# REPORT | CATHODIC PROTECTION ANNUAL SURVEY
# MOA POINT WASTEWATER OUTFALL PIPELINE

## WELLINGTON WATER LIMITED
## MOA POINT WWT PLANT

| | |
|---|---|
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## PURPOSE AND SCOPE

This document was developed to address the following requirements:

- To outline the methodology Corrosion Control Engineering employees followed during the survey
- Present and discuss the results of the survey
- Provide recommendations to improve/maintain the cathodic protection system

## DISTRIBUTION

**WWL:** – Craig Shuttleworth and Joemar Cacnio

## TECHNICAL REVIEW

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| | | |

## DOCUMENT CONTROL

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## UPDATES SINCE LAST REVISION

Rev1: Includes Subsea section of pipeline CP Inspection review. Changes in Executive Summary, Discussion and Conclusion

# Definitions and Abbreviations

| TERMS | DEFINITION |
|---|---|
| AS | Australian standard |
| Cathodic protection (CP) | A technique used to reduce the corrosion of a metal surface by making the surface the cathode of an electrochemical cell. |
| CCE | Corrosion Control Engineering (NZ) Ltd |
| Coating | The material adhering to the bare structure to prevent interaction of the steel with soil, water, and contaminants. |
| CSE (Also $Cu/CuSO_4$) | Copper/copper sulphate reference electrode. |
| DC | Direct current |
| Depolarised potential | The change in potential of a structure over time due to the interruption of applied current. |
| DMM | Digital multimeter |
| Electrolyte | A chemical substance containing ions that migrate in an electric field such as water, soil, or concrete. |
| FIK | Flange insulation kit |
| Galvanic (sacrificial) anode | A metal that provides cathodic protection current to more noble metals because of its position in the Electromotive Force Series when the two are connected electrically in an electrolyte. |
| IJ | Insulating joint |
| Instant off-potential | The measured structure-to-electrolyte potential taken immediately after all influencing cathodic protection systems have been de-energised. Also referred to as polarised potential. |
| IR | Resistance potential – the part of a measured potential from the passage of current through the resistance. Removed to obtain a true off-potential. |
| KCl | Potassium chloride |
| mA | Milliamperes ($10^{-3}$ A) |
| mV | Millivolts ($10^{-3}$ V) |
| Native potential | The mixed potential of a freely corroding metal surface with respect to a reference cell in contact with the same electrolyte (also referred to as corrosion, static or initial potential). |
| Off-potential | The measured structure-to-electrolyte potential taken with all influencing cathodic protection systems de-energised. |
| On-potential | The measured structure-to-electrolyte potential with cathodic protection current applied. The components of the on-potentials include the native potential, polarisation, and IR drop. |
| Polarisation | The deviation from the native potential of an electrode resulting from the application of current between the electrode and electrolyte. |
| Potential gradient | A change in potential with respect to distance expressed in volts (mV) per unit of distance. |
| Reference electrode | A portable or permanently installed half-cell, usually CSE or SSC, which is used to take coupon or structure-to-electrolyte potentials from grade, inside the coupon test station's reference tube or from a permanently installed buried location. |
| SACP | Sacrificial anode cathodic protection |
| SSC (also Ag/AgCl) | Silver/silver chloride reference electrode. |
| Structure-to-electrolyte potential | The potential difference between the metallic surface and the electrolyte that is measured with respect to a reference electrode in contact with the electrolyte. |
| TP | Test point |
| $V_{CSE}$ | Voltage with respect to a copper/copper sulphate reference electrode. |
| $V_{SSC}$ | Voltage with respect to a silver/silver chloride reference electrode. |
| $V_{ZRE}$ | Voltage with respect to a zinc reference electrode. |
| ZRE | Zinc reference electrode |

# Executive Summary

Corrosion Control Engineering conducted the cathodic protection annual survey for the Wellington Water Moa Point wastewater outfall pipeline.

Onshore Section of Pipeline CP Inspection was carried out by CCE personnel on 19 March 2025.

Subsea Section of Pipeline CP Inspection is planned to be carried out by Undersea Construction once there is suitable conditions in March or April 2025.

**Annual Cathodic Protection Survey**

### Onshore Section of Pipeline CP Inspection

Undersea welded sacrificial anodes could not be interrupted therefore Instant off potentials could not be measured on the pipeline. To assess the cathodic protection potential criterion as per Australian Standard Cathodic Protection of Metals AS 2832.1:2015 Pipes and Cables and AS 2832.5:2008 Steel in Concrete, we have introduced temporary coupon testing.

Based on temporary coupon testing, the cathodic protection system is operating effectively.

The potentials measured on the coupon exposed to the same vicinity of the pipeline and connected to the CP system at test location 'M1', met the criterion for cathodic protection as detailed in AS 2832.1:2015 and AS 2832.5:2008.

Cathodic protection for the pipe section from the manhole 'M1' to the plant is not determined due to no access to test locations M2, R1, M3. It is assumed this section of pipe is not protected based on last year survey reading taken at R1. M2 and M3 test locations were identified during 2025 survey investigation with help of GIS layout of wastewater pipeline.

### Subsea Section of Pipeline CP Inspection Review

Undersea welded sacrificial anodes could not be interrupted therefore Instant off potentials could not be measured on the pipeline due to which AS 2832.5:2008 cathodic protection of metals – steel in concrete structures could not be assessed. However, recorded potentials at the diffusers has met the -0.80 $V_{SSC}$ cathodic protection potential criterion as per Australian Standard AS 2832.3:2005 Cathodic Protection of Metals: Fixed immersed structures.

