New Zealand Aluminium Smelters Limited

SCL GROUNDWATER STATUS

2020

Distribution: Environment Southland

Provider: NZAS

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CONTENTS

1 Summary

Reports on the groundwater monitoring data for the Cathode Pad and Treatment Plant were provided to Environment Southland (ES) in 1999, 2002 and again in 2005 to confirm satisfactory progress of natural remediation of cyanide and fluoride leaching from the SCL pad. In 2006 Environment Southland approved and signed off the completion of the rehabilitation project[1] after reviewing the NZAS 2005 SCL Groundwater Report.

ES have requested an update of the monitoring data for the period 2005 to 2020 after a spill to ground occurred from a treatment tank on 2 April 2020. This monitoring data further supports the position that there have not been discharges arising from NZAS' current SCL pad; with all discharges the subject of this monitoring program relating to historical events in the early 1990's.

Groundwater results have been graphed and are displayed in Section 4: "Data for Individual Zones". The variability in the shallow pea gravel layer may be due to the normal variation of rainfall and storm surges as well as the general movement of groundwater towards the sea. The key findings from the monitoring data from 2005 to 2020 are summarised below.

Background Zone
The deep bore 2/2 has remained unchanged and relatively stable since 2005 for all analytes monitored.

SCL Zone
Shallow pea gravel bores 3/1, 3/2, 3/3: All contaminant levels have continued to decrease significantly since 2005 but bores have showed some variability over the last fifteen years. A single spike in cyanide was observed in 2011 for all three bores possibly due to higher than usual rainfall around the month of sampling. A fluoride spike was seen between 2007 and 2009. These incidents were investigated but no root cause was found. The underground discharge pipe for treated effluent was replaced in 2006 as a precaution for potential leaks into the ground. Contaminant levels seen for fluoride and free cyanide for bore 3/3 are similar to levels observed in the background zone. Total cyanide concentrations are above background levels seen in bore 2/2.

Deep sand bore 3A/1: All contaminant levels have dropped. Fluoride and free cyanide have stabilised and are approaching the levels measured in the background zone. The concentration of total cyanide is above the level seen in background bore 2/2.

Midshore Zone
Shallow pea gravel bore 4/5: All contaminant levels have continued to decrease since 2005. The fluoride concentration has decreased by approximately a factor of 5. Fluoride is now double the background value seen in bore 2/2. A fluoride spike was observed in 2010 which corresponds with the spikes seen in the SCL zone between 2007-2009. The total cyanide concentration has also decreased by a factor of 5 since 2005. The total cyanide is above the value of background bore 2/2. A spike was observed in 2015 which corresponds to the spike seen in the SCL zone in 2011. Free cyanide is similar to the concentration seen in background bore 2/2.

Deep sand bore 4/10: All contaminant levels have continued to decrease since 2005. The conductivity appears to be trending closely with the cyanide levels. Fluoride is approaching the levels of background bore 2/2.

Coastal Zone
Shallow pea gravel bore D: Contaminant levels have continued to decrease or stabilised since 2005. Fluoride has decreased by a factor of 20. Total cyanide has decreased by a factor of 2 and stabilised. One smaller spike was observed in in 2015 matching the spike seen in the SCL and Midzone in 2015.

Deep sand bore 5/4: Contaminant levels have continued to decrease for this coastal bore.
Total cyanide has decreased by a factor of 4 and stabilised. Fluoride has decreased by a factor of 4. One smaller spike was observed in 2017 matching the spike seen in the SCL and Midzone in 2015.

[1] ES response to NZAS (Shaun), 2005 SCL Groundwater Report. Ref 2005/23479, 14/2/2006. Copy in appendix A

2 Introduction

2.1 Background Information

Spent cathode liner (SCL) material is from an aluminium reduction cell when the cell has been decommissioned at the end of the life of the cell. It comprises mostly carbon cathodes and refractory bricks. SCL material may also contain other parts of the aluminium cell such as steel cathode bars, alumina and 'bath' (sodium aluminium fluoride).

SCL has been stored on a concrete pad on the Peninsula since the 1970's. In 1976 a Cathode Effluent Treatment Plant was constructed next to the SCL pad to process water run-off from the SCL pad.

In the early 1990's it was discovered that groundwater below the SCL pad at NZAS was contaminated by leachate from the SCL pad. Reports concluded that the concrete pad on which the SCL was placed had cracked, possibly due to an earthquake or failure of joints in the concrete pad as the pad was enlarged over time. Rainwater was leaching through the SCL material into the groundwater below the pad.

The original concrete pad (south) was reconstructed to enable covering with an impermeable membrane and reconfiguration of the drainage system. The SCL material was then moved from an adjacent smaller north pad to the larger concrete pad at the south. The SCL material was covered with an impermeable geo-membrane then topped with gravel to prevent further leachate from entering groundwater. The north pad was then deconstructed and closed.

Additional groundwater bores were installed to monitor the rehabilitation of the groundwater quality in the vicinity of the SCL pad. Regular groundwater bore monitoring started in late 1995 with annual reporting in July 1996 in accordance with the SRC's resolution of 11 October 1995.[2] Regular monitoring and reporting of groundwater data ceased on recommendation of Environment Southland in August 1999[3] in favour of snapshot monitoring in 2002.

ES responded[4] to the 2002 Report with a letter requesting that another set of samples were to be collected in 2005. These samples were collected and analysed as per the 2002 request. In early 2006 Environment Southland signed off the completion of the rehabilitation project after reviewing the December 2005 Report.

NZAS have continued to sample a selection of groundwater bores located around the Cathode Plant and SCL pad to verify the integrity of the concrete foundation and cover. Monitoring data are reported and discussed in the annual compliance reports to ES.

The discharge diffuser at sea and discharge pipe was replaced in 2003/2004 as the diffuser was mostly covered with sand due to accretion. The pipeline to the diffuser was again replaced in 2015 due to suspected damage resulting from harsh sea conditions.

On 2 April 2020 an operator at the Cathode Treatment Plant was setting up for a routine batch transfer of treated effluent from a treatment tank to a settling tank. The transfer pumps were started prematurely before the tank valves were opened which resulted in "Water Hammering" in the pipework. Several valves and pipes ruptured under the pressure resulting in up to 40 m^3 of untreated effluent being released to ground.[5] No effluent was able to be recovered due to the effluent dissipating into the underlying pea gravel. The groundwater bores have been sampled at least four times since the spill occurred.

Graphical representation of the concentration of contaminants monitored in groundwater has been plotted against an accurate timeline to provide a visual display over the last three decades. Data are displayed in the Data for Individual Zones in Section 4 of this report. Data points obtained for sampling in 2020 is tabled in Appendix B.

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[2] ES response to NZAS (Nicola), "Cathode Pad Contaminant Plume, Options for Remediation Ref A277, 11 October 1995
[3] ES response to NZAS (Manager), SCL Groundwater and Diesel Bioremediation Report, Ref N015-012, 4 August 1999
[4] ES response to NZAS (Shaun), SCL Groundwater Report, Ref N015-028, 14 June 2002
[5] ES response to NZAS (Shaun), SCL Groundwater Report, Ref 2005/23479, 14 February 2006

2.2 Flow of Groundwater

The groundwater flow is towards the beach to the south of the SCL pad[6] and treatment plant. There are two distinct layers present beneath the SCL pad area,

- Pea gravel to a depth of 12 – 14 metres underlain by
- Fine sands to a depth of 18 – 20 metres.

Silts, clay and peats form the boundary at the base of the fine sands layer. Groundwater flow is greater in the pea gravel layer than in the fine sands layer because of the higher permeability of the gravels. Contour of groundwater concentrations for cyanide and fluoride are appended in Appendix C together with a conceptual view of the groundwater surrounding the SCL pad.

[6] Groundwaters of Tiwai Peninsula, Volume 1 + 2, Woodward-Clyde, 1994

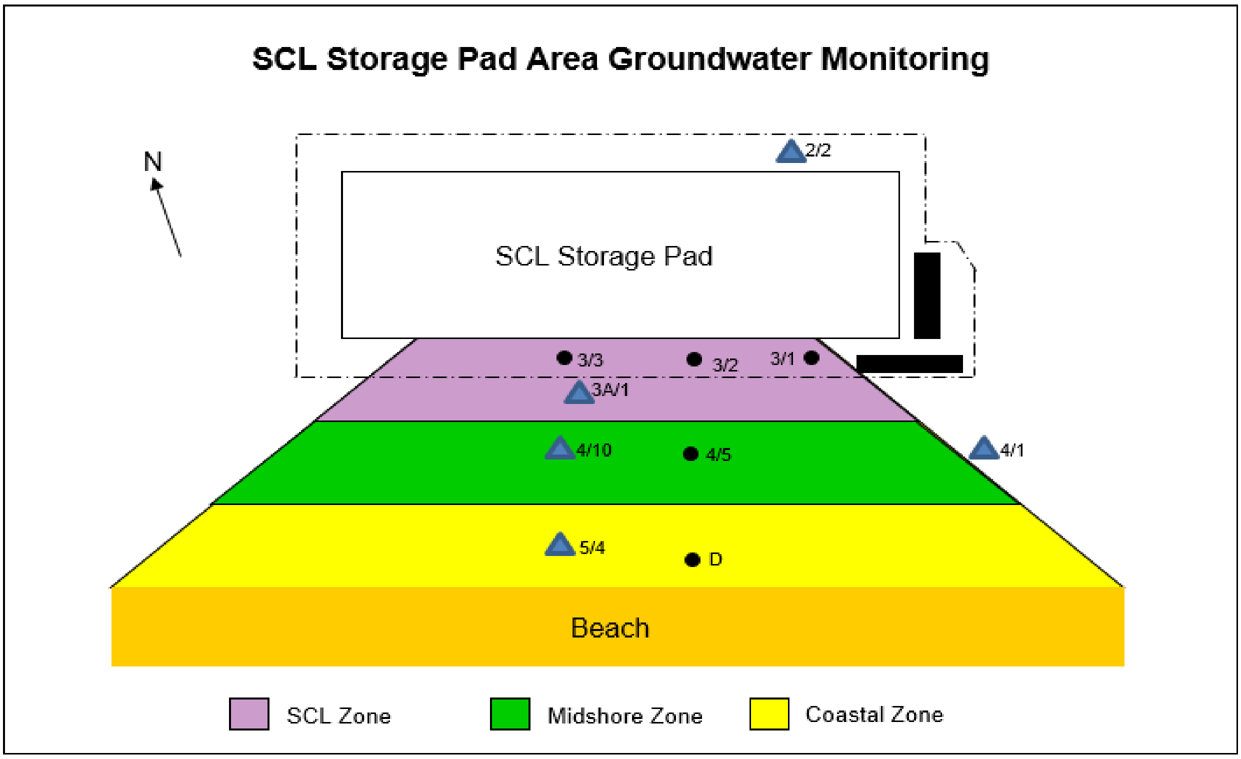
3 Groundwater Monitoring

3.1 Introduction

This section covers the groundwater monitoring of bores located around the SCL Pad and Treatment Plant. Nine bores have been regularly sampled and analysed for pH, conductivity, free cyanide, total cyanide and fluoride concentrations for 25 years. Sampling commenced for bores 3/1 and 3/2 in April 2002 and August 2020 for bore 4/1.

3.2 SCL Monitoring Bore Locations

The SCL pad is located approximately 85 metres from the beach. Monitoring bores are located between the SCL pad and the beach. The locations of the bores monitored are shown in the following diagram (not to scale).



To assist in assessing the movement of contaminants the bores have been separated to represent the groundwater in four zones:

- SCL zone, bores 3/1, 3/2, 3/3 and 3A/1, immediately south of the SCL pad,
- Midshore zone, bores 4/1, 4/5 and 4/10, the flat area between the SCL pad and the sand dunes,
- Coastal zone, bores 5/4 and D, the sand dunes near the top of the beach, and
- Background zone, bore 2/2 north and upstream of the SCL pad.

Bores 3/1, 3/2, 3/3, 4/5 and D are shallow bores ● that are used to sample groundwater in the pea gravel layer.

Bores 2/2, 3A/1, 4/1, 4/10 and 5/4 are deep bores ▲ that are suitable to sample groundwater in the underlying fine sands layer.

3.3 Sampling & Reporting

All bores are sampled twice per year for fluoride, free and total cyanide, pH and conductivity. All bores are also tested up to six times per year for fluoride as an additional line of assurance for potential changes in the groundwater quality. Annual results are calculated as an average of individual samples taken for this report.

3.4 Surrounding Groundwater Quality

Groundwater quality is monitored for potable water pumped to site from the underground aquifer on Tiwai Peninsula. Groundwater is also monitored around the land-based sewage field. Ground water monitoring locations are marked with red triangles on the map below.

3.4.1 Sewage Bores

Sewage bores are sampled twice a year for analytes specified in resource Consent 203376. Value ranges for pH, conductivity and fluoride are tabled below for the years 2019 and 2020.

Analyte	Sewage North	Sewage South
pH	7.8 - 8.0	7.3 - 7.9
Conductivity µS/cm	358 - 376	368 - 465
Fluoride mg/L	0.11 - 0.15	2.8

3.4.2 Potable Water Supply

Potable water is sampled monthly. Value ranges for pH, conductivity and fluoride are tabled below for the years 2019 and 2020.

Analyte	Potable Water Supply
pH	7.2 - 8.2
Conductivity µS/cm	229 - 407
Fluoride mg/L	< 0.05 (less than limit of detection)

3.4.3 Seawater

Seawater is sampled once a year for the discharge of treated effluent. Typical values are tabled below.

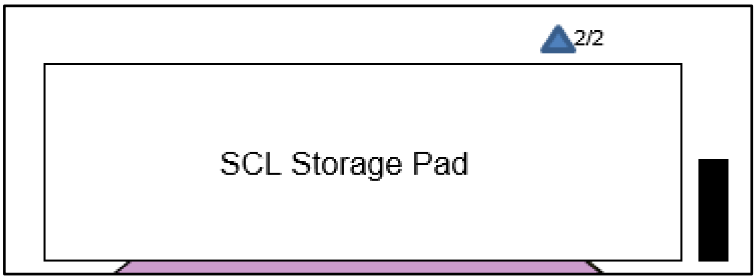
Analyte	Potable Water Supply
pH	8.1 – 8.2
Conductivity µS/cm	49000 - 50000
Fluoride mg/L	1.2 – 1.3
Total cyanide mg/L	< 0.01 (less than limit of detection)

4 Data for Individual Zones

Graphical representation of the concentration of contaminants monitored in groundwater has been plotted against an accurate timeline to provide a visual display over the last three decades for each zone. Multiple bores are present in each zone apart from the background zone representing the control sample as being upstream of the SCL pad. Each Zone is discussed in this section.

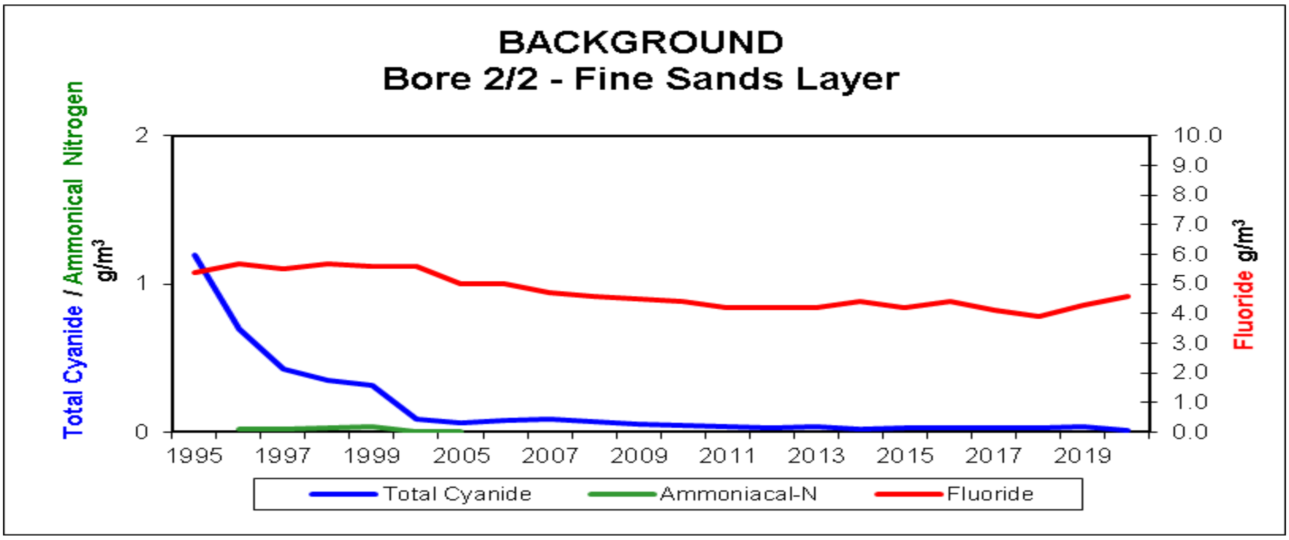
4.1 Background Zone

A single Bore 2/2, is used to monitor the background zone. This bore is a deep bore suitable for sampling the groundwater from the fine sands layer of the aquifer surrounding the SCL pad. Bore 2/2 is located immediately north/east, and 'upstream' of the SCL pad. This location indicates the quality of the groundwater flowing towards the SCL pad and eventually to the sea.



