CANADA – BRITISH COLUMBIA
WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF Quinsam River NEAR THE MOUTH (1986 – 2004)

Prepared by:
L. G. Swain, P. Eng.
B.C. Ministry of Environment

Prepared for:
B.C. Ministry of Environment
and
Environment Canada

March 2007

Environment Canada Environnement Canada

BRITISH COLUMBIA
The Best Place on Earth
Ministry of Environment

EXECUTIVE SUMMARY

The Quinsam River is located on eastern Vancouver Island, west of the town of Campbell River, B.C. It is a tributary to the Campbell River, which it joins 3 km inland from the Strait of Georgia. The Quinsam River basin is surrounded by various water bodies. The Campbell River and Campbell Lake border it to the north, Upper Campbell and Buttle Lakes are to the west, the Oyster River is to the south, and the Strait of Georgia is to the east. The main tributary to the Quinsam River is the Iron River, which flows from the south and meets the Quinsam River in between Quinsam and Middle Quinsam Lakes. The total drainage area of the Quinsam River is 280 km^2.

The Quinsam River just upstream from Middle Quinsam Lake has two B.C. Hydro dams, established in the 1950's. The second dam, located about 2 km upstream from Middle Quinsam Lake, diverts most of the water in the Upper Quinsam River through Gooseneck Lake into the Campbell River chain for hydroelectric use. The remainder of the flow, after leaving Middle Quinsam Lake, goes east for 10 km to Quinsam Lake. This section of the river has two main features, falls and a major tributary. The falls are 2 km downstream from Middle Quinsam Lake, below which is a favourite salmon spawning area, while the Iron River joins the Quinsam River upstream from Quinsam Lake.

The last segment of the Quinsam River, approximately 25 km long, flows east and then north toward its confluence with the Campbell River. On this stretch of the river are the Quinsam River Hatchery and Elk Falls Provincial Park, as well as the flow and water quality stations. The hatchery, operated by the Department of Fisheries and Oceans, is situated 3 km from the mouth of the river. The park is located near the mouth.

Fishing is a major water use associated with the Quinsam River. The river is home to a wide range of salmon, both wild and raised, as well as steelhead and cutthroat trout. Pacific salmon typically spawn below the falls downstream from Middle Quinsam Lake. This is the farthest upstream that the fish can migrate. Hatchery salmon are often introduced above the falls to encourage spawning in other parts of the river system.

Coal mining was introduced to the area when Quinsam Coal Ltd. began mining in December, 1987. The activity is concentrated near Middle Quinsam and Long Lakes, 27

km from Campbell River. Logging and generation of hydroelectric power are other important economic activities in the region. The Quinsam River watershed is uninhabited.

CONCLUSIONS

- Flows are typical of coastal streams, with peaks occurring during the late autumn to early winter period and low flows taking place during the late Spring through Summer periods.
- Several metals had occasional values that exceeded the guidelines for the protection of aquatic life, but also appeared to be correlated with turbidity and were likely not of biological concern. These included aluminum, cadmium, chromium, cobalt, copper, iron, and molybdenum.
- Total alkalinity has on occasion been below the guideline that indicates that there is only moderate buffering to acidic inputs. Alkalinity may be continuing to show a trend to increasing values, but this should be verified with appropriate statistics (in the 2000 Trend Report, alkalinity was shown to exhibit a statistically significant increasing trend).
- Increasing trends through time appeared to continue for a number of dissolved variables and related parameters, including boron, calcium, magnesium, sodium, sulphate, specific conductivity and hardness. These were identified as statistically significant trends in the 2000 Trend Report, and were attributed to neutralization of acid drainage at the upstream coal mine. The more current data set should be re-assessed statistically to confirm that these trends are continuing. These variables do not exceed aquatic life guidelines and therefore would appear to be of little concern to aquatic life at this time. However, benthic invertebrate assessments carried out in 2001 and 2003 indicated that the population was severely stressed, and deviated strongly from that expected. Assessments in 2004

and 2005 indicated that the population was still stressed, although not as greatly. The causes of these impacts on the benthic population are under investigation.

- Apparent colour values seem to fluctuate with turbidity and regularly exceeded the drinking water guideline for true colour; however, this is to be expected since true colour is measured on a filtered sample (i.e., turbidity removed). True colour values were lower than apparent colour values, as expected; however, values seem to fluctuate with turbidity and regularly exceeded the drinking water guideline.

- Phosphorus was measured as total dissolved phosphorus after 1999 and seemed to decrease between 1999 and 2005, probably due to this change (i.e. measurement of dissolved rather than total phosphorus), and possibly also due to a change in analytical laboratory at about that time.. Regardless, phosphorus levels in the river are relatively high. The benthic populations measured at the site have shown some characteristics of nutrient enrichment, so the elevated nutrient levels measured in the river may be the cause of the deviation.

- Larger fluctuations in pH values after 2000 likely reflect a change in analytical laboratory, and the use of more sensitive analytical techniques. pH varies strongly with conductivity. A recent calculation of the Water Quality Index for the Quinsam River site assessed the river as “Fair”. This ranking resulted from a number of values that exceeded the guideline for some total metals, nutrients and alkalinity. Metals that exceeded the guideline were primarily turbidity-related, which may be natural or may be exacerbated by upstream coal mining. It is unlikely that aquatic life would be impacted by these short-term events. However the elevated phosphorus and nitrogen levels could lead to nutrient enrichment of the river, leading to nuisance plant growth, and potentially affecting local aquatic life populations.

RECOMMENDATIONS

- We recommend monitoring be continued for the Quinsam River at the mouth to track the possible increases in variables that have been identified in this report. As well, either trivalent and hexavalent forms of chromium should be measured in the future, or alternately, guidelines be developed for total chromium values.

Water quality indicators that are important for future monitoring are:

- flow, water temperature, specific conductivity and related dissolved ions, hardness, alkalinity, pH, turbidity, dissolved nitrogen and phosphorus; total phosphorus and dissolved oxygen should also be added,
- appropriate forms of metals for comparison to their respective guidelines,
- other variables related to drinking water, such as colour. , and
- benthic invertebrates

ACKNOWLEDGEMENTS

The graphs in this report were prepared by Sacha Wassick of Environment Canada. The draft report was reviewed by Andrea Ryan from Environment Canada. We thank these individuals for their contributions to improving this document. Any errors or omissions are the responsibility of the author.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF FIGURES
(CONTINUED)

Page

LIST OF FIGURES
(CONTINUED)

Page

LIST OF FIGURES
(CONTINUED)

Page

INTRODUCTION

The Quinsam River is located on eastern Vancouver Island, west of the town of Campbell River, B.C. It is a tributary to the Campbell River, which it joins 3 km inland from the Strait of Georgia. The Quinsam River basin is surrounded by various water bodies. The Campbell River and Campbell Lake border it to the north, Upper Campbell and Buttle Lakes are to the west, the Oyster River is to the south, and the Strait of Georgia is to the east (Figure 1). The main tributary to the Quinsam River is the Iron River, which flows from the south and meets the Quinsam River in between Quinsam and Middle Quinsam Lakes. The total drainage area of the Quinsam River is 280 km^2.

The Quinsam River originates south of Upper Quinsam Lake, roughly 30 km southwest of Campbell River, B.C. It flows north for about 5 km into Upper Quinsam Lake and then Wokas Lake. The second part of the river flows east for about 5 km before entering Middle Quinsam Lake. This portion of the Quinsam River has two B.C. Hydro dams, established in the 1950's. The second dam, located about 2 km upstream from Middle Quinsam Lake, diverts most of the water in the Upper Quinsam River through Gooseneck Lake into the Campbell River chain for hydroelectric use.

After leaving Middle Quinsam Lake, the river flows east for 10 km to Quinsam Lake. The third part of the river has two main features, falls and a major tributary. The falls are 2 km downstream from Middle Quinsam Lake, below which is a favourite salmon spawning area. The Iron River joins the Quinsam River upstream from Quinsam Lake.

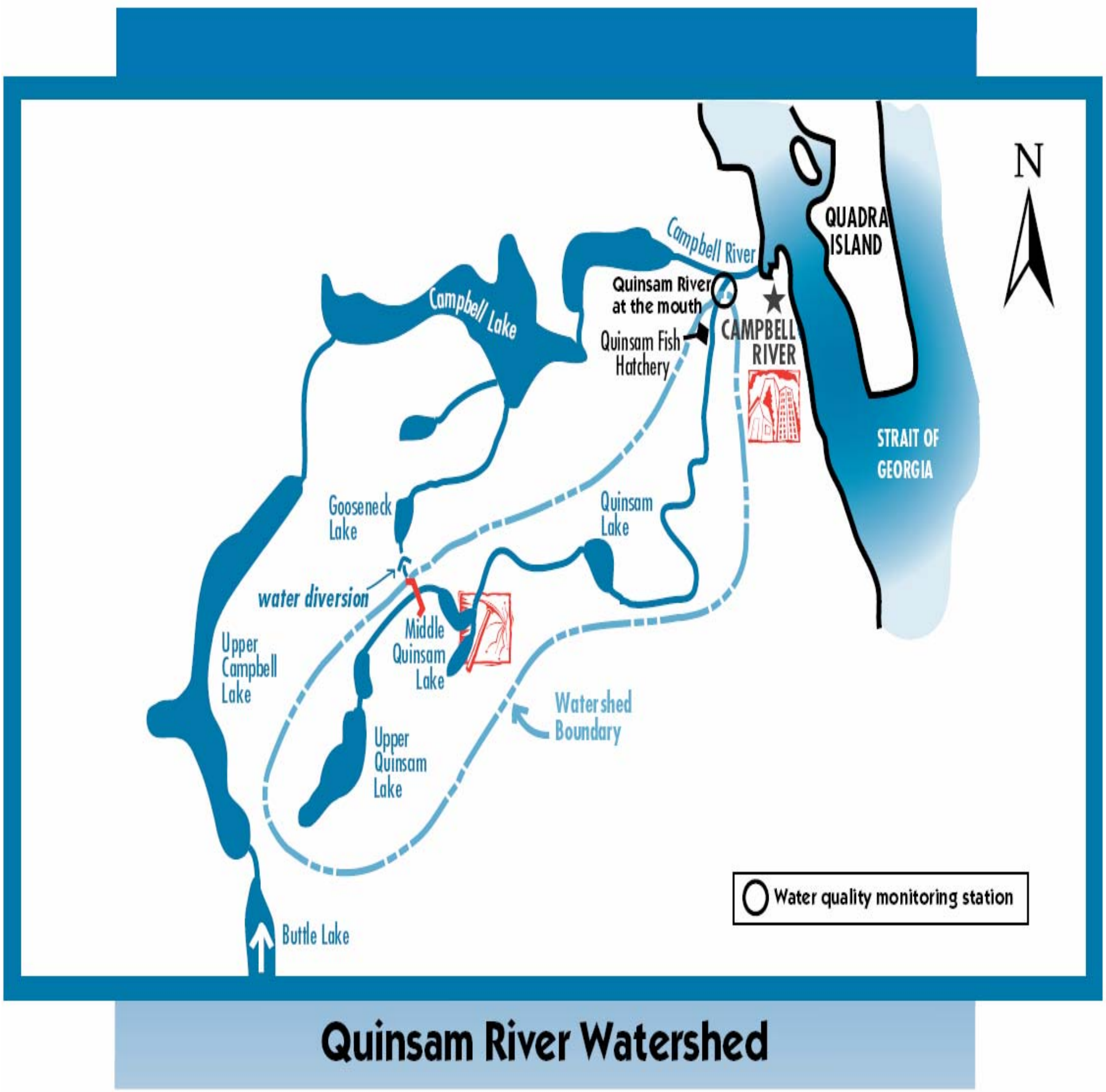
The fourth segment of the Quinsam River is approximately 25 km long. It flows east and then north toward its confluence with the Campbell River. On this stretch of the river are the Quinsam River Hatchery and Elk Falls Provincial Park, as well as the flow and water quality stations. The hatchery, operated by the Department of Fisheries and Oceans, is situated 3 km from the mouth of the river. The park is located near the mouth.

Fishing is a major water use associated with the Quinsam River. The river is home to a wide range of salmon, both wild and raised, as well as steelhead and cutthroat trout. Pacific salmon typically spawn below the falls downstream from Middle Quinsam Lake.

This is the farthest upstream that the fish can migrate. Hatchery salmon are often introduced above the falls to encourage spawning in other parts of the river system.

Coal mining was introduced to the area when Quinsam Coal Ltd. began mining in December, 1987. The activity is concentrated near Middle Quinsam and Long Lakes, 27 km from Campbell River. Logging and generation of hydroelectric power are other important economic activities in the region. The Quinsam River watershed is uninhabited.

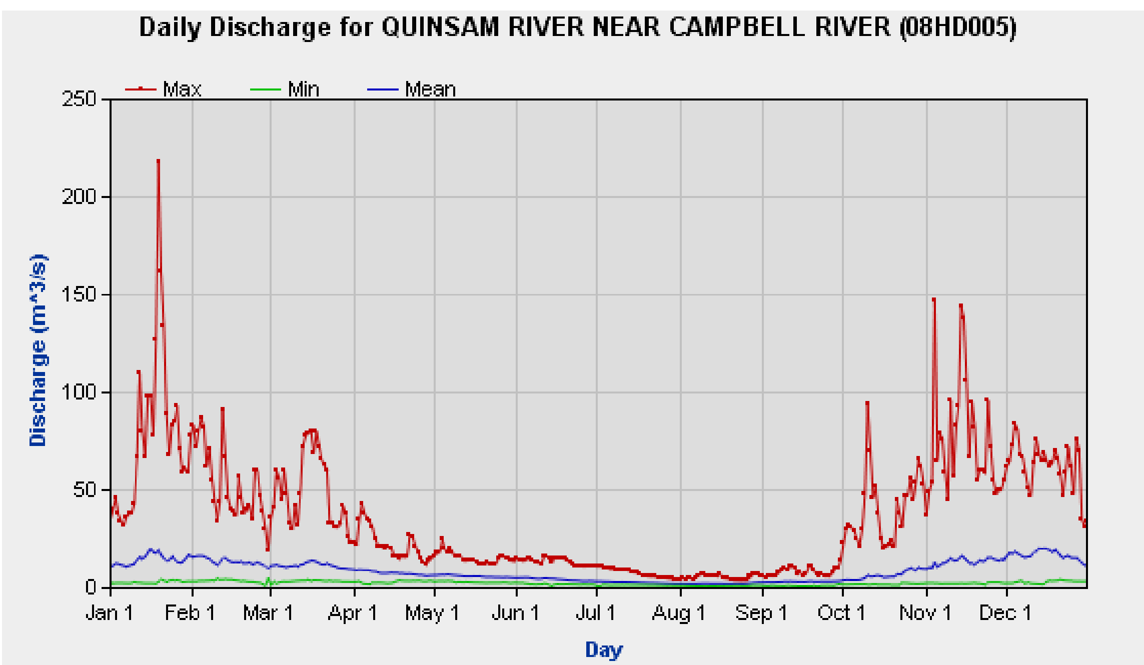
FIGURE 1: Quinsam River near the Mouth



This report assesses data from a station on the Quinsam River near its mouth. Data for the Quinsam River near the mouth have been collected at a frequency of about once every two weeks. As well, twice per year, two additional samples are collected in order to ensure that there are two periods when weekly samples are collected during five consecutive weeks, for future assessment of water quality objectives attainment. In addition, quality assurance samples (blanks and replicates) are collected three times per year.

The federal data are stored under ENVIRODAT station number BC08HD0004, and are all available on our Water Quality Website, at www.waterquality.ec.gc.ca. The water quality variables are plotted in Figures 3 to 79. Water Survey of Canada operates a flow gauge just upstream (site number BC08HD005). Flow data from 1986 to 2005 are graphed in Figure 2.

FIGURE 2: Water Survey of Canada Flow Data for Quinsam River near the Mouth



WATER QUALITY ASSESSMENT

The state of the water quality was assessed by comparing the values to B.C.'s approved and working guidelines for water quality (B.C. Ministry of Environment, Lands and Parks, 2001), and by looking for any obvious trends in the data. Any levels or apparent trends that were found to be deleterious or potentially deleterious to sensitive water uses, including drinking water, aquatic life, wildlife, recreation, irrigation, and livestock watering were noted in the following variable-by-variable discussion.

The following water quality indicators are not discussed as they met all water quality guidelines and showed no clearly visible trends: ammonia, arsenic, barium, beryllium, bismuth, bromide, niobium, nitrite, total nitrogen, tin, thallium, filterable residue, fixed filterable residue, non filterable residue, and fixed non filterable residue. The following water quality indicators seemed to fluctuate through the year according to turbidity concentrations, but were below guideline values and had no other trends: antimony, dissolved organic carbon, lanthanum, lithium, manganese, nickel, lead, and vanadium.

Other water quality indicators seemed to fluctuate through the year according to the specific conductivity of the water. For dissolved forms of many of these indicators, they would be a part of the measured conductivity, and this is to be expected. These types of indicators that were not measured above guideline values included: dissolved inorganic carbon, calcium, chloride, fluoride, potassium, magnesium, strontium, and uranium.

Flow (Figure 2) values are typical of coastal streams, with peaks ($\geq$100 m^3/s) occurring during the late autumn to early winter period and low flows (<10 m^3/s) taking place during the late spring through summer periods. Flow monitoring should continue because of its importance in interpreting many water quality indicators.

Total Aluminum (Figures 3 and 4): was measured as total and extractable forms; however, the guideline for the protection of aquatic life is expressed as a dissolved. Aluminum concentrations are strongly correlated with turbidity values, meaning that most of the aluminum is likely in particulate form and not available to aquatic life.

Alkalinity – total (Figure 5): has on occasion been below the 20 mg/L guideline that indicates that there is only moderate buffering to acidic inputs. Alkalinity tends to fluctuate with specific conductivity, with higher values when leak conductivity occurs. We tested alkalinity for the period of record using a linear regression analysis and determined there was a potential increasing trend ($R^2 = 0.07$). This should be verified with appropriate statistics. Low alkalinity is of concern at this site, due to the potential release of acid generated form coal mining operations upstream.

Boron – (Figure 10): Extractable concentrations seem to be reflective of specific conductivity, with peak values being approximately at the same time. We tested the data for possible increases through time using a linear regression analysis and determined that there was a potential increasing trend ($R^2 = 0.21$). This should be confirmed with appropriate statistics.

Cadmium (Figures 20 and 21): concentrations appeared to fluctuate with turbidity concentrations. Occasional cadmium concentrations that exceeded the aquatic life guideline coincided with peak turbidity values, which mean that the cadmium was likely associated with particulate matter and not biologically available.

Cobalt (Figures 23 and 24): one cobalt value in late 1993 exceeded the aquatic life guideline for 30-d mean concentrations; however, none since that time have exceeded the guideline. Cobalt concentrations appear to be related to turbidity concentrations, with peak values in each occurring simultaneously. This means that the cobalt is likely in particulate form and not biologically available.

Colour: apparent colour (Figure 25) values seem to fluctuate with turbidity and regularly exceeded the drinking water guideline for true colour; however, this is to be expected since true colour is measured on a filtered sample (i.e., turbidity removed). True colour values (Figure 26) were lower than apparent colour values, as expected; however, values seem to fluctuate with turbidity and regularly exceeded the drinking water guideline.

Specific Conductivity (Figure 27): values seem to increase during the period of record. We tested the data for possible increases through time using a linear regression analysis and determined that there was a potentially increasing trend ($R^2 = 0.24$). This should be verified with appropriate statistics.

Chromium (Figures 28 and 29): values fluctuate with turbidity values, and as a result the guideline for hexavalent chromium is exceeded during periods of high flow and turbidity. We recommend that either trivalent and hexavalent forms of chromium be measured in the future, or guidelines be developed for total chromium values.

Copper (Figures 30 and 31): values regularly exceeded the BC guidelines for 30-d mean concentrations but only on occasion exceeded the guideline for maximum concentrations. As well, values varied in relation to turbidity values, meaning that the higher copper values are likely in particulate form and not biologically available.

Iron (Figures 32 and 33): values exceeded the drinking water and aquatic life guideline of 300 µg/L more frequently in the late 1980's and up to 1991 when preservative vial contamination was potentially a problem, although values in excess of the guidelines continues. Iron concentrations vary in relation to turbidity, so that the iron is likely in particulate form and not biologically available.

Hardness (Figure 35): values seem to increase during the period of record, and varies with conductivity. In the 2000 Trend Report, hardness and other related variables were assessed as exhibiting statistically significant increasing trends, likely due to acid neutralization procedures being used at the upstream coal mine. One value in 1990 exceeded the drinking water guideline. When tested for the period of record using a linear regression analysis, it was determined that there was an ongoing potential increasing trend ($R^2 = 0.065$). This should be verified with appropriate statistics. **Magnesium** (Figure 41): values seem to increase during the period of record, and also varied with hardness and conductivity. We tested the data for possible increases through time using a linear regression analysis and determined that there was a potentially increasing trend ($R^2 = 0.05$) for extractable magnesium. This should be verified with appropriate statistics.

Molybdenum (Figures 44 and 45): values regularly exceeded the CCME guideline of 73 µg/L and on occasion the BC guideline of 1 µg/L. Values seem to fluctuate with conductivity, indicating that molybdenum is mainly in the dissolved form at the site..

Sodium (Figure 47): values are also related to specific conductivity and hardness, and show similar apparent increasing concentrations during the period of record. We tested the data for possible increases through time using a linear regression analysis and determined that there was a potentially increasing trend ($R^2 = 0.\ 35$). This should be tested using appropriate statistics.

Phosphorus (Figures 55 and 56): values seemed to be related to turbidity values and regularly exceeded the guideline of 0.01 mg/L for drinking water supplies. Total phosphorus values ceased to be collected in 1999 and total dissolved phosphorus values continued thereafter. Total dissolved phosphorus values seemed to decrease between 1999 and 2005, and this may be related to a change in analytical laboratory at about that time. We tested the values to see if there was a trend in the data using a linear regression analysis and determined that here was a potentially decreasing trend ($R^2 = 0.10$). This should be verified using appropriate statistics. Regardless, dissolved phosphorus values at the site are quite high; benthic invertebrate populations assessed at the site are stressed, and show some indications of nutrient enrichment. Total phosphorus measurements should be re-instated at the site to assess overall phosphorus loadings.

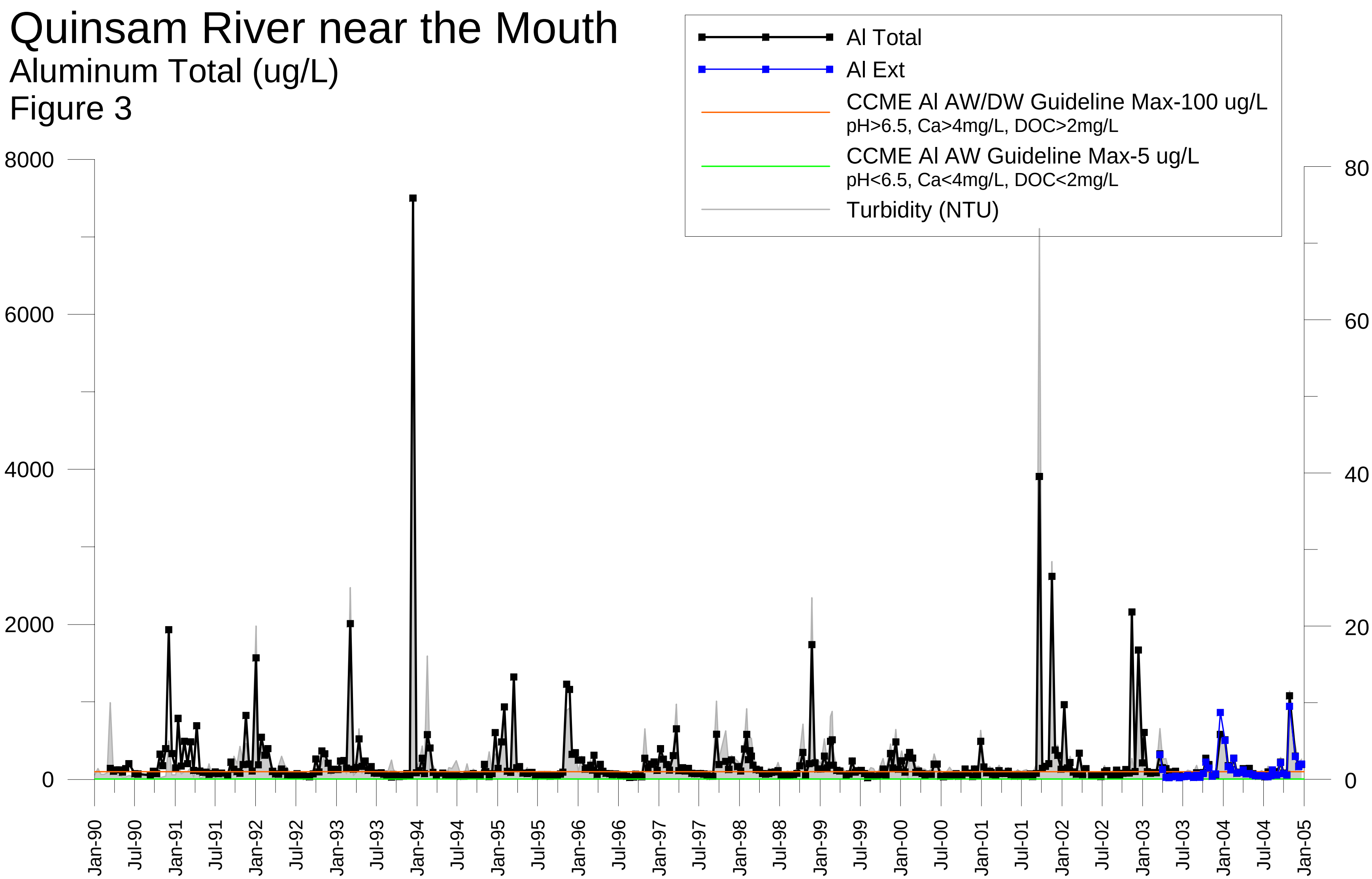
pH (Figure 59): Larger fluctuations in pH values after 2000 are likely related to a change in analytical laboratory and the use of more sensitive analytical techniques at that time.

