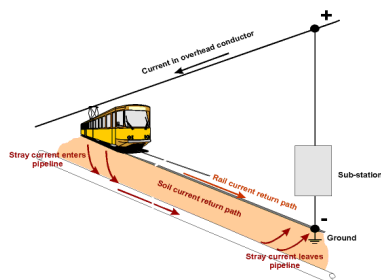




*Cathodic Protection Services*

# Electrolysis & Stray Traction Current Report

MULTISTORY DEVELOPMENT  
NO 7 RAILWAY STREET  
CHATSWOOD



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**\*\* TABLE OF CONTENTS \*\***

**1. INTRODUCTION .....3**

**2. CONCLUSIONS.....4**

**3. CODES AND STANDARDS .....4**

**4. DESCRIPTION OF THE PROPOSED DEVELOPMENT .....4**

**5. THE PROBLEM. ....6**

5.1 BACKGROUND .....6

5.2 CORROSION HAZARD FROM STRAY TRACTION CURRENT .....7

**6. MITIGATION OF STRAY CURRENT.....8**

6.1. ELIMINATE OF REDUCE EXPOSURE TO STRAY TRACTION CURRENT .....8

6.1.1. *Reduce Length of Structure in Alignment with Traction Current Path.* .....8

6.1.2. *Isolate the Structure from Stray Traction Current.* .....9

6.1.3. *Use of High Strength Concrete.*.....9

6.2 STRAY TRACTION CURRENT MITIGATION .....10

**7. NO 7 RAILWAY STREET CHATSWOOD.....11**

7.1 TEMPORARY ROCK ANCHORS .....11

7.2 PILES .....11

7.3 SHOTCRETE WALLS .....11

7.4 CAPPING BEAMS .....12

7.5 BASEMENT FLOORS .....12

7.6 INTERNAL UNDERGROUND WALLS .....12

7.7 EXTERNAL WALLS .....12

7.8 INTERNAL WALLS.....13

7.9 INCOMING SERVICES .....13

**APPENDIX:**

A: Corrosion by Stray Traction Current



## 1. INTRODUCTION

A multi storey building is proposed for construction at No 7 Railway Street, Chatswood.

It is a requirement of RailCorp that for all Developments in the vicinity of electrified tracks;

- a. The existence of stray traction current in the ground is investigated.
- b. A report is developed identifying the extent of the stray traction problem, and what measures should be taken to ensure the stray current does not present a corrosion hazard to the proposed development.

Cathodic Protection Services were commissioned to;

- a. Review the development plans and possible exposure to stray traction current.
- b. Provide an opinion on whether stray traction current presents a corrosion hazard to the proposed development, and what, if any, remedial or mitigation actions are necessary.

This report essentially addresses electrolysis implications of potential corrosion hazards to the structure from stray traction current for the first stage of the project, which is the excavation and installation of piers and shotcrete walls.

The electrolysis mitigation measures proposed are unlikely to adversely affect the design of the structure for the building.



## 2. CONCLUSIONS

The conclusions of this investigation are;

- 2.1 Stray traction current can be expected to be present on the site of the Development
- 2.2 Recommendations are provided regarding the construction of the building to eliminate corrosion hazards from stray traction current as outlined in Clause 7.

## 3. CODES AND STANDARDS

This report has been undertaken with reference to the following RIC Standards;

- EP 12 10 00 13 SP 1500 V Traction System Earthing
- EP 12 10 00 20 SP Low Voltage Distribution Earthing
- EP 12 10 00 21 SP Low Voltage Installations Earthing
- EP 12 10 00 22 SP Buildings and Structures Under Overhead Lines
- EP 12 20 00 01 SP Bonding of Overhead Wiring Structures to Rail
- EP 12 30 00 01 SP Electrolysis From Stray DC Current
- ESC 510 Boundary Fences [Civil]
- SPC 511 Boundary fences [Right of Way]

## 4. DESCRIPTION OF THE PROPOSED DEVELOPMENT

A multi storey tower is proposed for construction at No 7 Railway Street Chatswood. The site is adjacent to and on the western side of the Chatswood electrified rail line.