**Recommendations**

The following actions are recommended to ensure effective operation of the cathodic protection system:

- WWL shall consider the following:
  - Develop a plan to address the following tasks when feasible at the earliest opportunity
    - Drain water from manhole M1 and inspect the pit with the CCE technician.
    - Implement traffic management for inspecting manhole M2, assess the as found conditions, drain any accumulated water and inspect the pit with the CCE technician.
    - Inspect the pipe transition aboveground at the base of hill and evaluate the wrapped joint with the CCE technician.
    - Inspect the manhole M3, assess the as found conditions and drain any accumulated water and inspect the pit with the CCE technician.
- After detailed inspections of M1, M2, R1 and M3, CCE shall evaluate the possibility of installing a bond cable at the isolation joints to integrate the unprotected buried sections of pipe with the existing CP system.
- Continue to inspect the cathodic protection system of Moa Point wastewater outfall pipeline on annual basis by trained and qualified cathodic protection personnel.

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Appendix C: Land Based Pipe Section Site Layout

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# 1. Introduction

Corrosion Control Engineering (NZ) Ltd. was contracted by Wellington Water Limited to conduct the assessment of the cathodic protection system operating on Moa Point wastewater outfall pipeline.

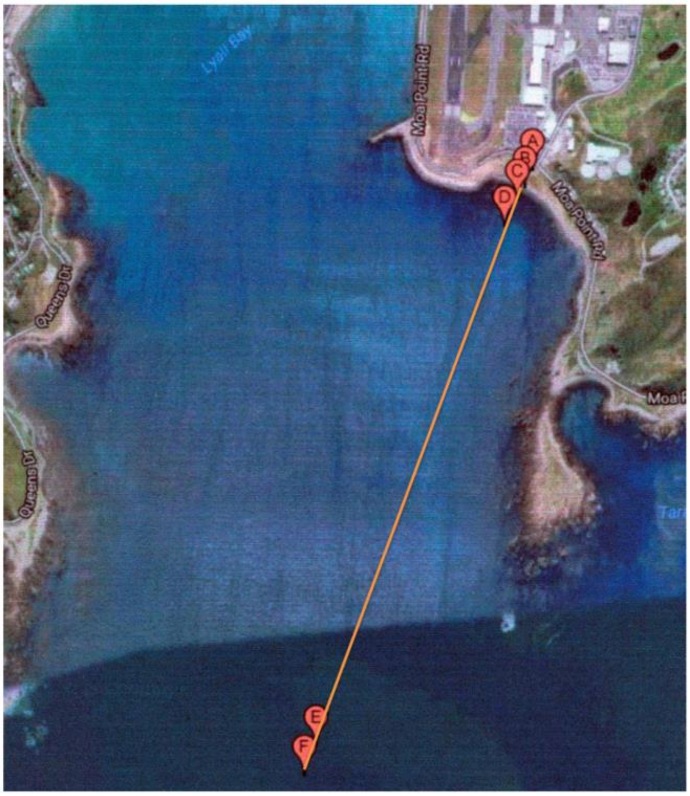
The onshore section of pipeline CP Inspection was completed by CCE personnel, Matthew Clements on 19 March 2025.

The subsea section of pipeline CP Inspection was completed by Undersea Construction Ltd. Personnel.

## 1.1 Structure Description

The Moa Point wastewater outfall pipeline spans a length of 1870 meters, extending into the outer waters of Lyall Bay. Apart from the shallow water inshore exposed section, the pipeline is buried beneath the seabed, with a minimum cover of 1.0 – 1.5 meters.

The outfall comprises a 1321mm outer diameter concrete-lined and coated steel pipeline, encased in a reinforced concrete weight coating approximately 125mm thick. At the seaward end termination, there are 18 diffuser risers. The pipeline was installed in 1997.




Pipeline route and distances between reference points from above figure-1 is as follows:
A: 0m|B: 52m|C: 84.2m| D: 175m|E: 1765m|F: 1858m

## 1.2 Cathodic Protection System Description

The sacrificial anode cathodic protection system comprises 26 off WZ18 zinc alloy sacrificial anodes, each with the following specifications:

- Anode Type: WZ18
- Net Mass: 17.0 Kg
- Gross Mass: 18.3 Kg

- Material: Zinc Base Alloy
- Specification: AS 2239 Designation ZI

These anodes are positioned along the pipeline in 13 pairs, with each pair diametrically opposed. The spacing between each pair of anodes is 150 ± 15 meters.

Each anode is embedded longitudinally in the concrete weight coating, with its outer face exposed end flush with the external concrete surface. Electrical contact with the pipeline is achieved through two studs at appropriate height and spacing centres, welded to the pipe surface. Anodes are electrically isolated from all steel reinforcement within the weight coating.

Additionally, the design includes a test point at the shore end of the pipeline.

It should be noted that there are limitations to cathodic protection of concrete coated structures. If there is delamination and cracking of the concrete it may be the case that CP current will not flow to the delaminated surface (due to geometry considerations) this cannot be detected by the CP survey.

## 1.3 Scope of Work

The scope of work was to undertake cathodic protection system assessment on the Moa Point wastewater outfall pipeline as per Australian Standards AS2832.

### Onshore Section of Pipeline CP Inspection

- Measure and record the pipeline ON potentials
  - Inside the manhole M1 (2 cable terminations on a mounting plate) near coastline
  - Pipe rising aboveground at the base of the fill
- Protection demonstration by using temporary coupon and Datalogger at the manhole cable terminations
- Undertake a general visual inspection for the accessible test points
- Confirm effective operation of isolation joints
- Prepare and provide a detailed technical report including recommendations for maintenance or future works

### Subsea Section of Pipeline CP Inspection Review

- Review the underwater inspection data provided by Undersea Construction Ltd. for 2024 underwater survey report and cover the assessment in this report.
  - Pre & Post Dive CP meter calibration
  - Visual Inspection of diffusers and exposed pipe underwater
  - Photograph/Video of diffusers and exposed pipe underwater
  - Pipe potentials with respect to Ag/AgCl reference at the diffusers

## 1.4 Reference Documents

The survey complied with the requirements of the following standards, codes, and other related documents.