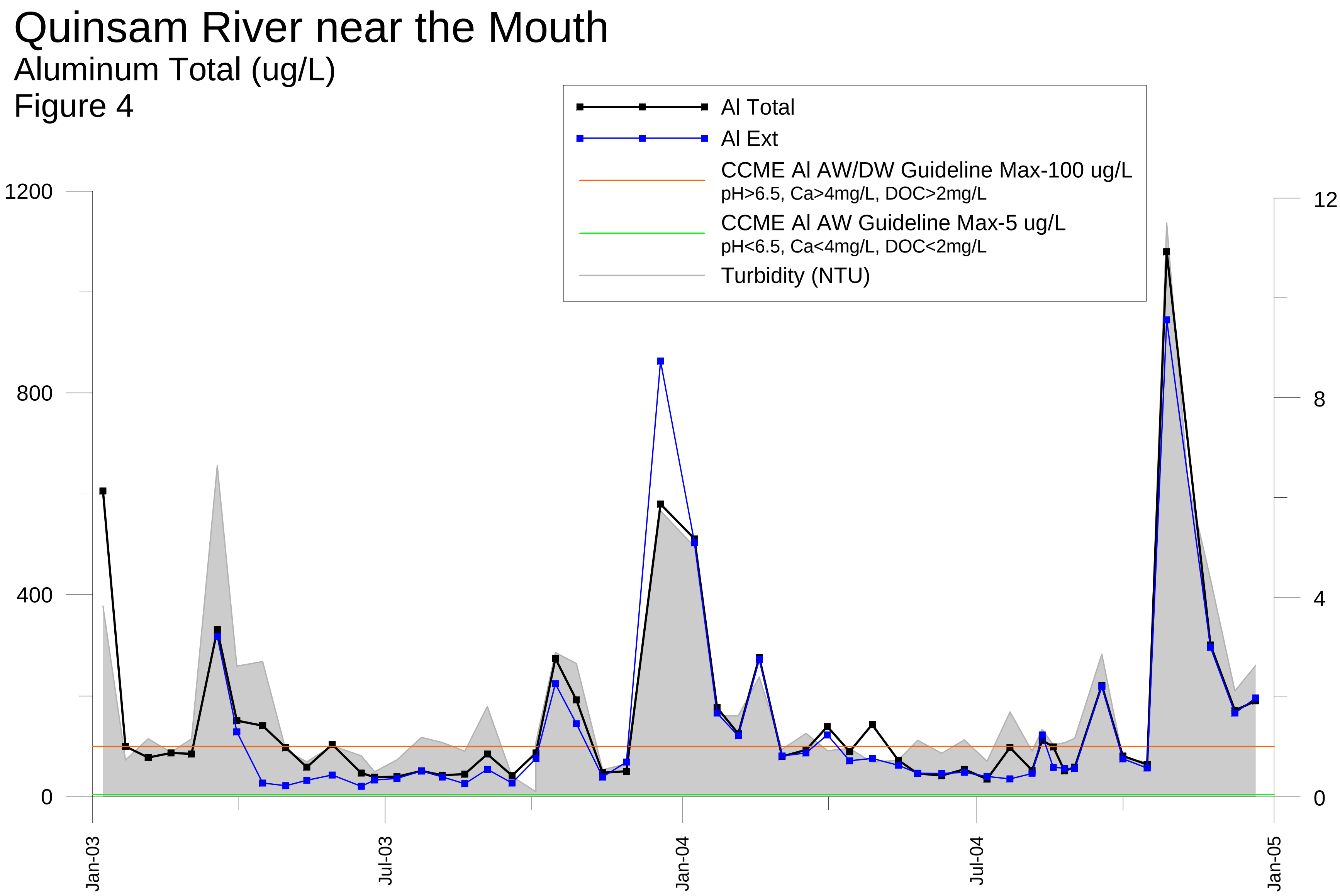
pH values correlate well with conductivity at the site. pH should continue to be monitored due to its effect on organism physiology and its influence on other variables.

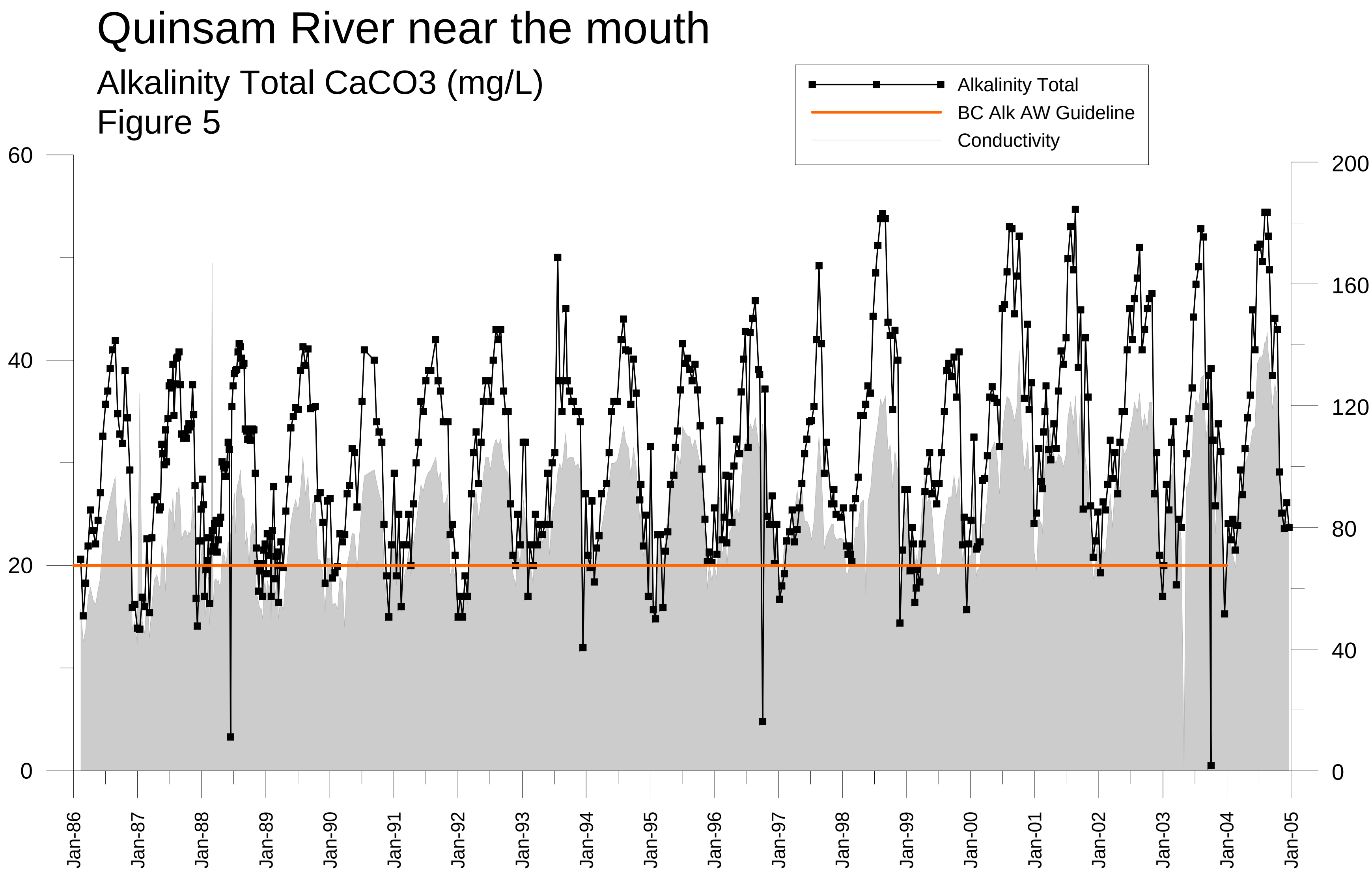
REFERENCES

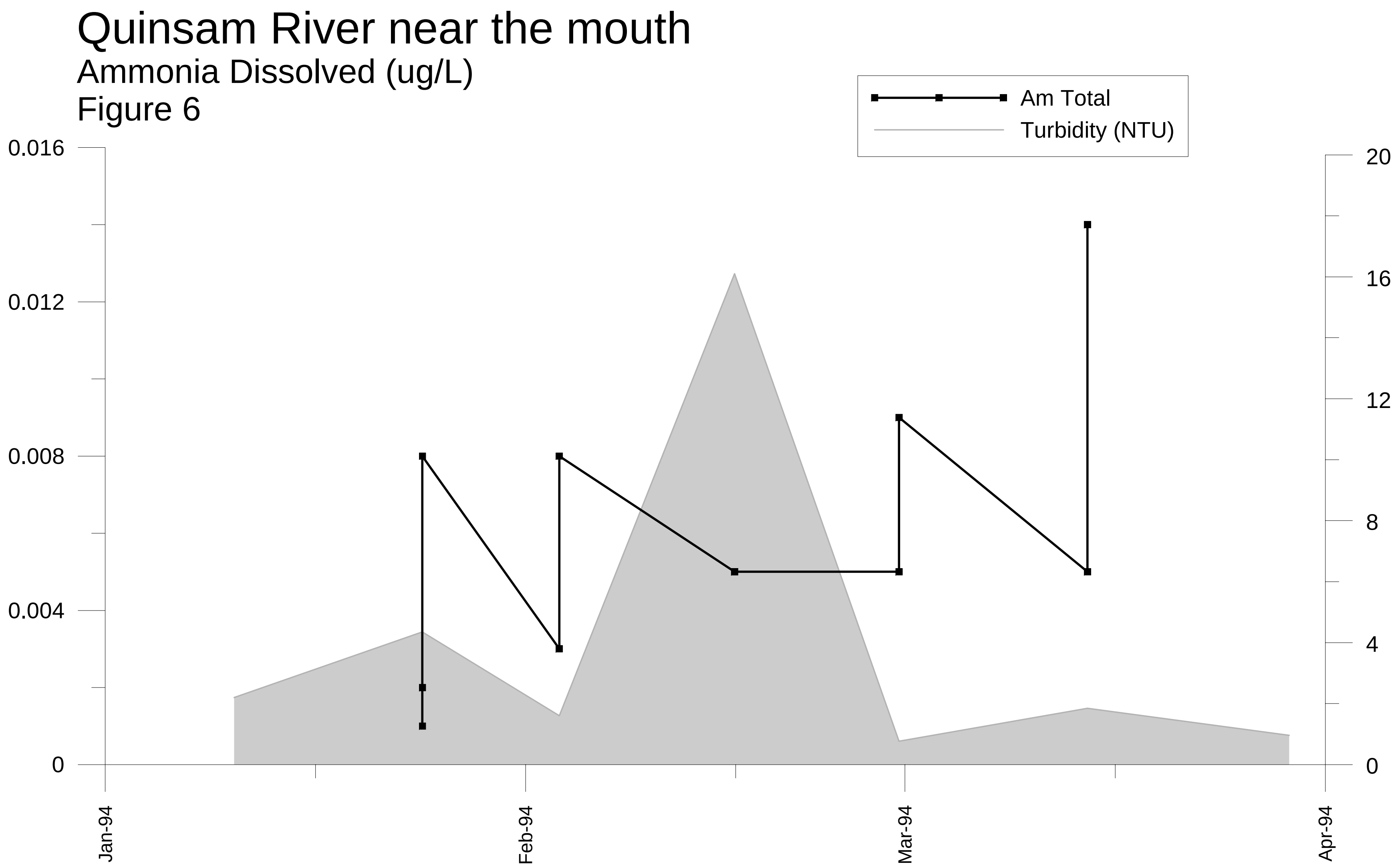
BC Ministry of Water, Lands and Air Protection. 2001. A Compendium of Working Water Quality Guidelines for British Columbia. N. K. Nagpal, L. W. Pommen, and. L. G. Swain. Victoria, B.C. http://www.env.gov.bc.ca/wat/wq/BCguidelines/working.html

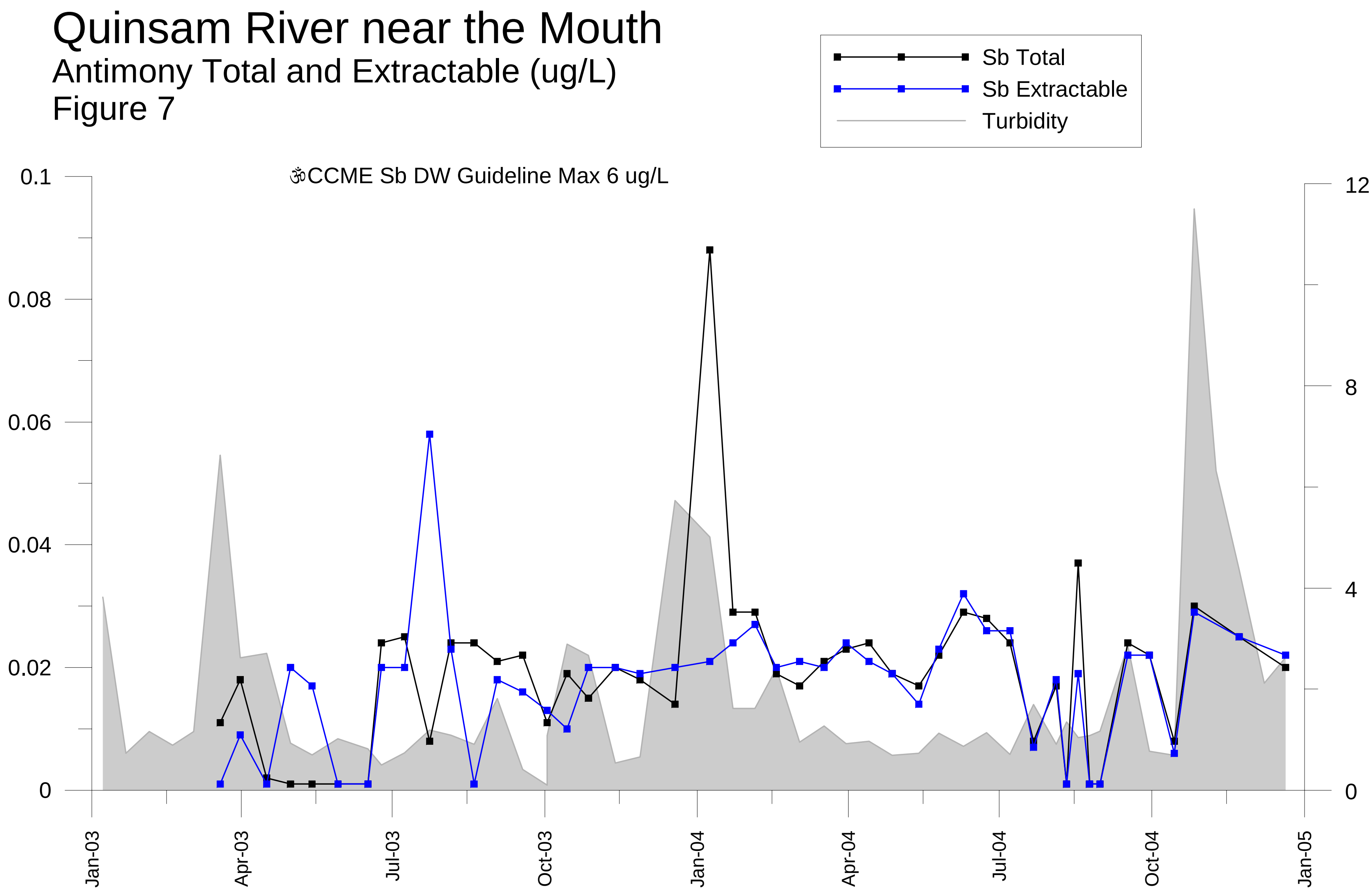
BC Ministry of Water, Lands and Air Protection. 2001. British Columbia Approved Water Quality Guidelines (Criteria) 1998 Edition. Updated: August 24, 2001. http://www.env.gov.bc.ca/wat/wq/BCguidelines/approv_wq_guide/approved.html

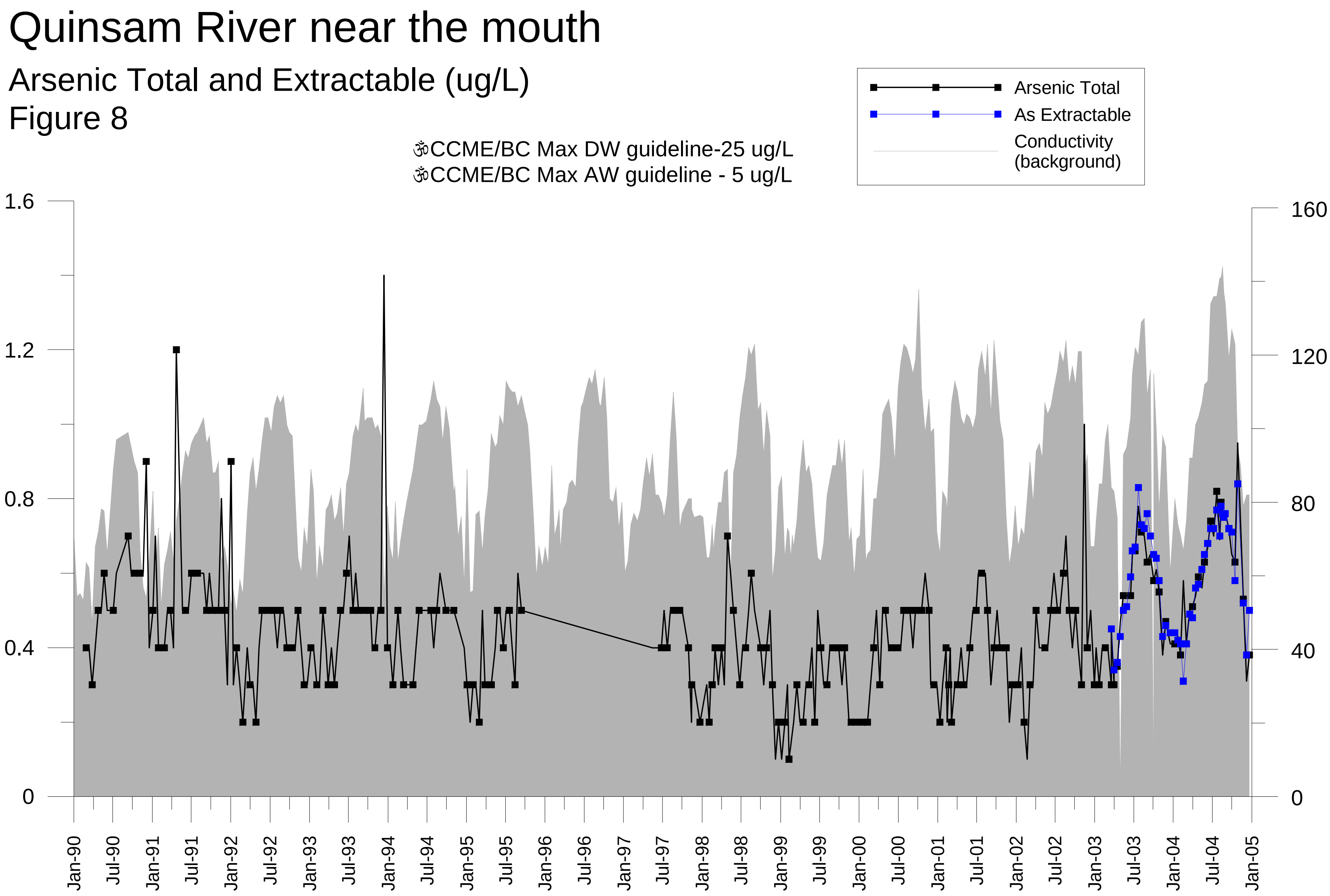

Quinsam River near the Mouth
Aluminum Total (ug/L)
Figure 3
Al Total
Al Ext
CCME Al AW/DW Guideline Max-100 ug/L
pH>6.5, Ca>4mg/L, DOC>2mg/L
CCME Al AW Guideline Max-5 ug/L
pH<6.5, Ca<4mg/L, DOC<2mg/L
Turbidity (NTU)
8000
6000
4000
2000
0
80
60
40
20
0
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05


Quinsam River near the Mouth
Aluminum Total (ug/L)
Figure 4
Al Total
Al Ext
CCME Al AW/DW Guideline Max-100 ug/L
pH>6.5, Ca>4mg/L, DOC>2mg/L
CCME Al AW Guideline Max-5 ug/L
pH<6.5, Ca<4mg/L, DOC<2mg/L
Turbidity (NTU)
1200
800
400
0
12
8
4
0
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05

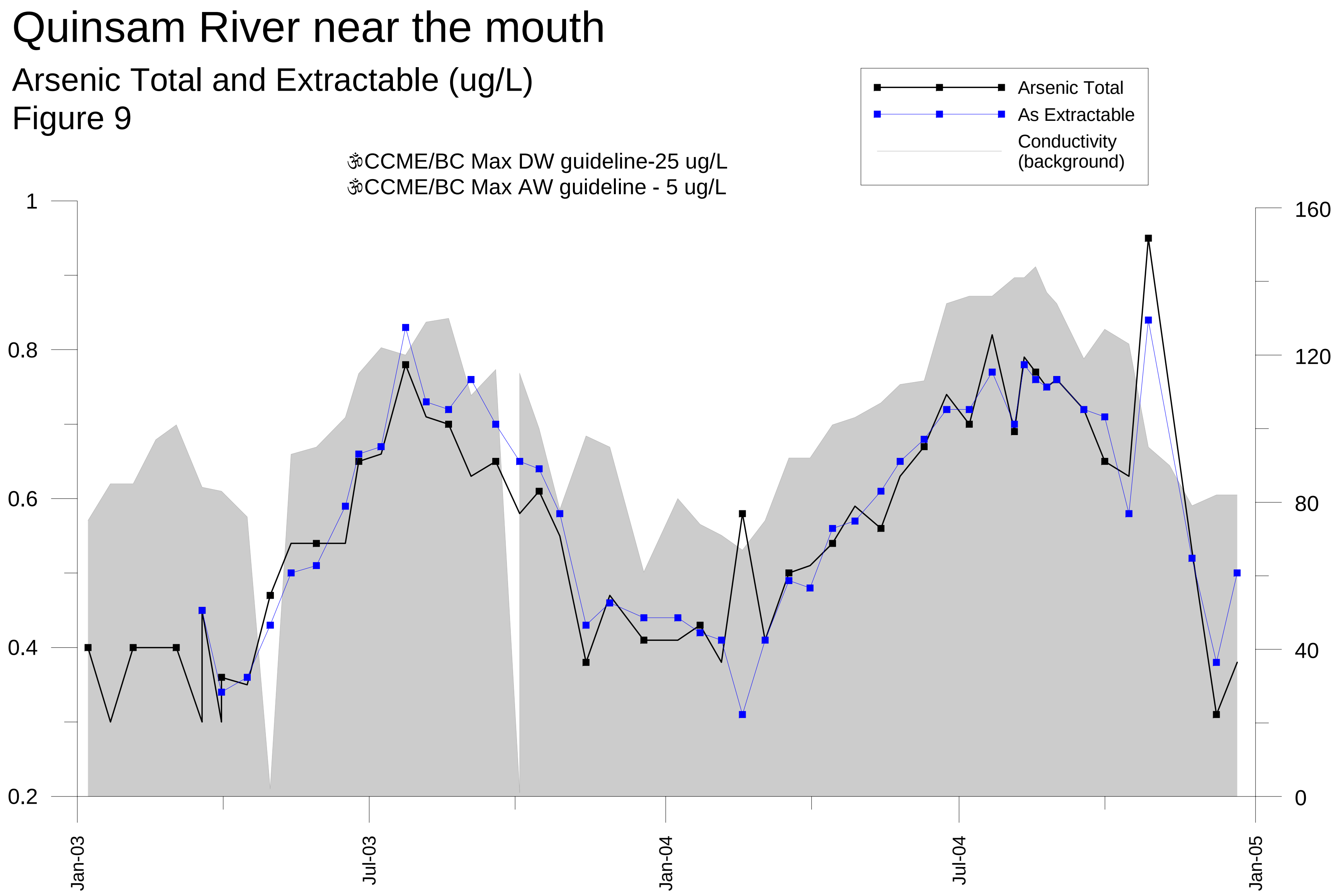

Quinsam River near the mouth
Alkalinity Total CaCO3 (mg/L)
Figure 5
Alkalinity Total
BC Alk AW Guideline
Conductivity
60
40
20
0
200
160
120
80
40
0
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

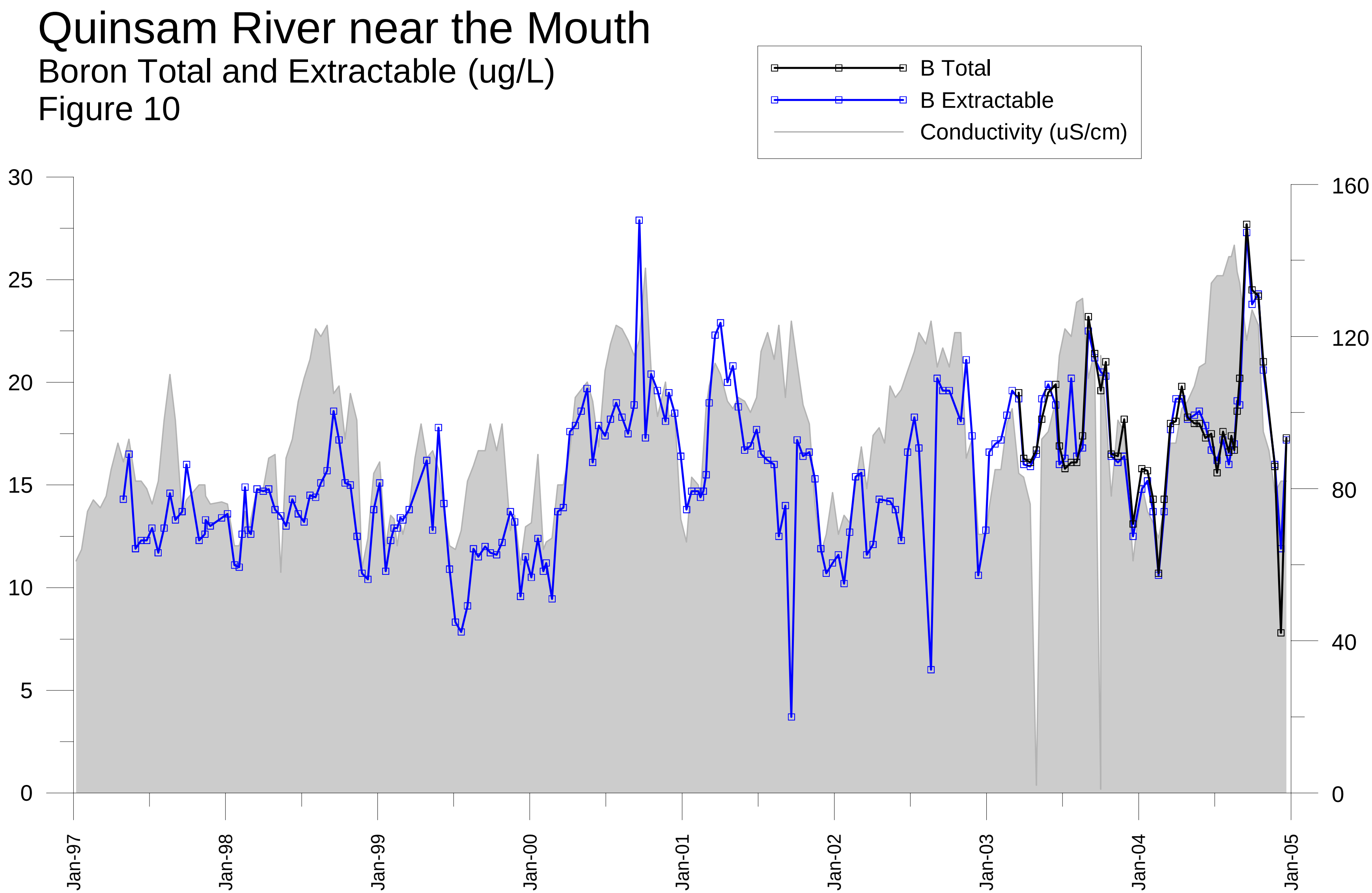

Quinsam River near the mouth
Ammonia Dissolved (ug/L)
Figure 6
Am Total
Turbidity (NTU)
0.016
0.012
0.008
0.004
0
20
16
12
8
4
0
Jan-94
Feb-94
Mar-94
Apr-94