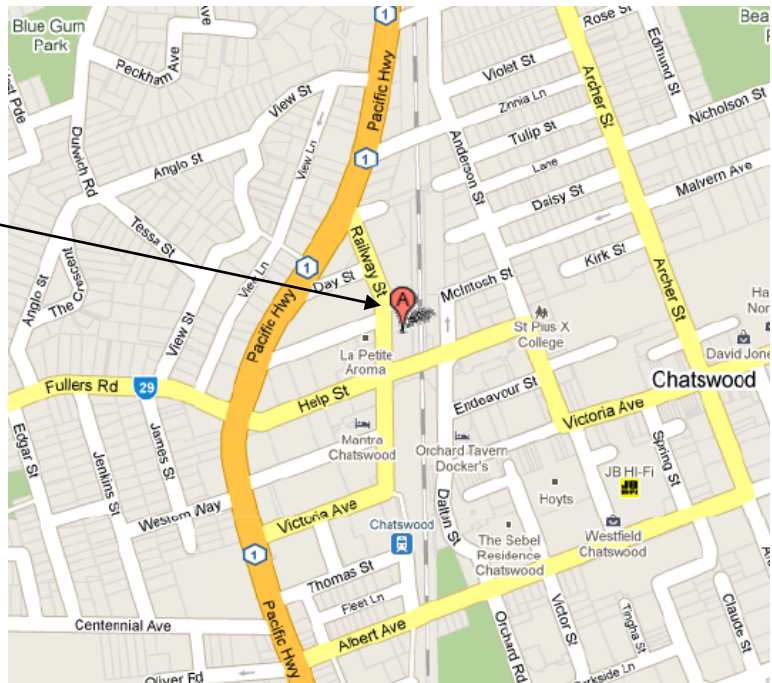
Details of the construction of the foundations are shown on the following Opus International Drawings;

DRAWING NO	REVISION	TITLE
11768-2001	WIP	SHORING, CIVIL NOTES
11768-200	WIP	SHORING, PART PLAN SHEET 1
11768-2003	WIP	SHORING, PART PLAN SHEET 2
11768-2004	WIP	SHORING, WEST ELEVATION SHEET 1
11768-2005	WIP	SHORING, WEST ELEVATION SHEET 2
11768-2006	WIP	SHORING, EAST ELEVATION SHEET 1
11768-2007	WIP	SHORING, EAST ELEVATION SHEET 2
11768-2008	WIP	SHORING SECTIONS
11768-2009	WIP	SHORING DETAILS

Stage 1 of the Development will consist of the excavation for the basement levels of the towers. This will include;

- Installation of temporary rock anchors to support the walls of the excavation.
- Installation of reinforced concrete piles.
- Infilling of the space between the piles with steel reinforced shotcrete walls.

7 Railway Street, Chatswood





## **5. THE PROBLEM.**

### **5.1 BACKGROUND**

RailCorp use 1500 volt direct current to operate the traction system. The current is delivered by the overhead catenary cables and the return path to the sub station is via the track. The track is not insulated from earth, principally because of the difficulty of achieving insulation and secondly, for safety reasons.

Whilst the steel track is large in cross section, some of the current leaks from the tracks and finds alternate paths back to the sub station. Considerable current can be involved, for instance, a Tangara train requires about 4000 amps to start from rest.

All current obeys Ohms Law and if a low resistance metallic structure exists in the path of the “stray” current this can pick up the stray current which then flows along the structure to a point close to the sub station, where it discharges back to earth, and ultimately returns to the sub station.

Where the “foreign” structure picks up the stray current a small measure of corrosion control or “cathodic protection” is achieved. However, where the current discharges from the foreign structure back to the soil, corrosion of the foreign structure occurs as shown on Sketch CP34.

The problem of stray current corrosion was first identified in the 1930's. For stray current to be a serious problem the foreign structure has to be electrically continuous.

At that time the only organisation which had electrically continuous structures were the PMG (now Telstra) with their lead sheathed cables. They suffered corrosion failures and for many years considered this to be a necessary evil. However an enterprising Engineer decided to plot failures on a map and found they were predominantly grouped around rail lines or tram lines. Further investigation showed that they were also grouped around the sub stations associated with the tracks. He eventually identified the corrosion problem as being caused by stray current. The PMG approached the Railways for compensation and it did appear that the Federal Government would be suing the State Government.



Whilst this was occurring the Engineering staff developed a solution to the problem. This was to connect the foreign structure to the tracks via a simple control system. This provided a low resistance path for the stray current to return to the tracks thus eliminating the corrosion problem. The control bond could be engineered such that a degree of additional corrosion protection could be provided to the foreign structure.