4.1.1 Results for Bore 2/2

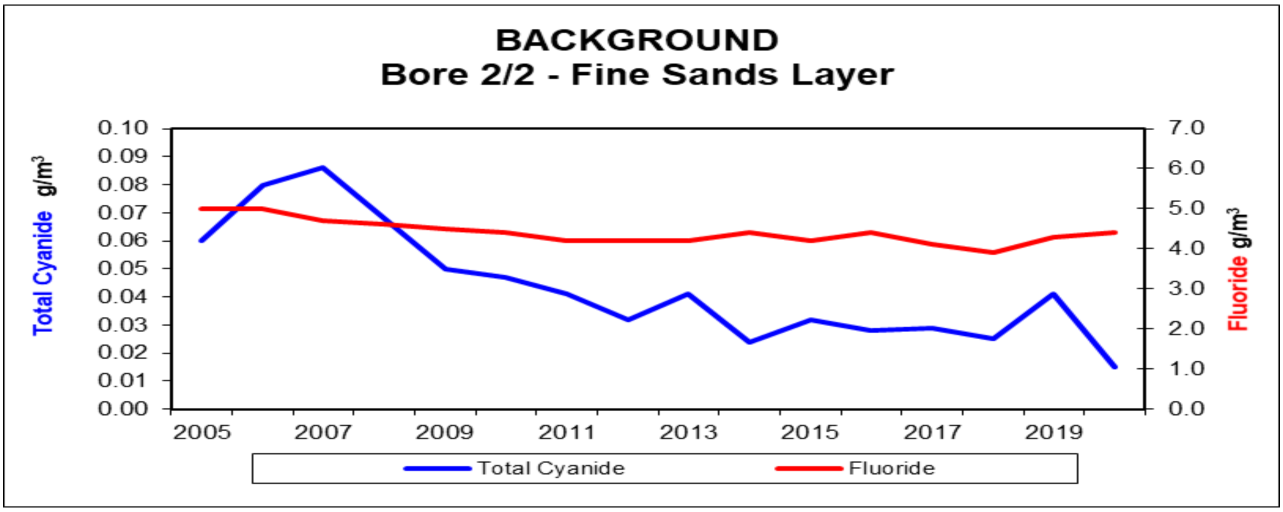
The following graph shows the annual average concentration of total cyanide, fluoride, and ammoniacal nitrogen measured in the groundwater from Bore 2/2 since 1995. Note that ammoniacal nitrogen has not been measured since May 2005. Total cyanide is typically measured at 0.05-0.02 mg/L with free cyanide < 0.01 mg/L.



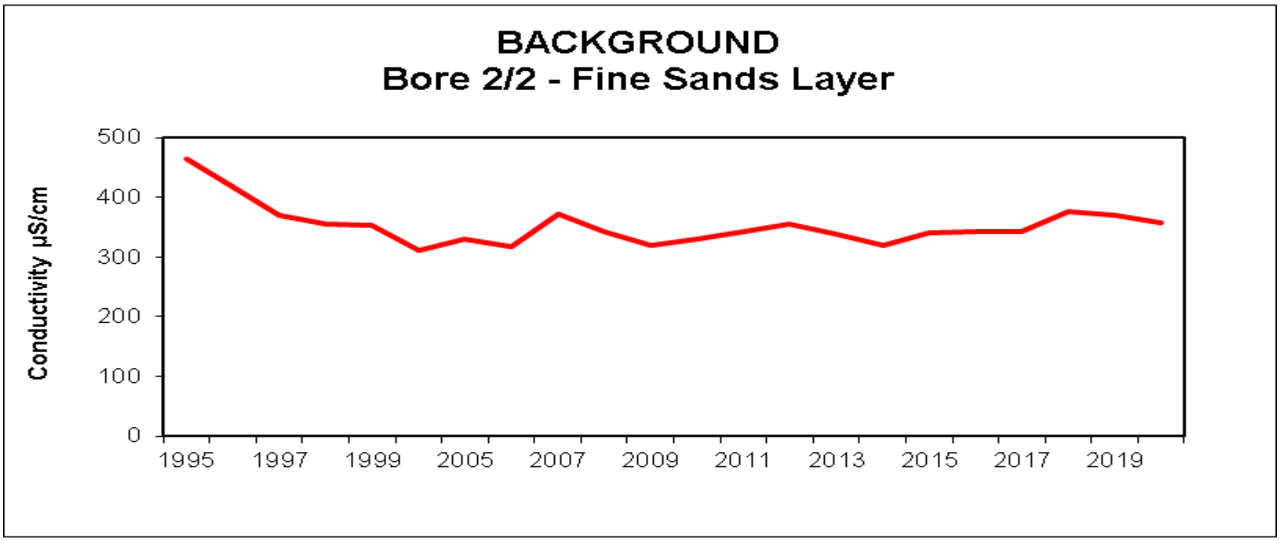
The elevated levels of total cyanide in the early 1990s were due to SCL leachate entering the groundwater around the pad. The SCL material was shifted to a temporary concrete pad to the north of the existing pad while the original location was reconstructed. The original SCL pad was covered in 1992 to stop any further leachate entering groundwater.

Part of the same data set as displayed in the graph above, is displayed in the following graph for years 2005 to 2020 to provide greater clarity of the most recent concentrations of fluoride and total cyanide.

Background Zone, continued



The following graph shows the annual average conductivity measured in groundwater samples from Bore 2/2 since 1995.



4.1.1.1 Comments on Bore 2/2

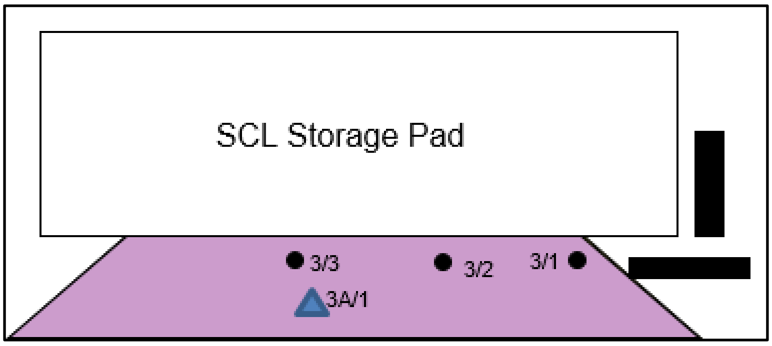
Conductivity measurements at Bore 2/2 indicate that the groundwater flowing into the SCL pad area has low levels of contamination. The conductivity is similar to values seen for groundwater in the vicinity of the sewage field and potable water supply.

By 2020 the cyanide concentration had decreased by a factor of three since 2005.

The fluoride concentration has remained relatively stable since 2005. A sample taken in May 2020 was slightly elevated, and an unexplained value of 6.3 mg/L after the spill at the treatment plant in April, however, the latest data sets show a fluoride concentration between 3.7 - 4.1 mg/L for June - December 2020 which is a range typical for this bore. Fluoride discharged to air from the smelting process is also likely to contribute to the general fluoride level in groundwater when washed with rainwater into the ground. The prevalent wind direction is north/westerly for Tiwai Peninsula.

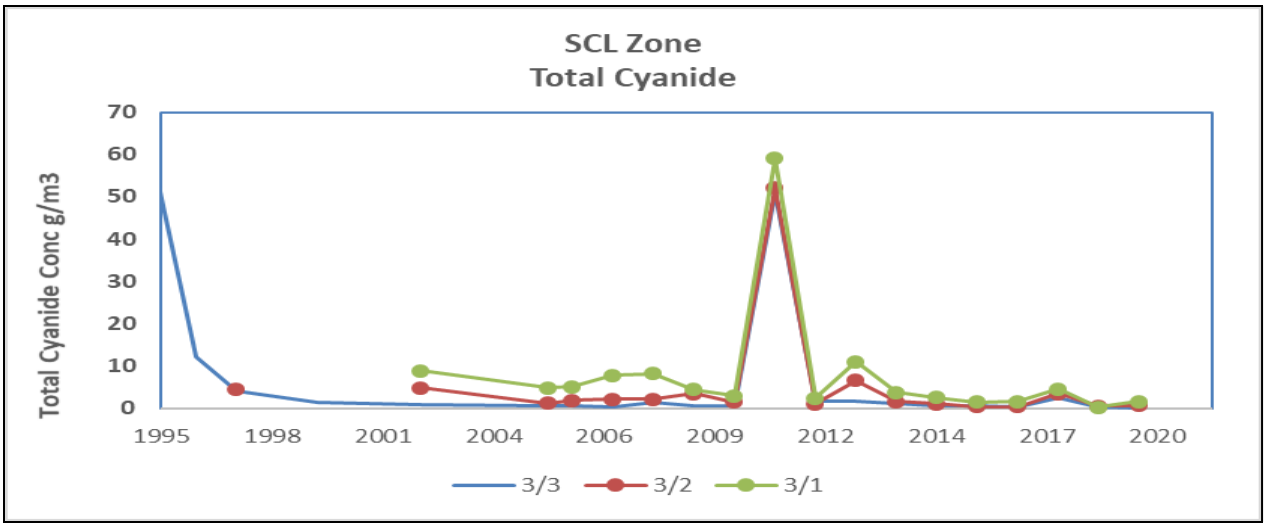
4.2 SCL Zone

Four bores, Bores 3/1, 3/2, 3/3 and 3A/1, are used to monitor the SCL zone. Bore 3/1, 3/2 and 3/3 are shallow bores suitable for sampling groundwater from the pea gravel layer of the aquifer surrounding the SCL pad. Bore 3A/1 is a deep bore suitable for sampling groundwater from the fine sands layer of the aquifer.

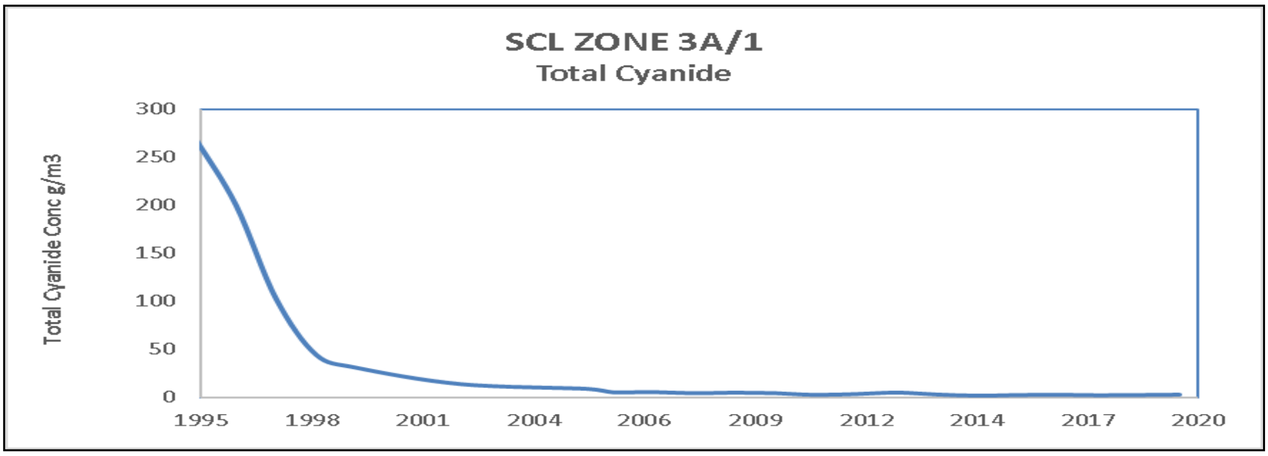


4.2.1 Results for Cyanide

Free cyanide has ranged from < 0.01 – 0.32 mg/L for bores 3/3; 3/2; 3/1 with bore 3/3 showing the lowest free cyanide concentrations typically below 0.01 mg/L. The following graph shows the annual average concentration of total cyanide since 1995 (Note – g/m^3 = mg/L).

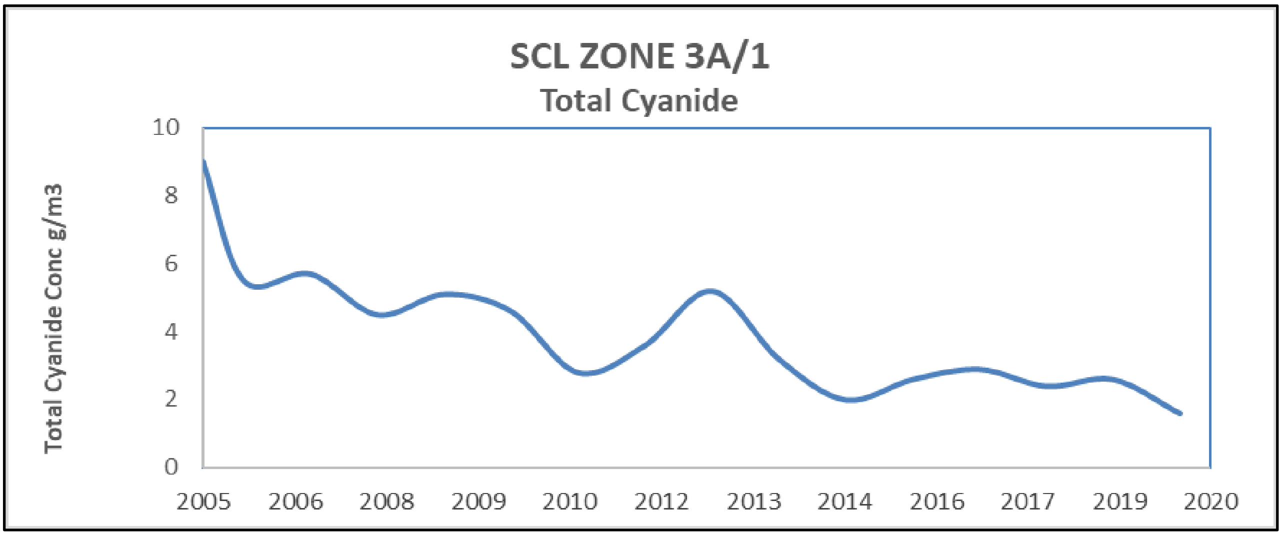


The following graph shows the annual average concentration of total cyanide from Bore 3A/1 since 1995. Free cyanide is consistently below 0.05 mg/L and typically < 0.01 mg/L.



SCL Zone, continued

Part of the same data set as displayed in the previous graph, is displayed in the graph below for years 2005 to 2020 to provide greater clarity of the most recent concentrations of total cyanide. Total cyanide remains elevated above background in Bore 3A/1.

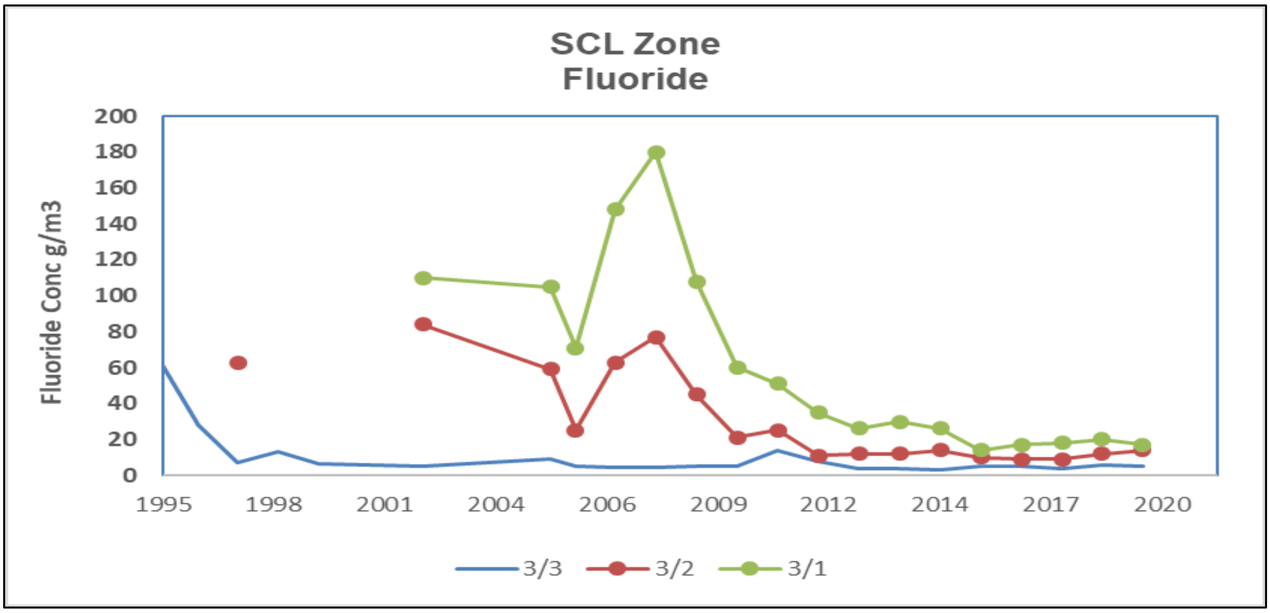


4.2.1.1 Comments on Cyanide in Bore 3A/1

Cyanide concentrations have continued to decrease over time. A cyanide spike was observed in July 2011 for the shallow bores 3/1, 3/2 and 3/3 located close to the southern side of the SCL pad. Only one sample was collected in 2011 and when re-sampled 6 months later it had decreased to previous concentrations of approximately 1 mg/L. A similar spike was not detected in deep bore 3A/1 located just a few metres downstream of bore 3/3. An investigation into the elevated levels was conducted but no underlying root cause was found.