### 1.4.1 Australian Standards, Codes, and Regulations

The jurisdictional regulations and legal requirements that apply to this report are:

| Standard | Title | Revision |
|---|---|---|
| AS 2832.1 | Cathodic protection of metals – Pipes and cables | 2015 |
| AS 2832.5 | Cathodic protection of metals – Steel in concrete structures | 2008 [R2018] |
| AS 2832.3 | Cathodic protection of metals – Fixed immersed structures | 2005 [R2016] |

### 1.4.2 Client Documentation

The document that applies to this report is:

| Document | Title | Revision |
|---|---|---|
| QMS-Item: Inspection - Moa Point Pipeline – March 2025 | UCL – QMS – IMS – Moa Point Wastewater Outfall Pipeline – Annual Inspection 2025 | 0 |

## 1.5 Personnel

The following qualified and experienced CCE personnel completed the scope of work:

| Personnel Name | Position | Certification |
|---|---|---|
| Matthew Clements | Corrosion Technician | AMMP CP Level 1 |
| Mohammed Abdul Basith | Senior Corrosion Engineer | AMMP CP Level 3 |

# 2. Criterion for Cathodic Protection

The CP system is somewhat in unusual in that the structure to be protected is a buried and immersed concrete coated pipeline. The protection criteria for this are included in the below standards.

## 2.1 Pipes and Cables

*AS 2832.1 Cathodic protection of metals: Pipes and cables* states the criterion for corrosion protection of a buried ferrous structure shall be the achievement of potentials equal to, or more negative than, -0.85 $V_{CSE}$.

To ensure that overprotection does not cause accelerated disbondment of the coating, or other deleterious effects, the polarised potential should not be more negative than -1.20 $V_{CSE}$.

The above potentials should not include the error associated with the voltage gradient caused by the flow of cathodic protection current in the electrolyte, and hence, the instant off-potential should be measured.

*AS 2832.1 Cathodic protection of metals: Pipes and cables* states an alternative criterion for corrosion protection of a buried structure shall be to maintain an instantaneous off-potential on all parts of the structure, which is at least 100 mV more negative that the depolarized potential.

## 2.2 Steel in Concrete Structures

The criteria for cathodic protection of steel in concrete are outlined in *AS 2832.5 Cathodic protection of metals: Steel in concrete structures*.

The standard states the initial and continuous adjustment of the cathodic protection system shall be based on meeting at least one of the following criteria (listed in no order of priority):

a) Potential decay criterion: A potential decay over a maximum of 24 hrs of at least 100 mV from the instant off-potential.
b) Extended potential decay criterion: A potential decay over a maximum of 72 hrs of at least 100 mV from the instant off-potential subject to a continuing decay and the use of reference electrodes (not potential decay sensors or pseudo reference electrodes) for the measurement extended beyond 24 hrs.
c) Absolute potential criterion: An instant off-potential (measured between 0.1 s and 1 s after switching the DC circuit open) more negative than -720 mV with respect to Ag/AgCl/0.5M KCl.
d) Absolute passive criterion: A fully depolarised potential, or a potential which is continuing to depolarise over a maximum of 72 hrs after the cathodic protection system has been switched off, which is consistently less negative than -150 mV with respect to Ag/AgCl/0.5M KCl.

Compliance with at least one of the above criteria shall be maintained on a continuous basis for the life of the system. If any of the monitoring sensors do not confirm adequacy of protection, additional testing shall be undertaken to confirm the rate of corrosion is insignificant.

In addition, the standard states that to avoid the deleterious effects resulting from overprotection, no instant off steel/concrete potential shall be more negative than -1100 mV with respect to Ag/AgCl/0.5M KCl for plain steel or -900 mV with respect to Ag/AgCl/0.5M KCl for prestressed steel.

## 2.3 Fixed Immersed Structures

*AS 2832.3 Cathodic protection of metals: Fixed immersed structures* states the criterion for cathodic protection of steel in sea water shall be the achievement of potentials equal to, or more negative than, - 0.80 $V_{SSC}$.

However, in tropical waters where steel structures may be subject to microbiological influenced corrosion (MIC) or accelerated low water corrosion, a potential of - 0.90 $V_{SSC}$ (or more negative) is recommended.

To ensure that overprotection does not cause accelerated disbondment of the coating, or other deleterious effects, the polarised potential should not be more negative than -1.15 $V_{SSC}$.

The above potentials should not include the error associated with the voltage gradient caused by the flow of cathodic protection current in the electrolyte, and hence, the instant off-potential should be measured.

# 3. Methodology

### Onshore Section of Pipeline CP Inspection

The following cathodic protection tests were carried out by CCE during the onshore section of pipeline survey:

- DC "on" potentials of the structure
- Temporary coupon potential measurements
- Insulating joint tests

## 3.1 Structure Potential Measurements

The CP current source could not be interrupted due to galvanic anodes directly connected to the pipeline underwater. At all accessible land based test locations, the following measurements were recorded with respect to a portable copper/copper sulphate reference electrode

- DC on-potential

## 3.2 Temporary Coupon Potential Measurements

A steel coupon was buried approx. 10cm below ground over the pipe route and approx. 2m from the manhole adjacent to Moa Point Road where cable connections to the pipeline are accessible.

The steel coupon was electrically connected to the cable terminal labelled "Protected Pipe" which allows coupon to polarize utilizing the pipe CP system.

Datalogger was setup to record the temporary coupon potential measurements and depolarization, total data logging was setup and continued for three hours.

The following measurements were recorded with respect to a portable copper/copper sulphate reference electrode

- Coupon native potential
- Coupon on-potential data logging
- Coupon depolarization data logging

## 3.3 Insulating Joints

Insulating joints were not visible/accessible at manholes M1, M2 and M3. DC "on" potentials were measured, with respect to a copper/copper sulphate reference electrode on either side of the isolation joint (terminals in test box inside manhole M1 which had protected and unprotected labels). The isolating joint is considered to be effectively isolated if a minimum of 50 mV potential difference is recorded between the protected side and isolated side of the flange. It is noted that the potential difference tests are only indicative and can produce inaccurate results.