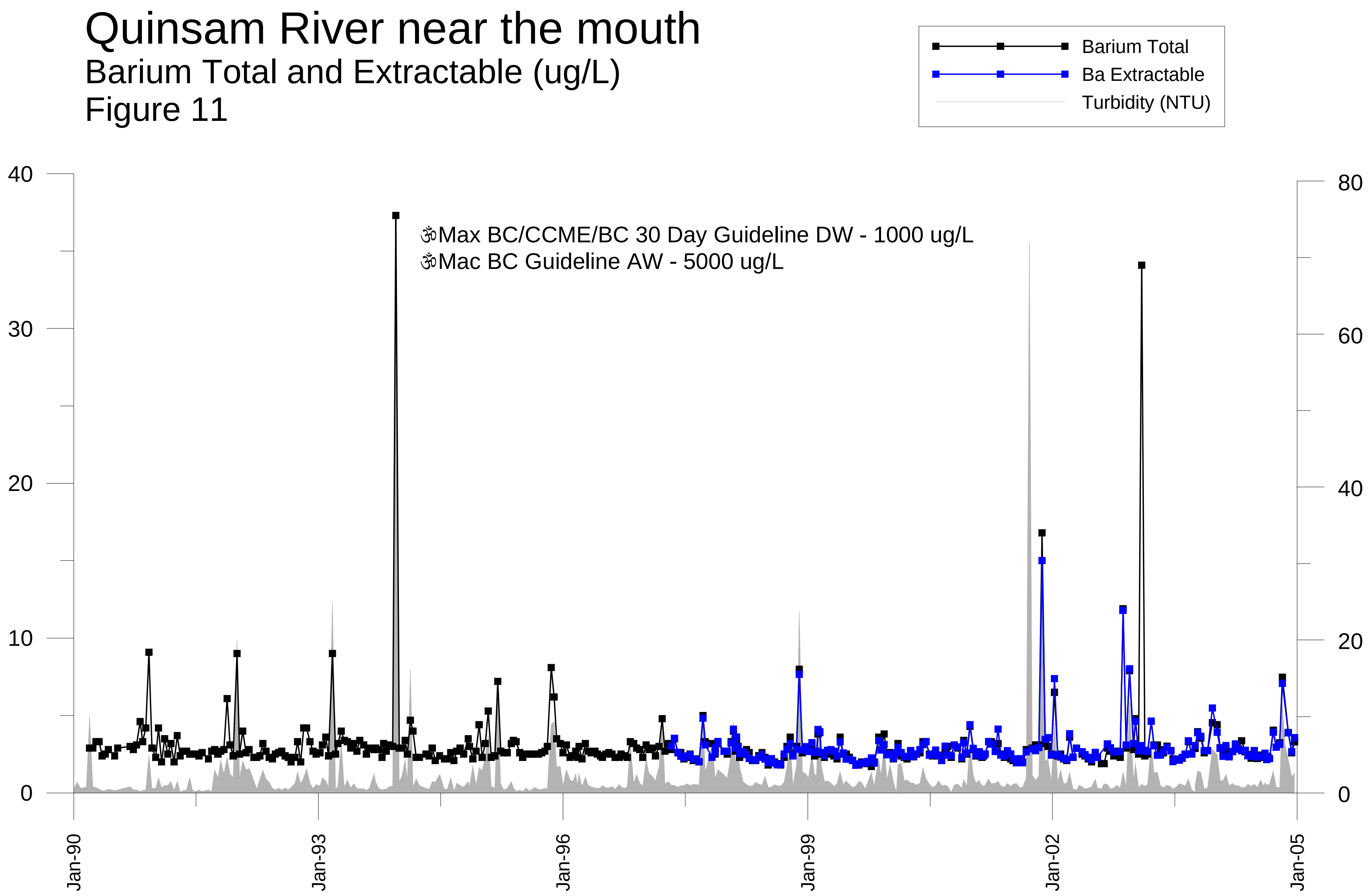

Quinsam River near the Mouth
Antimony Total and Extractable (ug/L)
Figure 7
Sb Total
Sb Extractable
Turbidity
CCME Sb DW Guideline Max 6 ug/L
0.1
0.08
0.06
0.04
0.02
0
12
8
4
0
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05



Quinsam River near the mouth
Arsenic Total and Extractable (ug/L)
Figure 8
ॐCCME/BC Max DW guideline-25 ug/L
ॐCCME/BC Max AW guideline - 5 ug/L
Arsenic Total
As Extractable
Conductivity (background)
1.6
1.2
0.8
0.4
0
160
120
80
40
0
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05


Quinsam River near the mouth
Arsenic Total and Extractable (ug/L)
Figure 9
CCME/BC Max DW guideline-25 ug/L
CCME/BC Max AW guideline - 5 ug/L
Arsenic Total
As Extractable
Conductivity
(background)
1
0.8
0.6
0.4
0.2
160
120
80
40
0
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05


Quinsam River near the Mouth
Boron Total and Extractable (ug/L)
Figure 10
B Total
B Extractable
Conductivity (uS/cm)
30
25
20
15
10
5
0
160
120
80
40
0
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

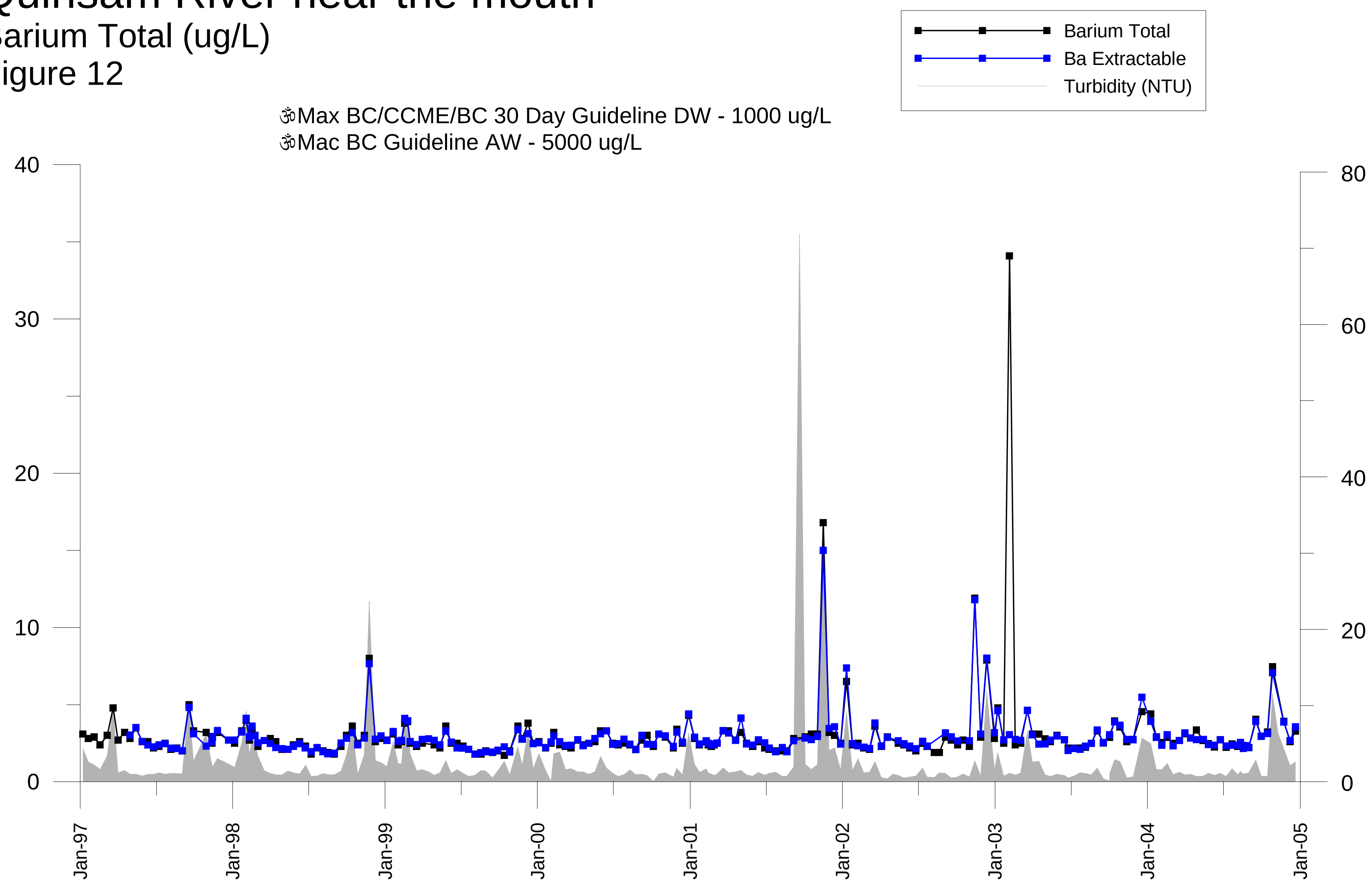

Quinsam River near the mouth
Barium Total and Extractable (ug/L)
Figure 11
Barium Total
Ba Extractable
Turbidity (NTU)
ॐMax BC/CCME/BC 30 Day Guideline DW - 1000 ug/L
ॐMac BC Guideline AW - 5000 ug/L
40
30
20
10
0
80
60
40
20
0
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05

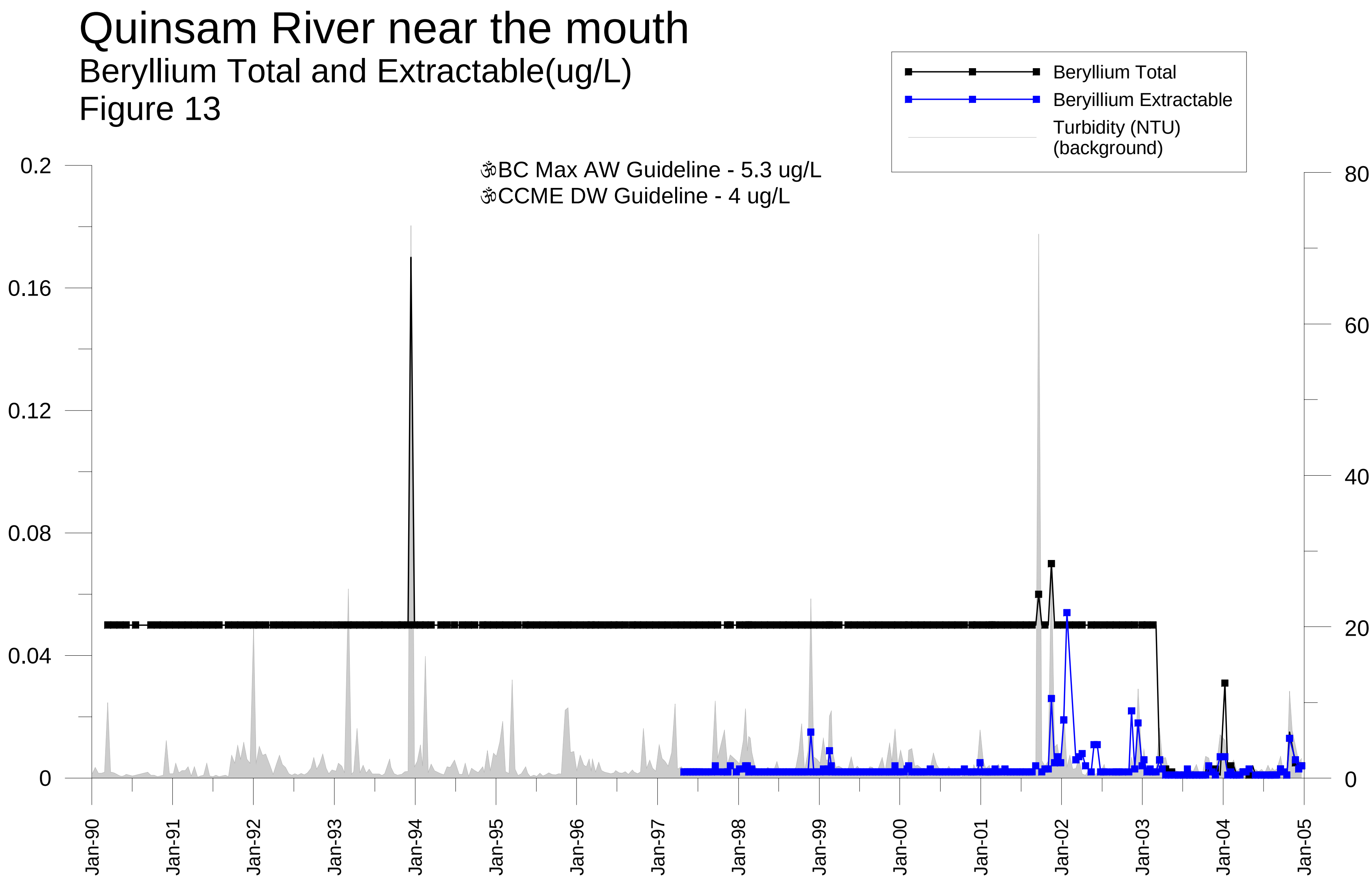
Quinsam River near the mouth

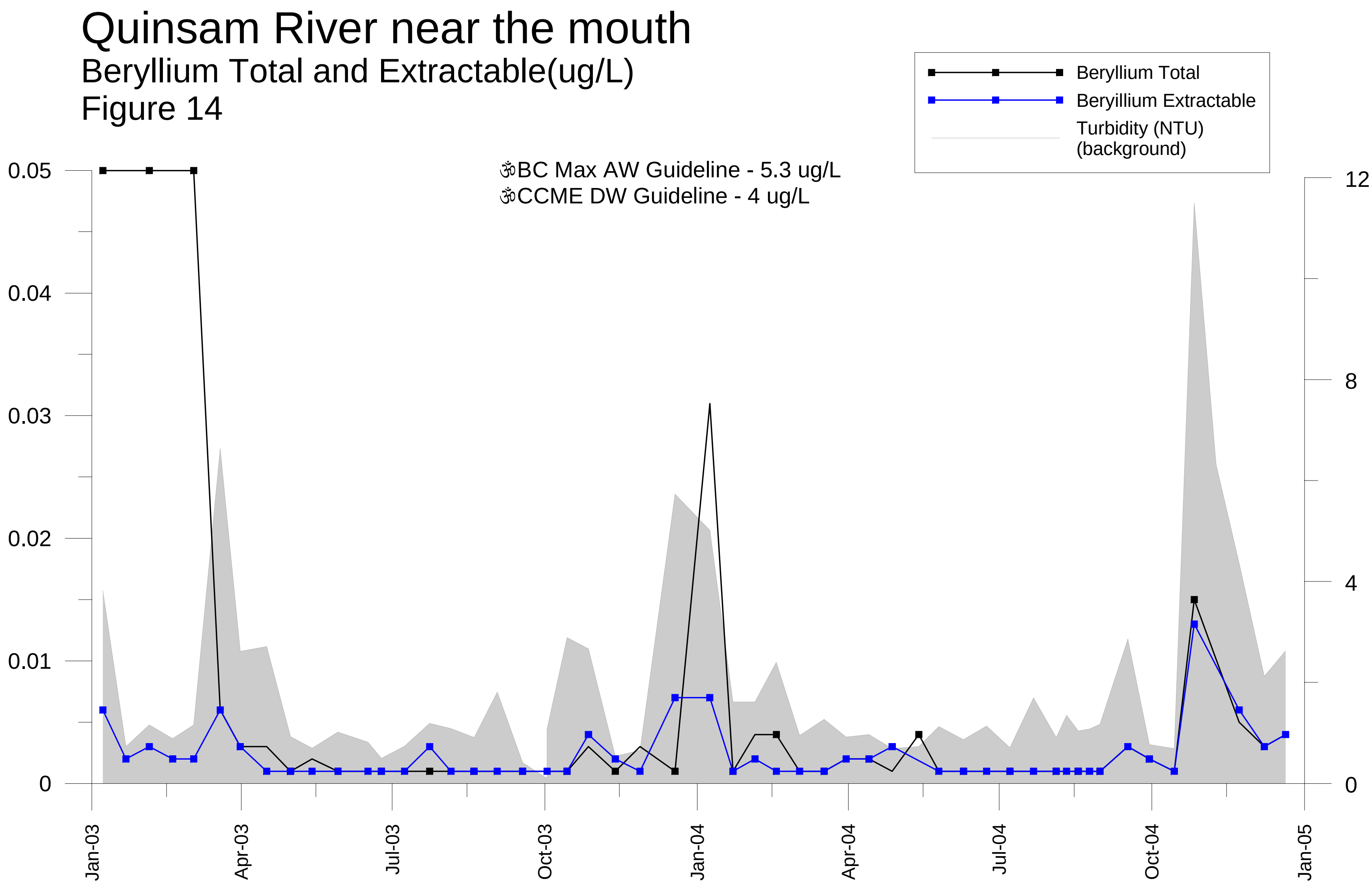
Barium Total (ug/L)

Figure 12

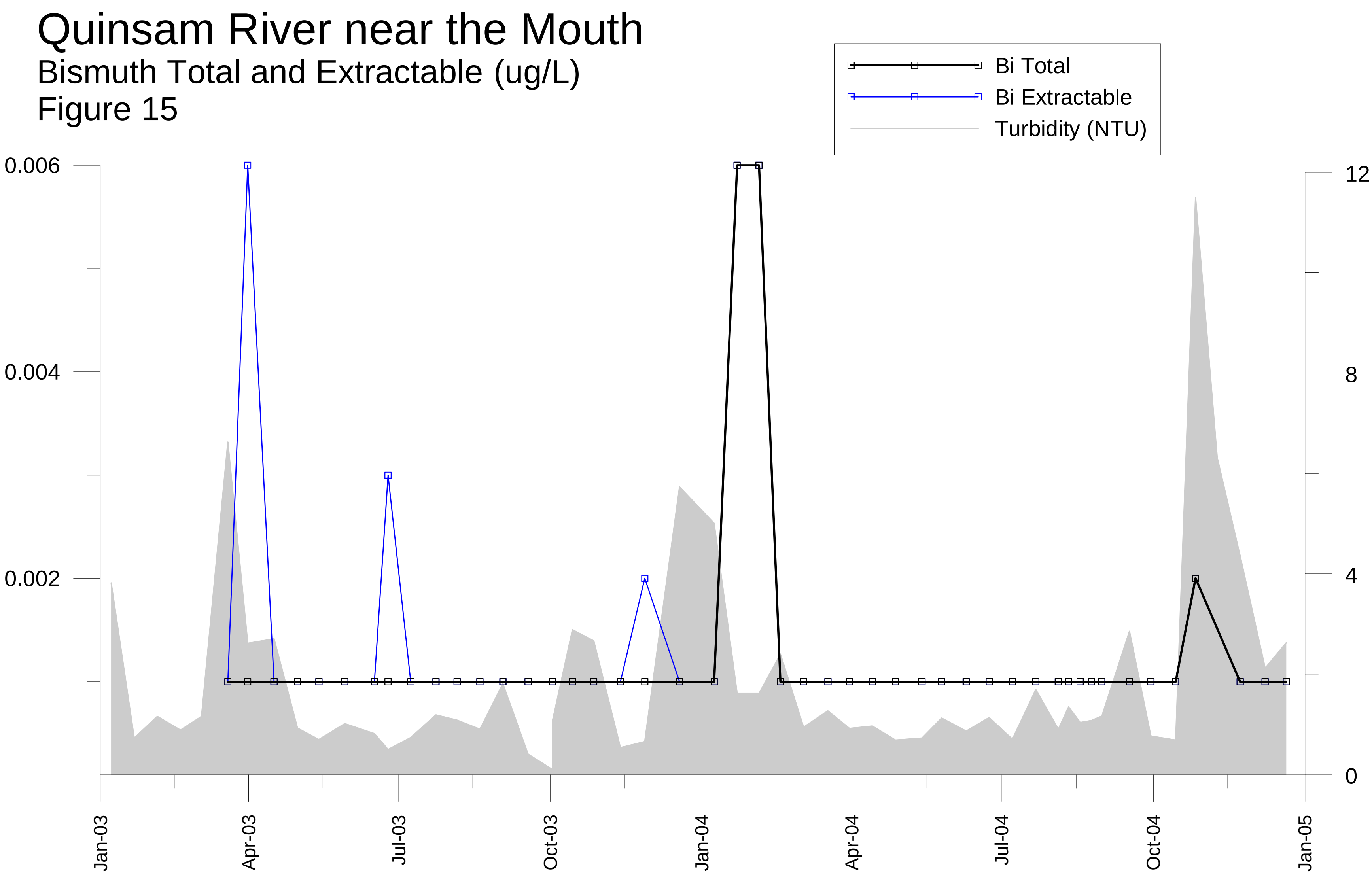
ॐMax BC/CCME/BC 30 Day Guideline DW - 1000 ug/L
ॐMac BC Guideline AW - 5000 ug/L

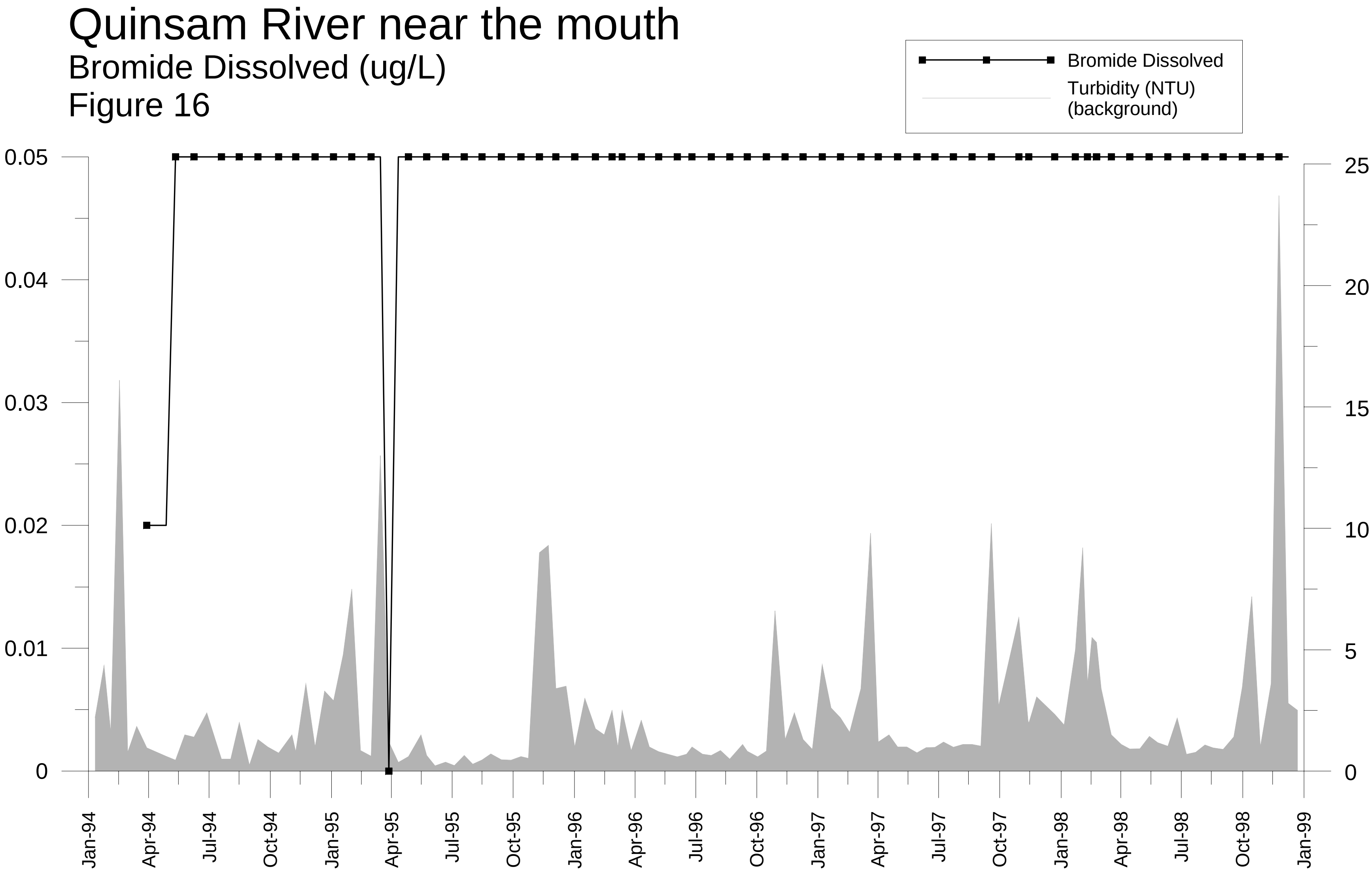


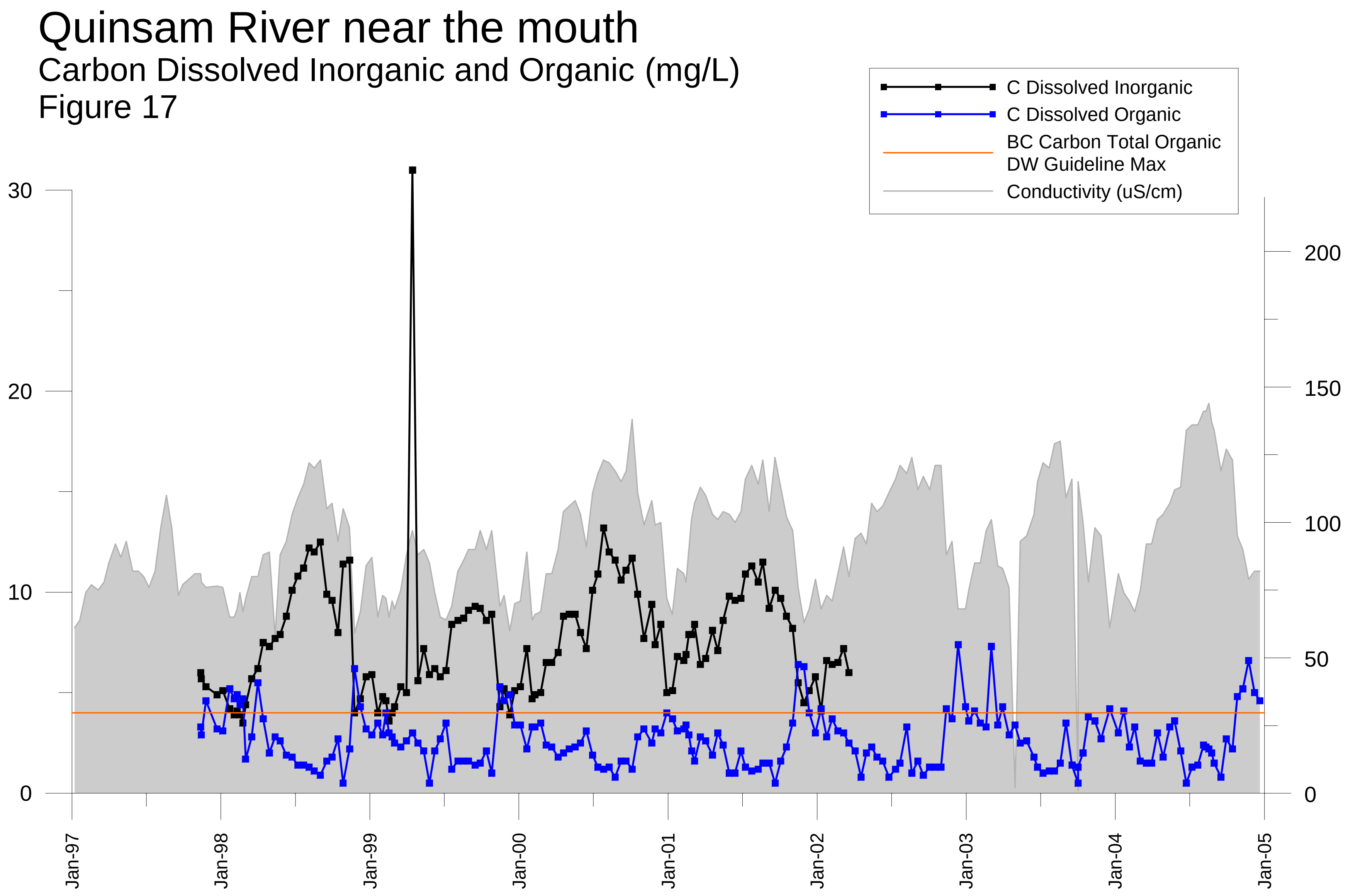

Quinsam River near the mouth
Beryllium Total and Extractable(ug/L)
Figure 13
Beryllium Total
Beryillium Extractable
Turbidity (NTU) (background)
BC Max AW Guideline - 5.3 ug/L
CCME DW Guideline - 4 ug/L
0.2
0.16
0.12
0.08
0.04
0
80
60
40
20
0
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