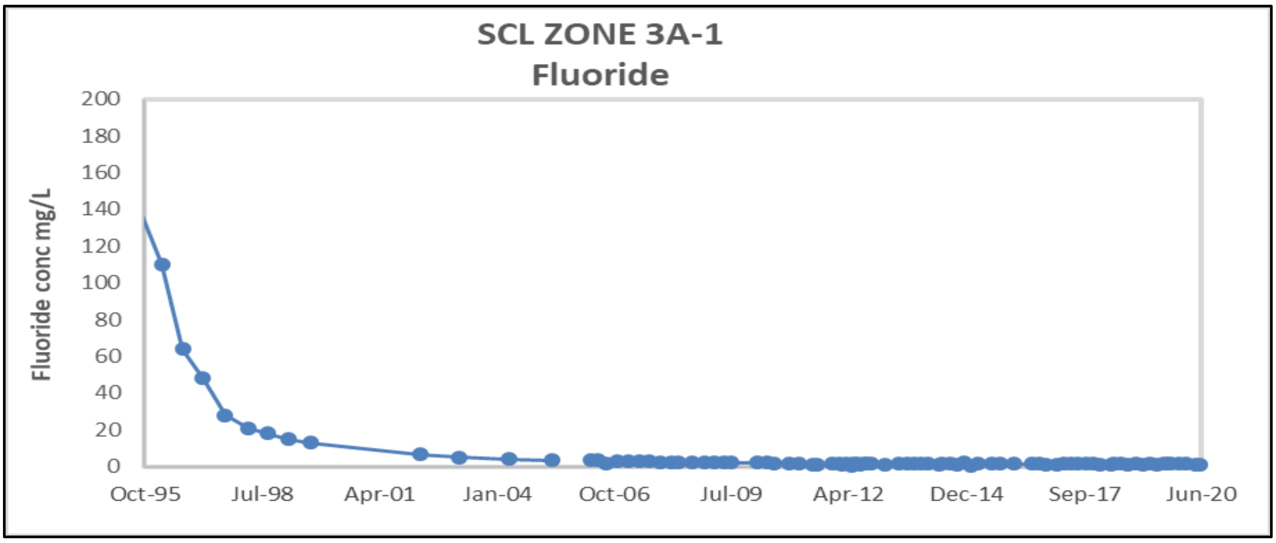
4.2.2 Results for Fluoride

The following graph shows the annual average concentration of fluoride measured in the groundwater from shallow Bores 3/3, 3/2 and 3/1 since 1995.

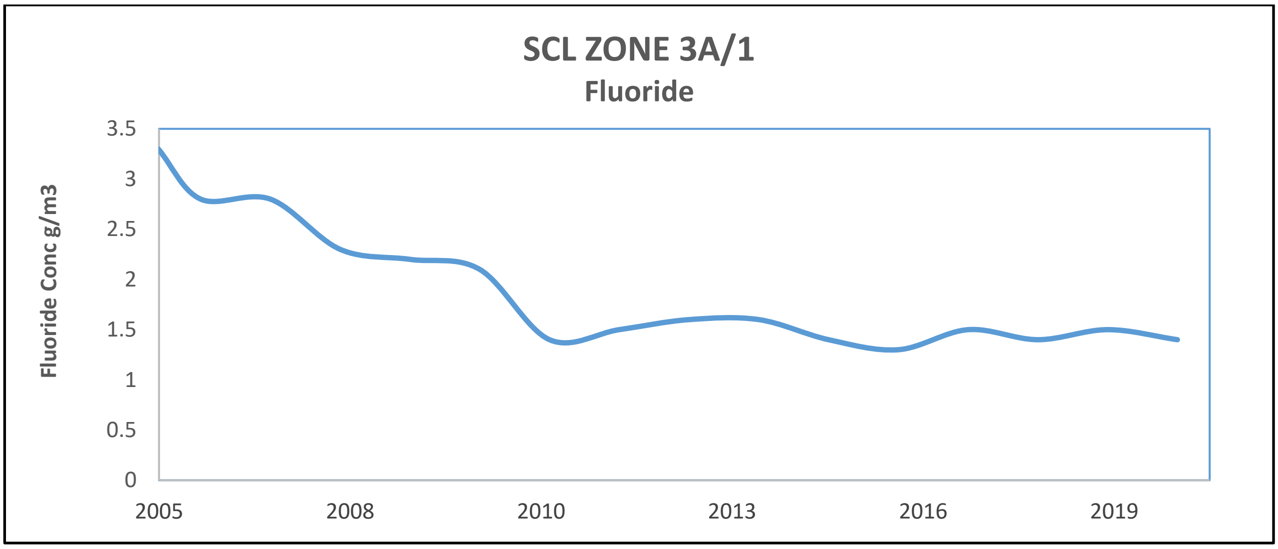


SCL Zone, continued

The following graph shows the annual average concentration of fluoride measured in deep bore 3A/1 since 1995.



Part of the same data set as displayed in the graph above, is displayed in the following graph for year 2005 to 2020 to provide greater clarity of the most recent concentrations of fluoride.



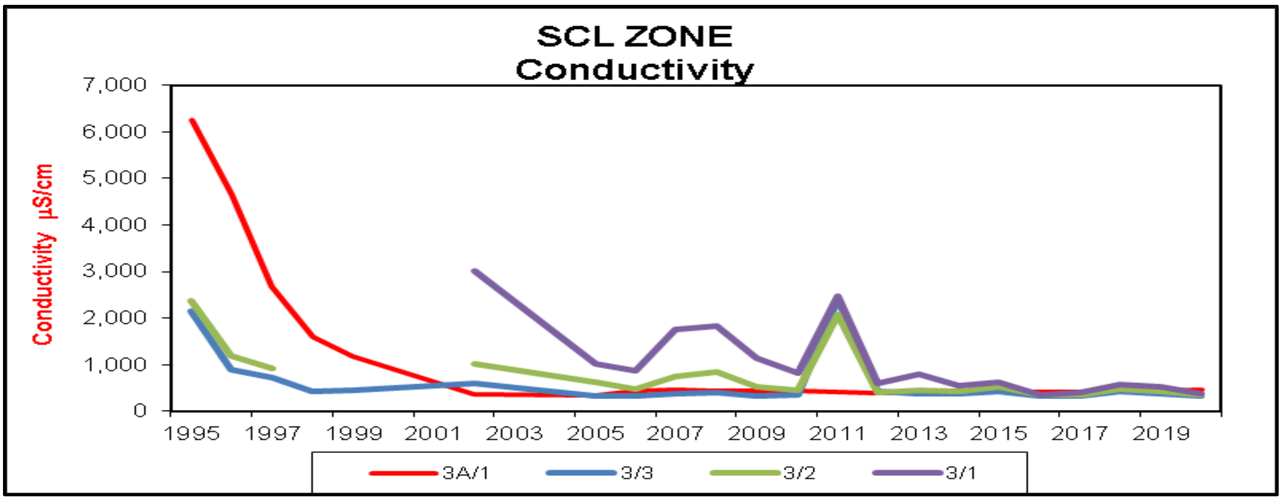
4.2.2.1 Comments on Fluoride in Bore 3A/1

The fluoride concentrations in the SCL zone have significantly decreased from 2005 till 2020. The decreases in concentration in groundwater from east to west with deep bore 3/1A showing the lowest concentration. A fluoride spike was observed for bore 3/2 and 3/1 between 2007-2009. No spike in fluoride was detected for deep bore 3A-1. The root cause for the spike was never identified. The underground discharge pipe which was replaced in 2003/2004 but is unlikely to be the source of contamination. Since 2010 the fluoride concentration in bore 3A/1 is nearing background levels found in seawater surrounding the Peninsula.

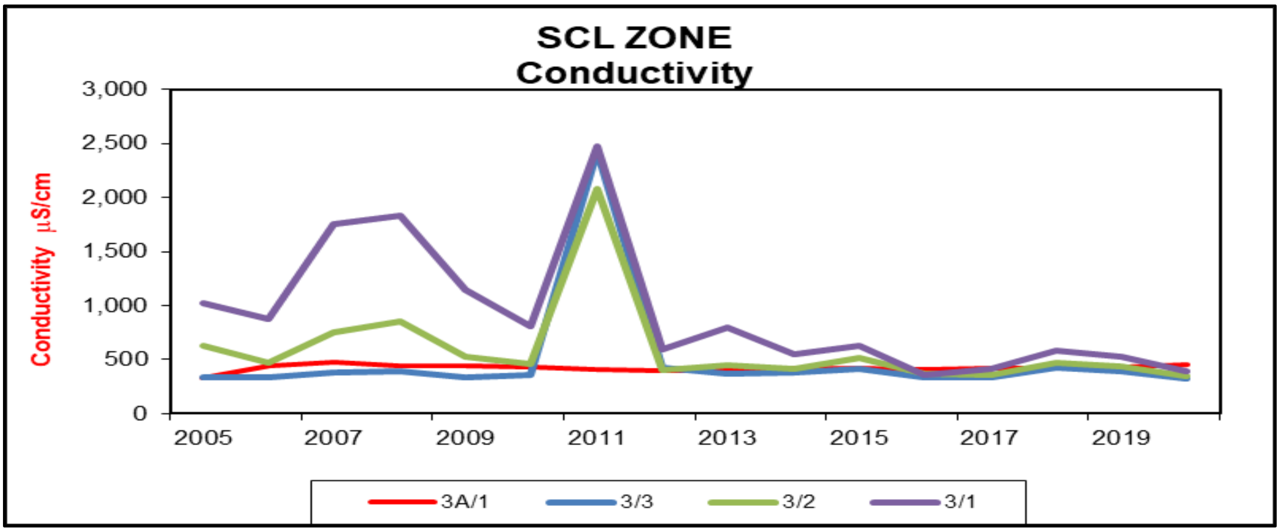
SCL Zone, continued

4.2.3 Results for Conductivity

The following graph shows the annual average conductivity measured in groundwater sampled from Bores 3/1; 3/2; 3/3 and 3A/1 since 1995.



Part of the same data set as displayed in the graph above, is displayed in the following graph for year 2005 to 2020 to provide greater clarity of the most recent conductivity values.



4.2.3.1 Comments on Conductivity

Conductivity has continued to decrease over time for bore 3/1 and 3/2. Monitoring at Bore 3A/1 indicates that the conductivity of the deeper groundwater layer in fine sands had recovered by 2005 and has maintained a conductivity of just below 500 µS/cm ever since. The same level of conductivity is observed at the sewage field and potable water supply areas of the aquifer.

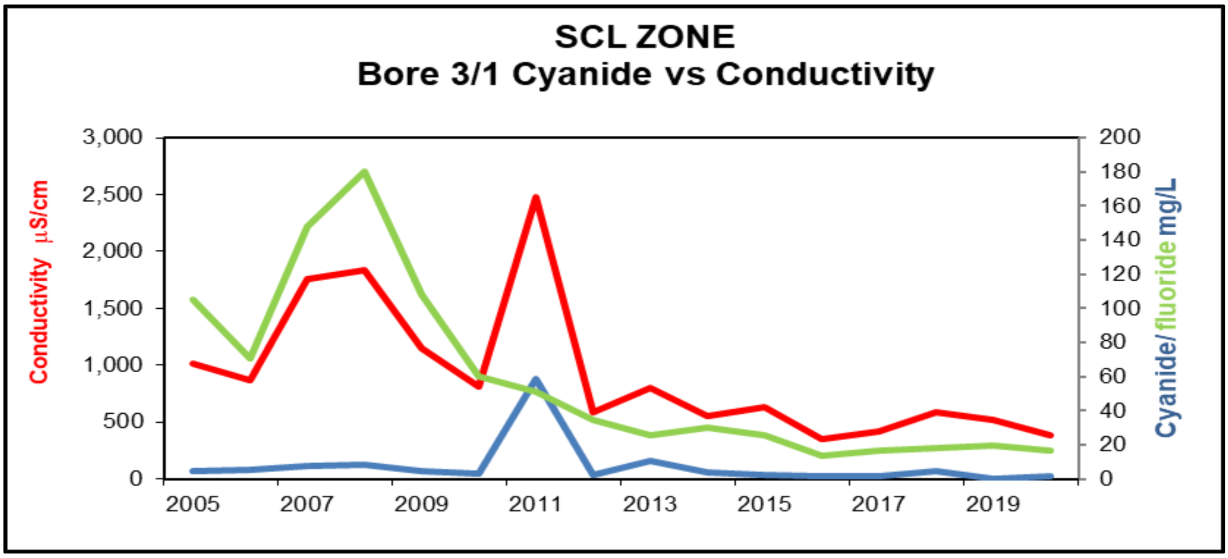
An increase in conductivity was observed for Bores 3/1, 3/2 and 3/3 when the fluoride (2007-9) and cyanide (2011) levels increased. Currently the conductivity for these bores is approaching those of background bore 2/2.

The variability in the pea gravel layer may be due to normal variation in groundwater analyte concentrations with rainfall and storm surges as well as the general movement of groundwater towards the sea.

SCL Zone, continued

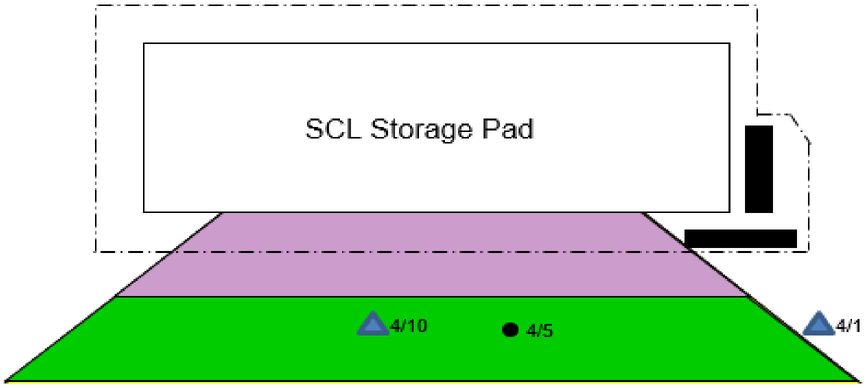
4.2.4 Trends for Bore 3/1

The cyanide concentrations track well with conductivity but not with fluoride for shallow bore 3/1 in the SCL Zone. See the graphs below for details. There appears to be limited or no correlation between total cyanide and fluoride concentrations for this bore.



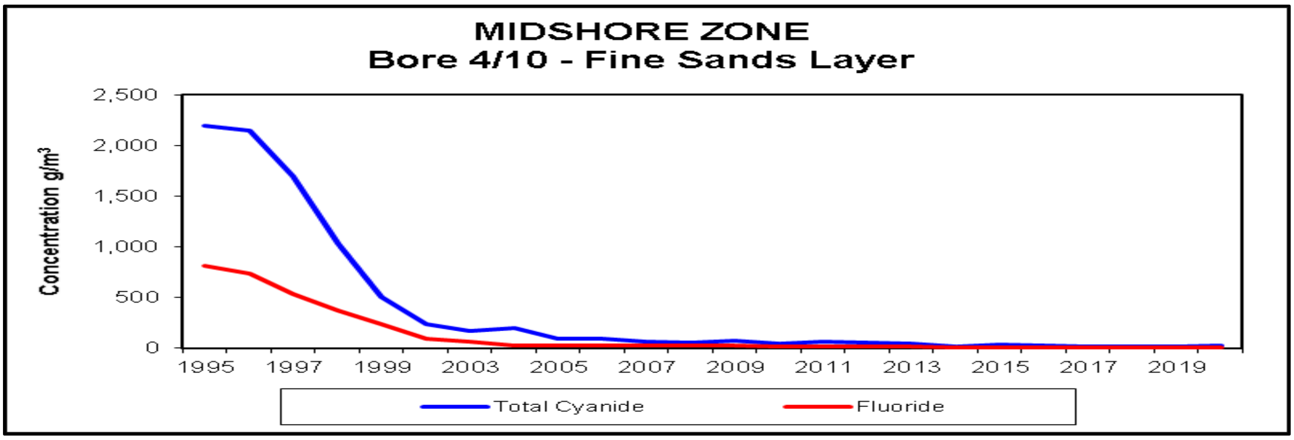
4.3 Midshore Zone

Two bores, Bores 4/5 and 4/10, have been used to monitor the Midshore zone since 1995. Bore 4/5 is a shallow bore suitable for sampling groundwater from the pea gravel layer of the aquifer surrounding the SCL pad. Bore 4/10 is a deep bore suitable for sampling of groundwater from the fine sands layer of the aquifer. In August 2020 sampling also began from shallow bore 4/1 as a replacement for bore D in the Coastal Zone. Seawater intrusion started to occur in early 2020 due to coastal erosion of the southern coast. The rate of coastal erosion has been actively monitored since 2017.