### Subsea Section of Pipeline CP Inspection

Methodology consistent with the philosophy of operation set out in the Undersea Construction Ltd. CP Testing - Moa Point Pipeline – 2025 report (Ref # QMS - Item: Inspection – Moa Point Pipeline – March 2025 – Rev. 0)

# 4. Discussion

The onshore field works commenced and finished on 19 March 2025 by CCE. The work was conducted over 1 field trip.

Weather conditions during the survey were heavy gusts and rain. The results are attached in the Appendix A and are discussed in further detail in the sections below.

## 4.1 Onshore Section of Pipeline CP Inspection

Undersea welded sacrificial anodes could not be interrupted therefore Instant off potentials could not be measured on the pipeline.

During this survey, all identified test locations M1, M2, R1 and M3 are marked on site layout included in Appendix C for reference.

Test location 'M1' manhole near to coastline:

- To assess the cathodic protection potential criterion as per Australian Standard Cathodic Protection of Metals AS 2832.1:2015 Pipes and Cables and AS 2832.5:2008 Steel in Concrete, we have introduced temporary coupon testing as detailed in next section.
- This test point has two labelled terminals. One as protected and the other unprotected, this indicated that this is an isolation point.
    - Protected terminal ON potential measured -800mVcse (potential fluctuations consistent with traction) at the test box inside manhole 'M1'. Datalog analysis indicates ON potentials is in range of -860mVcse to -990mVcse. Unprotected terminal ON potential measured -960mVcse (potential fluctuations consistent with traction).
        - Potential fluctuations were observed, this may be due to stray traction or another fluctuating interference. This is not causing any adverse effects at present
    - Testing indicates unstable electrical continuity between these two terminals (or pipe sections) at the joint, with a potential difference varying from -160mV to 30mV and a measured resistance of 250 kΩ. This instability may be caused by electrolytic conduction through water in the manhole or partial failure of the flange insulation kit (FIK). Further investigation, including dry-condition measurements could confirm the root cause.

The buried pipe is continuing from the manhole 'M1' to the base of the hill

- There is a manhole 'M2' between the coastline and the hill which is under the road and would requires traffic management to access and investigate.
- Pipe transitions aboveground at the base of the hill which was not accessible for testing during the survey due to other construction works around this area.
- As per last year survey, at the pipe transition aboveground, it was observed there could be a thickly wrapped flanged joint at this point. It needs further investigation to check the isolation joint condition at this point. Potential measured last year at this point was -355mVcse confirming this section of pipe is electrically isolated and not receiving the cathodic protection.

The above-ground pipe rises from the lower elevation to the top of the hill, then transitions underground and remains buried until it reaches the treatment plant (by observing the pipe site layout included in Appendix C of this report). This part of the section is assumed to be not protected based on last year readings taken at the base of the hill as explained above.

- There is a manhole ‘M3’ between the top of the hill and plant which was not accessible due to weather conditions.

- As per the plant personnel pipe does not rises aboveground at the plant end.

**Temporary Coupon Testing at test location ‘M1’**

A steel coupon was buried approx. 10 centimetres below ground over the pipe route and approx. 2 meters from the manhole adjacent to Moa Point Road where cable connections to the pipeline are accessible. The steel coupon was electrically connected to the cable terminal labelled “Protected Pipe” which allows coupon to polarize utilizing the pipe CP system.

Datalogger was setup to record the temporary coupon potential measurements and depolarization, total data logging was setup and continued for three hours.

After 3 hours, the coupon was then disconnected from the pipeline to allow a depolarization test: Within 10 minutes the potential of the coupon had changed from -793mVcse to -685mVcse, a difference of >100 mV, indicating that the pipeline is protected against corrosion in this vicinity by the 100-mV criterion of the Australian Standard AS 2832.1:2015 and AS 2832.5:2008.

Appendix A provides a graph illustrating the coupon's potential measurements, including the transition from native potential to ON potential (pipe connection) and the depolarization potentials.

## 4.2 Subsea Section of Pipeline CP Inspection Review

Undersea Construction Ltd (UCL) divers use a Buckleys BathyCorrometer (BCM) cathodic potential meter to take ON readings.

The report supplied (UCL – QMS – IMS – Moa Point Wastewater Outfall Pipeline – Annual Inspection 2025) was reviewed by CCE and found to be satisfactory.

Calibration checks of BCM was completed by UCL pre & post dive.

The ON potentials measured on the underwater pipeline diffusers 1, 3, 7, 11 and 17 were more negative than -990 $mV_{SSC}$ similar to previous survey. This indicates that the anodes are in a satisfactory condition.

Undersea welded sacrificial anodes could not be interrupted therefore Instant off potentials could not be measured on the pipeline due to which AS 2832.5:2008 cathodic protection of metals – steel in concrete structures could not be assessed. However, recorded potentials has met the -0.80 $V_{SSC}$ cathodic protection potential criterion as per Australian Standard AS 2832.3:2005 Cathodic Protection of Metals: Fixed immersed structures.

# 5. Conclusions

## 5.1 Onshore Section of Pipeline CP Inspection

Based on temporary coupon testing, the cathodic protection system is operating effectively.

The potentials measured on the coupon exposed to the same vicinity of the pipeline and connected to the CP system at test location 'M1', met the criterion for cathodic protection as detailed in AS 2832.1:2015 and AS 2832.5:2008.

Cathodic protection for the pipe section from the manhole 'M1' to the plant is not determined due to no access to test locations M2, R1, M3. It is assumed this section of pipe is not protected based on last year survey reading taken at R1. M2 and M3 test locations were identified during 2025 survey investigation with help of GIS layout of wastewater pipeline.