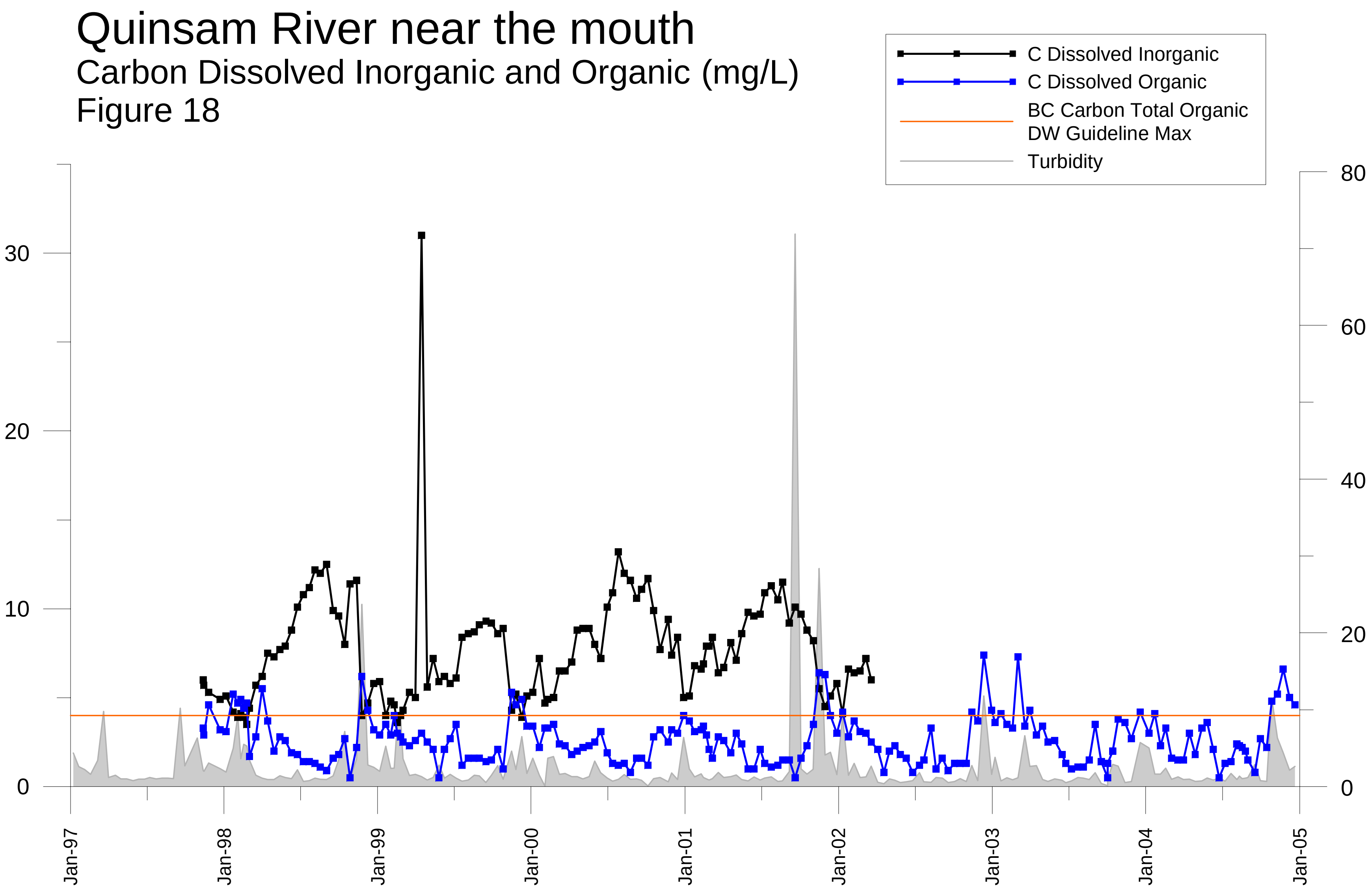


Quinsam River near the mouth
Beryllium Total and Extractable(ug/L)
Figure 14
Beryllium Total
Beryillium Extractable
Turbidity (NTU) (background)
BC Max AW Guideline - 5.3 ug/L
CCME DW Guideline - 4 ug/L
0.05
0.04
0.03
0.02
0.01
0
12
8
4
0
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05

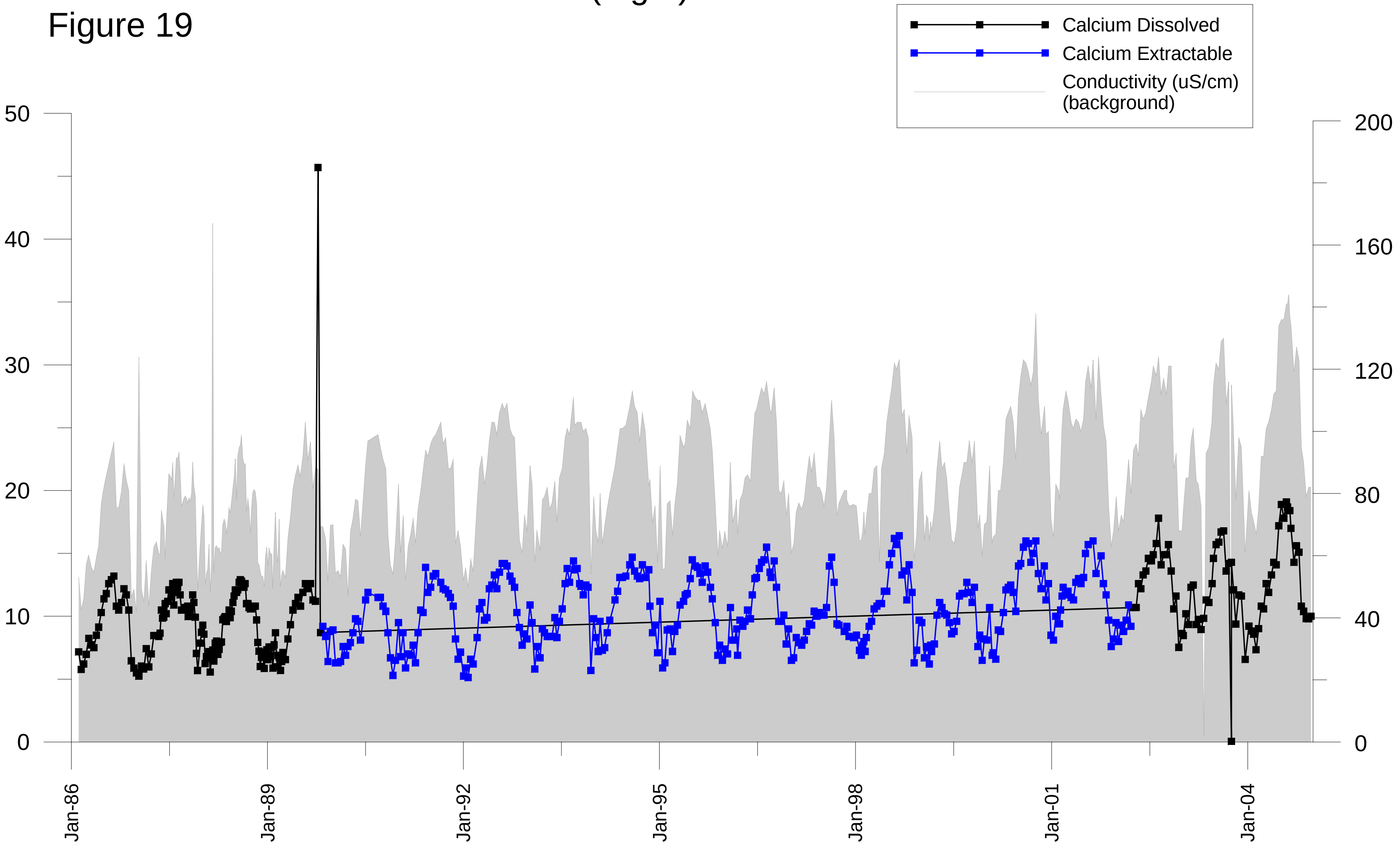

Quinsam River near the Mouth
Bismuth Total and Extractable (ug/L)
Figure 15
Bi Total
Bi Extractable
Turbidity (NTU)
0.006
0.004
0.002
12
8
4
0
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05

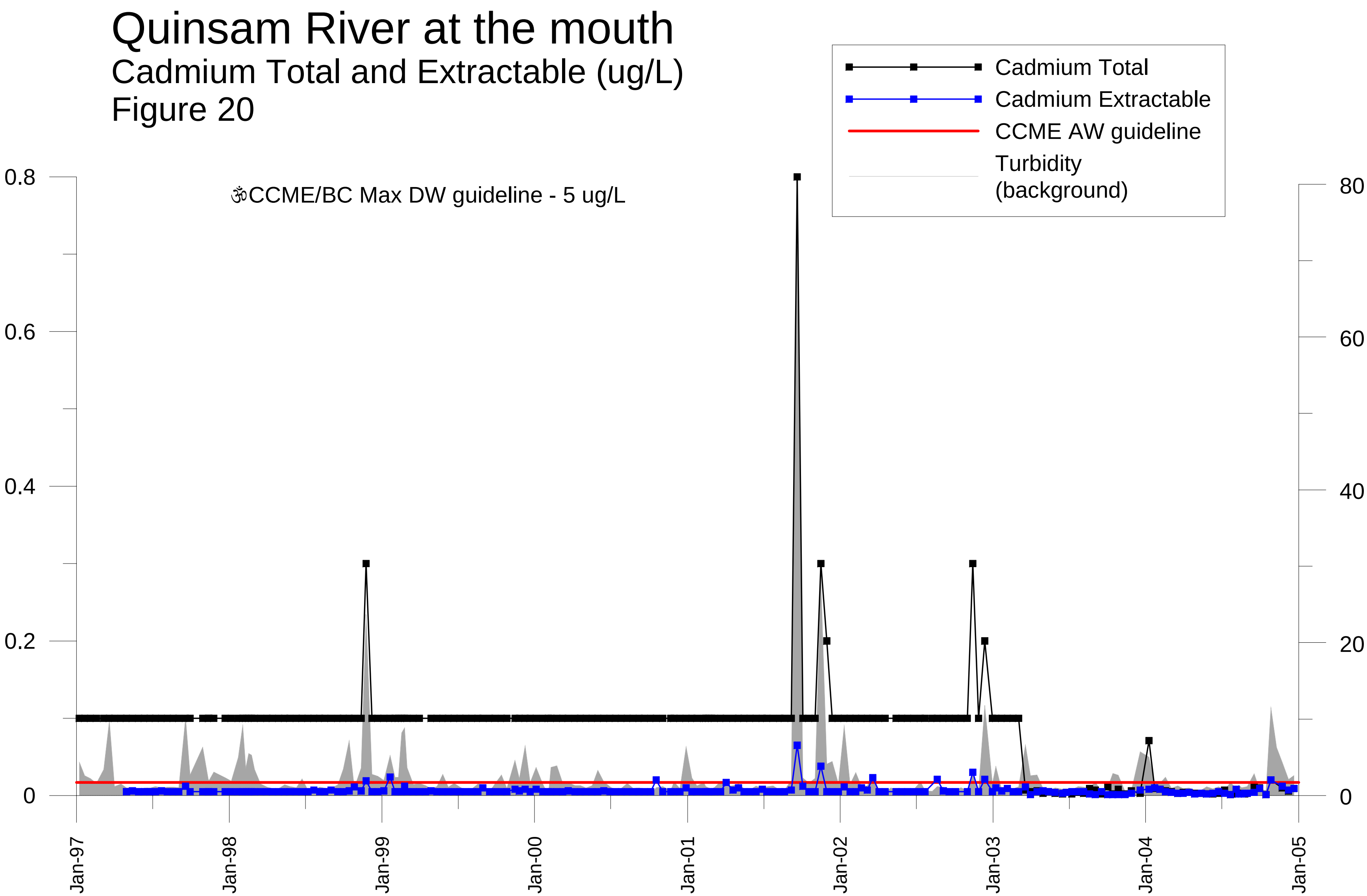

Quinsam River near the mouth
Bromide Dissolved (ug/L)
Figure 16
Bromide Dissolved
Turbidity (NTU)
(background)
0.05
0.04
0.03
0.02
0.01
0
25
20
15
10
5
0
Jan-94
Apr-94
Jul-94
Oct-94
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99

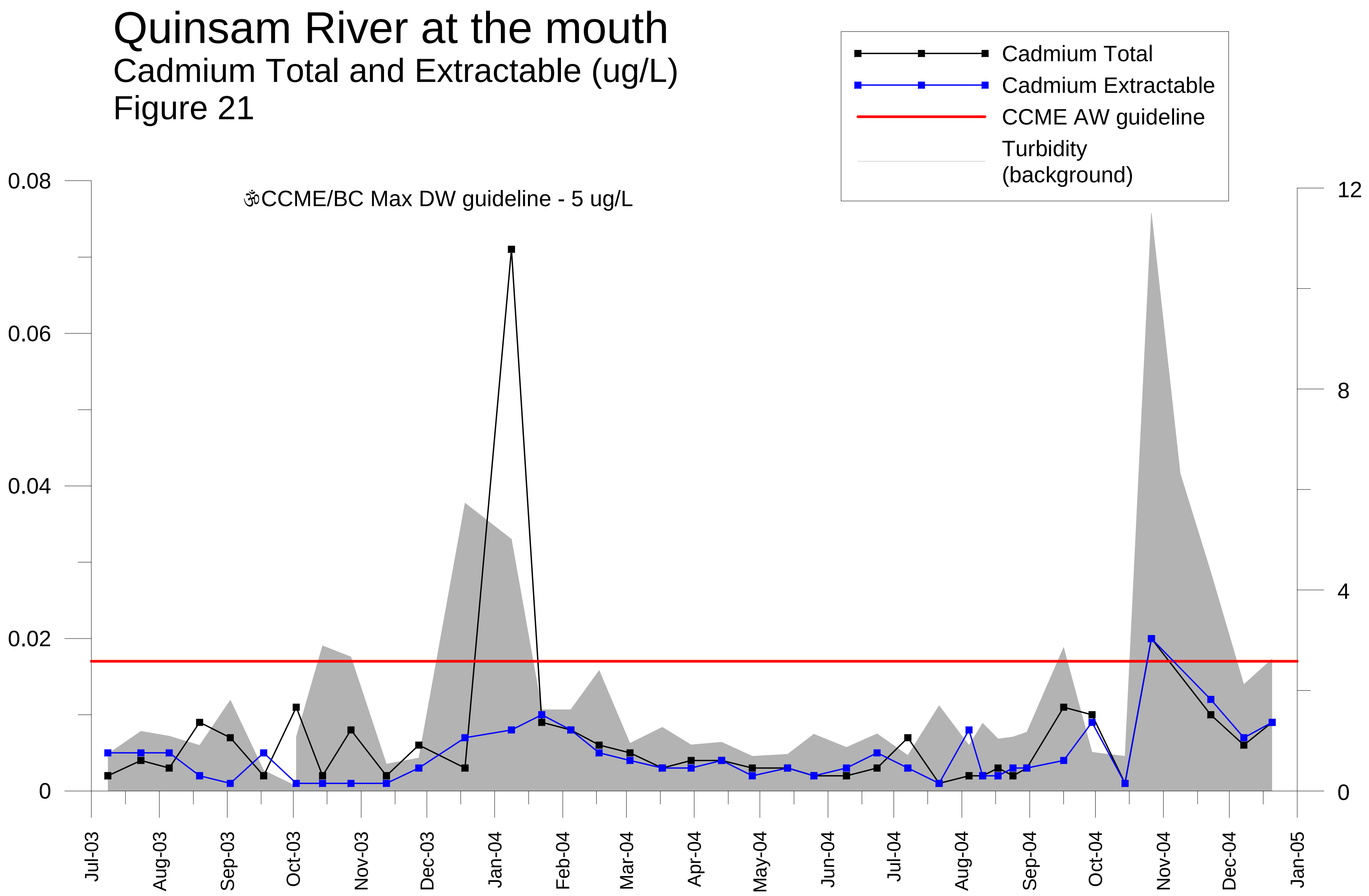

Quinsam River near the mouth
Carbon Dissolved Inorganic and Organic (mg/L)
Figure 17
C Dissolved Inorganic
C Dissolved Organic
BC Carbon Total Organic DW Guideline Max
Conductivity (uS/cm)
30
20
10
0
200
150
100
50
0
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05


Quinsam River near the mouth
Carbon Dissolved Inorganic and Organic (mg/L)
Figure 18
C Dissolved Inorganic
C Dissolved Organic
BC Carbon Total Organic DW Guideline Max
Turbidity
0
10
20
30
0
20
40
60
80
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

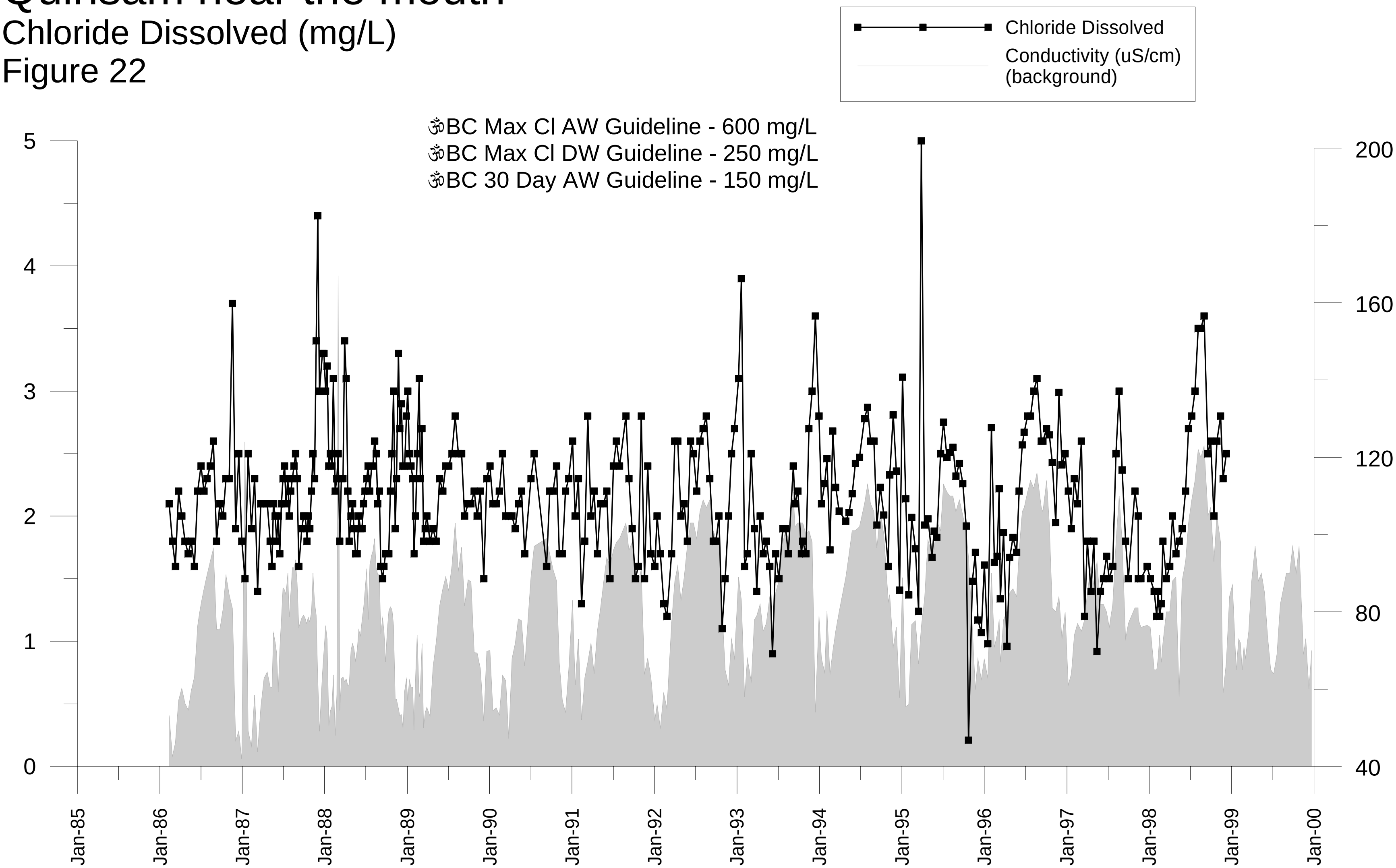
Quinsam River near the mouth
Calcium Dissolved and Extractable (mg/L)
Figure 19




Quinsam River at the mouth
Cadmium Total and Extractable (ug/L)
Figure 20
Cadmium Total
Cadmium Extractable
CCME AW guideline
Turbidity (background)
ꙮCCME/BC Max DW guideline - 5 ug/L
0.8
0.6
0.4
0.2
0
80
60
40
20
0
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05


Quinsam River at the mouth
Cadmium Total and Extractable (ug/L)
Figure 21
Cadmium Total
Cadmium Extractable
CCME AW guideline
Turbidity
(background)
CCME/BC Max DW guideline - 5 ug/L
0.08
0.06
0.04
0.02
0
12
8
4
0
Jul-03
Aug-03
Sep-03
Oct-03
Nov-03
Dec-03
Jan-04
Feb-04
Mar-04
Apr-04
May-04
Jun-04
Jul-04
Aug-04
Sep-04
Oct-04
Nov-04
Dec-04
Jan-05

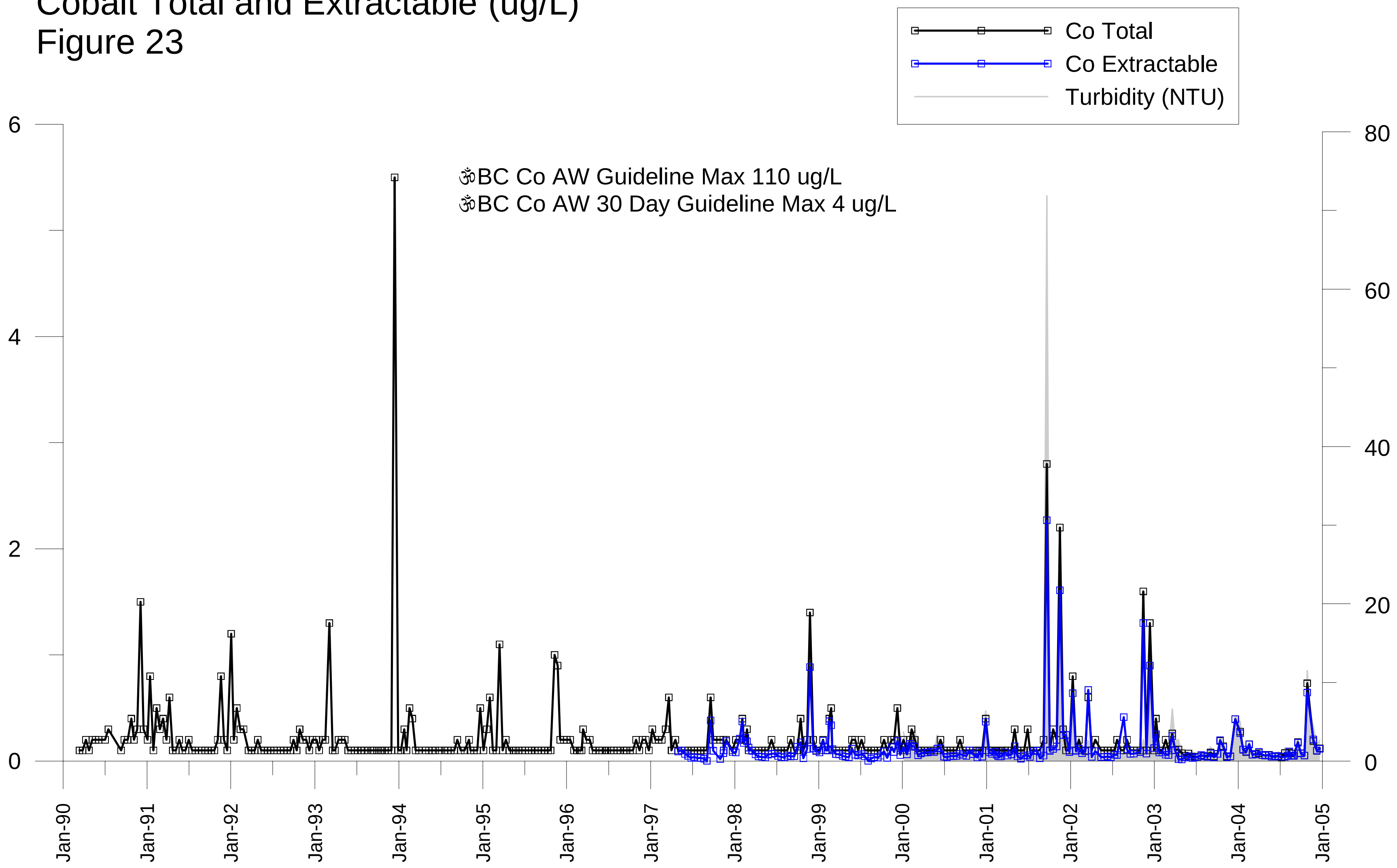
Quinsam near the mouth
Chloride Dissolved (mg/L)
Figure 22