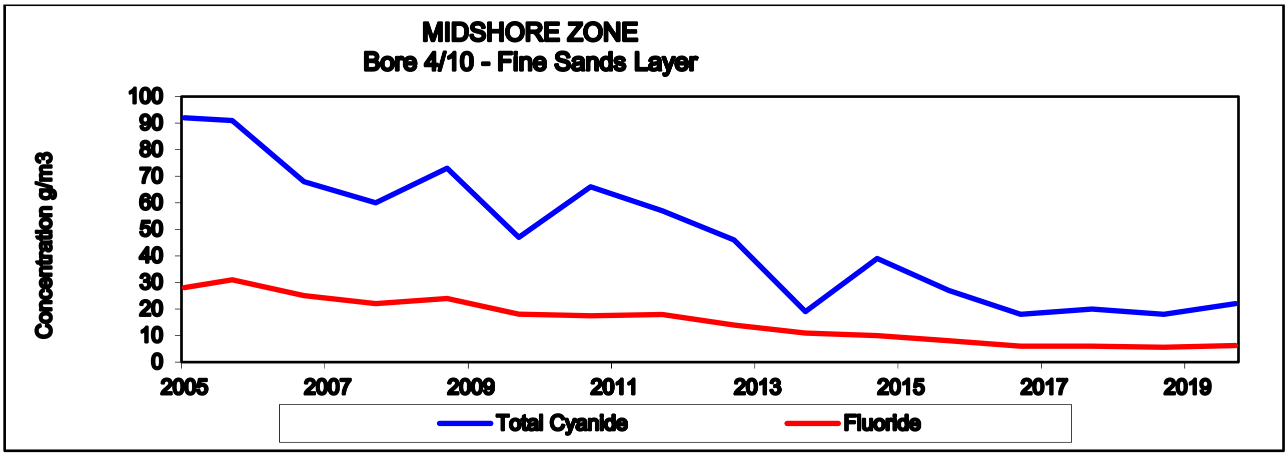


4.3.1 Results for Bore 4/10

The following graph shows the annual average concentration of total cyanide and fluoride measured in the groundwater samples from deep Bore 4/10 since 1995.



Part of the same data set as displayed in the graph above, is displayed in the following graph for year 2005 to 2020 to provide greater clarity of the most recent concentrations of fluoride and total cyanide. Free cyanide is typically 0.03 mg/L.



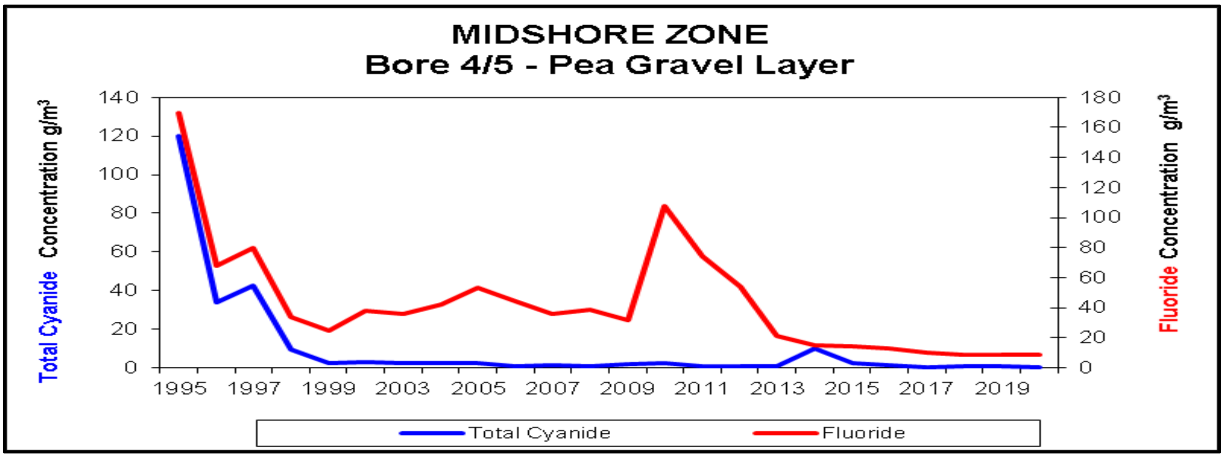
Midshore Zone, continued

4.3.1.1 Comments on Bore 4/10

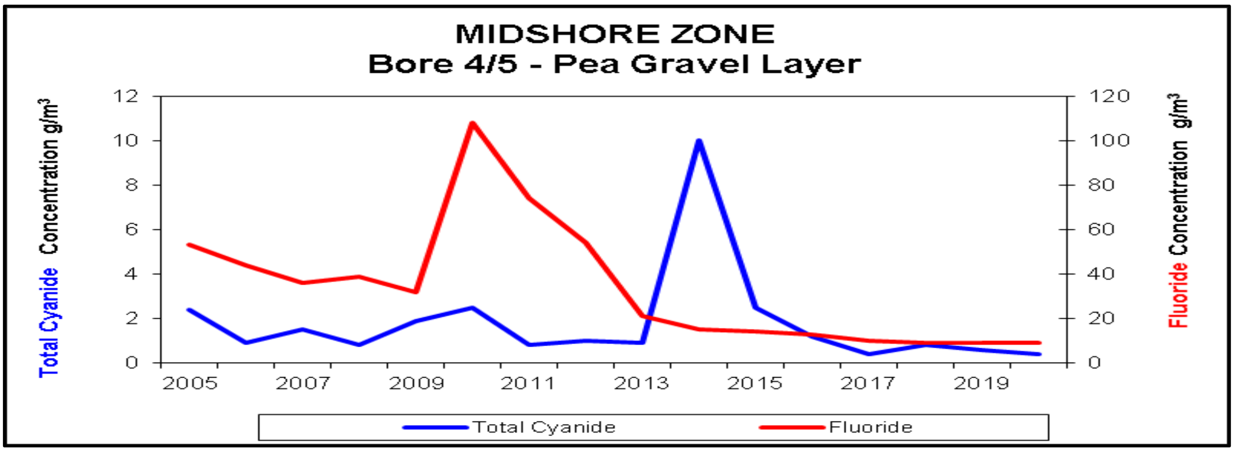
Both cyanide and fluoride concentrations have decreased significantly since monitoring began in 1995. The concentration of fluoride is near the background value but the total cyanide remains elevated above the background level as measured in bore 2/2.

4.3.2 Results for Bore 4/5

The following graph shows the annual average concentration of total cyanide and fluoride measured in the groundwater from shallow Bore 4/5 since 1995.



Part of the same data as displayed in the graph above is displayed in the following graph for year 2005 to 2020, to provide greater clarity of the most recent concentrations of fluoride and total cyanide. Free cyanide is typically < 0.04 mg/L.



4.3.2.1 Comments on Bore 4/5

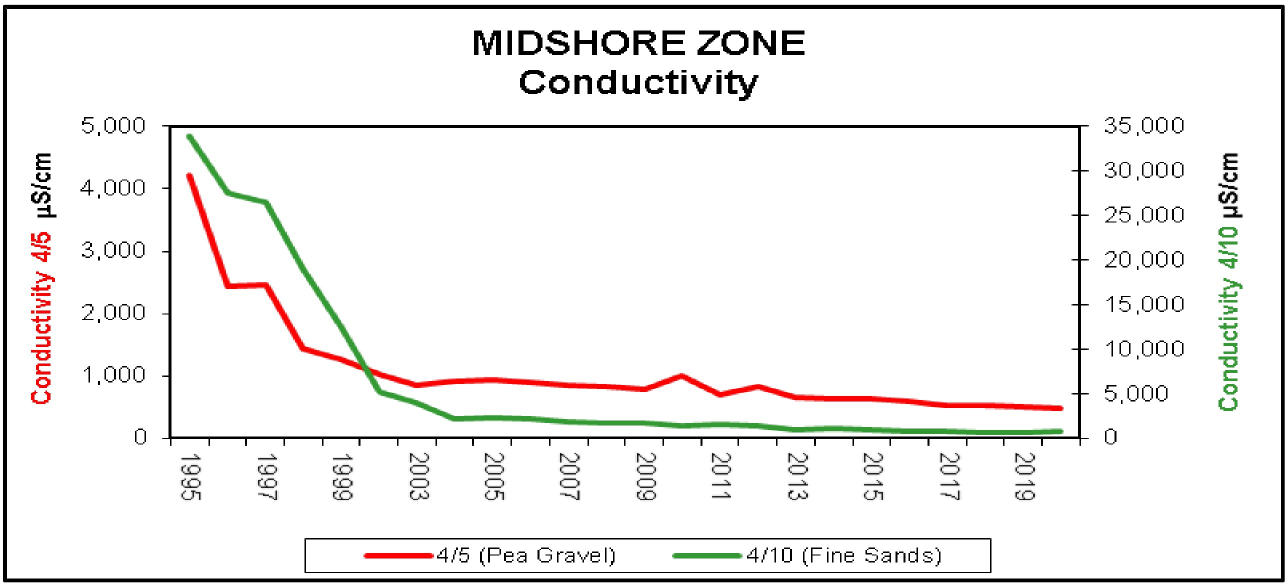
Both fluoride and cyanide levels have decreased significantly since monitoring began in 1995 and nearing the background values found in Bore 2/2. Total cyanide is higher than background but is much lower than that in the underlying fine sands layer. A spike in concentration for the analytes was observed for:

- fluoride in 2010/2011 which corresponds to a spike seen for bores in the SCL Zone occurring 3 years prior.
- cyanide in 2015 which corresponded to the spike observed for the SCL Zone bores in 2011. The underground discharge pipe was replaced in 2015 due to potential leakage.

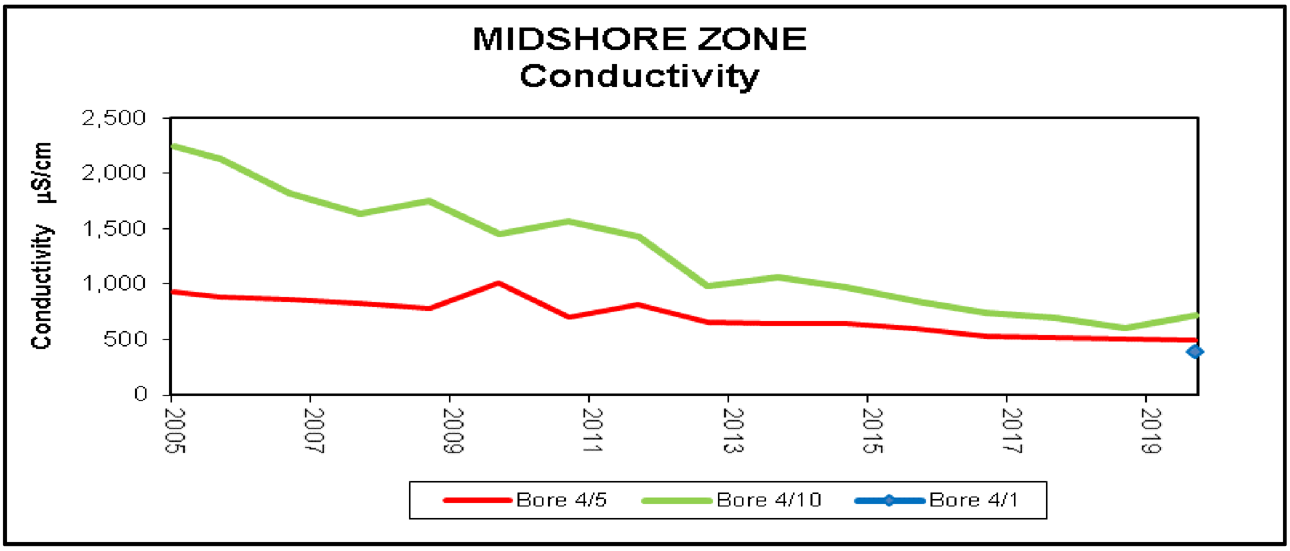
Midshore Zone, continued

4.3.3 Results for Conductivity

The following graph shows the conductivity measured in groundwater sampled from Bores 4/5 and 4/10 since 1995.



Part of the same data as displayed in the graph above is displayed in the following graph for year 2005 to 2020 to provide greater clarity of the most recent conductivity measurements. Bore 4/1 was sampled for the first time since 1998 in August 2020 to assess the area to the east of the pad now that bore D and 5/1 are destroyed by coastal erosion.



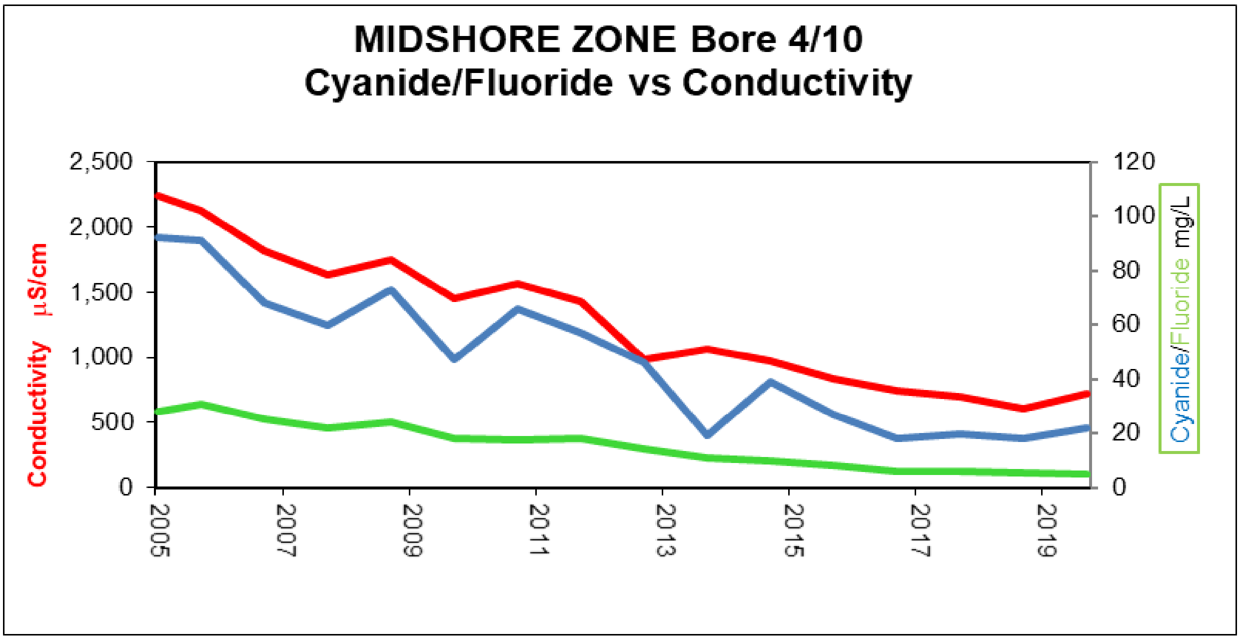
4.3.3.1 Comments on Conductivity

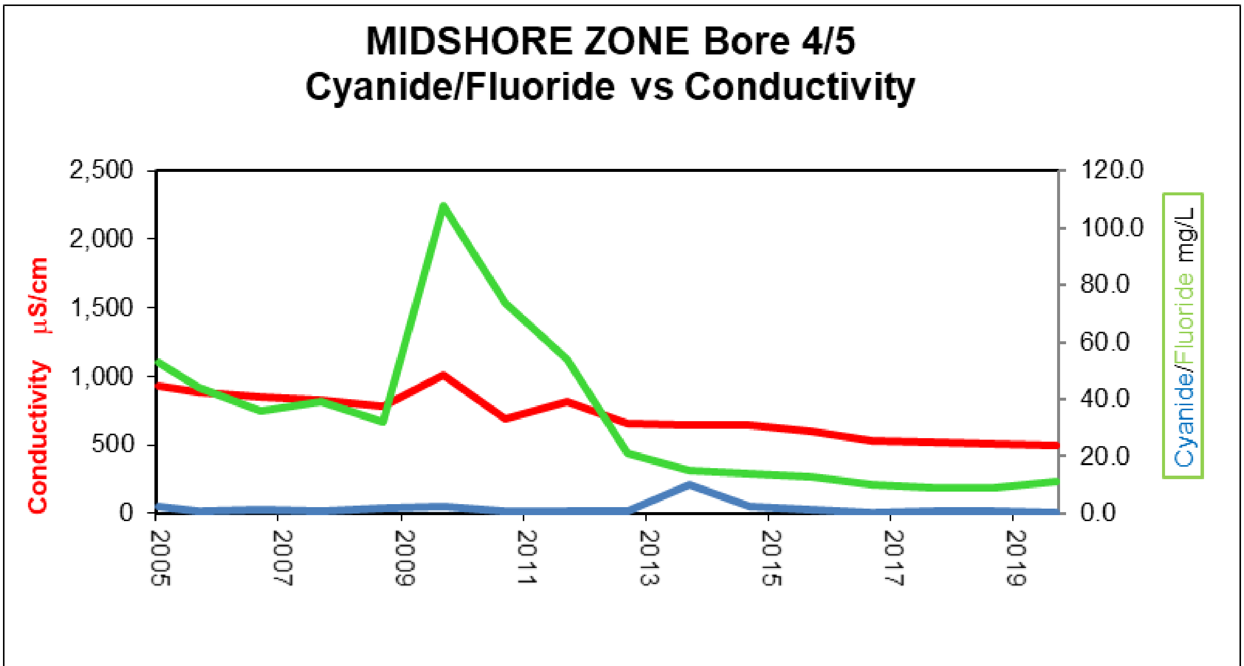
Contaminants are present in both layers, with the highest concentrations seen in the fine sands layer. The conductivity of the midshore bores 4/10 (deep) and 4/5 (shallow) have recovered significantly since monitoring began in 1995 and is approaching background levels, as are already seen in bore 4/1 (shallow). The conductivity in the midshore zone bores is 100-200 µS/cm above levels observed for the sewage field to the west of the pad.