The above led to the formation of the Electrolysis Committee which has representatives of the owners of all underground services, and RailCorp. Cathodic Protection Services represents the interests of the Oil and Chemical Industry on the Committee. Apart from the War Years the committee has met at about monthly intervals since the 1930's to discuss stray current problems and its mitigation with the Railways.

## **5.2 CORROSION HAZARD FROM STRAY TRACTION CURRENT**

Direct current as used by the traction system can cause serious corrosion to underground metallic services and the steel reinforcement of concrete. Stray traction current flowing in the ground can be picked up by the steel reinforcement one side of the development, flow along the steelwork and discharge back to the soil on the opposite side of the building. At the discharge point of the current, corrosion of the reinforcement will occur.

For a building, the most common means of eliminating the corrosion hazard from stray traction current is to increase the electrical resistance of the concrete to the ground. This prevents the flow of stray traction current through the reinforcement.

Increasing the electrical resistance of the structure to ground for an onground slab is automatically achieved by the moisture barriers installed to prevent water entry into the structure. The moisture barrier is an electrically insulating membrane.

Where the structure is supported on pad and/or piered footings, increasing the resistance of the structure to ground can be achieved by either;



- a. Applying moisture barrier to the excavation into which the pad footings or piers are poured.
- b. If installation of moisture barriers into the excavation is impractical, ie for piered footings, these can be insulated from the structure by the application of insulating sleeving to the starter bars where they tie into the building reinforcement.

## 6. MITIGATION OF STRAY CURRENT

There are a number of options to deal with the potential corrosion problems which can result from stray traction current. These include,

- a. Prevent or reduce exposure of the structure to stray traction current.
- b. Install a mitigation system to offset the problem.

In the case of the latter this is an expensive approach as it requires the establishment of infrastructure necessary for the mitigation of the problem.

### 6.1. ELIMINATE OF REDUCE EXPOSURE TO STRAY TRACTION CURRENT

The simplest approach is to avoid exposure of the structure to stray traction current. Two approaches, which can be adopted, are;

#### 6.1.1. *Reduce Length of Structure in Alignment with Traction Current Path.*

As noted in Section 6, the hazard from stray traction current is due to the current flowing onto and then off the metallic structure. Corrosion occurs at the point of discharge of the current back to the soil.

The hazard from the stray traction current increases as the length of the conducting service increases. Stray traction corrosion is a problem because the metallic service presents a lower electrical resistance path to current flow than the alternative path through the earth.



For current to flow onto and discharge from an underground structure, electrochemical reactions need to occur to generate or absorb electrons. Both these reactions require energy, which results in a resistance existing between the structure and the earth. If the structure is short in length, the combined resistance of the pick up and discharge reactions is sufficient to prevent the traction current flowing onto the structure.

Additional to the above, the passage of the stray traction current causes development of potential gradient in the earth. For a short metallic conductor, the potential gradient to which it is exposed is too small to allow the pick up of the current.

Accordingly the shorter the length of the metallic structure the less likely it is to be affected by stray traction current.

#### ***6.1.2. Isolate the Structure from Stray Traction Current.***

The effects of stray traction current can be avoided by increasing the resistance of the structure to the soils in which stray traction current is flowing. This can be achieved by use of moisture barriers such as FORTICON which provides an electrically insulating membrane which prevents entry of stray traction current. Even if the membrane is damaged, it will still provide sufficient resistance to prevent entry of stray traction current.

#### ***6.1.3. Use of High Strength Concrete.***

Increasing the strength of the concrete increases the electrical resistance of the concrete. Thus if concrete of 40 mpa is used for the underground components, this has a high resistance, due partly to the reduced water content, and acts as an electrical insulator to the entry of stray traction current.



## 6.2 STRAY TRACTION CURRENT MITIGATION

Stray traction current mitigation is achieved by providing a low resistance path from the structure to allow discharge of any stray traction current directly back to the rail.

Provision of a mitigation system involves the following;

- a. The reinforcement of the concrete has to be made electrically continuous. This involves tack welding all members of the reinforcement cages.
- b. Testing has to be undertaken to provide evidence to the Railways that a stray traction current corrosion hazard exists.
- c. If the testing identifies a corrosion hazard to the steel reinforcement does exist, installation of a “railway drainage bond” can proceed.