## 5.2 Subsea Section of Pipeline CP Inspection Review

The cathodic protection system is operating effectively. The potentials measured on the structure at all tested locations met the criterion for cathodic protection as detailed in AS 2832.3:2005

# 6. Recommendations

The following actions are recommended to continue effective operation of the cathodic protection system:

- WWL shall consider the following:
  - Develop a plan to address the following tasks when feasible at the earliest opportunity
    - Drain water from manhole M1 and inspect the pit with the CCE technician.
    - Implement traffic management for inspecting manhole M2, assess the as found conditions, drain any accumulated water and inspect the pit with the CCE technician.
    - Inspect the pipe transition aboveground at the base of hill and evaluate the wrapped joint with the CCE technician.
    - Inspect the manhole M3, assess the as found conditions and drain any accumulated water and inspect the pit with the CCE technician.
- After detailed inspections of M1, M2, R1 and M3, CCE shall evaluate the possibility of installing a bond cable at the isolation joints to integrate the unprotected buried sections of pipe with the existing CP system.
- Continue to inspect the cathodic protection system of Moa Point wastewater outfall pipeline on annual basis by trained and qualified cathodic protection personnel.

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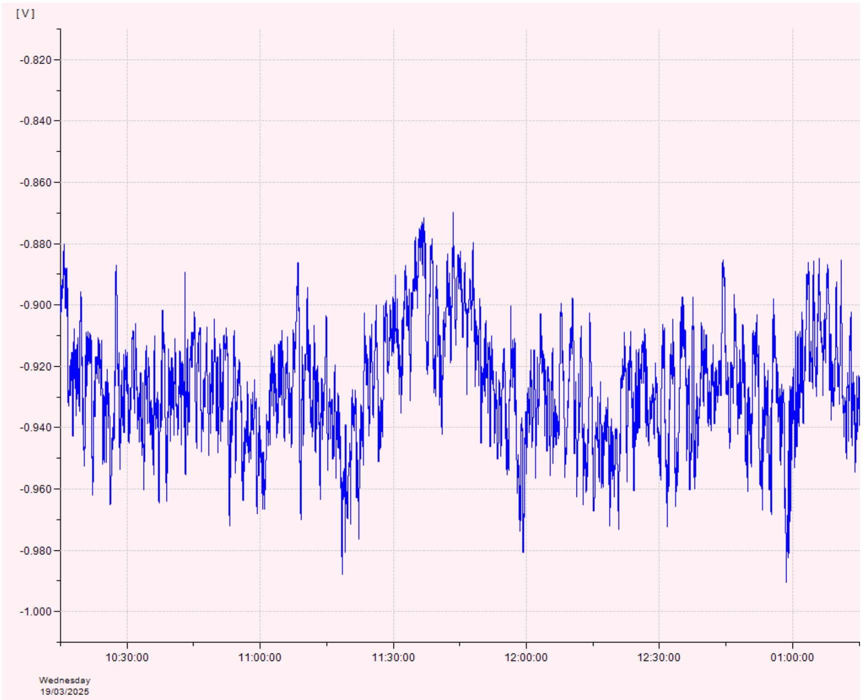
# Appendix A: Cathodic Protection Test Results

### TEST LOCATION 'M1'– ONSHORE SECTION MANHOLE NEAR COAST LINE

| Test Location | Structure Vs Portable CSE (mVcse) | | Remarks |
|---|---|---|---|
| | On | Off | |
| Tested at the manhole 'M1' cable termination plate. (Labelled: Protected pipe) | -800<br>(potential fluctuations) | NA | Potential fluctuations consistent with traction found when measuring the pipe potentials. Datalogger graph below shows pipe potential between -870mVcse and -990mV |




| Test Location | On | Off | Remarks |
|---|---|---|---|
| Tested at the manhole 'M1' cable termination plate. (Labelled: Unprotected pipe) | -960<br>(potential fluctuations) | NA | Potential fluctuations consistent with traction found when measuring the pipe potentials. |

Site notes: Potential difference between both the above terminals measures -160mv to +30mV (potential fluctuations). Resistance measured 250kΩ.

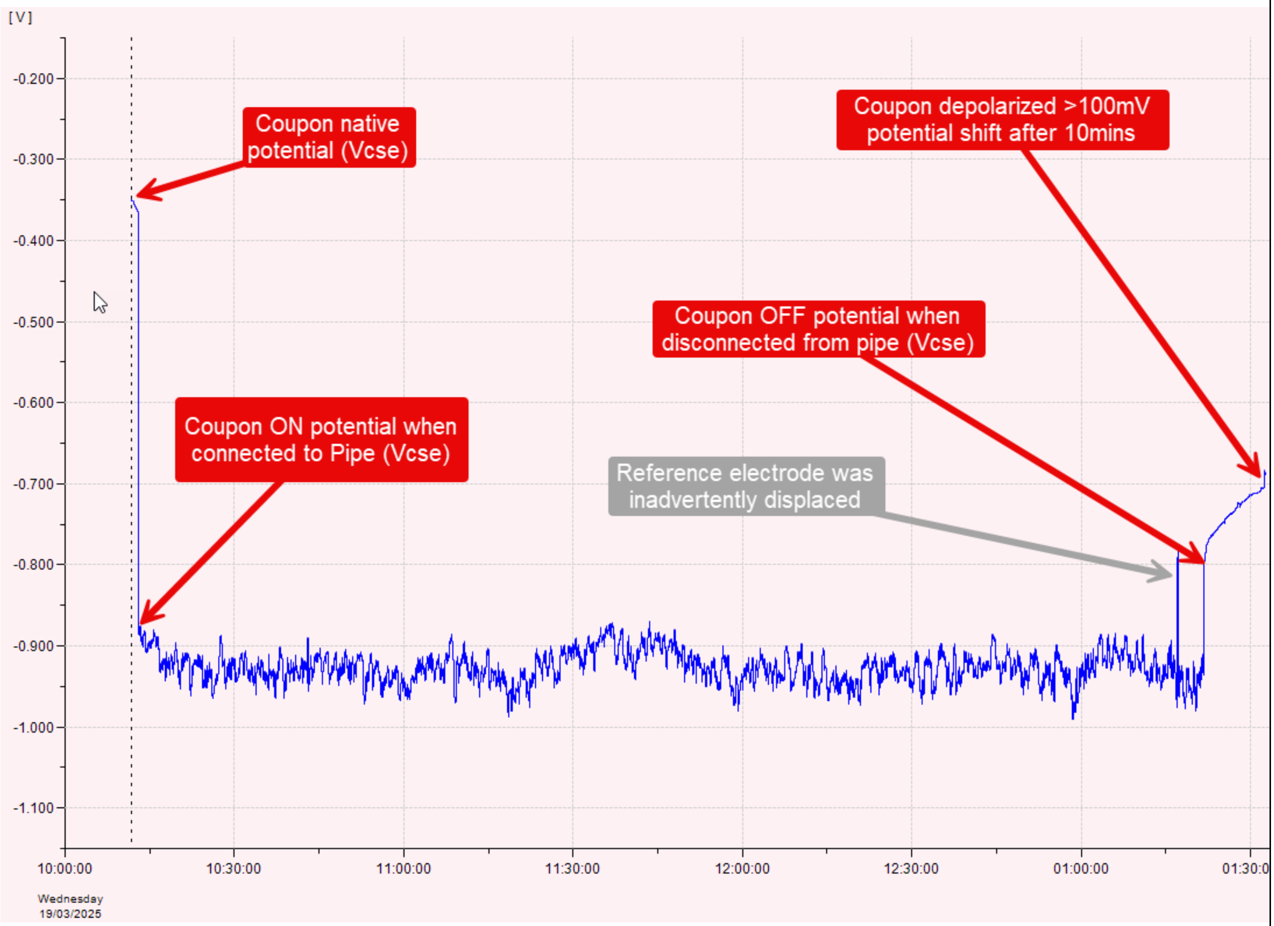
### TEST LOCATION 'R1'– ONSHORE SECTION OF PIPE RISING ABOVEGROUND AT BASE OF HILL