Midshore Zone, continued

4.3.4 Trends in the Midshore Zone

The cyanide concentrations track well with conductivity but less with fluoride for deep bore 4/10 in the Midshore Zone. There is limited correlation between cyanide and fluoride with conductivity for shallow bore 4/5. Both cyanide and fluoride have continued to decrease in the midshore zone.

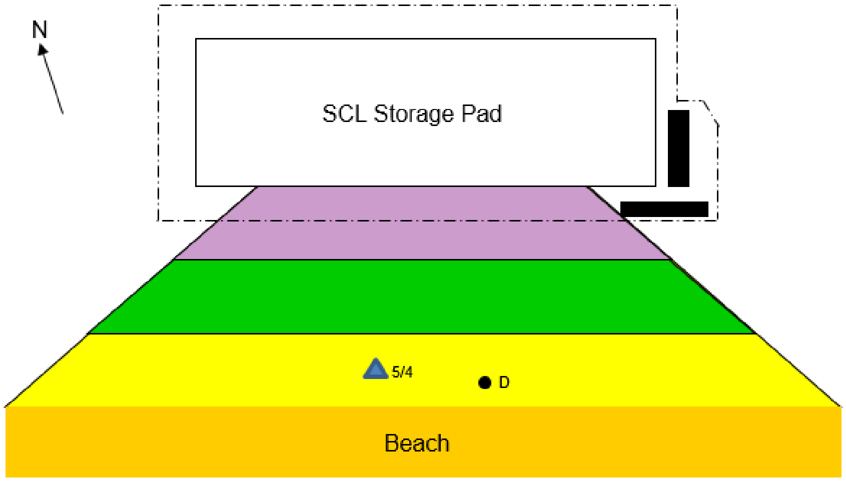




There appears to be limited correlation between fluoride and total cyanide concentrations for the midshore bores. This is to be expected given the differences in the underlying pea gravel and fine sands layers.

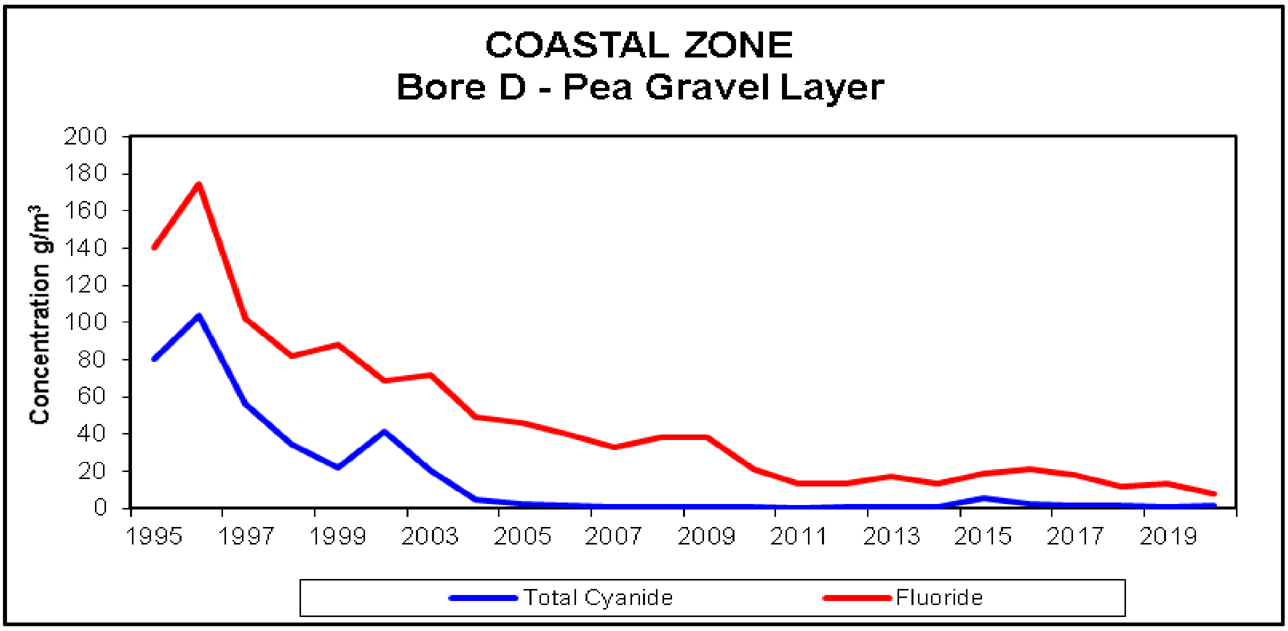
4.4 Coastal Zone

Bores D and 5/4, were used to monitor the Coastal zone until 2020. Bore D was a shallow bore suitable for sampling groundwater from the pea gravel layer of the aquifer surrounding the SCL pad but due to coastal erosion this bore is now fully flooded with seawater. Monitoring of bore D ceased in August 2020 when the bore was within 5 metres from the edge of the sand dunes. Bore 5/4 is a deep bore located a little further inland and is still suitable for sampling the groundwater from the fine sands layer of the aquifer.



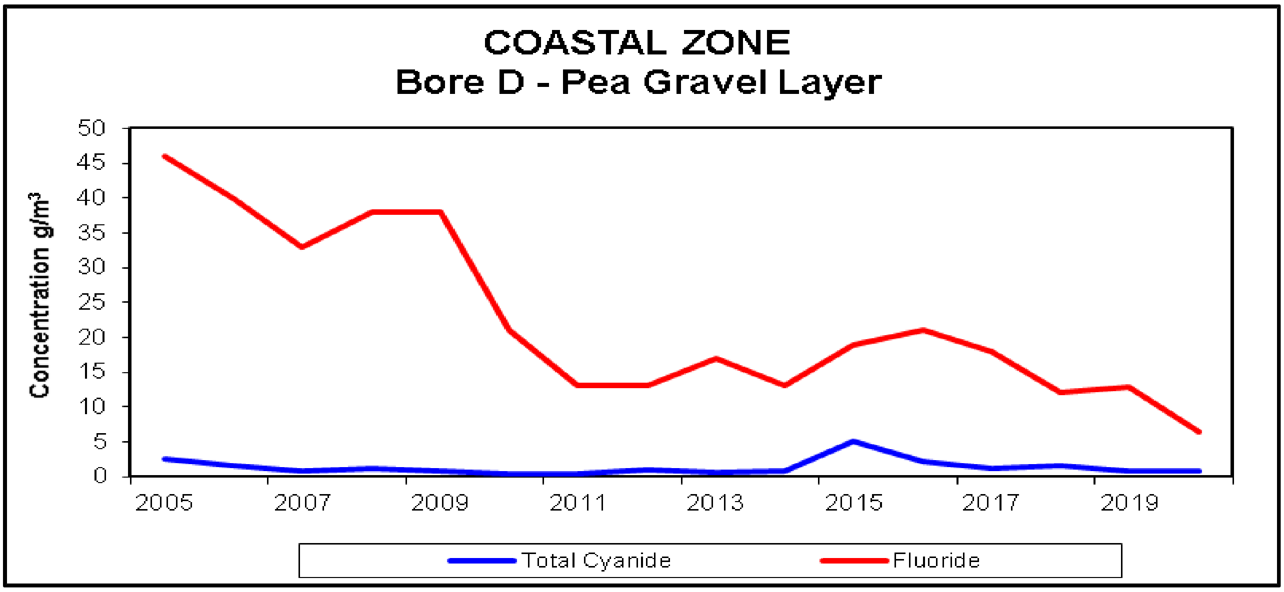
4.4.1 Results of Cyanide & Fluoride in Bore D

The following graph shows the annual average concentration of total cyanide and fluoride measured in the groundwater samples from Bore D since 1995. Free cyanide was typically < 0.04 mg/L.



Part of the same data as displayed in the graph above is displayed in the following graph for year 2005 to 2020 to provide greater clarity of the more recent fluoride and total cyanide measurements.

Coastal Zone, continued

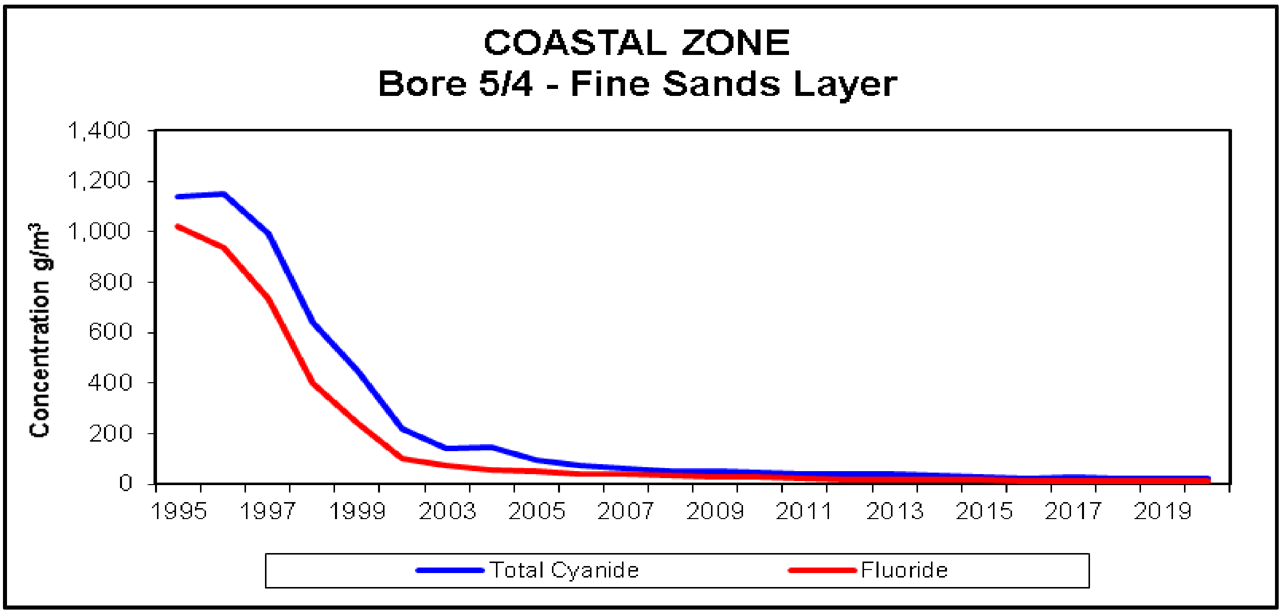


4.4.1.1 Comments on Cyanide & Fluoride in Bore D

Fluoride and total cyanide concentrations in coastal Bore D have recovered significantly since monitoring began in 1995. Fluoride has stabilised to near background levels where as the total cyanide level is above levels observed in bore 2/2. The total cyanide peak observed in the midshore bores for 2015 are also seen in coastal bore D. In August 2015 the underground discharge pipe was replaced as it was suspected to have broken in the coastal zone due to coastal erosion and or storm damage.

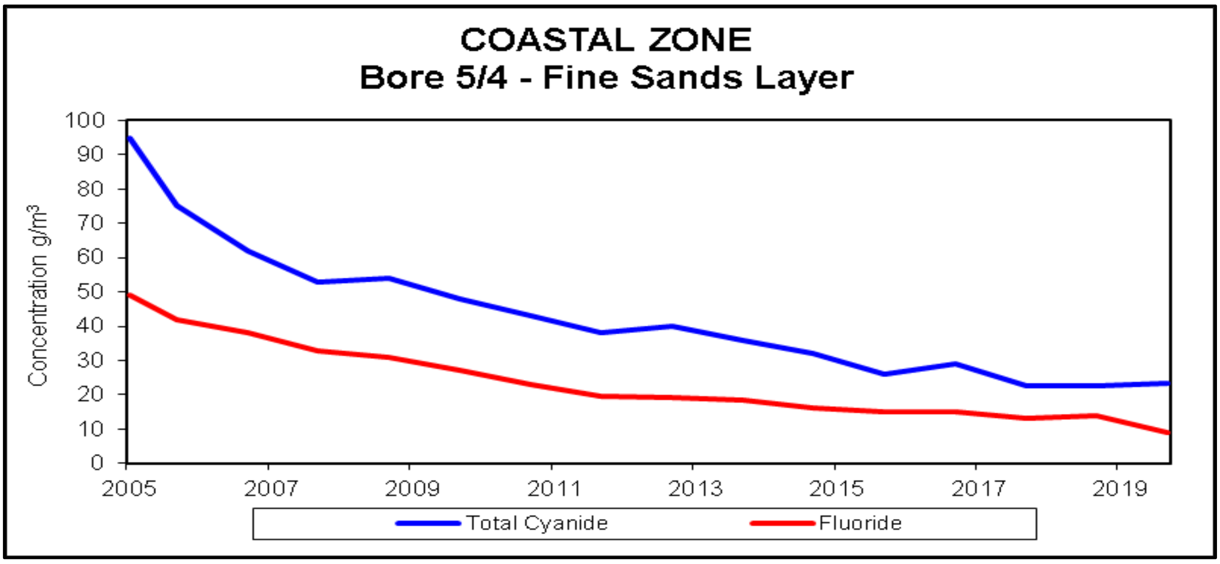
4.4.2 Results for Cyanide & Fluoride in Bore 5/4

The following graph shows the annual average concentration of total cyanide and fluoride measured in the groundwater samples from deep Bore 5/4 since 1995.



Coastal Zone, continued

The following graph shows the annual average concentration of total cyanide and fluoride measured in the groundwater from deep Bore 5/4 between 2005 and 2020.

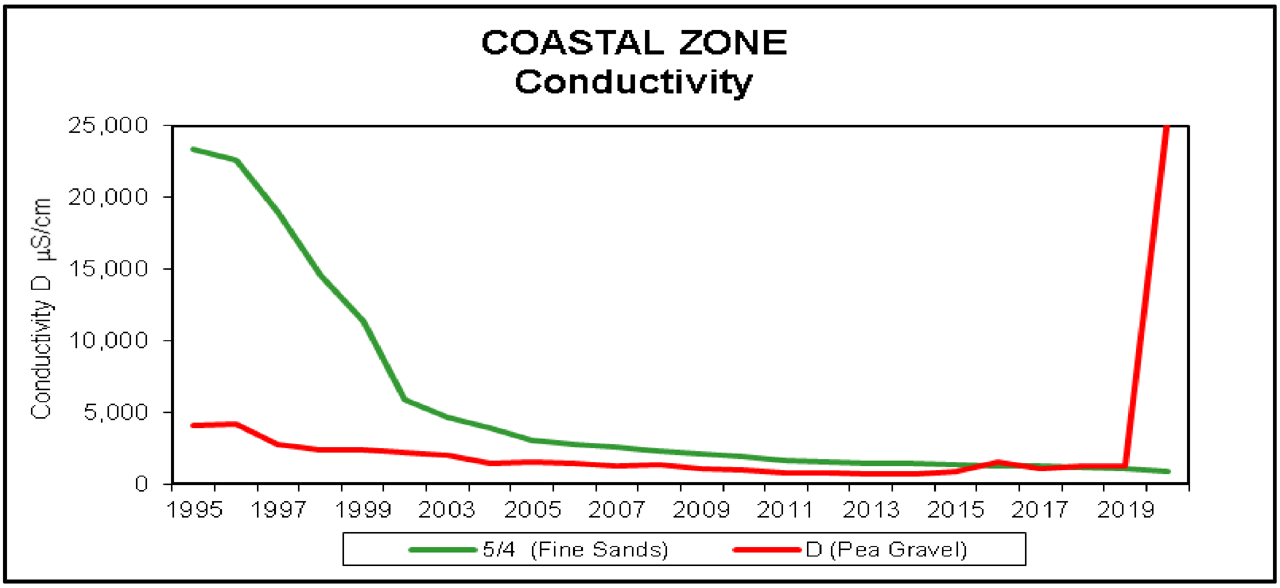


4.4.2.1 Comments on Cyanide & Fluoride in Bore 5/4

Fluoride and total cyanide concentrations of coastal bore 5/4 have recovered since monitoring began in 1995 and are continuing to decrease. Fluoride has reached the background level found in bore 2/2. Cyanide is still currently elevated compared to bore 2/2 and is similar in concentration to that in the up-gradient bore 4/10. Again, the concentration in the overlying pea gravel is much less than that in the deeper fine sands. This bore will continue to be monitored for seawater ingress as it is only currently 11 metres from the coast.