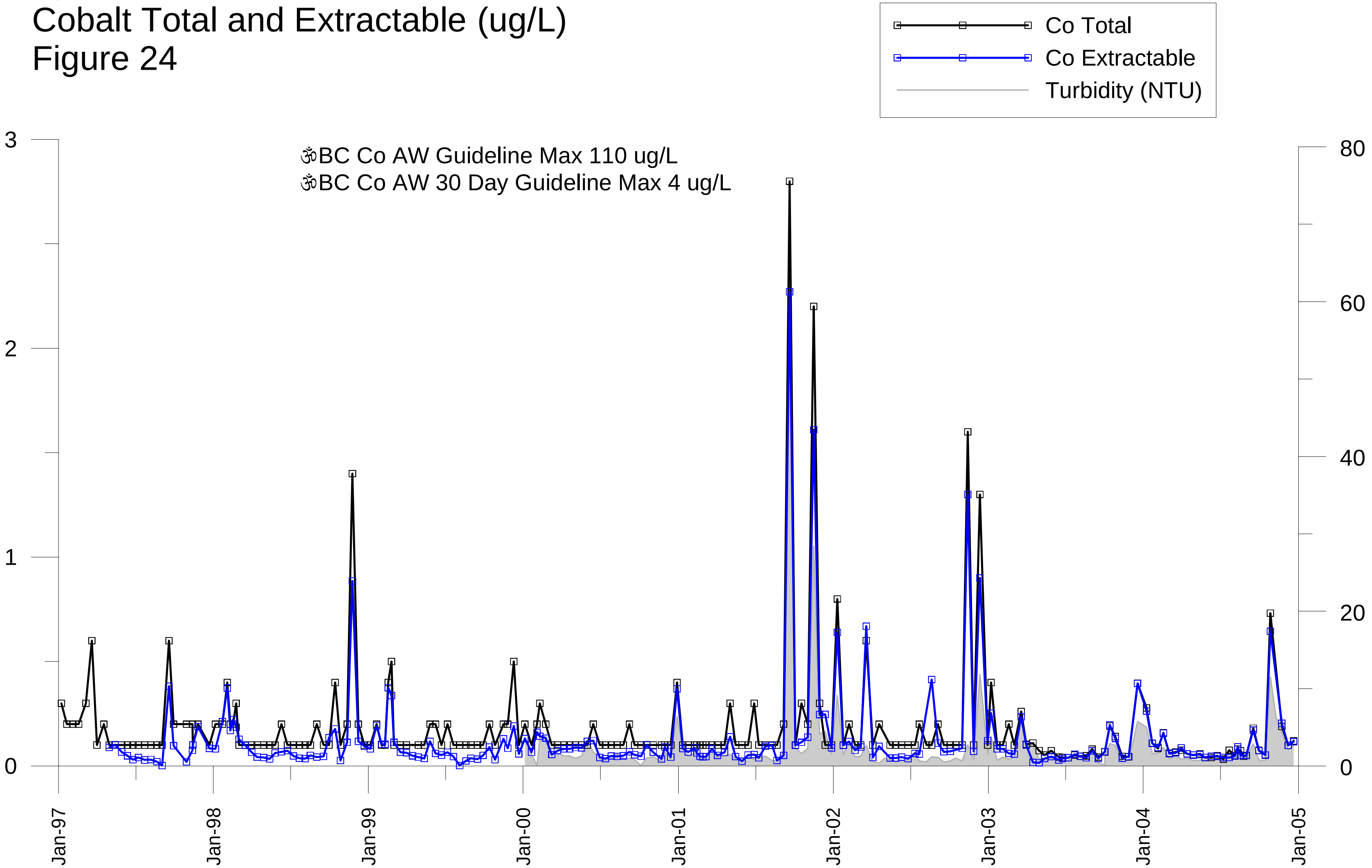
Quinsam River near the Mouth

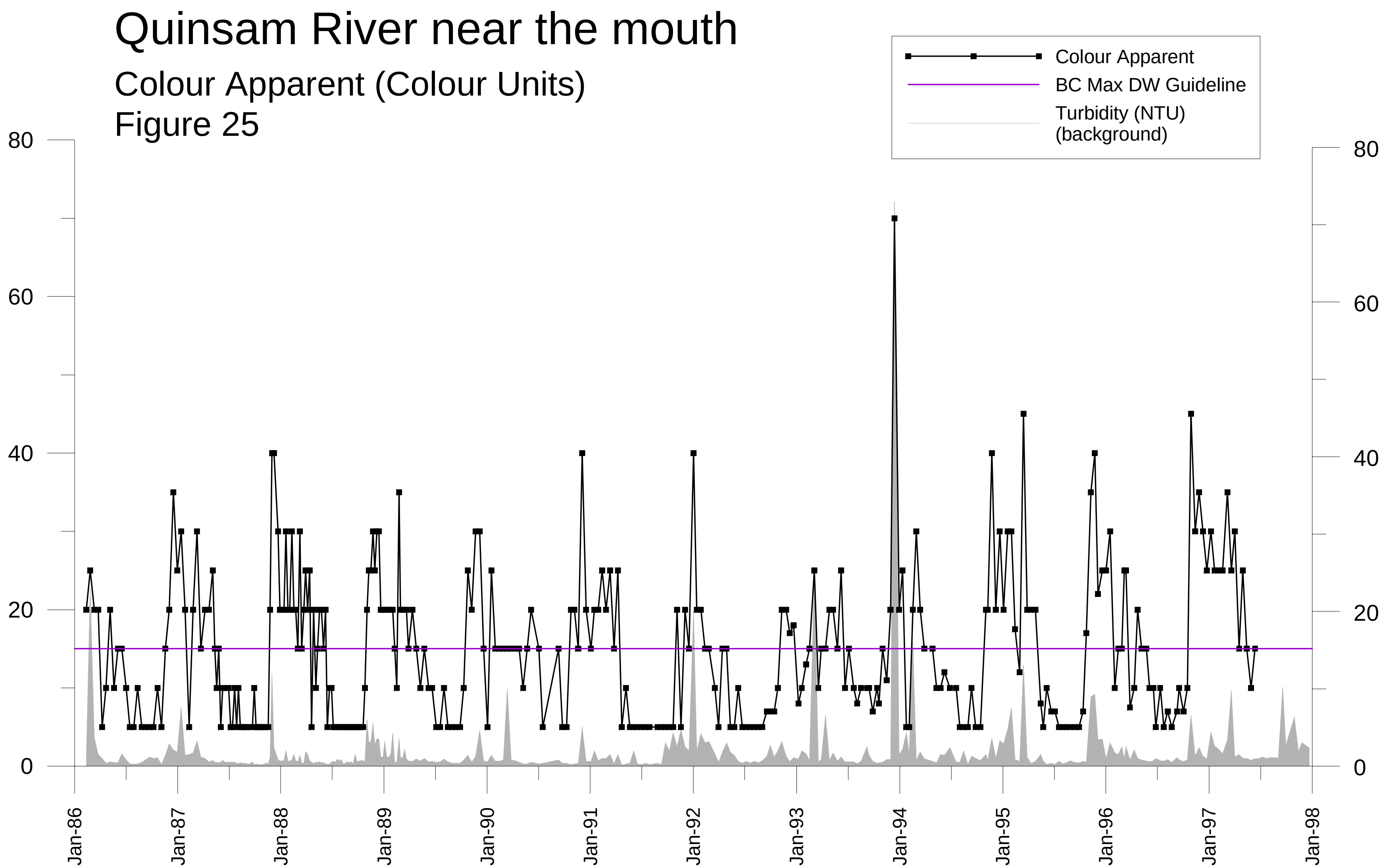
Cobalt Total and Extractable (ug/L)

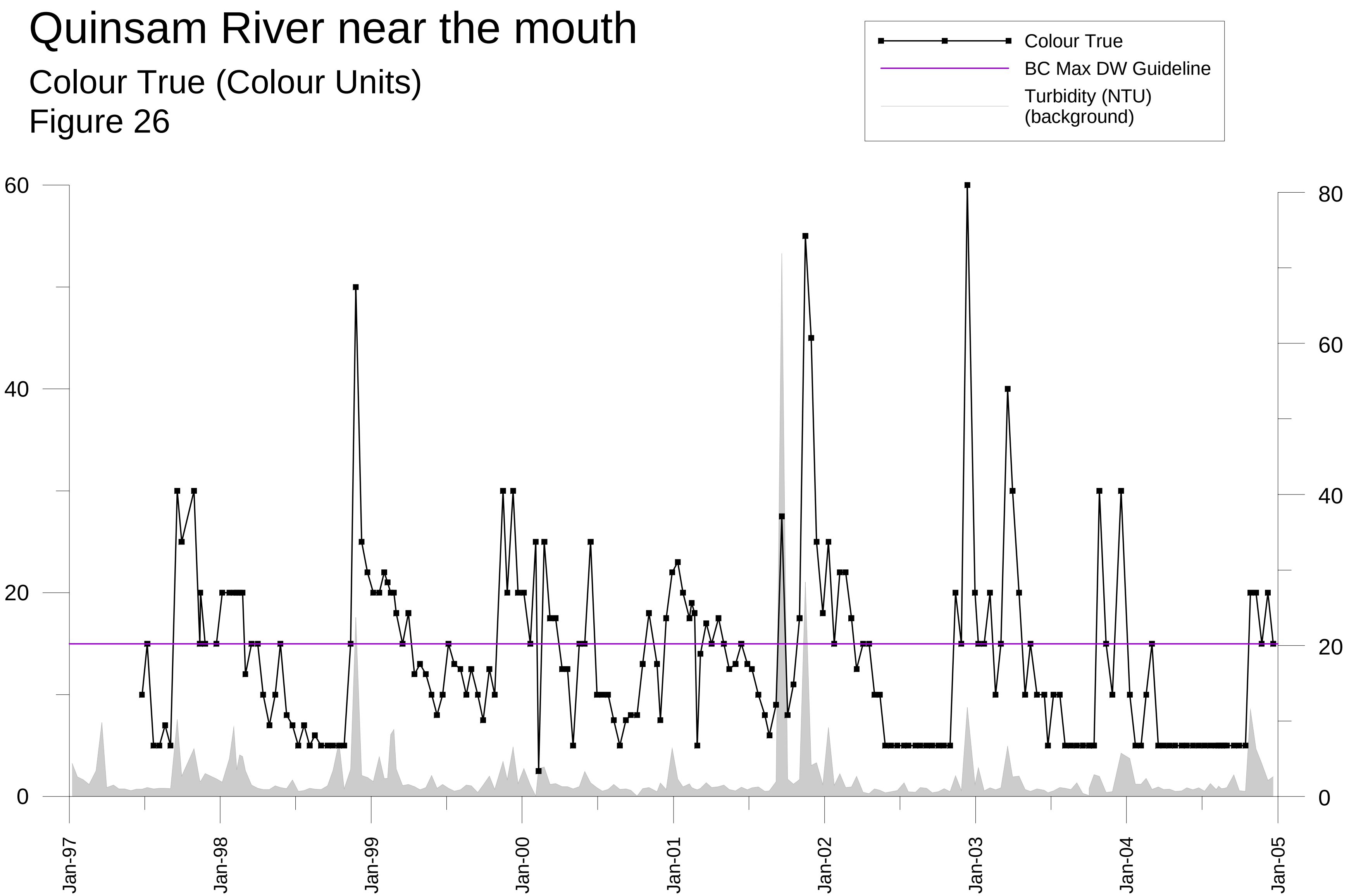
Figure 23

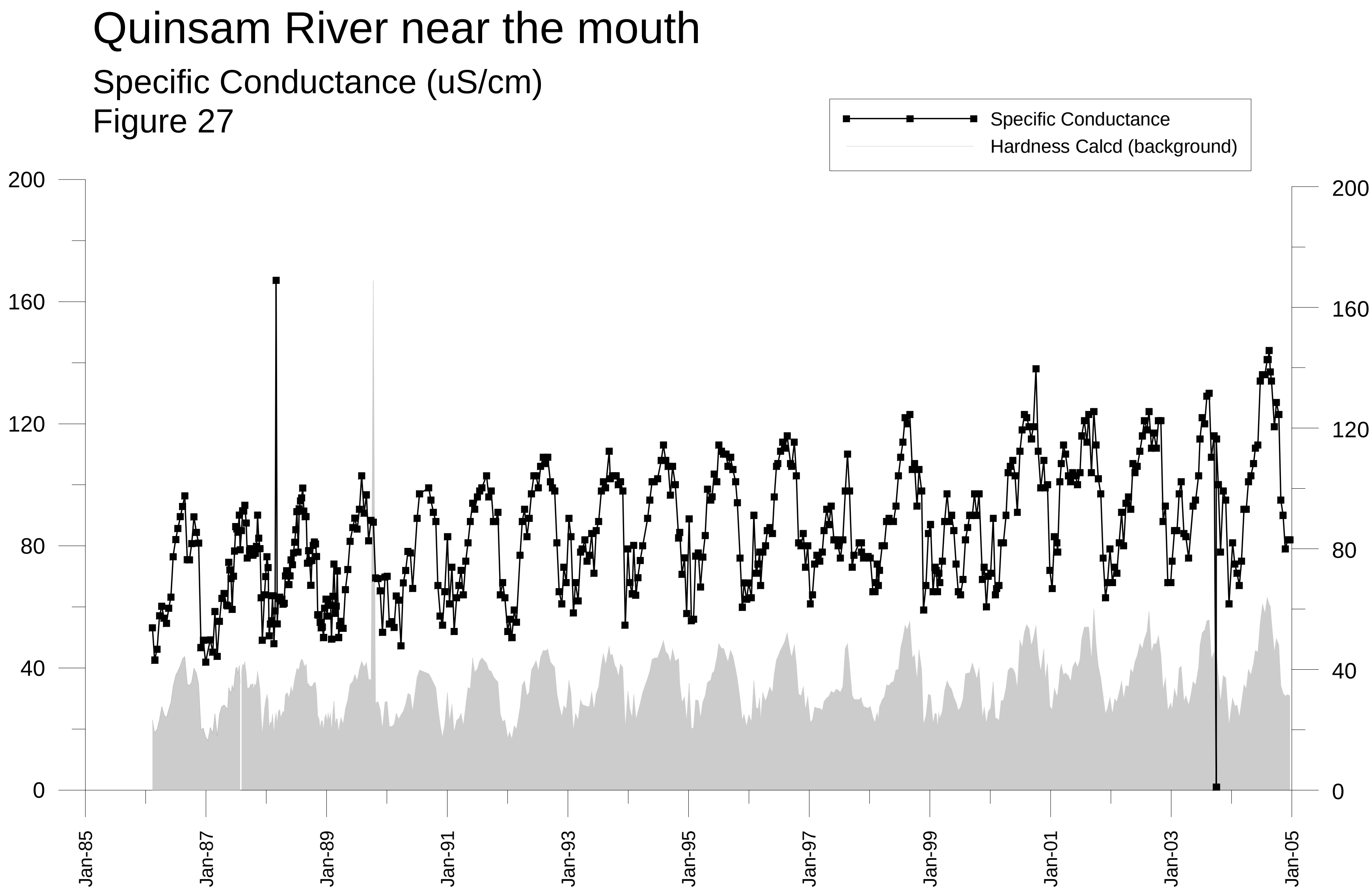


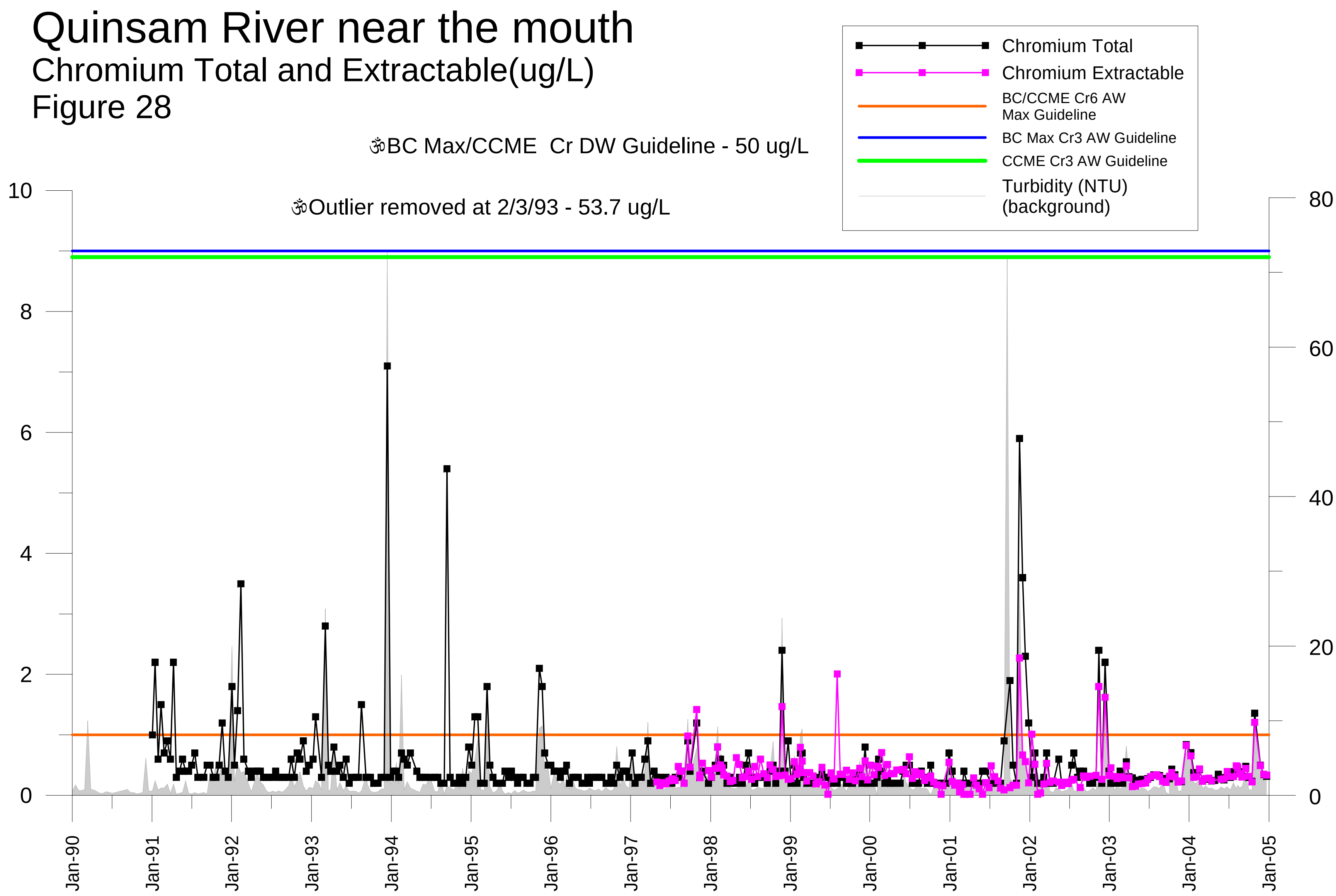
Quinsam River near the Mouth
Cobalt Total and Extractable (ug/L)
Figure 24

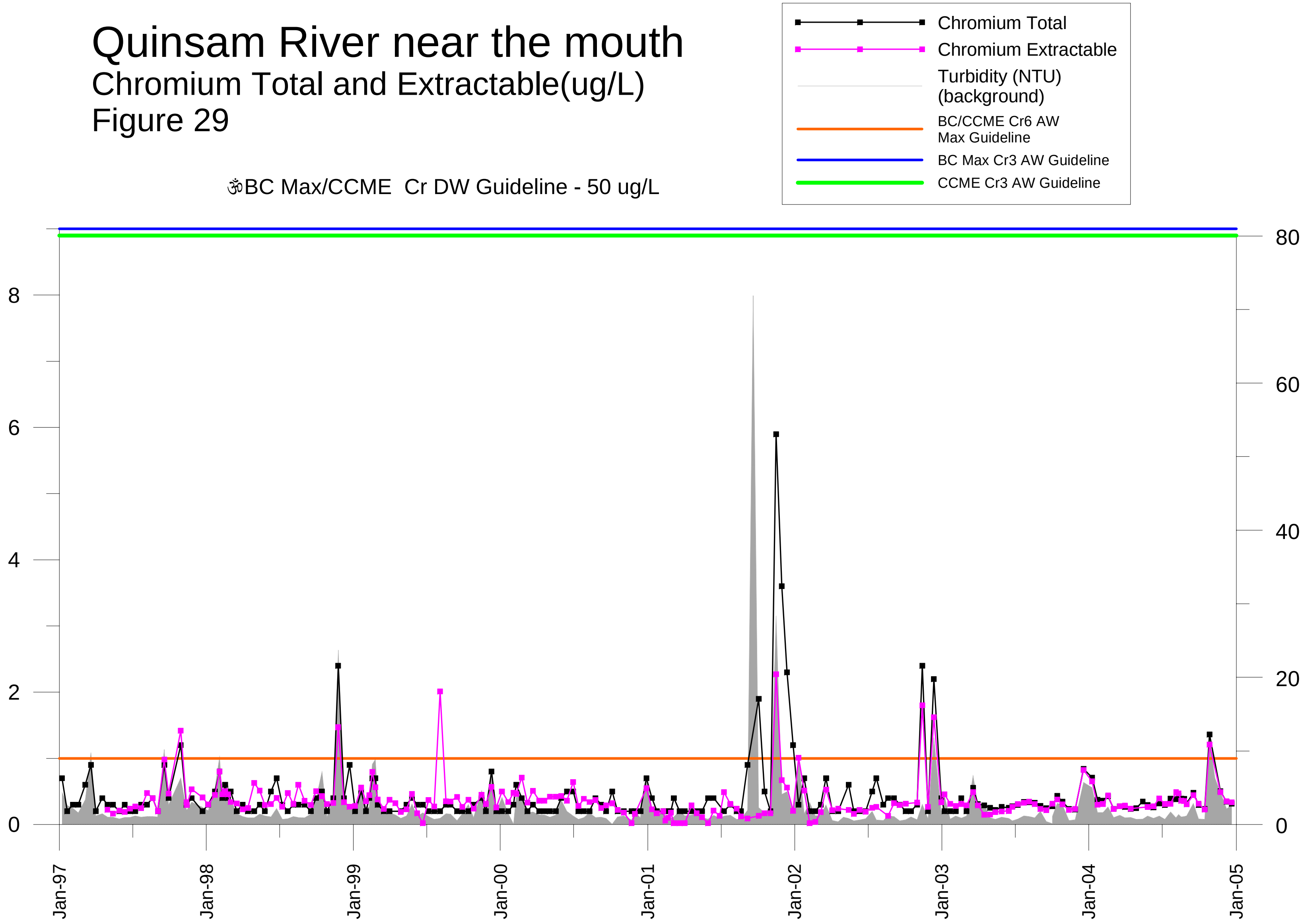


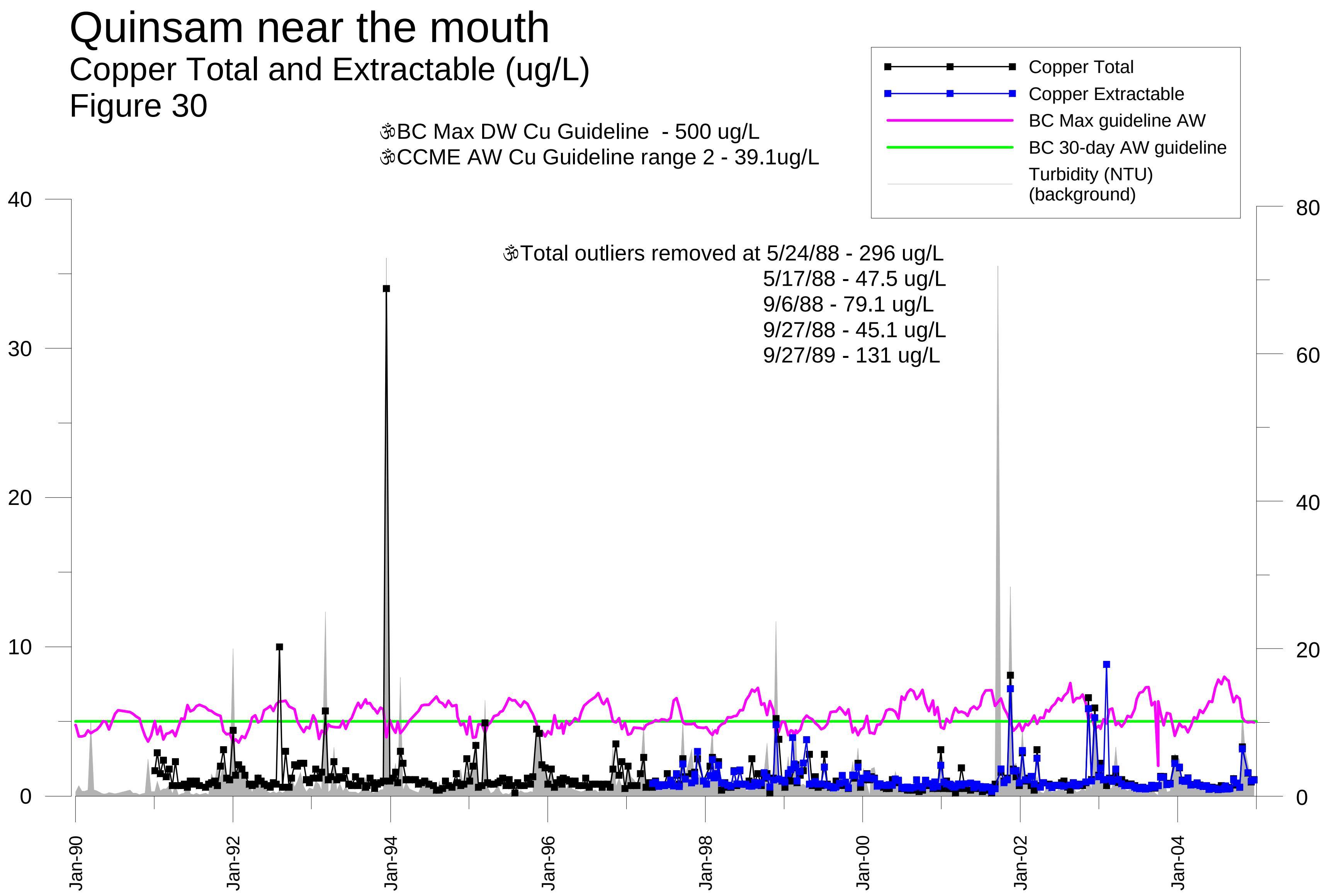

Quinsam River near the mouth
Colour Apparent (Colour Units)
Figure 25
Colour Apparent
BC Max DW Guideline
Turbidity (NTU)
(background)
0
20
40
60
80
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98


Quinsam River near the mouth
Colour True (Colour Units)
Figure 26
Colour True
BC Max DW Guideline
Turbidity (NTU)
(background)
60
40
20
0
80
60
40
20
0
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

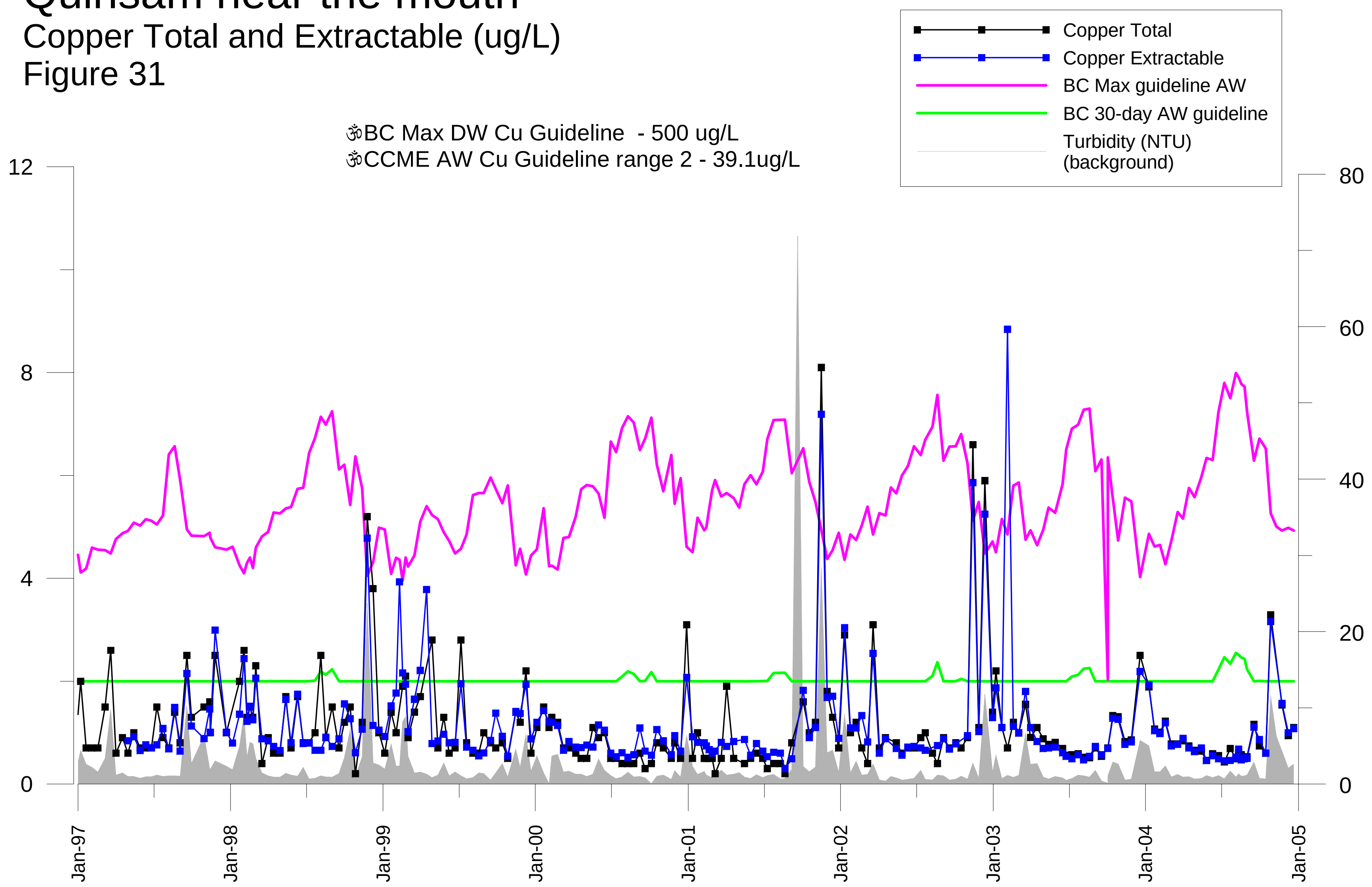

Quinsam River near the mouth
Specific Conductance (uS/cm)
Figure 27
Specific Conductance
Hardness Calcd (background)
200
160
120
80
40
0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05