| Test Location | Structure Vs Permanent RE (mV) | | Remarks |
|---|---|---|---|
| | On | Off | |
| Above ground pipe section at base of hill | NT | NA | Not accessible due to on-going construction |

## TEST LOCATION 'M1' - TEMPORARY COUPON TESTING

| Test Location | Structure Vs Portable CSE (mV) | | Remarks |
|---|---|---|---|
| | **On** | **Off** | |
| Coupon native potential | NA | -318 | 10mins after burying the coupon |
| Coupon potentials when connected to the protected pipe (after 3Hrs) | -940 | -793 | 3 Hrs. Polarization time |
| Coupon potentials when disconnected from pipe (Depolarization test) | NA | -793 to -685 | Coupon potential shift of >100mV within 10 mins. of depolarization / disconnection of coupon from pipe |

Moa Point Wastewater Pipeline
Datalogging of Temporary Coupon Potentials



# Appendix B: CP System Schematic

## Pipe Section & CP

(Reference: Undersea Construction Ltd./Doc No. UCL-VEOLIA-MOA POINT PIPELINE – Rev.0 Mar.2023)

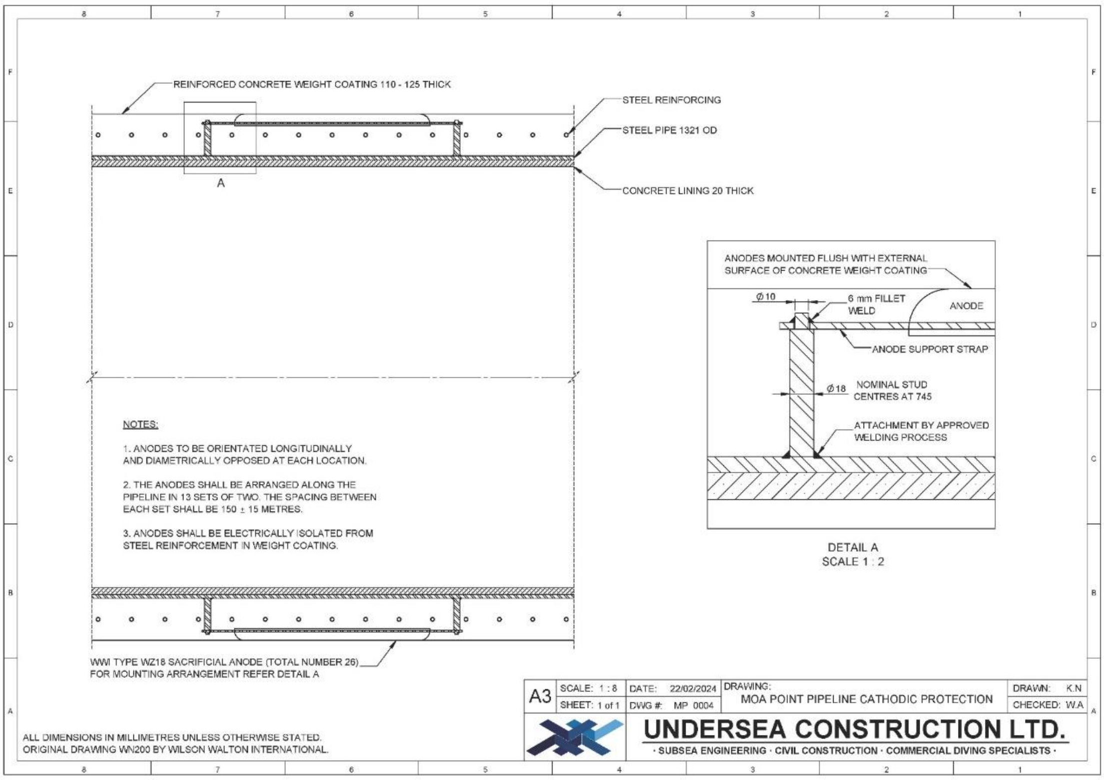



**Figure 4, Pipe section & CP**

## In-Ground Section of the Pipeline

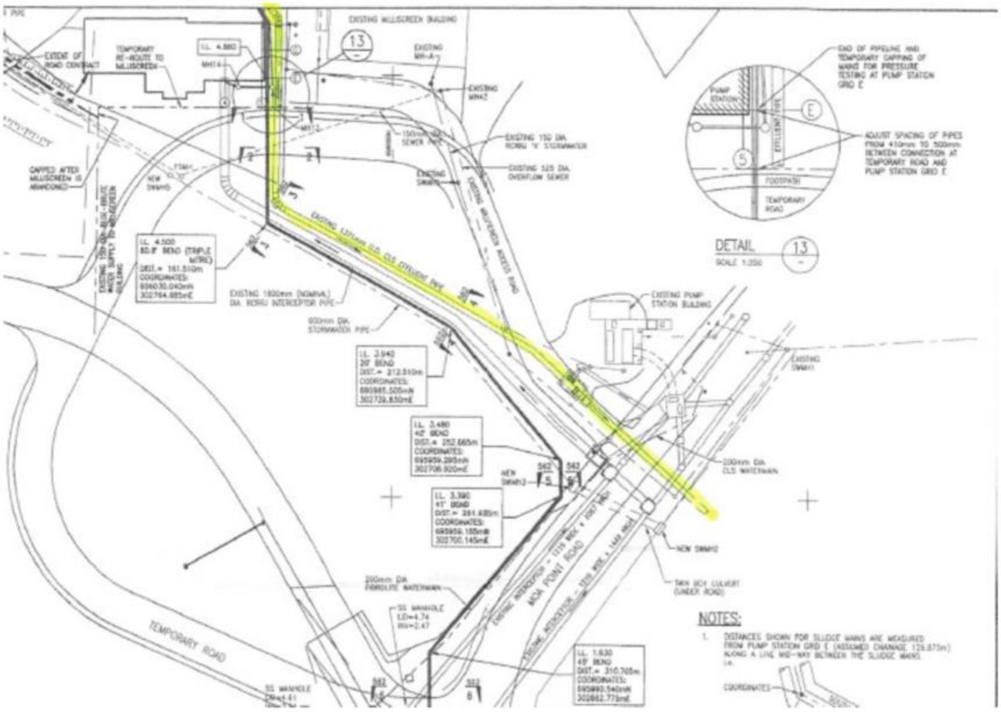



**Figure 5, In-Ground Section of the Pipeline**

In-Water Section of the Pipeline

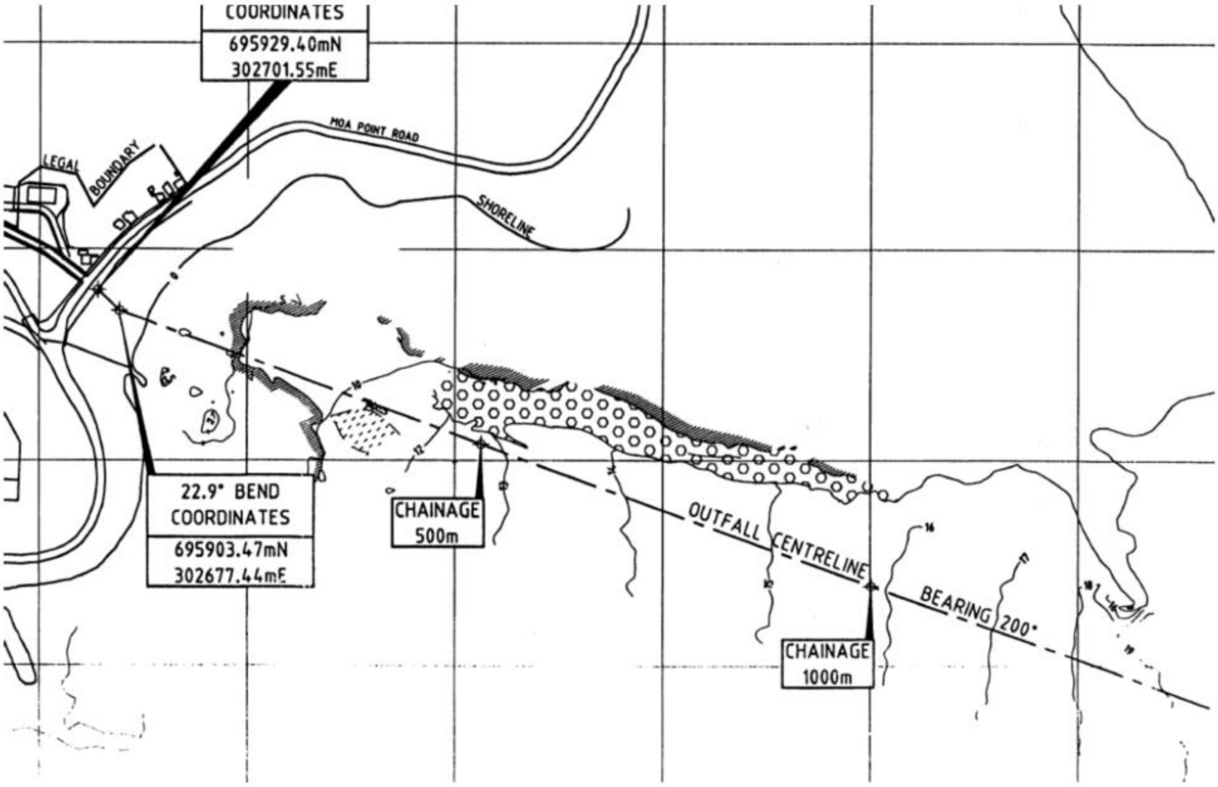
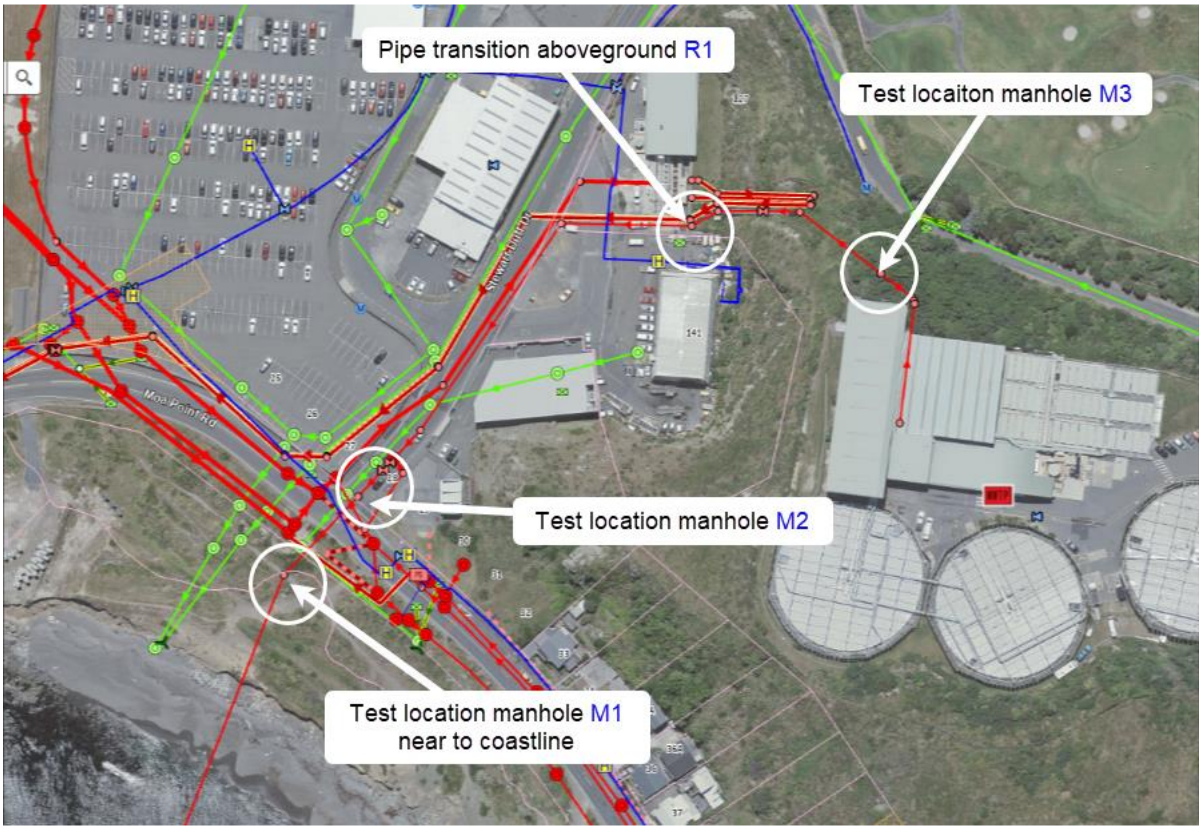