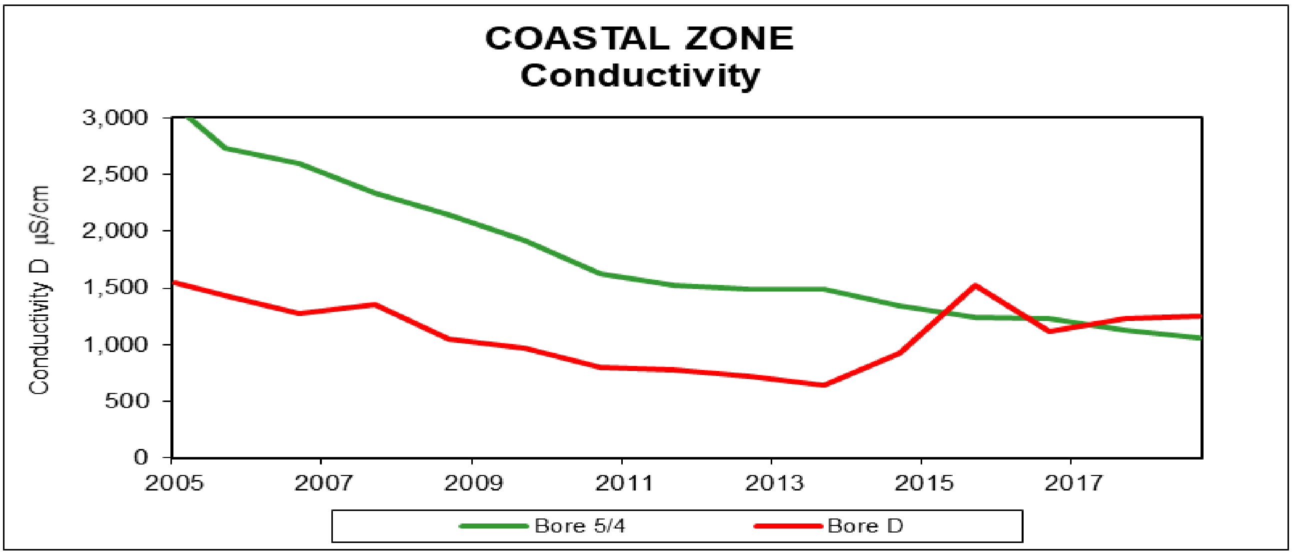
4.4.3 Results for Conductivity

The following graph shows the conductivity measured in groundwater sampled from Bores D and 5/4 since 1995.



Part of the same data as displayed in the graph above for year 2005 to 2020, is displayed in the following graph to provide greater clarity of the more recent conductivity measurements.

Coastal Zone, continued



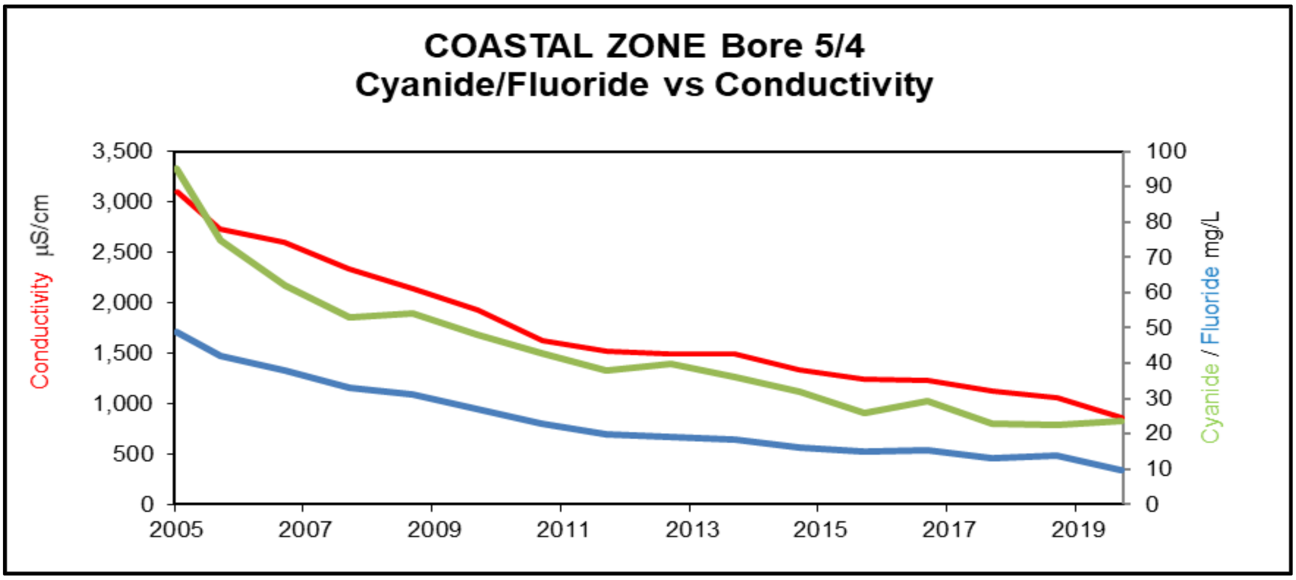
4.4.3.1 Comments on Conductivity

Monitoring at deep bore 5/4 in the fine sands layer demonstrates continued recovery over time. This bore is approximately 11 metres from the edge of the sand dunes to the beach. The conductivity is about 700 µS/cm greater than levels observed in the background bore 2/2 and 500 µS/cm above levels seen around the sewage field. This may be due to the start of sea water intrusion in this bore.

The shallow bore D has also recovered over time, however, this bore now contains largely seawater. This bore is now located only 5 metres from the edge of the sand dunes. The samples taken in June and August 2020 recorded conductivities > 45,000 µS/cm and fluoride at 2-1.6 mg/L (a drop from 15 mg/L in late 2019) indicating seawater intrusion has occurred due to coastal erosion. Monitoring at this bore has ceased as it is unsuitable for monitoring of groundwater in the coastal zone.

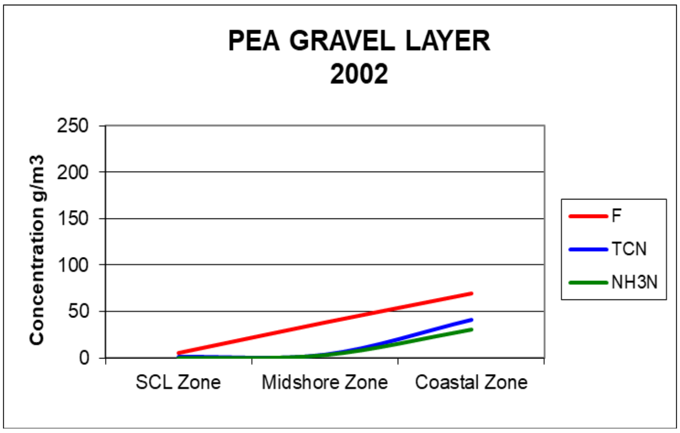
4.4.4 Trends for Coastal bore 5/4

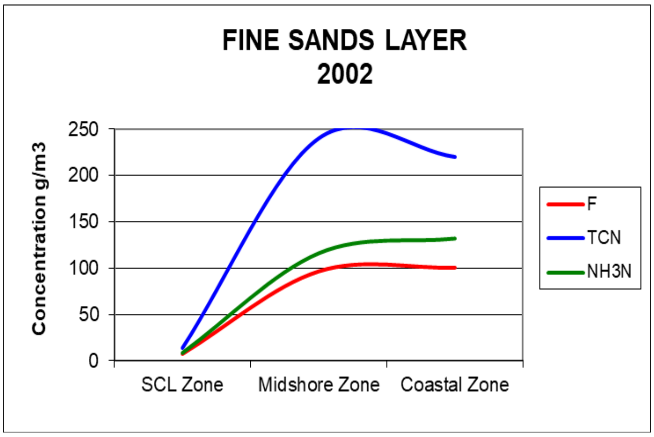
The cyanide and fluoride concentrations track reasonably well with conductivity for deep bore 5/4. Similar to what was observed for the SCL zone. See graphs below for detail.

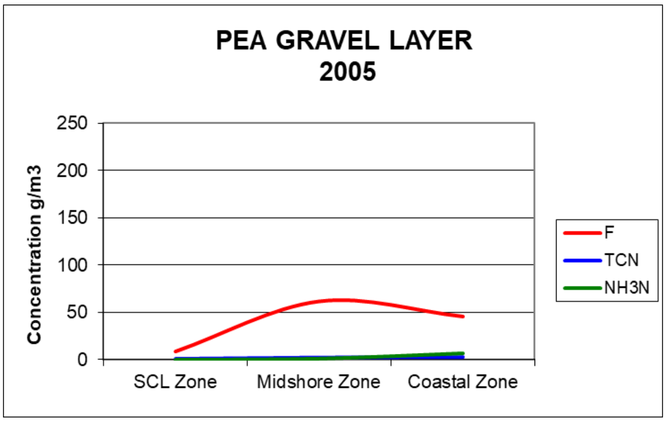


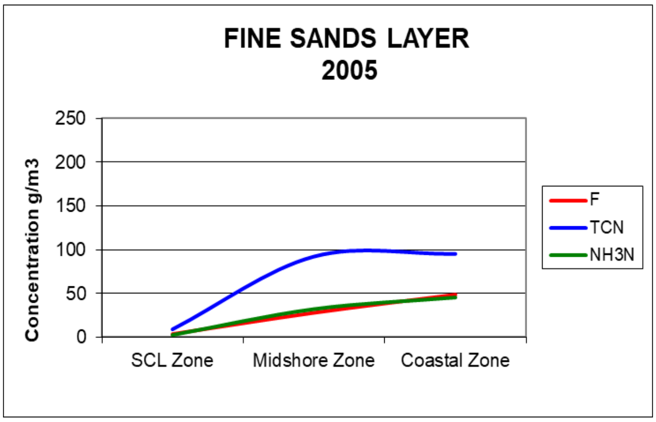
4.5 Comparison of Zones over Time

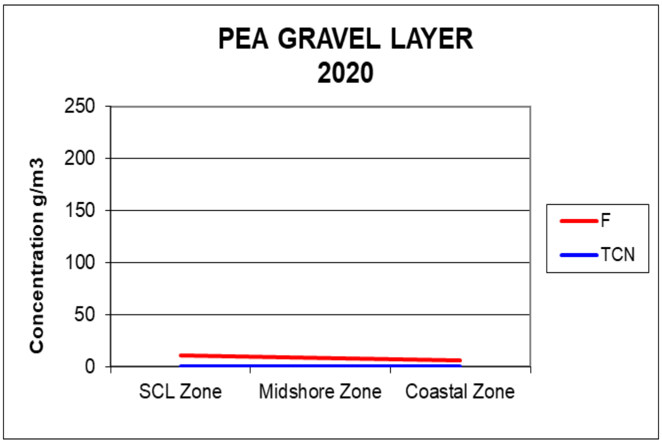
Comparison of Zones for the reporting years 2002, 2005 and 2020 are displayed below to show the general recovery of the groundwater over time.

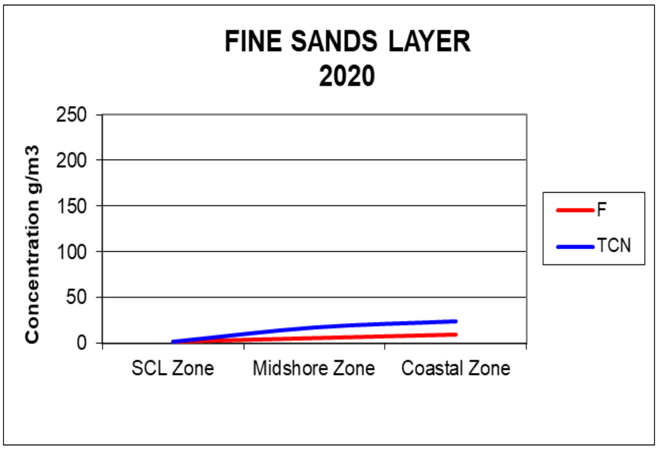












Both the pea gravel and find sand layers show great recovery from the 1990s groundwater contamination for all zones. The shallower pea gravel layers are showing less contamination than the fine sand layers which is expected due to the higher permeability in the pea gravel.

5 APPENDICES

Appendix A: ES Correspondence

R... onal House
C... ner Price St and North Rd
Invercargill,
New Zealand

SOUTHLAND REGIONAL COUNCIL

Private Bag 90116
Invercargill
Telephone (03) 215-6197
Fax (03) 215-8081

Our Reference: A277
Enquiries to :

11 October 1995

Site Services Manager
New Zealand Aluminium Smelter Ltd
Private Bag 90110
Invercargill

Dear Nicola

Cathode Pad Contaminant Plume, Options for Remediation

Following consideration of AquaFirma's report on the options for remediation of the cathode pad contaminant plume, the Council resolved on 11 October 1995 that NZAS be advised that:

(i) it is Council's opinion that the cathode pad contaminant plume be allowed to continue to recover by natural dispersion alone.

(ii) the monitoring regime recommended in the AquaFirma report should be implemented.

(iii) an annual report on results and possible alternative methods for remediation should be supplied to the Council each July.

The intention is that the need for any external audit of the annual report will be made at the end of each sampling year.

Thank you for your pro-activeness in this matter.

Yours faithfully

W J Tuckey
Director of Planning and
Resource Management
WJT:EHR

Managing Your Environment

Regional House
Corner Price St and North Rd
Invercargill,
New Zealand

SOUTHLAND REGIONAL COUNCIL

Private Bag 90116
Invercargill
Telephone (03) 215-6197
Fax (03) 215-8081

Our Reference: N015-012
Refer Accession No: 04782
Enquiries to: Ian Welsh

9 August 1999

The Manager
New Zealand Aluminium Smelters Ltd
Private Bag 90110
Invercargill

Dear Sir

Further to the Groundwater Reports, July 1999, regarding SCL Groundwater Report and the Diesel Bioremediation Report for 1999, I wish to confirm the following:

1. Council's Planning and Resource Management Committee has accepted staff recommendations made in the 4 August 1999 Planning and Resource Management meeting. A copy of the staff report and recommendations are enclosed.

2. The Committee also expressed its satisfaction at the responsible way in which NZAS had dealt with and progressed the matters.

Should you require more information or wish to discuss matters, please ask for Ian Welsh of this office.

Yours faithfully

JDR (James) Holloway
Environmental Compliance Manager

14 June 2002

environment
SOUTHLAND
Te Taiao Tonga

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Invercargill New Zealand
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Email service@envirosouth.govt.nz
Website www.envirosouth.govt.nz

Shaun O'Neill
Superintendent
Laboratory Services
New Zealand Aluminium Smelters Limited
Private Bag 90110
Invercargill

Our Reference: N015-028
Refer Accession No:
Enquiries to: James Holloway

Dear Shaun

SCL Groundwater Report

Thank you for the report on the results of the 2002 SCL groundwater monitoring. The report indicates further reduction in the contamination of groundwater and both the pea gravels and fine sand layers south of the storage pad.

We have noted that the graphical presentation of the data in the report has to be interpreted very carefully. While the report notes attenuation occurring at relatively constant rates, the discontinuous time intervals in sampling are not well represented in the graphs and the recovery rate of the groundwater may in fact be reducing over time.

Given that there is variable reductions of contaminant concentrations in the pea gravel layer, it is recommended that a further "snap shot" be taken in three years. At that time, the graphical representation of data should be plotted against an accurate timeline to provide a better visual determination of the reduction in contaminants in the groundwater.

If you have any further questions, please contact me.

Yours faithfully

Warren Tuckey
Director of Environmental Management

Received
JON
15/02/06

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14 February 2006

Shaun O'Neill
Superintendent, Laboratory Services
New Zealand Aluminium Smelters
Private Bag 90110
Invercargill

Our Reference: N015-028
Refer Accession No: 2005/23479

Dear Shaun

SCL Groundwater Report

Council has considered the monitoring results which you presented in the 2005 SCL Groundwater Report. They have accepted that contaminants below the SCL site are declining due to both dilution and transport to the CMA. There is no evidence that transport and discharge to the CMA through groundwater is having any measurable impact on the environment.

As a consequence of the report, Council have concluded that there is no further requirement to undertake monitoring of the SCL groundwater contamination, unless the SCL storage area is unsealed and opened to the environment.

If you have any questions, please contact me.

Yours sincerely

JDR (James) Holloway
Environmental Compliance Manager

air water coast land

Appendix B: 2020 Comparison of all Bores

The table below is detailing the average groundwater data obtained for 2020. Six samples for fluoride, pH and conductivity and two samples for free and total cyanide. Note sampling at bore D

		Ground Water Bores 2020 – Average Value								
Analyte	Unit	2/2 (sand)	3/1	3/2	3/3	3A1 (sand)	4/5	4/10	5/4 (sand)	D
Conductivity	µS/cm	350	449	408	386	458	562	651	885	41700
Fluoride	g/m^3	4.4	17.1	13.7	5.1	1.4	11.2	5.2	9.7	1.6
Total Cyanide	g/m^3	0.02	1.6	0.74	0.15	1.6	0.44	17	23.5	0.8
Free Cyanide	g/m^3	<0.01	0.17	0.1	<0.01	<0.01	0.01	0.04	0.04	<0.01
pH		7.4	8.6	8.3	7.7	9.3	9.1	10.2	9.9	8

ceased after August due to seawater contamination.

The table below is detailing the December 2020 ground water data obtained.

