.gov/ttnchie1/ap42/ch13/bgdocs/b13s02.pdf
- *Chaffey Dam Augmentation – Preliminary Environmental Assessment*, Prepared by Molino Stewart Pty Ltd for State Water, November 2011.
- *National Pollutant Inventory (NPI) for Mining*, Version 3.1, January 2012, Department of Sustainability, Environment, Water, Population and Communities.
- *Protection of the Environment Operations (Clean Air) Regulation*, July 2010, New South Wales Government, *http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+428+2010+cd+0+N*
- *Protocol for the Application of the CALPUFF Model for Analyses of Best Available Retrofit Technology (BART)*, Visibility Improvement State and Tribal Association of the Southeast (VISTAS), December 2005, http://www.vistas-sesarm.org/BART/VISTASBARTModelingProtocol_Dec222005.pdf
- *Workbook of Emission Factors AP-42*, Fifth Edition, US EPA's Technology Transfer Network Clearinghouse for Inventories & Emissions Factors, http://www.epa.gov/ttnchie1/ap42/
- *40 CFR Part 51 Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions*; Final Rule US EPA, November 2005, http://www.epa.gov/scram001/guidance/guide/appw_05.pdf