It is appreciated that installation of a mitigation system is a particularly expensive option. The only building projects on which Cathodic Protection Services have recommended a stray traction mitigation system are;

- ❖ The Sydney Harbour Tunnel. This structure is 3200m in length and testing indicated the existence of a stray traction current hazard.
- ❖ Chatswood Connection project. This development by Girvan was over one km in length and provision for a stray traction current mitigation system was designed into the proposed project. Unfortunately Girvan went into receivership in the early stages of the project.



## **7. NO 7 RAILWAY STREET CHATSWOOD**

The elimination of corrosion hazards from stray traction current involves increasing the resistance of the conductive path for stray current which may otherwise be conducted into the underground sections of the structure. If stray current is conducted into the structure, severe corrosion of the concrete reinforcement can result, ultimately resulting in structural failures.

Comments relating to the No 7 Railway Street Development are;

### **7.1 TEMPORARY ROCK ANCHORS**

Rock anchors will be installed to provide temporary support to the excavation. Potentially rock anchors could act to conduct stray traction current within the structure. However it is a requirement of RailCorp that rock anchors are fitted with an insulating pad which prevents any conduction of stray traction current. Drawings show the anchors are provided with a "NOVASTEEN PAD" on which the anchors will bare.

### **7.2 PILES**

The steel reinforced concrete piles will be installed around the perimeter of the excavation.. The piers will be a minimum of 32 mpa concrete and 75mm cover. This construction is considered to have sufficient electrical resistance to resist the entry of stray traction current.

### **7.3 SHOTCRETE WALLS**

The concrete piles will be infilled with steel reinforced shotcrete walls.

Measures to protect the piers and shotcrete walls from corrosion hazards from stray traction current and acting as a conductor for stray traction current include;

- a. Provide the reinforcing fabric of the walls with an "electrical gap" at each pile. This provides high electrical resistance along the length of the walls.



- b. Stagger the dowels into the piles which support the reinforcing fabric. It is assumed the dowels will be secured into the piles in holes drilled for the purpose and fixed in position with epoxy resin.

#### **7.4 CAPPING BEAMS**

The design of the capping beam will need to incorporate measures to prevent the conduction of stray traction current. Typical design features which will control the conduction of stray traction current include;

- a. Prevent electrical interconnection of the shotcrete walls and the capping beam reinforcement.
- b. Provide an electrical gap in the reinforcement within the capping beam at 20m intervals to eliminate electrical continuity along the length of the capping beams.

#### **7.5 BASEMENT FLOORS**

Basement floors generally are provided with a moisture barrier. This acts as an insulating barrier to the entry of stray traction current. Additionally high electrical resistance is provided by construction and expansion joints which increase the electrical resistance through the slab.

#### **7.6 INTERNAL UNDERGROUND WALLS**

The design of support for the internal underground walls will need to be designed to avoid short circuiting of the electrical isolation provided by the electrical gaps in the shotcrete wall reinforcing.

#### **7.7 EXTERNAL WALLS**

It is understood that the external walls will be constructed from steel reinforced precast concrete. Precast elements generally have high electrical resistance from section to section, and are thus unlikely to allow conduction of stray traction current.



## 7.8 INTERNAL WALLS

It is understood the internal walls will be of lightweight construction, and will not provide a conduction path for stray traction current.

## 7.9 INCOMING SERVICES

Stray traction current can affect metallic water, fire and gas services. Should stray traction current be picked up by the services, this can result in a corrosion problem on;

- a. The services.
- b. The Development's electrical earth system. This is because the earth and the water service have a direct interconnection via the MEN system. Current picked up by the water and/or fire services can discharge back to the earth via the earth system resulting in corrosion of the earth grid or stake.

This problem can be eliminated by installation of an insulating fitting, or non-metallic sections in the services at or close to the boundary of the property as detailed in RIC Standard EP 12 30 00 01 SP "Electrolysis from Stray DC Current", Clause 5.3.

*"Water and gas pipes servicing buildings on the Railway Corridor and near 1500 V track to have an isolating joint installed at the boundary."*

Suitable insulating fittings are available from Savcor Art, telephone 96632322.

If the water service, or the water meter is constructed from non metallic materials, no other insulation is necessary.

Gas services do not require any additional insulation. If the incoming service is steel construction, this will be fitted with a cathodic protection system incorporating an insulating joint at the meter. If the service is low pressure, this will be run in non-metallic pipe.

**APPENDIX A**