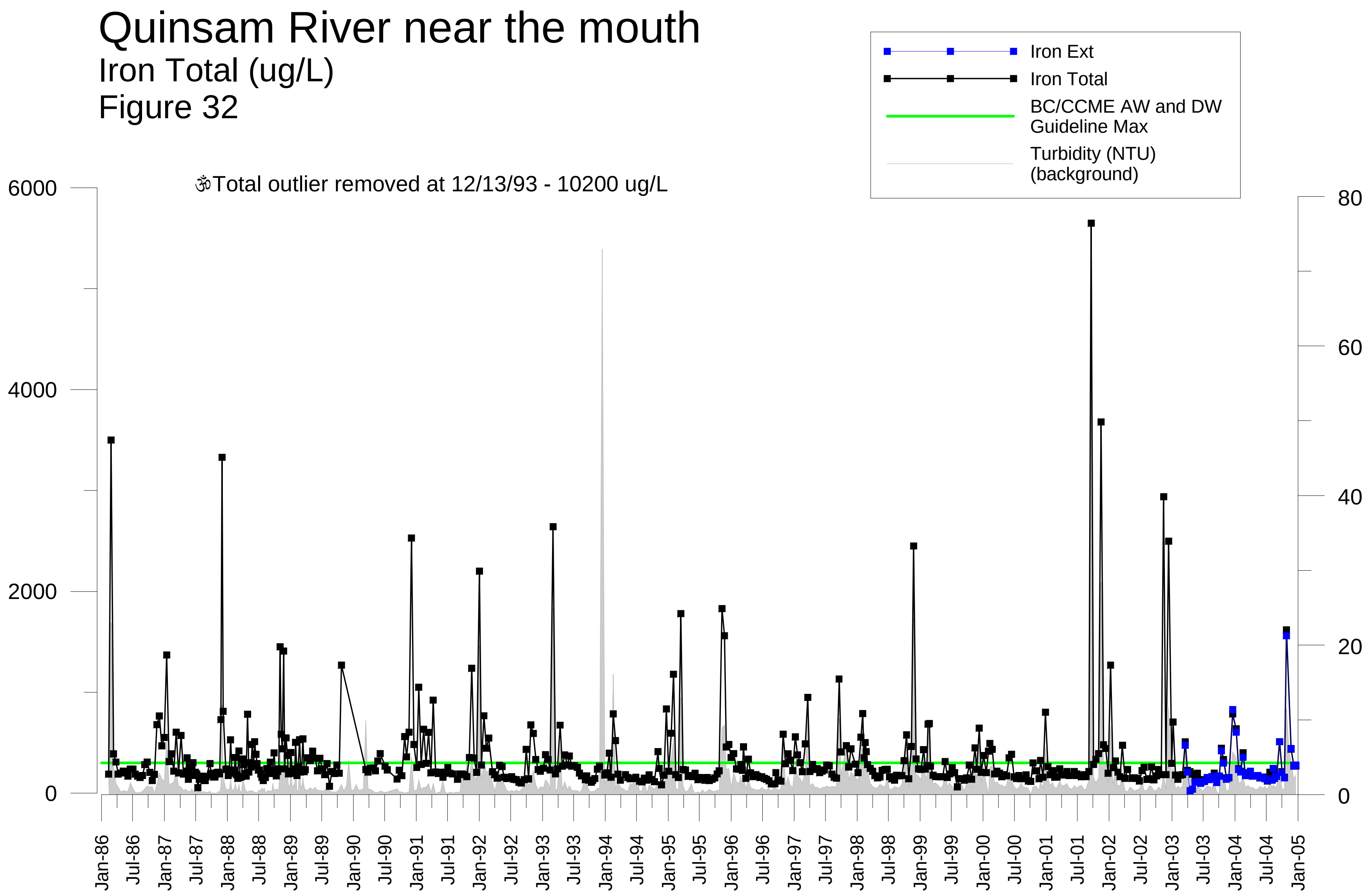

Quinsam River near the mouth
Chromium Total and Extractable(ug/L)
Figure 28
ॐBC Max/CCME Cr DW Guideline - 50 ug/L
ॐOutlier removed at 2/3/93 - 53.7 ug/L
Chromium Total
Chromium Extractable
BC/CCME Cr6 AW Max Guideline
BC Max Cr3 AW Guideline
CCME Cr3 AW Guideline
Turbidity (NTU) (background)
0
2
4
6
8
10
0
20
40
60
80
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05


Quinsam River near the mouth
Chromium Total and Extractable(ug/L)
Figure 29
Chromium Total
Chromium Extractable
Turbidity (NTU) (background)
BC/CCME Cr6 AW Max Guideline
BC Max Cr3 AW Guideline
CCME Cr3 AW Guideline
ॐBC Max/CCME Cr DW Guideline - 50 ug/L
0
2
4
6
8
0
20
40
60
80
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

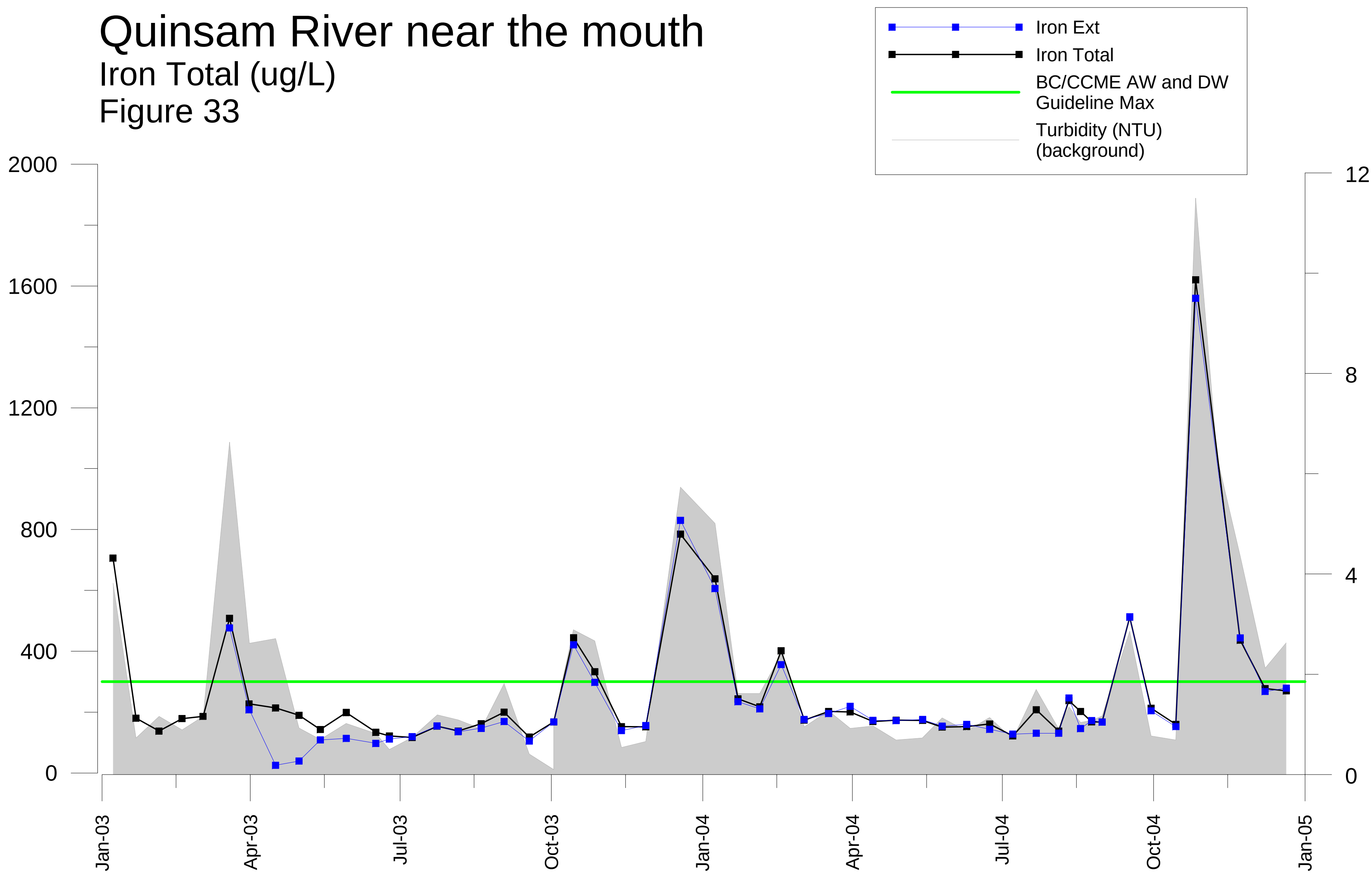

Quinsam near the mouth
Copper Total and Extractable (ug/L)
Figure 30
ॐBC Max DW Cu Guideline - 500 ug/L
ॐCCME AW Cu Guideline range 2 - 39.1ug/L
Copper Total
Copper Extractable
BC Max guideline AW
BC 30-day AW guideline
Turbidity (NTU) (background)
ॐTotal outliers removed at 5/24/88 - 296 ug/L
5/17/88 - 47.5 ug/L
9/6/88 - 79.1 ug/L
9/27/88 - 45.1 ug/L
9/27/89 - 131 ug/L
40
30
20
10
0
80
60
40
20
0
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04

Quinsam near the mouth
Copper Total and Extractable (ug/L)
Figure 31

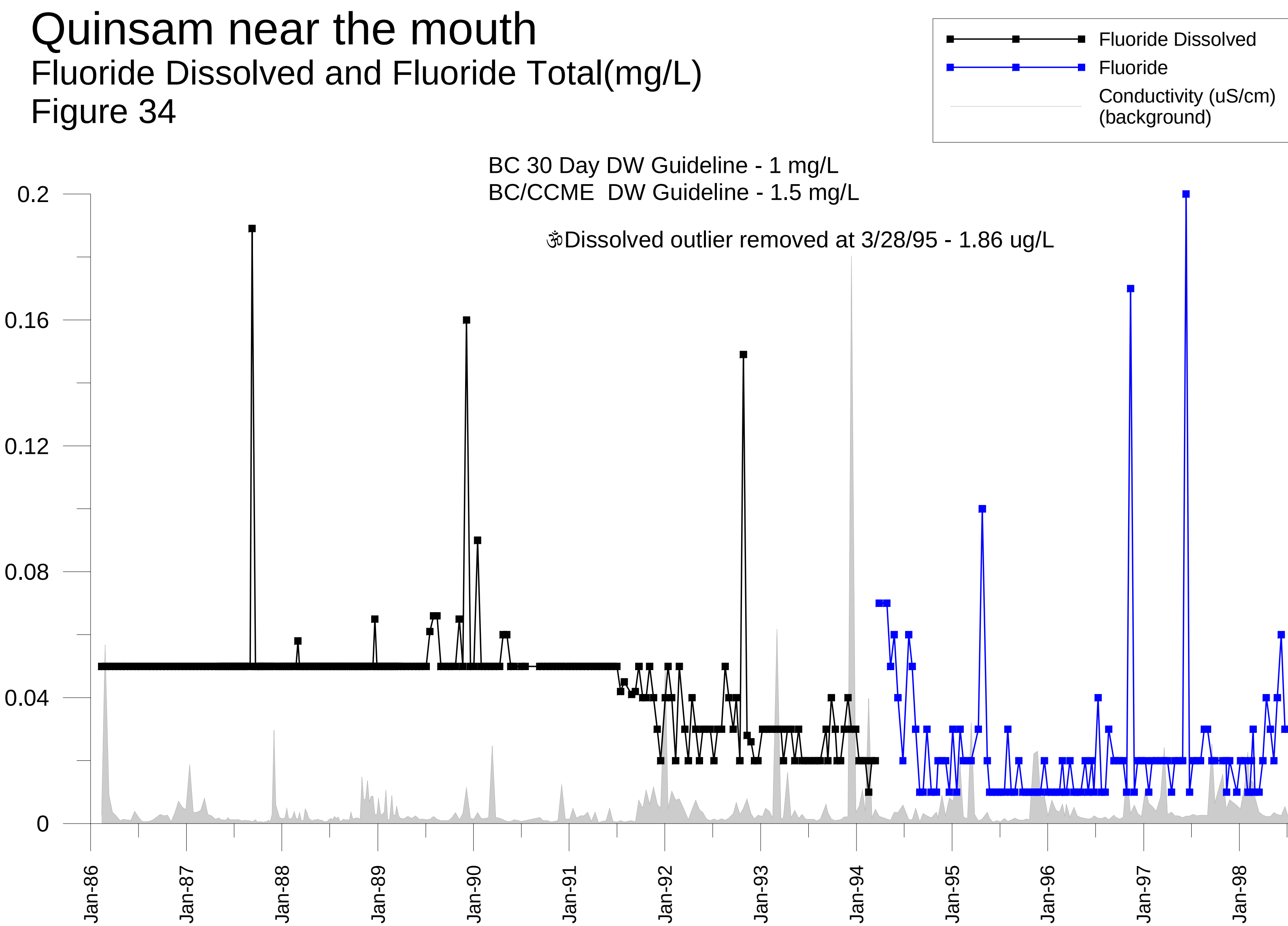


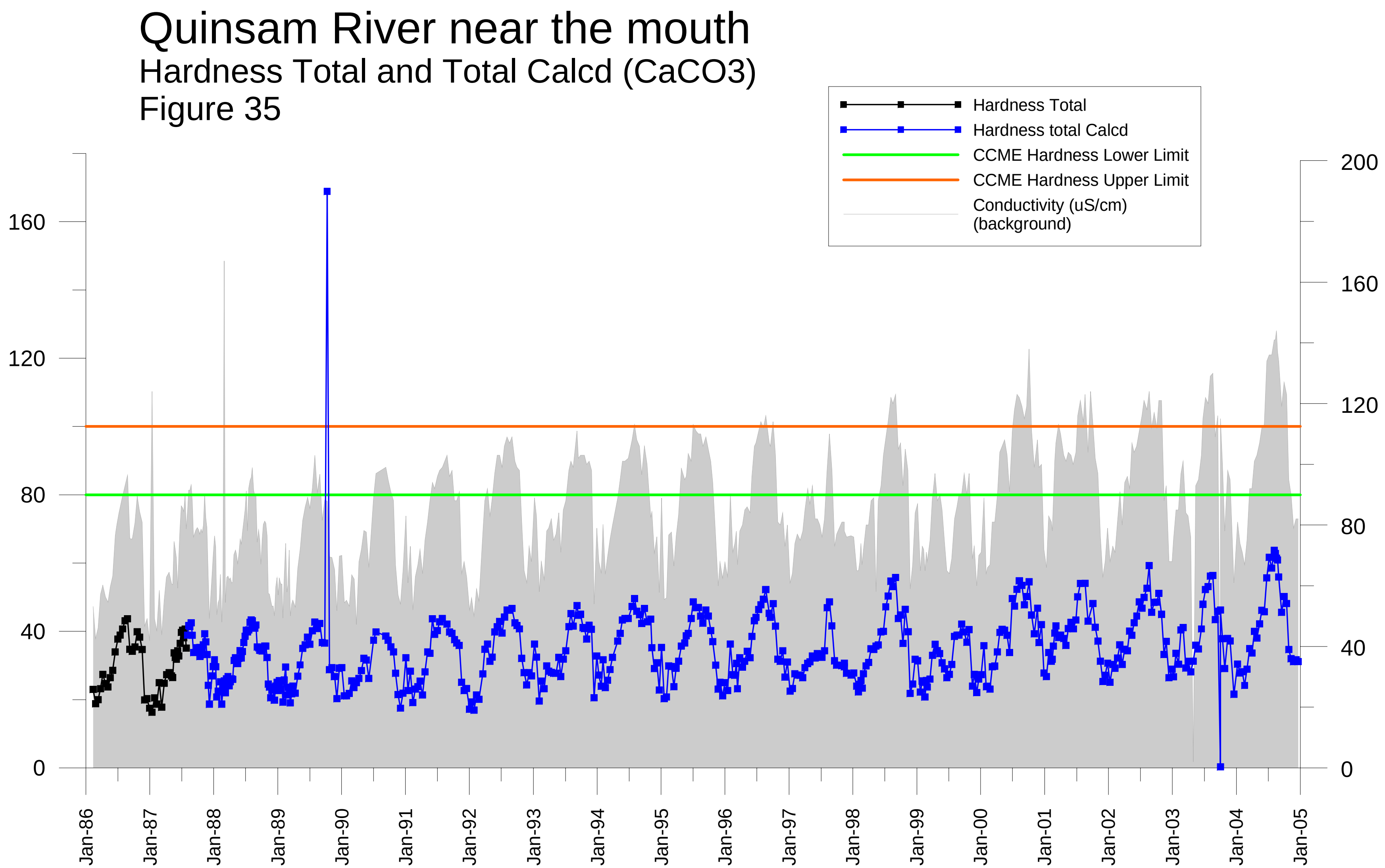


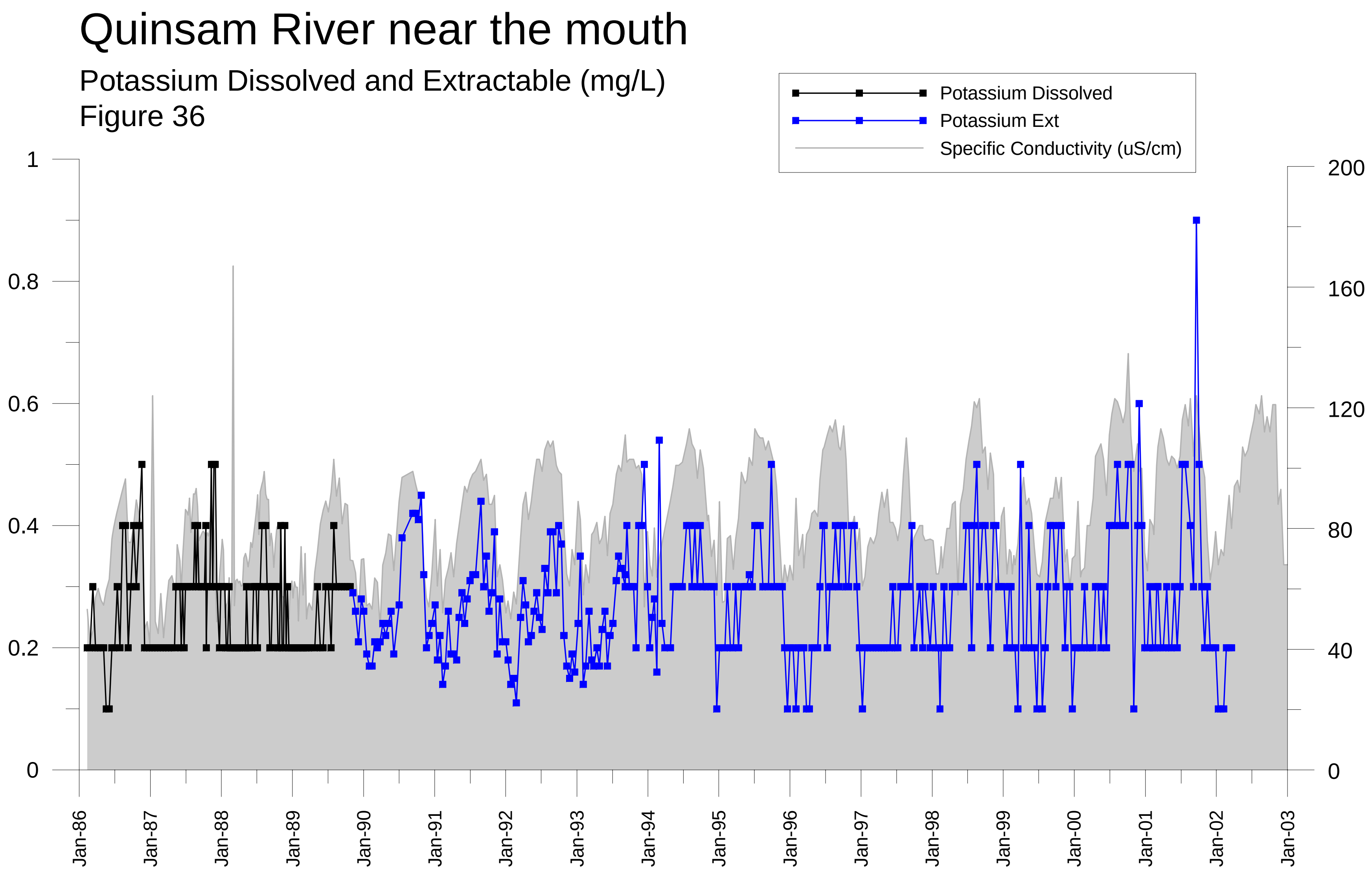
Quinsam River near the mouth
Iron Total (ug/L)
Figure 32
Iron Ext
Iron Total
BC/CCME AW and DW Guideline Max
Turbidity (NTU) (background)
ॐTotal outlier removed at 12/13/93 - 10200 ug/L
6000
4000
2000
0
80
60
40
20
0
Jan-86
Jul-86
Jan-87
Jul-87
Jan-88
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05



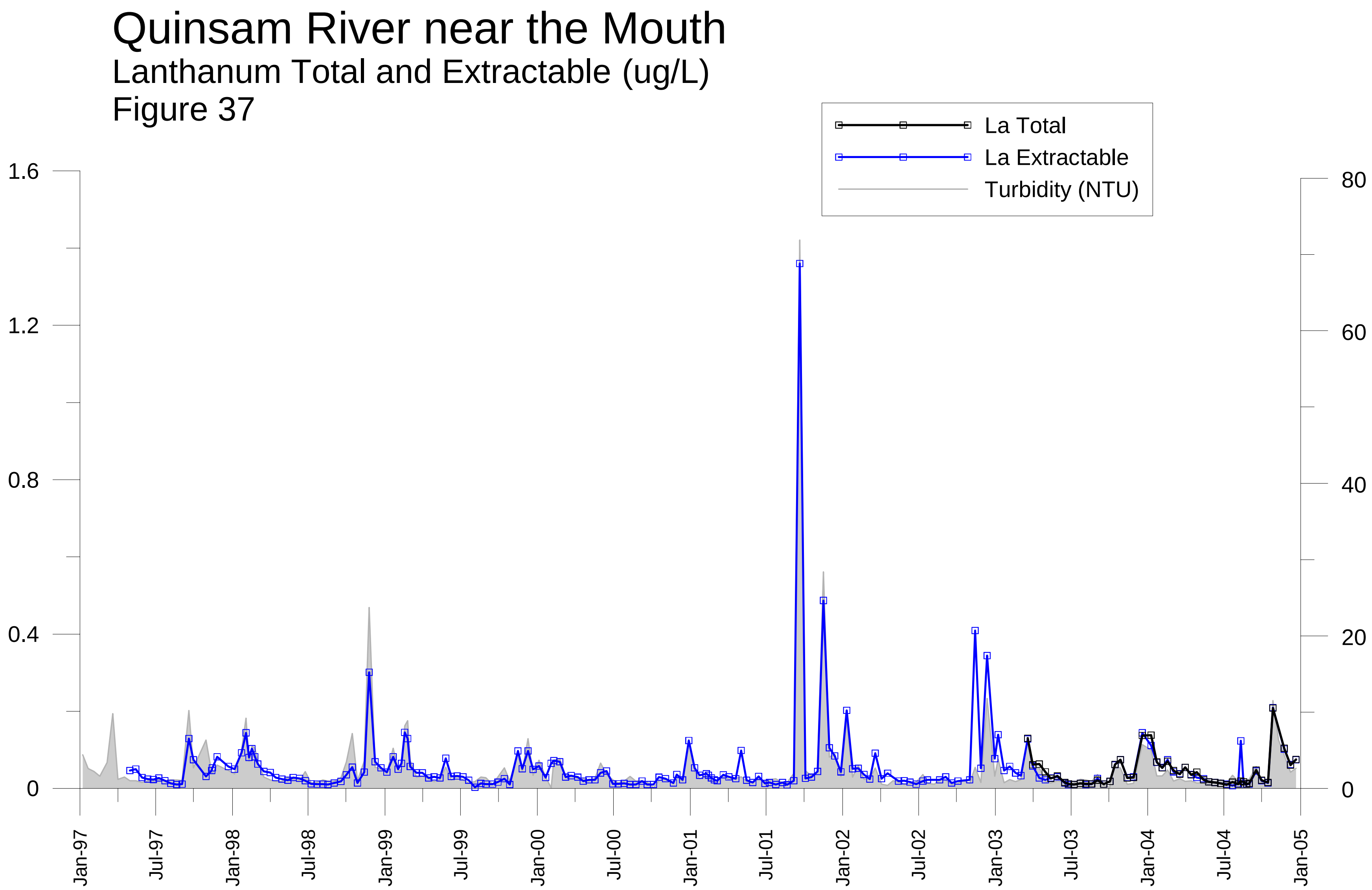
Quinsam River near the mouth
Iron Total (ug/L)
Figure 33
Iron Ext
Iron Total
BC/CCME AW and DW Guideline Max
Turbidity (NTU) (background)
2000
1600
1200
800
400
0
12
8
4
0
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05


Quinsam near the mouth
Fluoride Dissolved and Fluoride Total(mg/L)
Figure 34
Fluoride Dissolved
Fluoride
Conductivity (uS/cm) (background)
BC 30 Day DW Guideline - 1 mg/L
BC/CCME DW Guideline - 1.5 mg/L
Dissolved outlier removed at 3/28/95 - 1.86 ug/L
0.2
0.16
0.12
0.08
0.04
0
80
60
40
20
0
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99