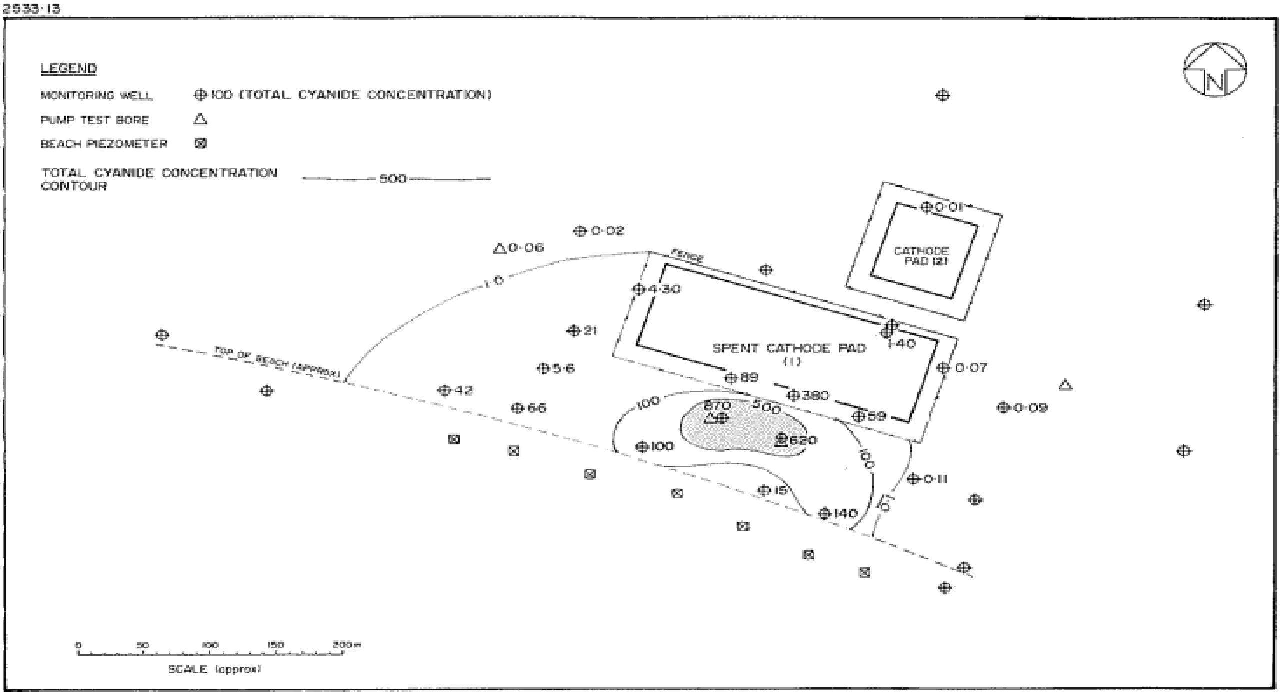
		Ground Water December 2020								
Analyte	Unit	2/2 (sand)	3/1	3/2	3/3	3A1 (sand)	4/5	4/10	5/4 (sand)	4/1
Conductivity	µS/cm	336	645	701	826	464	816	585	993	389
Fluoride	g/m^3	3.7	20	39	7	1.5	25	4.1	12	0.7
Total Cyanide*	g/m^3	0.015	2.8	1.1	<0.125	<0.25	0.675	12	24	0.808
Free Cyanide*	g/m^3	<0.01	0.013	<0.01	<0.01	<0.01	0.014	0.012	0.016	<0.01
pH		7.5	9	8.6	7.9	9.4	9.5	10.2	10.2	8.8

Total and free cyanide was last measured in August 2020.

Appendix C: 1992 SCL Pad Groundwater Investigations

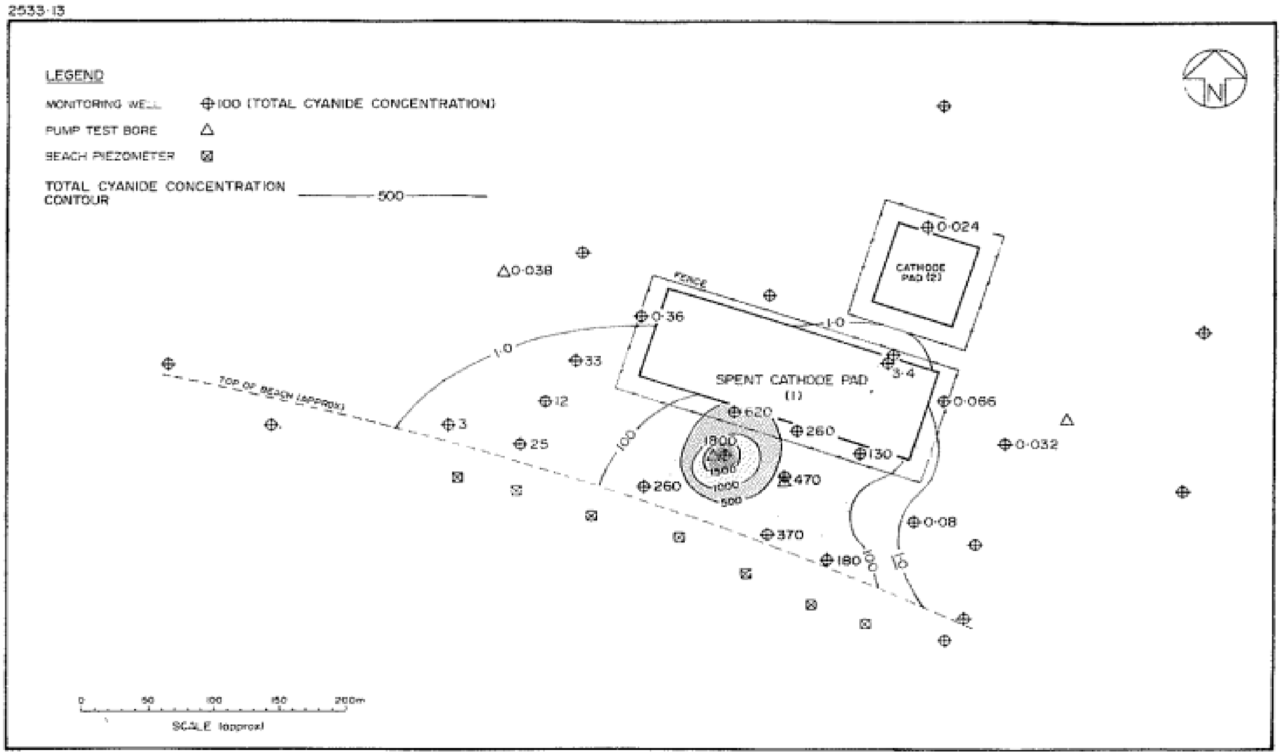
Reference: Groundwaters of Tiwai Peninsula Volume 1, Woodward-Clyde (NZ) Ltd, 1994

2533·13

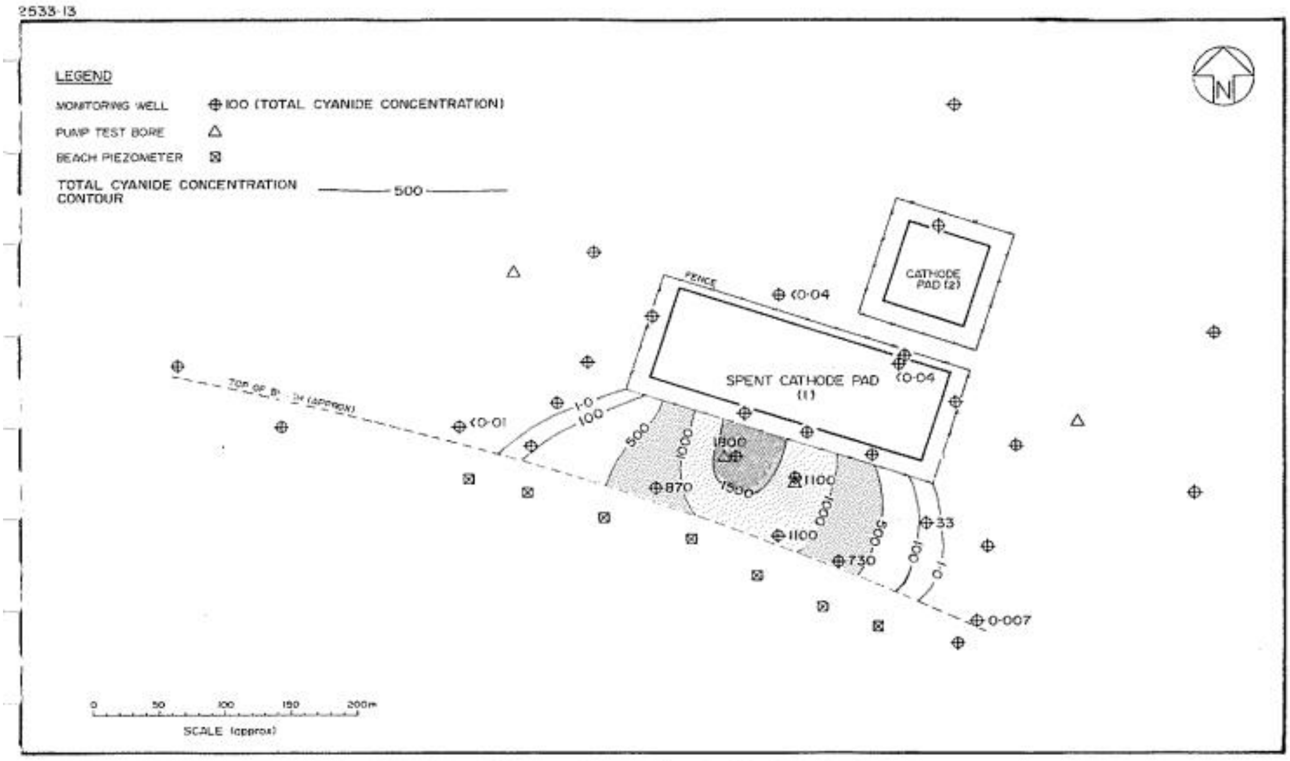


SPENT CATHODE PAD - TOTAL CYANIDE CONCENTRATIONS (g/m^3) IN SHALLOW PEA GRAVEL, JUNE 1992

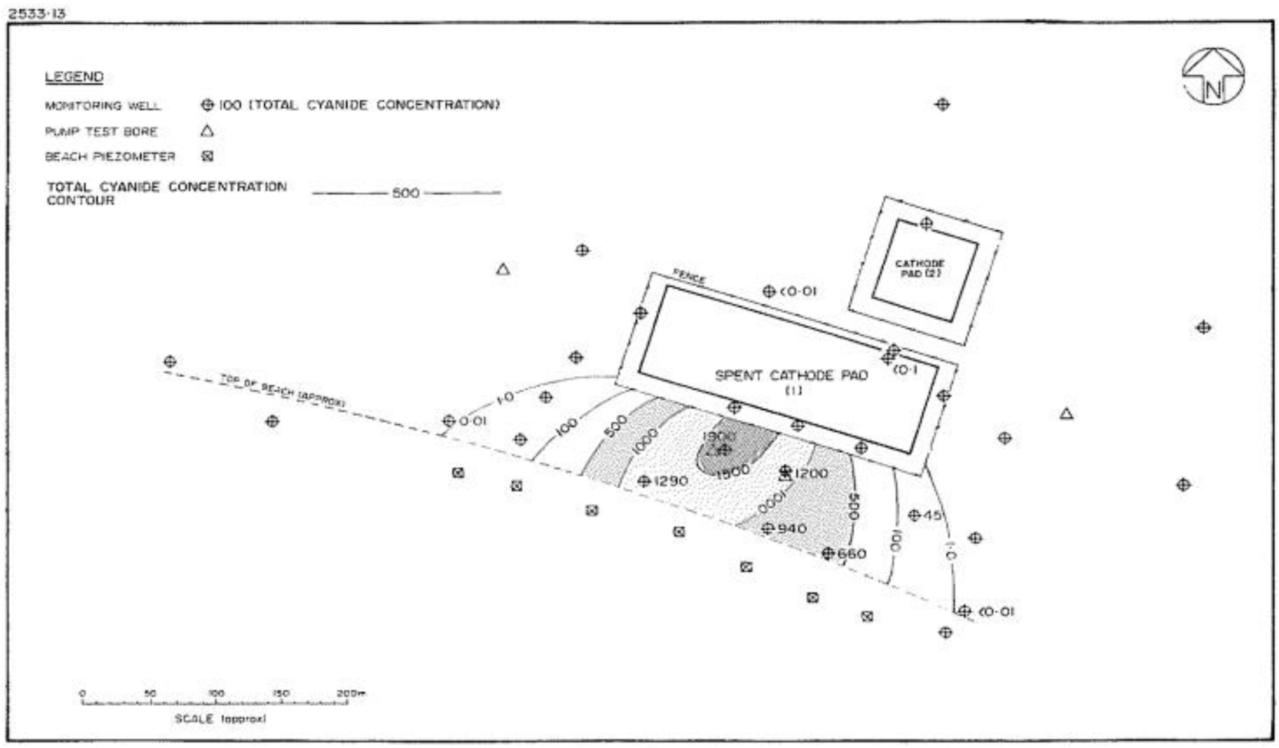
2533·13



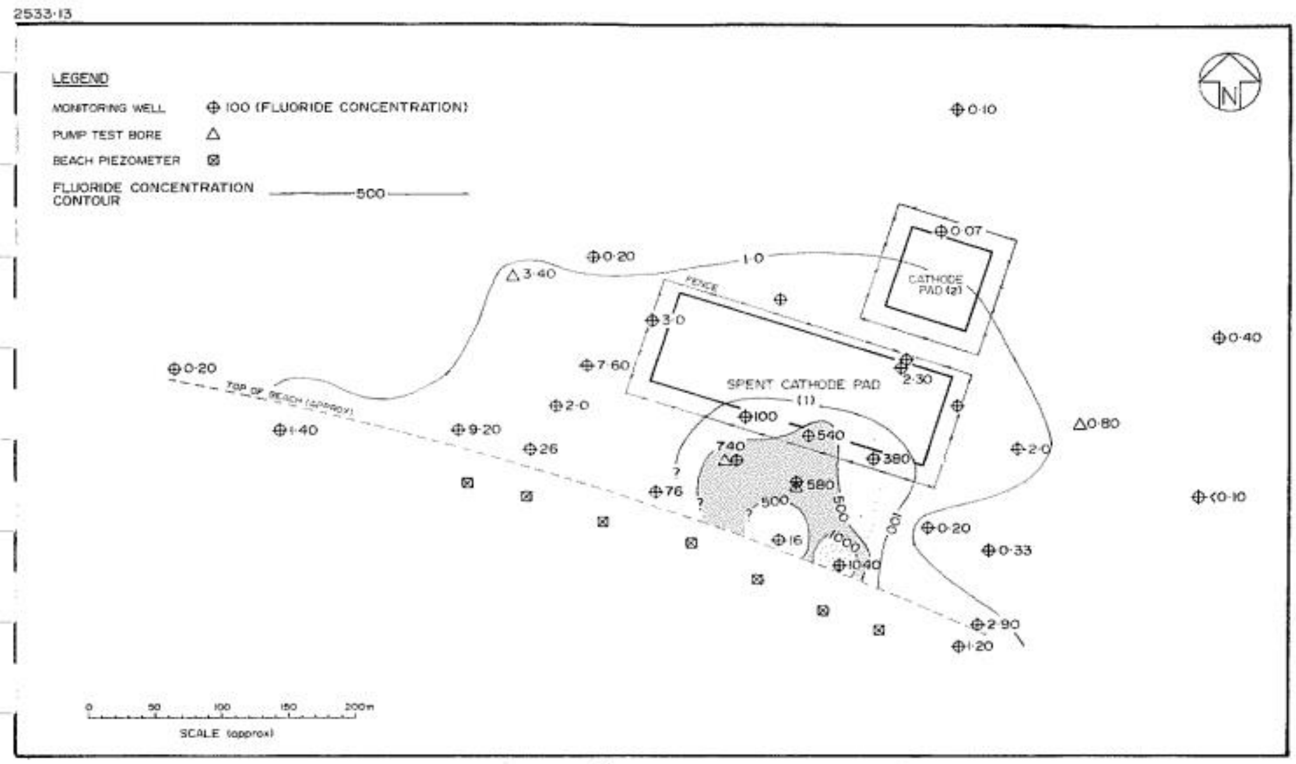
SPENT CATHODE PAD - TOTAL CYANIDE CONCENTRATIONS (g/m^3) IN SHALLOW PEA GRAVEL, OCTOBER 1992