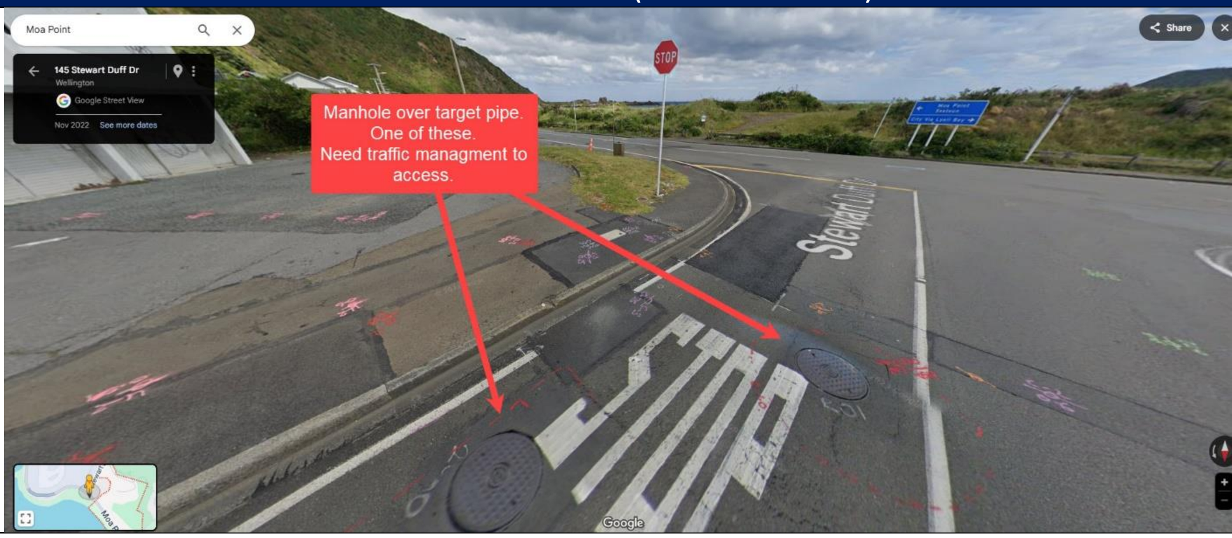

**Figure 5, In-Water Section of the Pipeline**

# Appendix C: Land Based Pipe Section Site Layout

**MOA POINT WASTEWATER OUTFALL PIPELINE (ONSHORE SECTION)**



# Appendix D: Site Photos

<table>
<tr><th>Test Location M1</th><th>Test Location R1 (Not Accessible)</th></tr>
<tr><td></td><td rowspan="2">
</td></tr>
<tr><td>
</td></tr>
<tr><th colspan="2">Test Location M2 (Not Accessible)</th></tr>
<tr><td colspan="2">
</td></tr>
</table>

| Pipe transition underground at top of hill |
| --- |
|  |
| **Test Location M3 (Not Accessible)** |
|  |