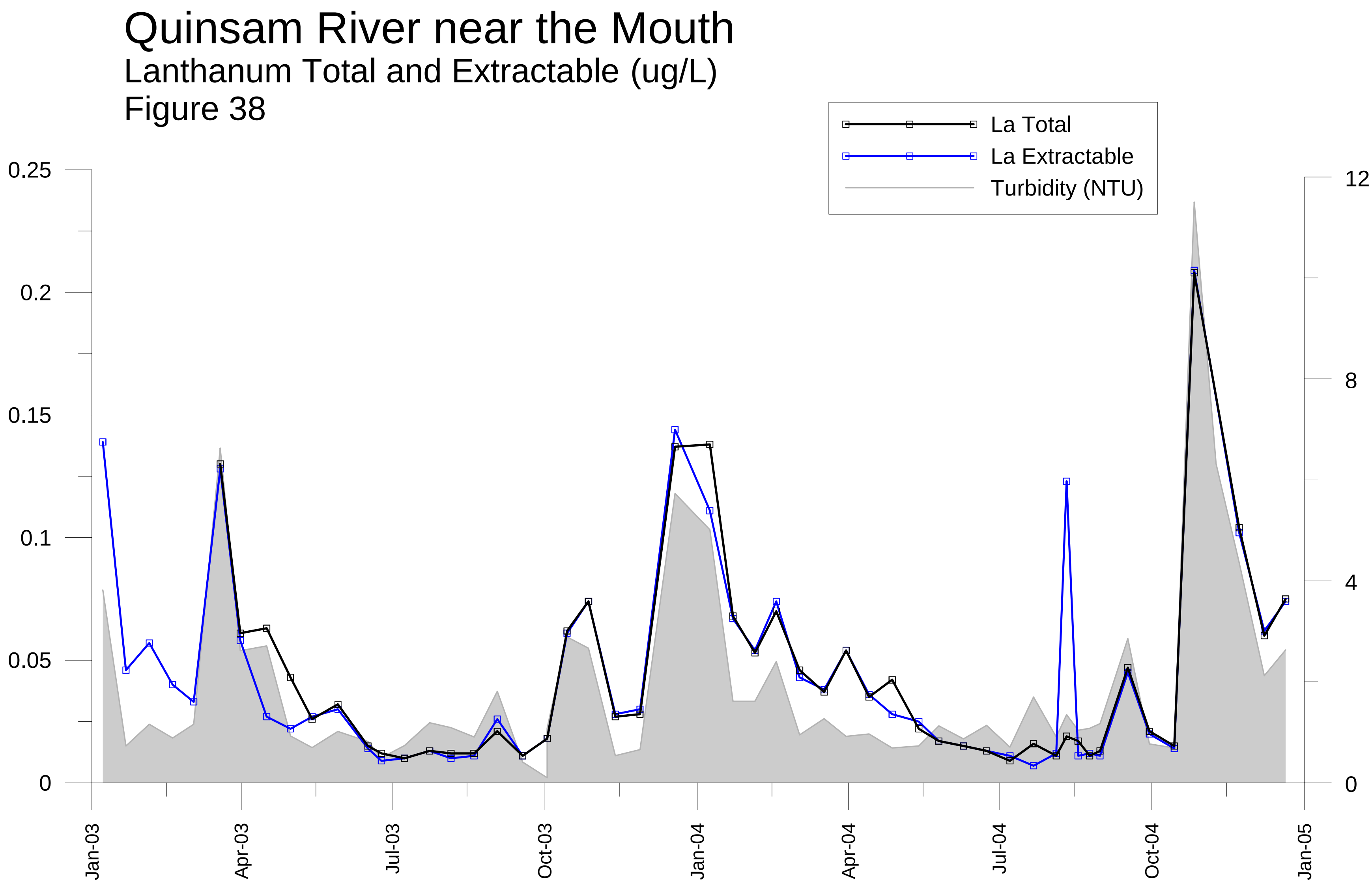

Quinsam River near the mouth
Hardness Total and Total Calcd (CaCO3)
Figure 35
Hardness Total
Hardness total Calcd
CCME Hardness Lower Limit
CCME Hardness Upper Limit
Conductivity (uS/cm) (background)
0
40
80
120
160
200
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

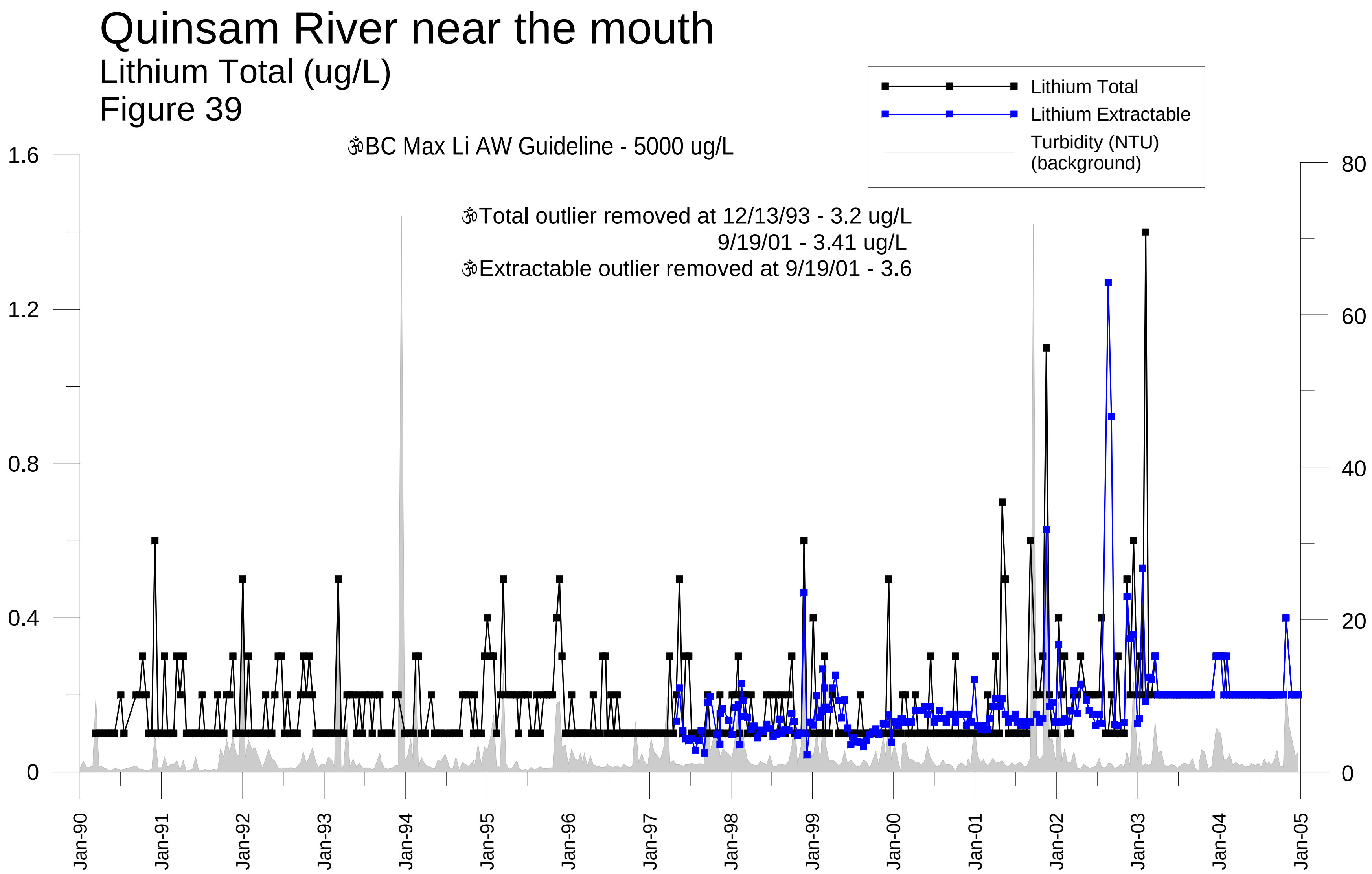


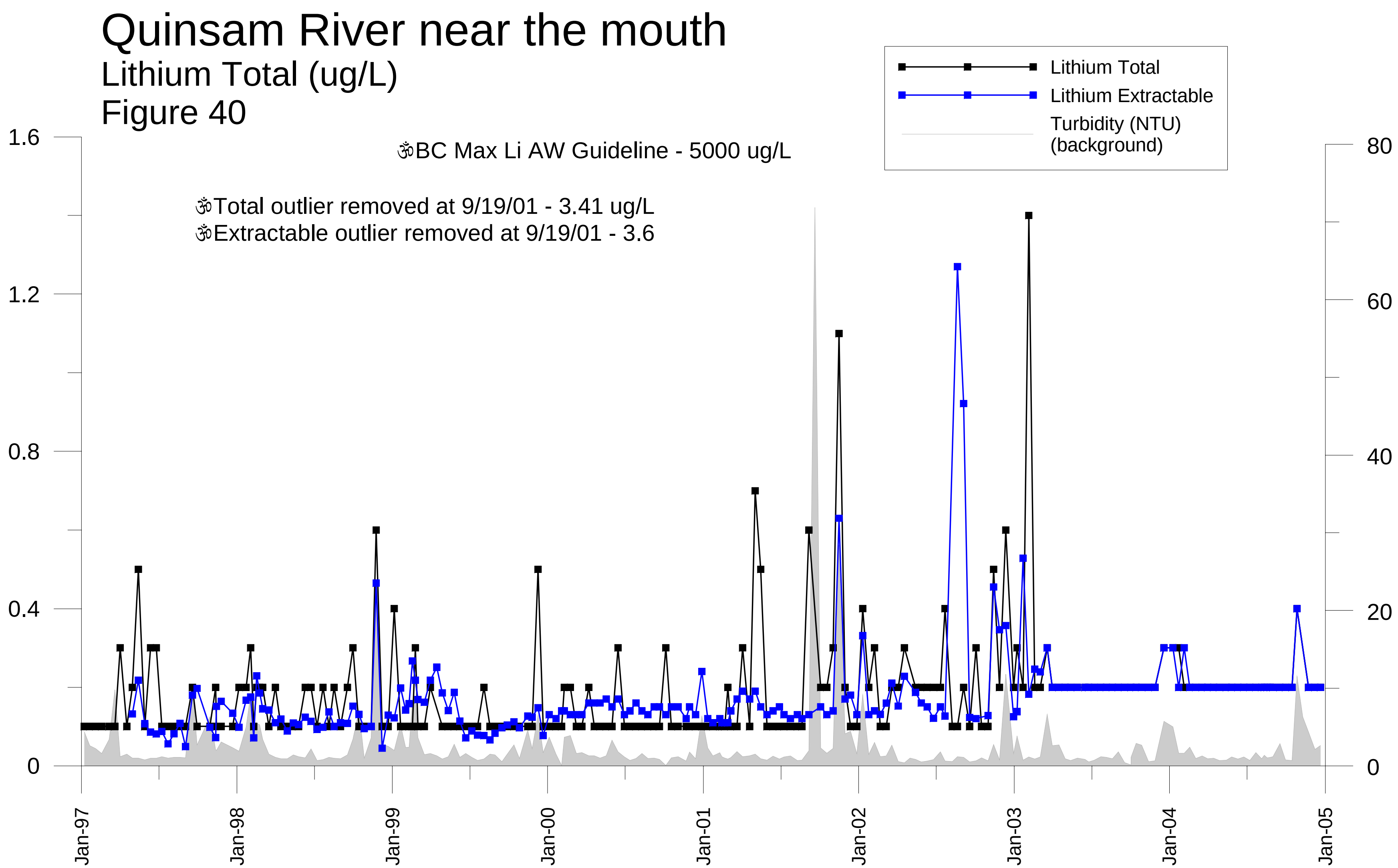
Quinsam River near the mouth
Potassium Dissolved and Extractable (mg/L)
Figure 36
Potassium Dissolved
Potassium Ext
Specific Conductivity (uS/cm)
1
0.8
0.6
0.4
0.2
0
200
160
120
80
40
0
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03



Quinsam River near the Mouth
Lanthanum Total and Extractable (ug/L)
Figure 37
La Total
La Extractable
Turbidity (NTU)
1.6
1.2
0.8
0.4
0
80
60
40
20
0
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05


Quinsam River near the Mouth
Lanthanum Total and Extractable (ug/L)
Figure 38
La Total
La Extractable
Turbidity (NTU)
0.25
0.2
0.15
0.1
0.05
0
12
8
4
0
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05

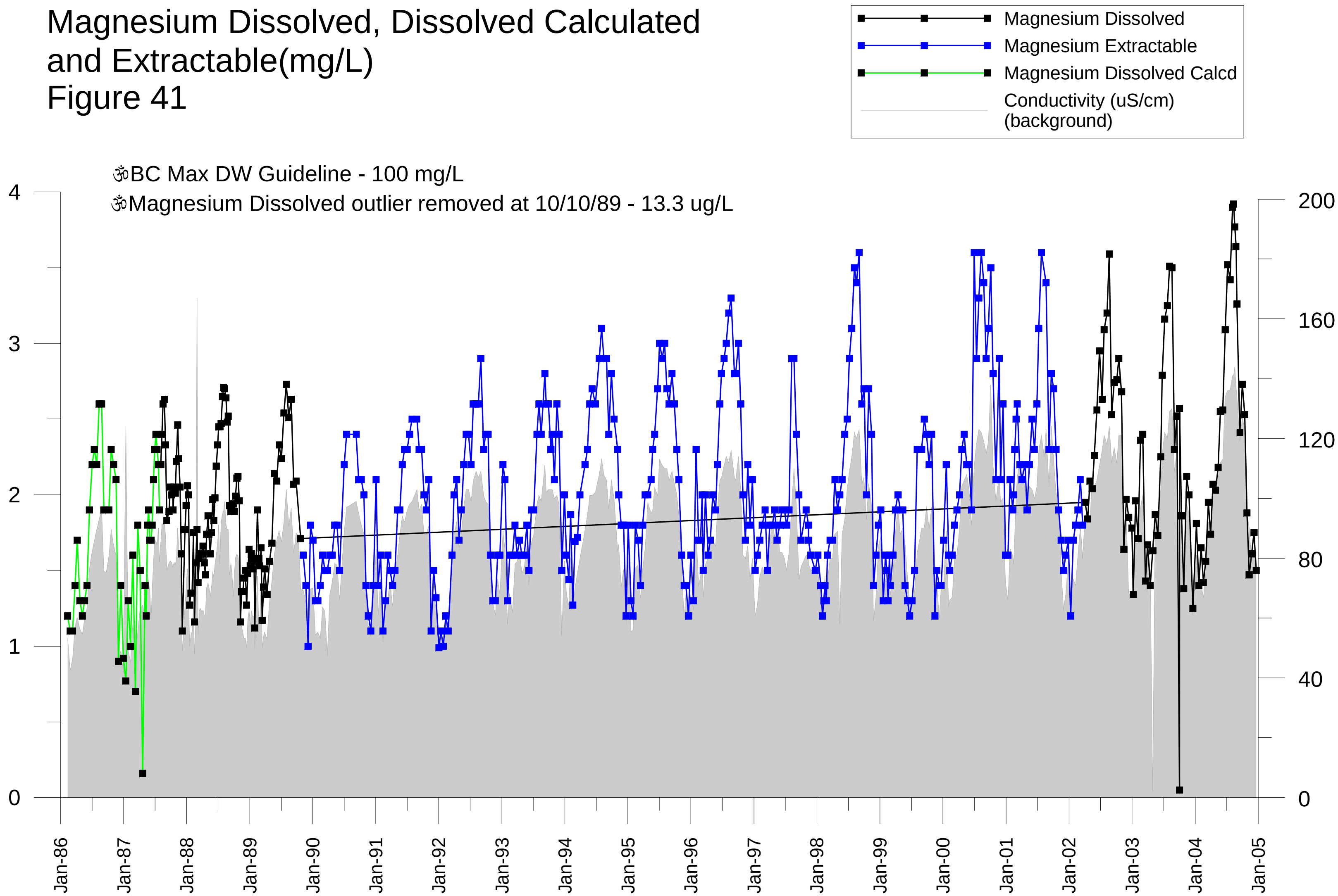

Quinsam River near the mouth
Lithium Total (ug/L)
Figure 39
BC Max Li AW Guideline - 5000 ug/L
Total outlier removed at 12/13/93 - 3.2 ug/L
9/19/01 - 3.41 ug/L
Extractable outlier removed at 9/19/01 - 3.6
Lithium Total
Lithium Extractable
Turbidity (NTU)
(background)
1.6
1.2
0.8
0.4
0
80
60
40
20
0
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

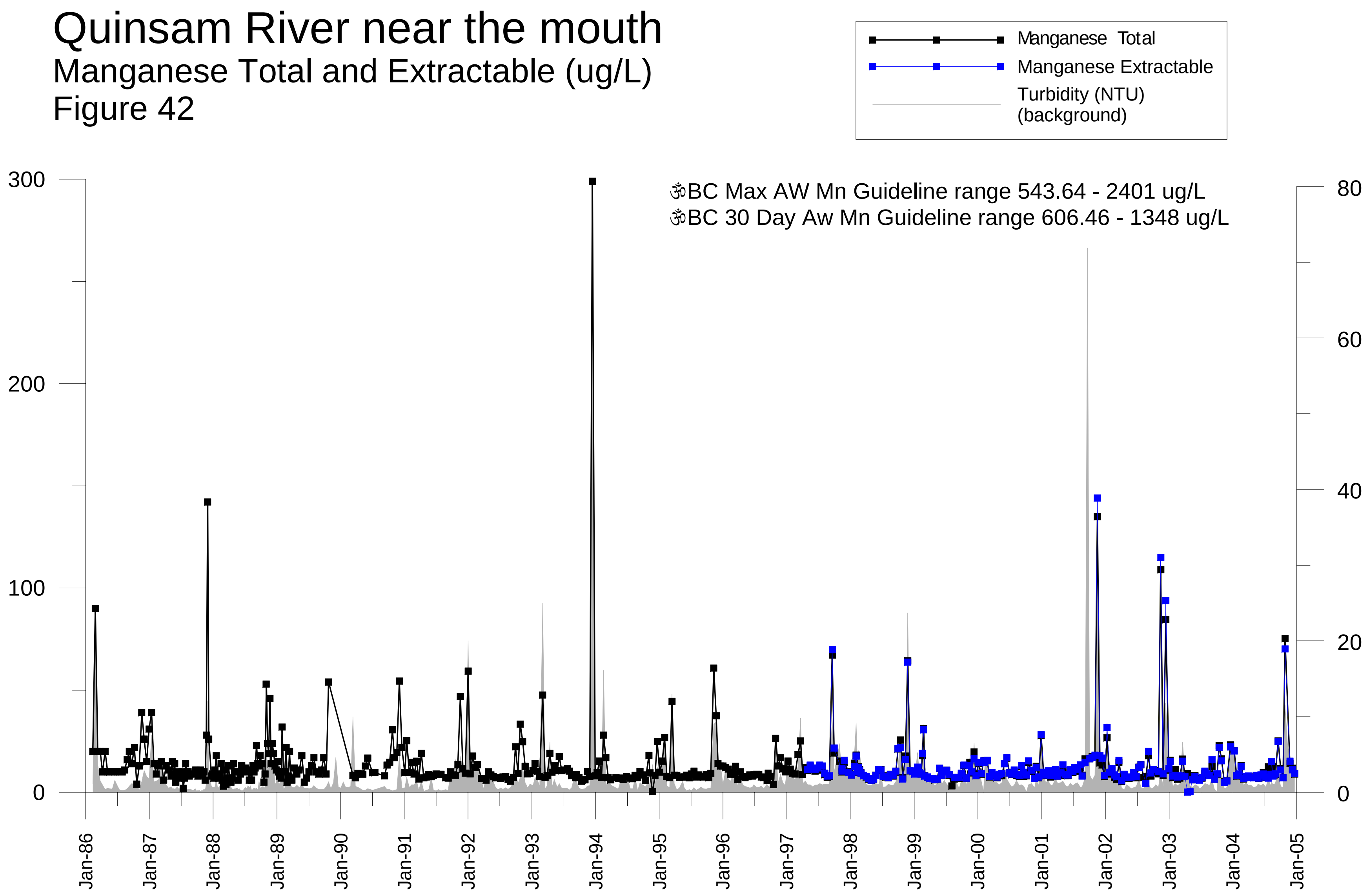

Quinsam River near the mouth
Lithium Total (ug/L)
Figure 40
ॐBC Max Li AW Guideline - 5000 ug/L
ॐTotal outlier removed at 9/19/01 - 3.41 ug/L
ॐExtractable outlier removed at 9/19/01 - 3.6
Lithium Total
Lithium Extractable
Turbidity (NTU) (background)
1.6
1.2
0.8
0.4
0
80
60
40
20
0
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

Quinsam River near the mouth

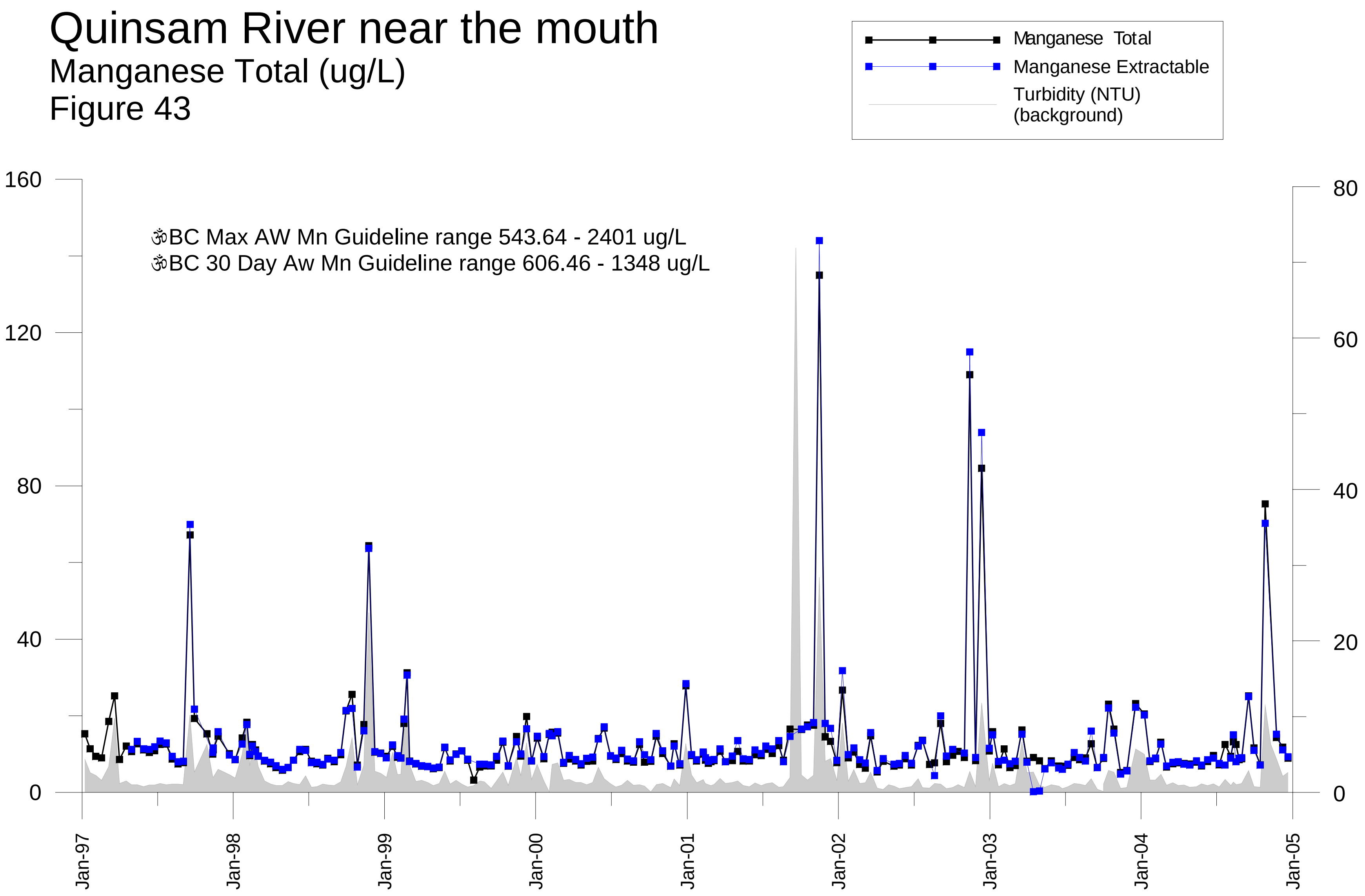
Magnesium Dissolved, Dissolved Calculated and Extractable(mg/L)

Figure 41





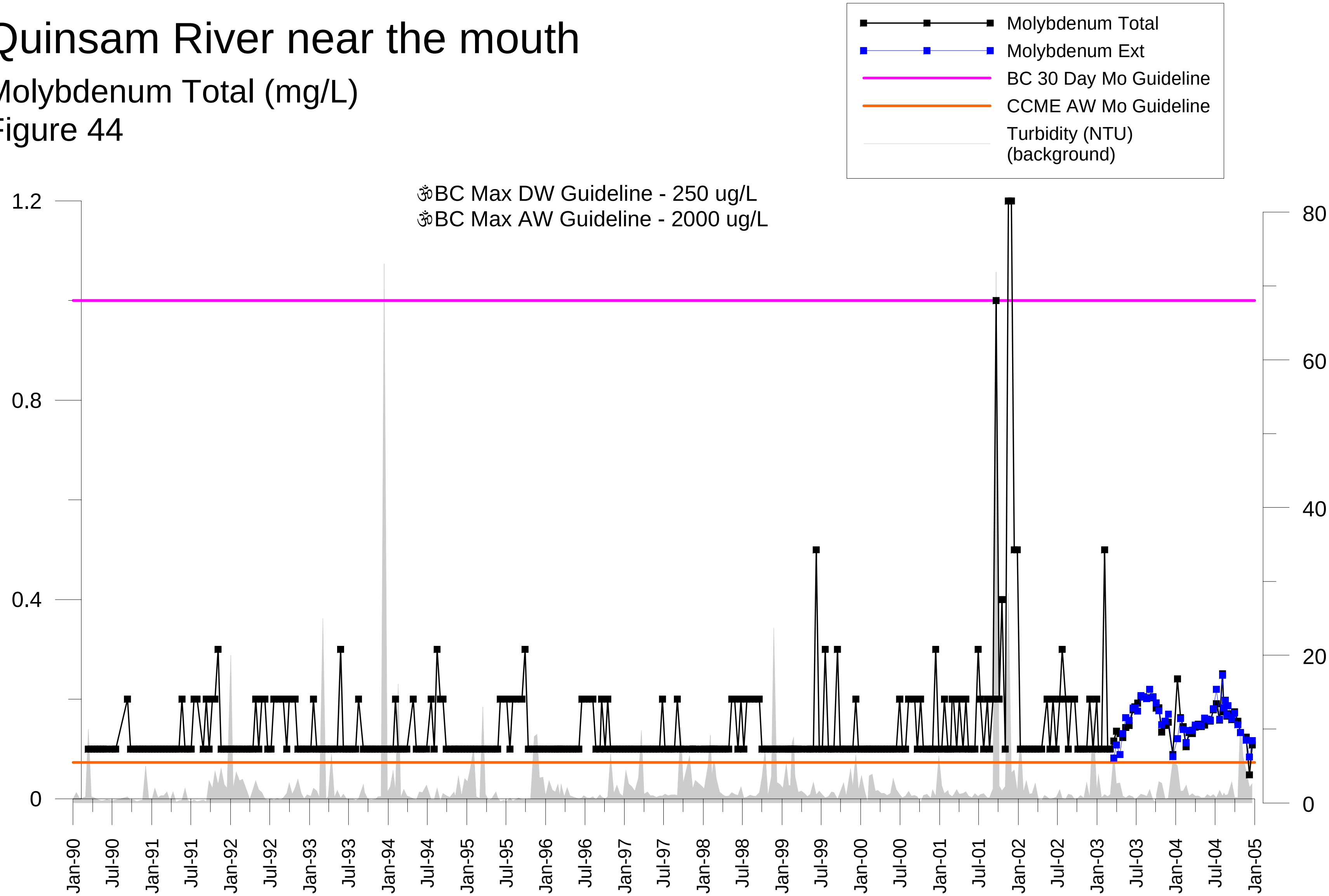
Quinsam River near the mouth
Manganese Total and Extractable (ug/L)
Figure 42
Manganese Total
Manganese Extractable
Turbidity (NTU) (background)
ॐBC Max AW Mn Guideline range 543.64 - 2401 ug/L
ॐBC 30 Day Aw Mn Guideline range 606.46 - 1348 ug/L
300
200
100
0
80
60
40
20
0
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