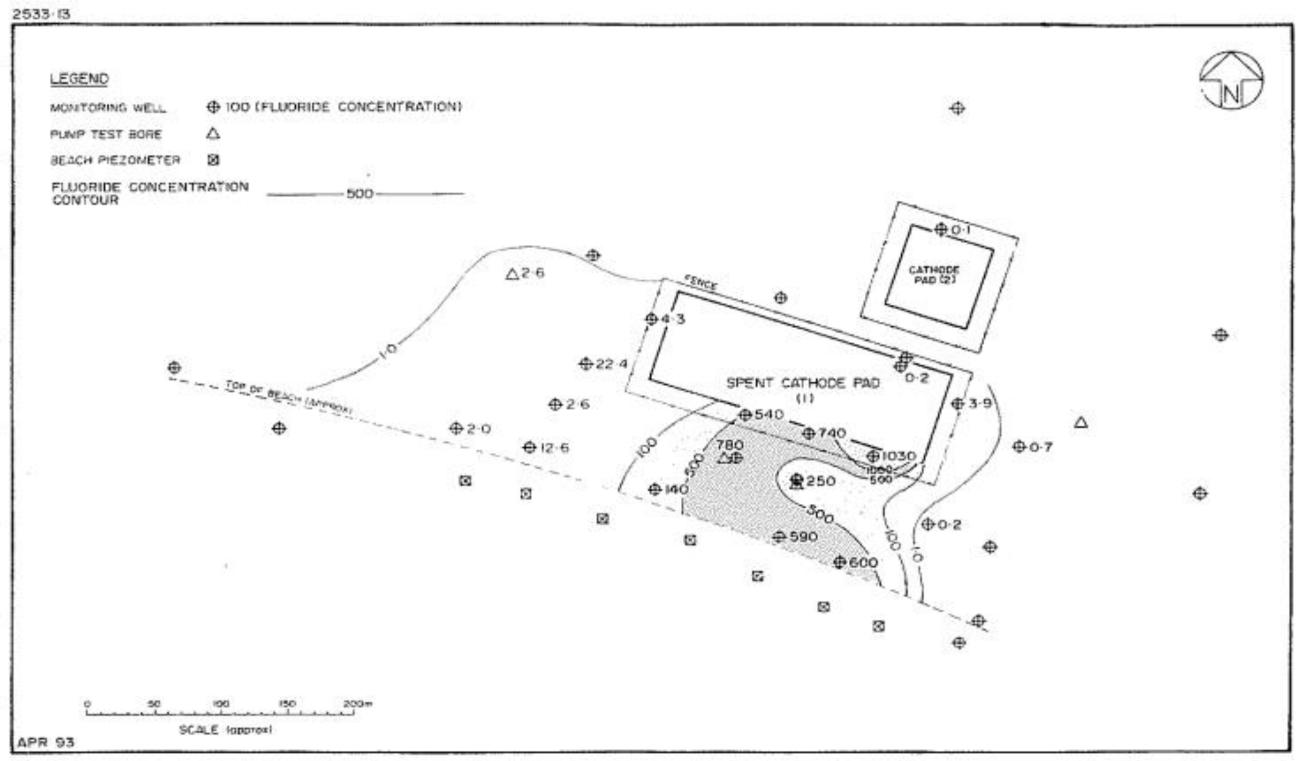
SPENT CATHODE PAD - TOTAL CYANIDE CONCENTRATIONS (g/m^3) IN DEEPER SANDS, JUNE 1992



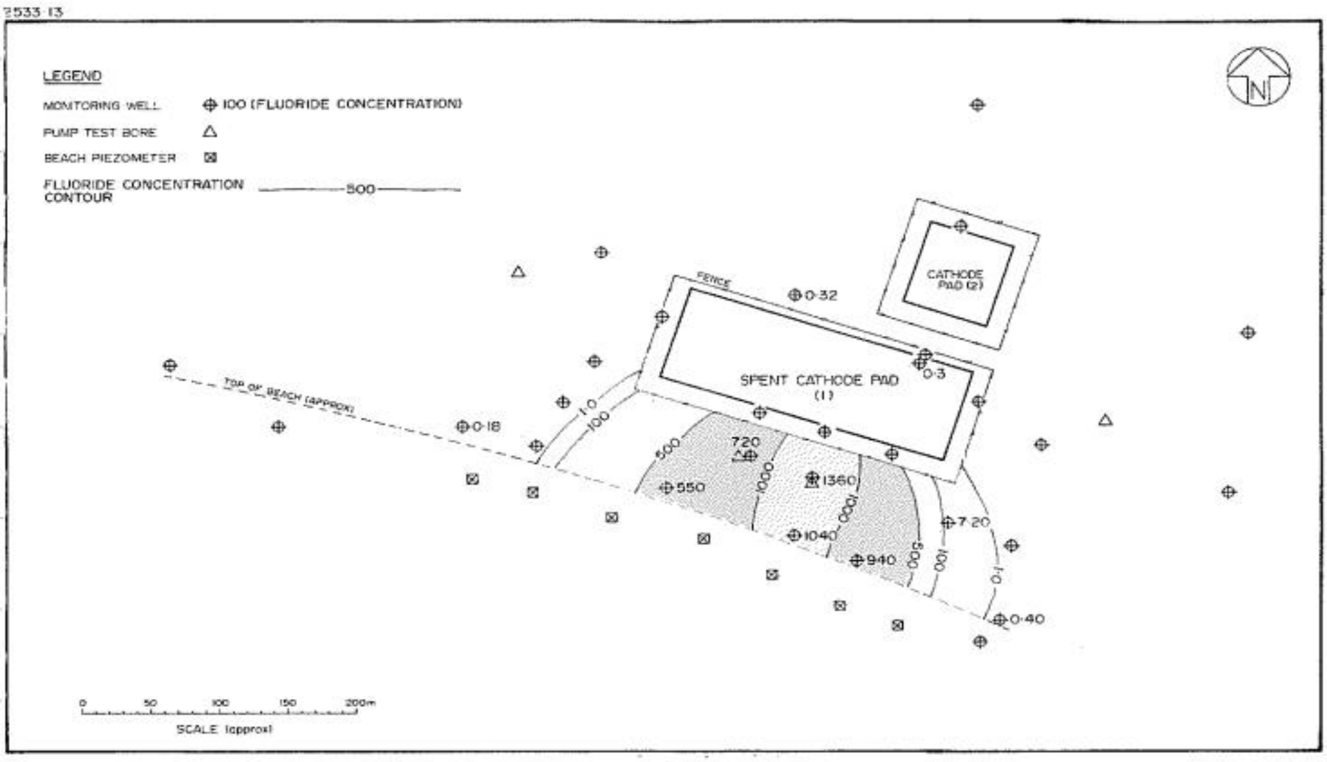
SPENT CATHODE PAD - TOTAL CYANIDE CONCENTRATIONS (g/m^3) IN DEEPER SANDS, OCTOBER 1992



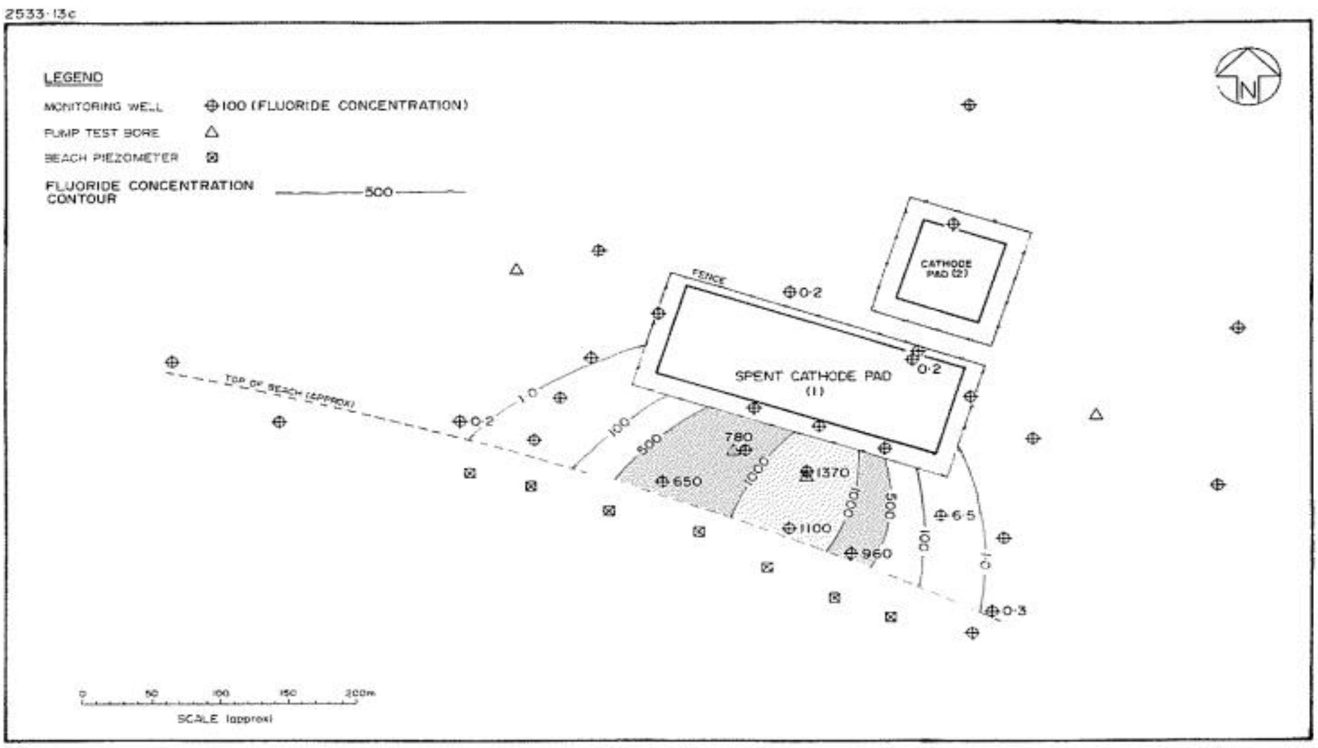
SPENT CATHODE PAD - FLUORIDE CONCENTRATIONS (g/m³) IN SHALLOW PEA GRAVEL, JUNE 1992



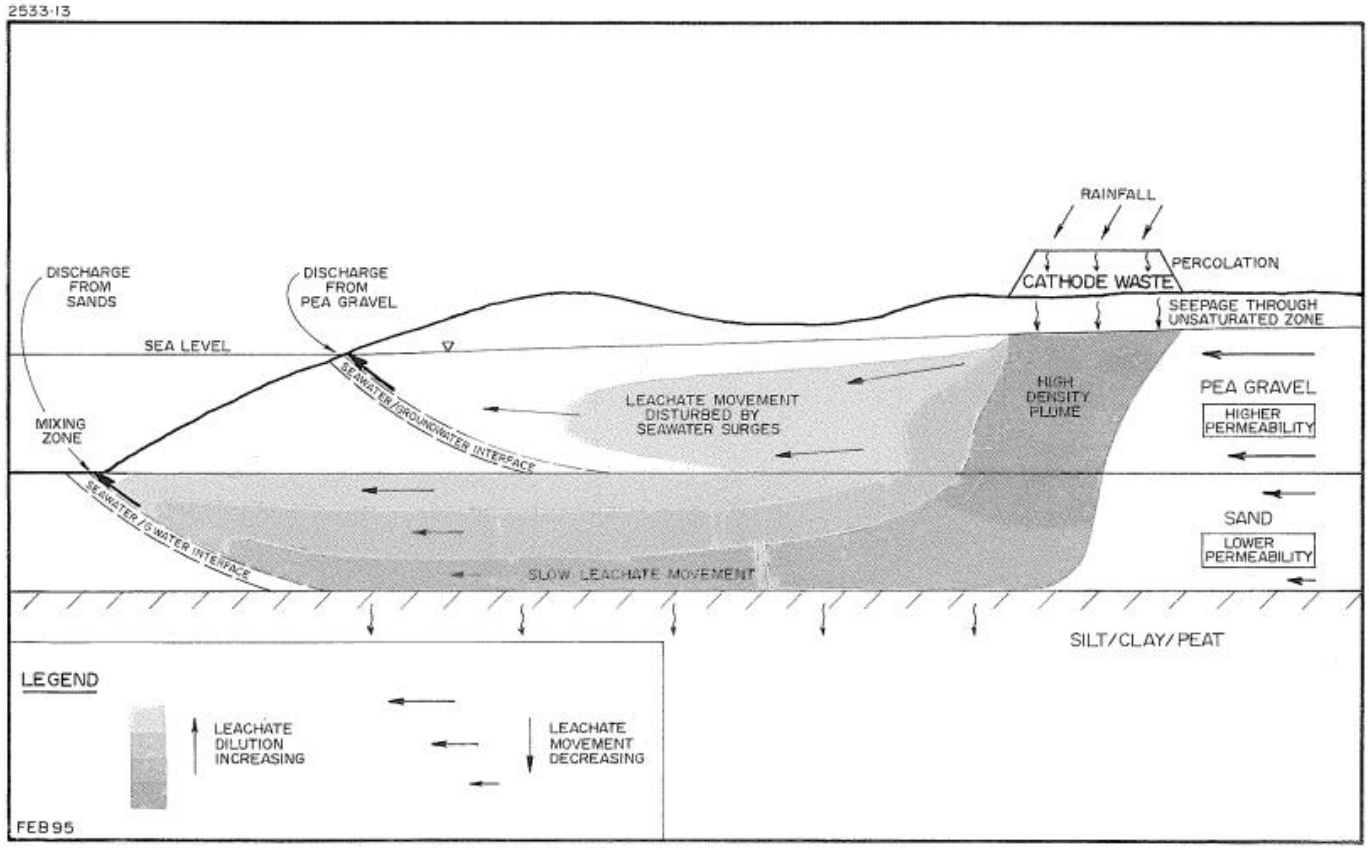
SPENT CATHODE PAD - FLUORIDE CONCENTRATIONS (g/m³) IN SHALLOW PEA GRAVEL, OCTOBER 1992



SPENT CATHODE PAD - FLUORIDE CONCENTRATIONS (g/m^3) IN DEEPER SANDS, JUNE 1992

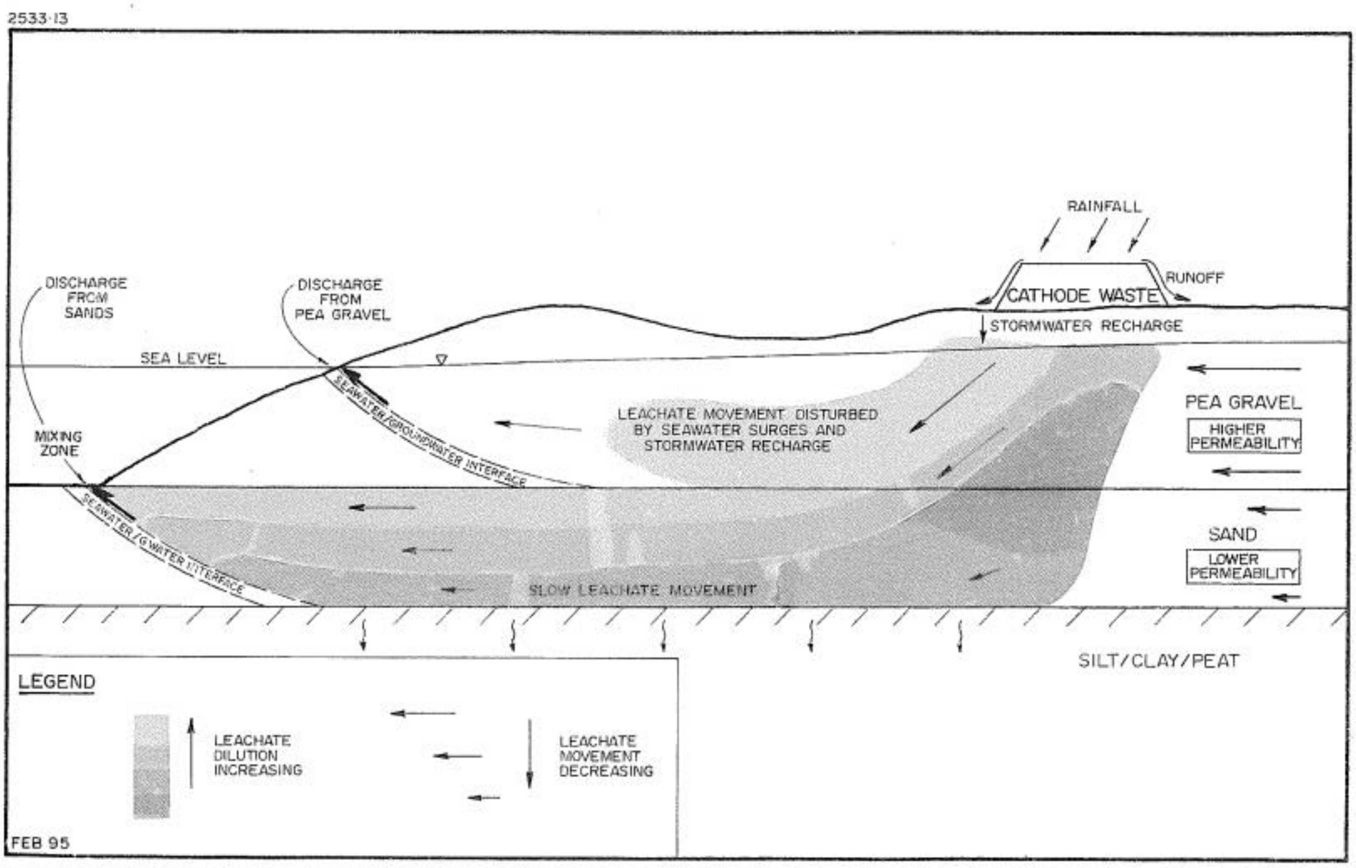


SPENT CATHODE PAD - FLUORIDE CONCENTRATIONS (g/m^3) IN DEEPER SANDS, OCTOBER 1992



CONCEPTUALISATION - PRE COVER - SPENT CATHODE PAD

Figure 13



CONCEPTUALISATION - POST COVER - SPENT CATHODE PAD

Figure 14