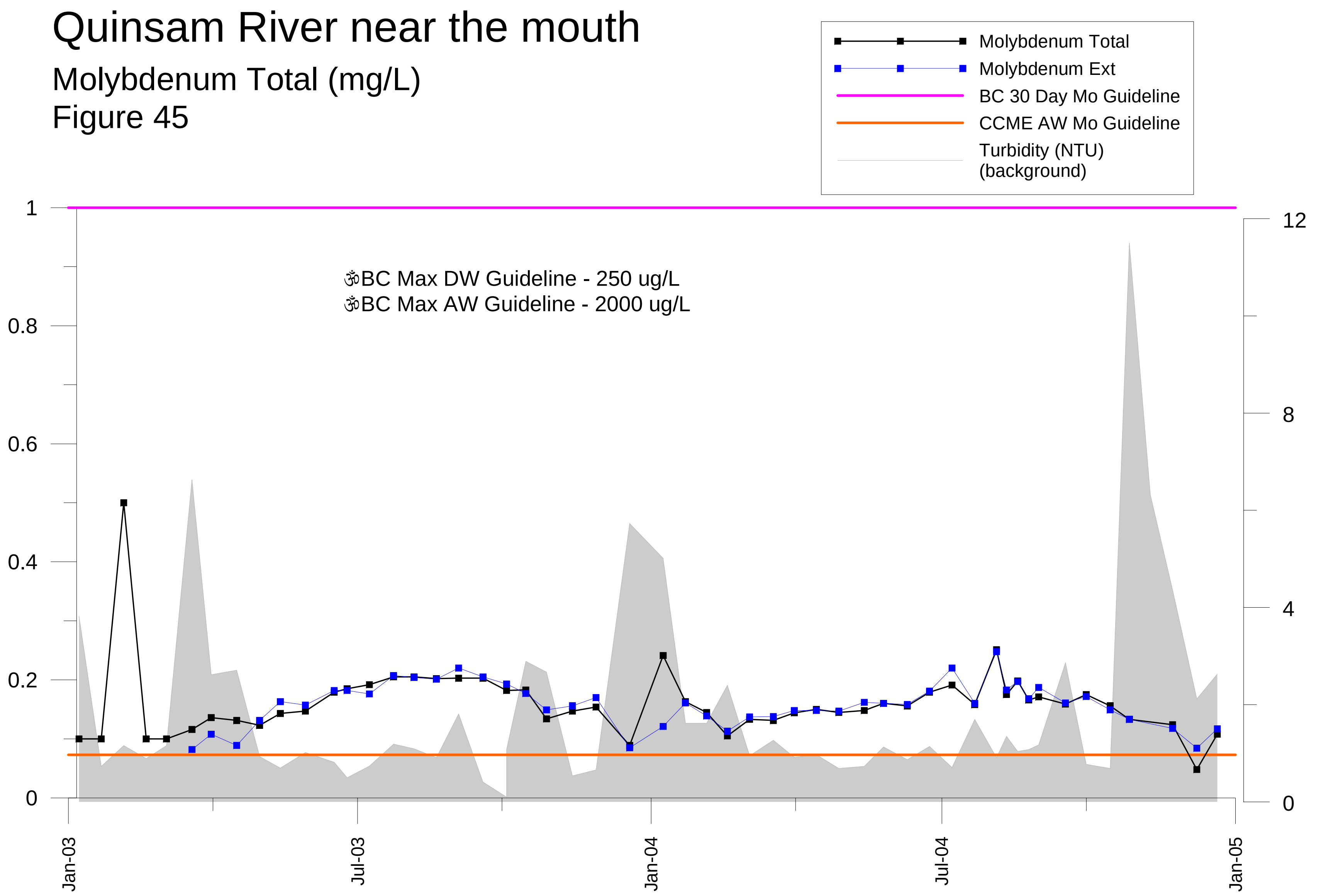

Quinsam River near the mouth
Manganese Total (ug/L)
Figure 43
Manganese Total
Manganese Extractable
Turbidity (NTU)
(background)
ॐBC Max AW Mn Guideline range 543.64 - 2401 ug/L
ॐBC 30 Day Aw Mn Guideline range 606.46 - 1348 ug/L
160
120
80
40
0
80
60
40
20
0
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

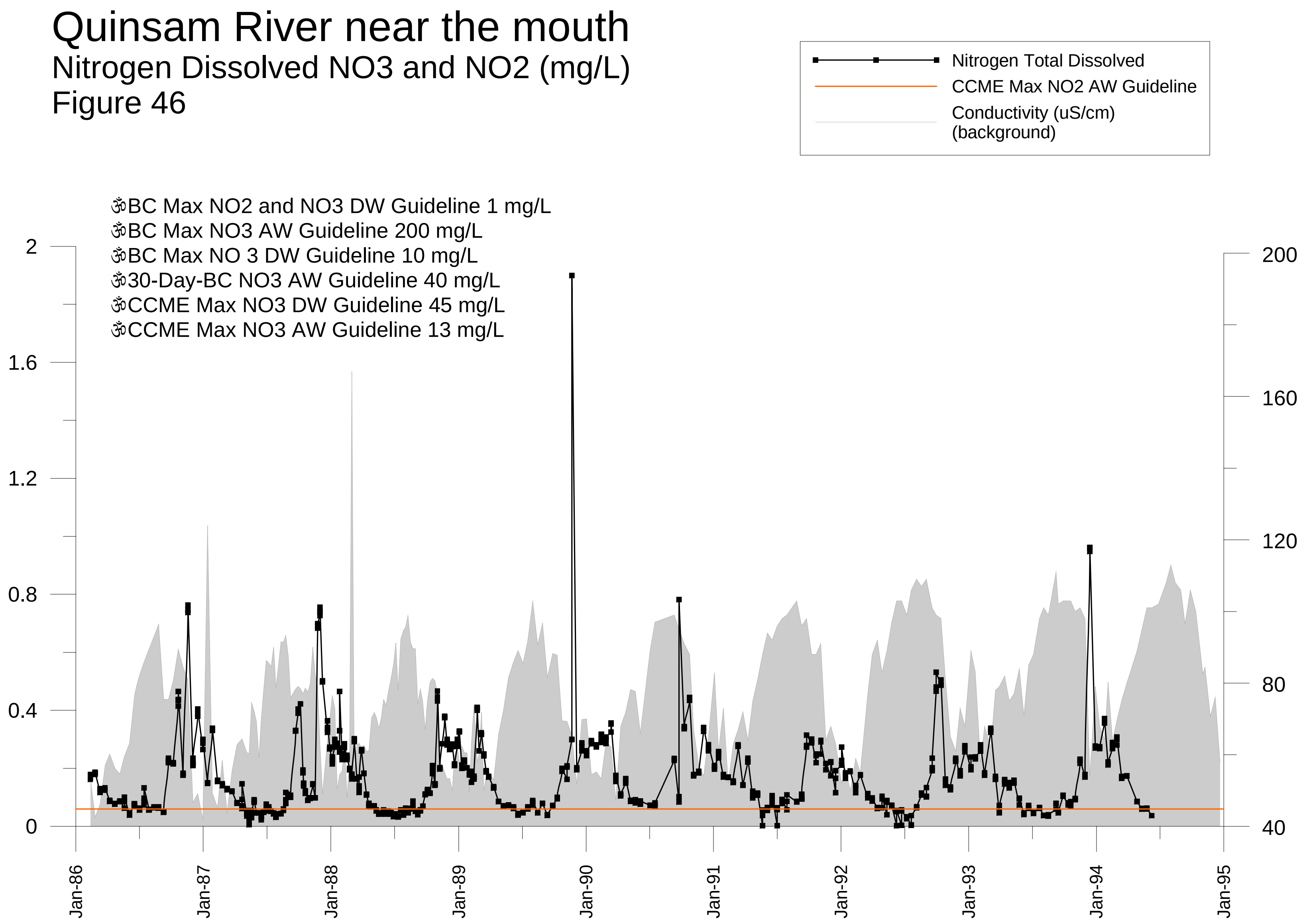
Quinsam River near the mouth

Molybdenum Total (mg/L)

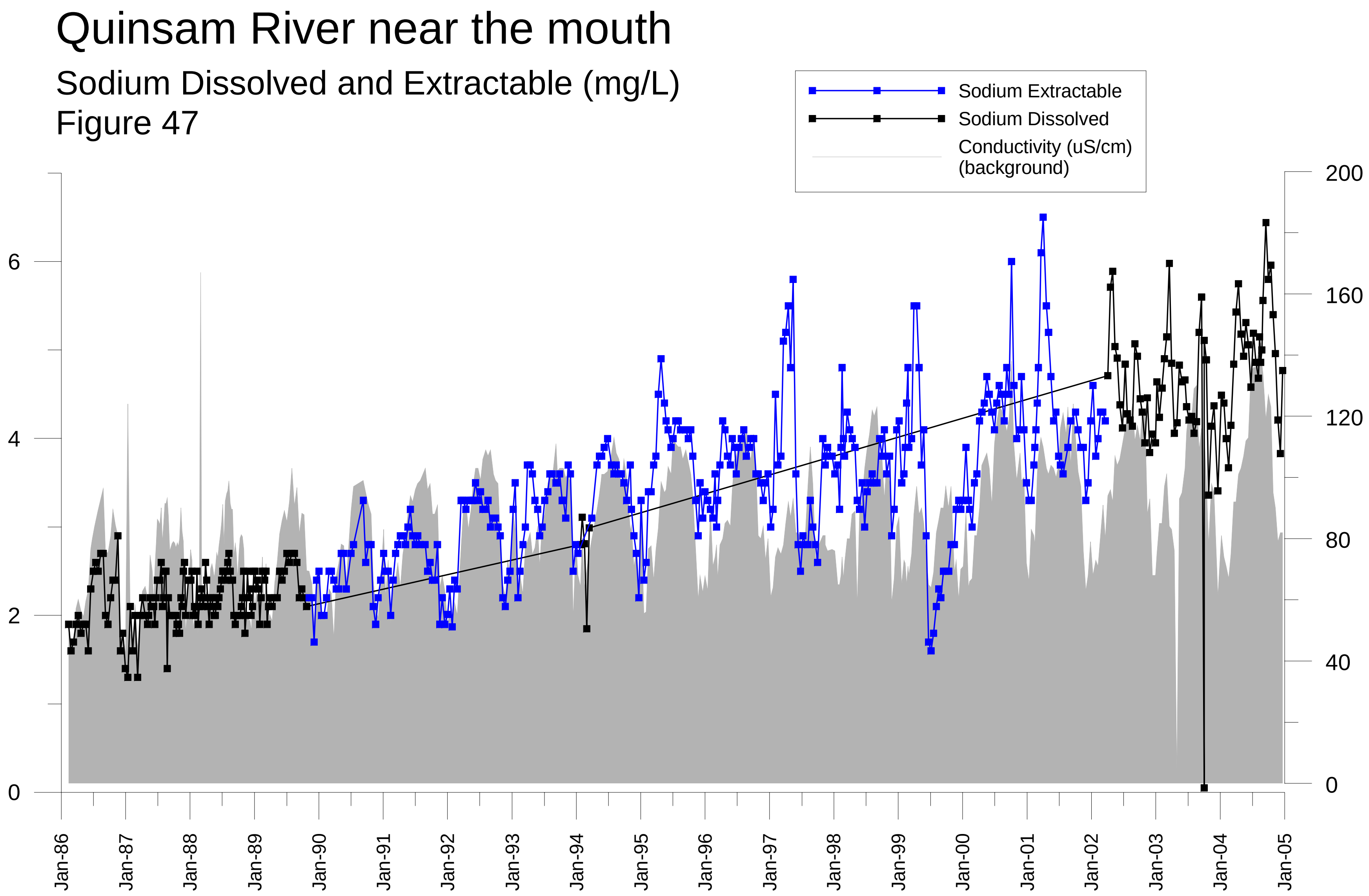
Figure 44




Quinsam River near the mouth
Molybdenum Total (mg/L)
Figure 45
Molybdenum Total
Molybdenum Ext
BC 30 Day Mo Guideline
CCME AW Mo Guideline
Turbidity (NTU) (background)
ॐBC Max DW Guideline - 250 ug/L
ॐBC Max AW Guideline - 2000 ug/L
1
0.8
0.6
0.4
0.2
0
12
8
4
0
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05

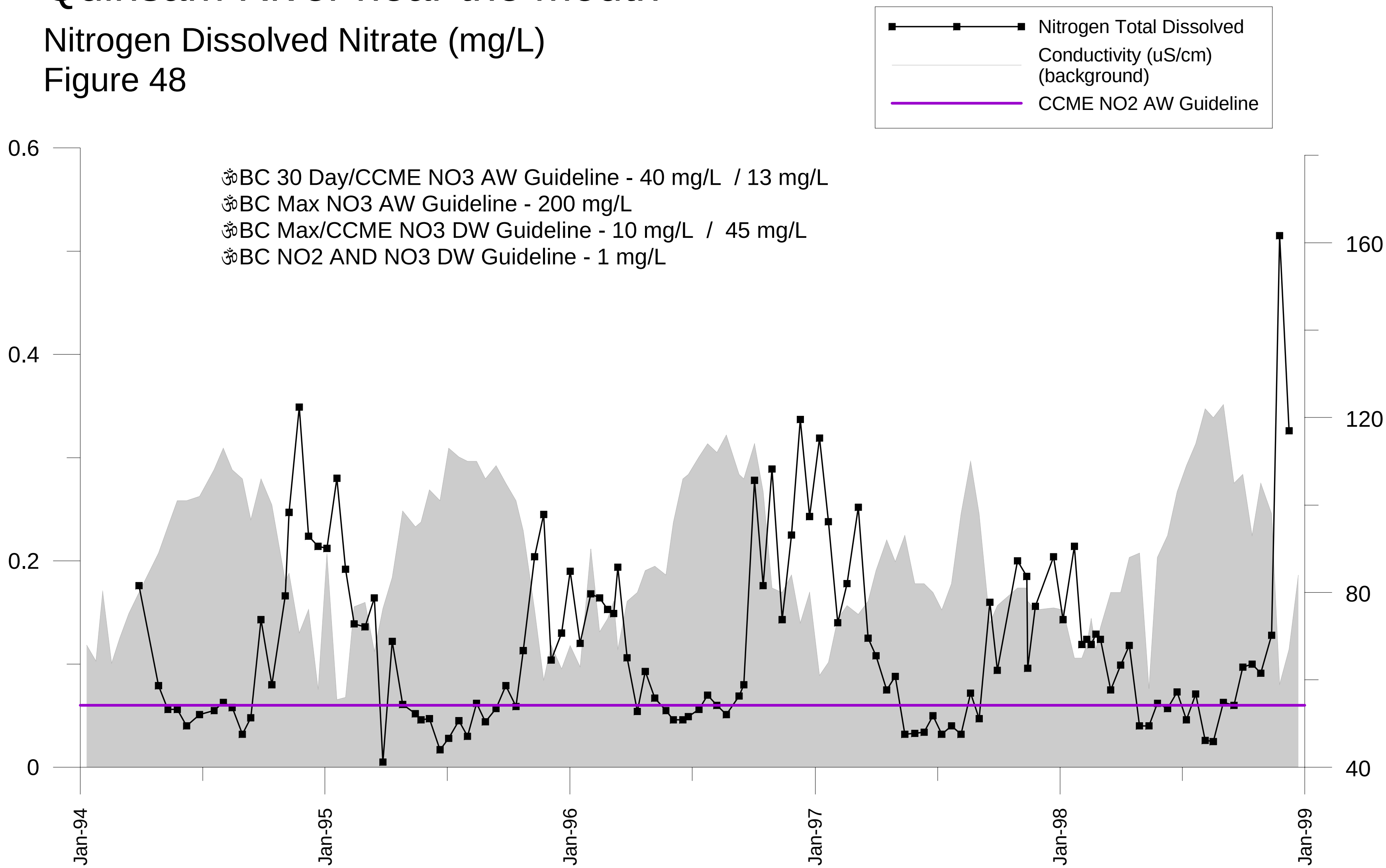


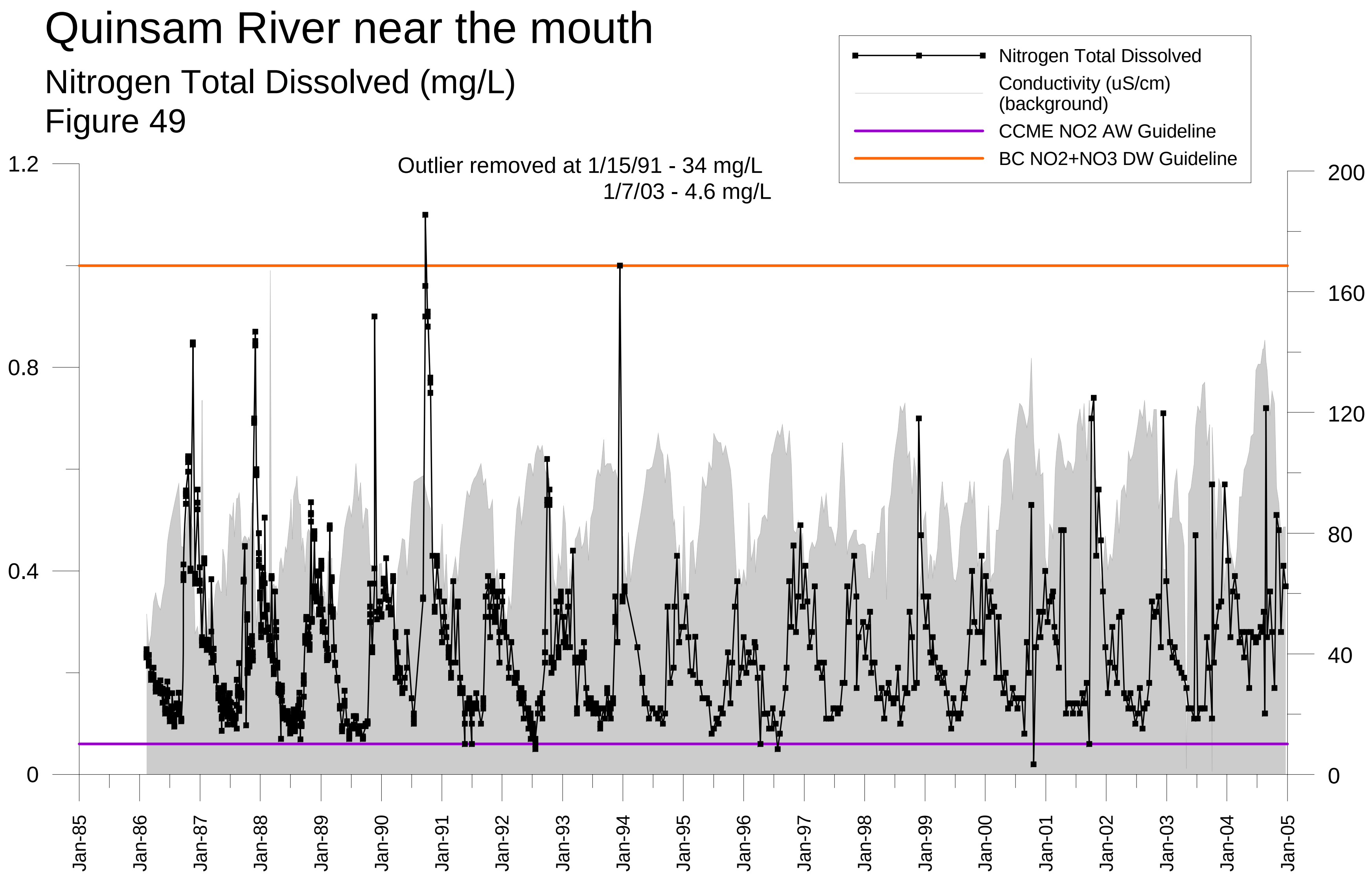
Quinsam River near the mouth
Nitrogen Dissolved NO3 and NO2 (mg/L)
Figure 46
Nitrogen Total Dissolved
CCME Max NO2 AW Guideline
Conductivity (uS/cm) (background)
ॐBC Max NO2 and NO3 DW Guideline 1 mg/L
ॐBC Max NO3 AW Guideline 200 mg/L
ॐBC Max NO 3 DW Guideline 10 mg/L
ॐ30-Day-BC NO3 AW Guideline 40 mg/L
ॐCCME Max NO3 DW Guideline 45 mg/L
ॐCCME Max NO3 AW Guideline 13 mg/L
2
1.6
1.2
0.8
0.4
0
200
160
120
80
40
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95

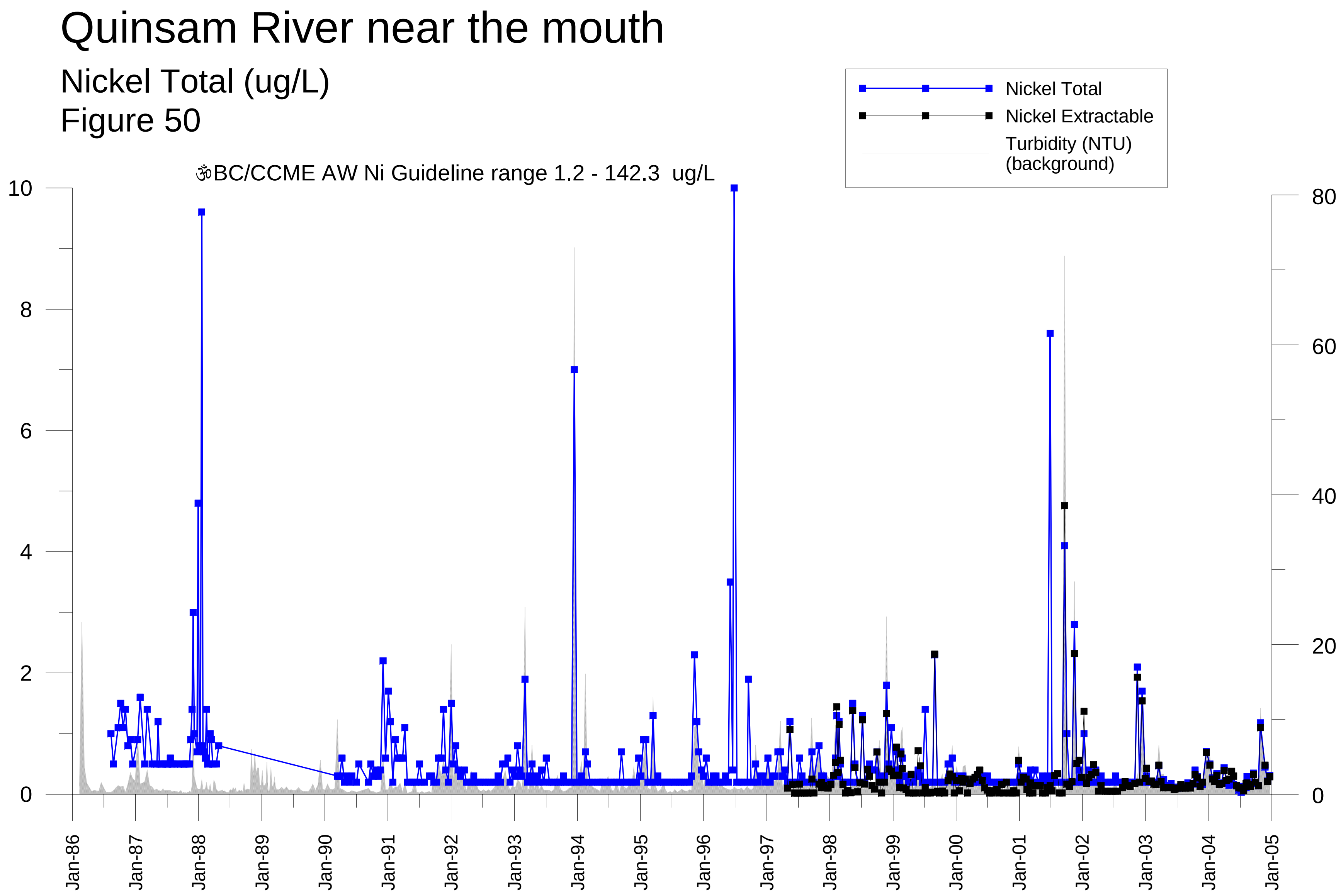

Quinsam River near the mouth
Sodium Dissolved and Extractable (mg/L)
Figure 47
Sodium Extractable
Sodium Dissolved
Conductivity (uS/cm)
(background)
0
2
4
6
0
40
80
120
160
200
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

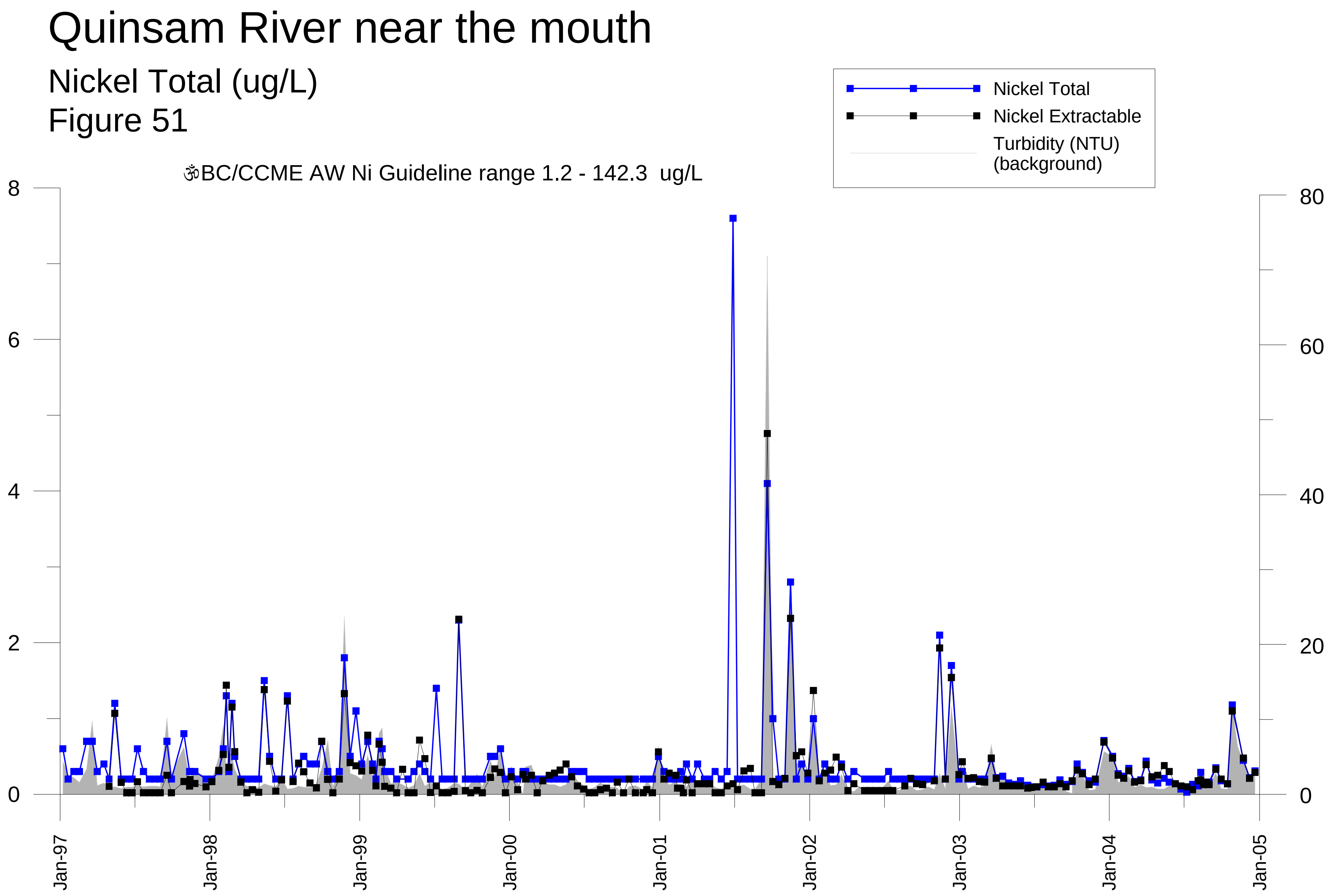
Quinsam River near the mouth

Nitrogen Dissolved Nitrate (mg/L)
Figure 48

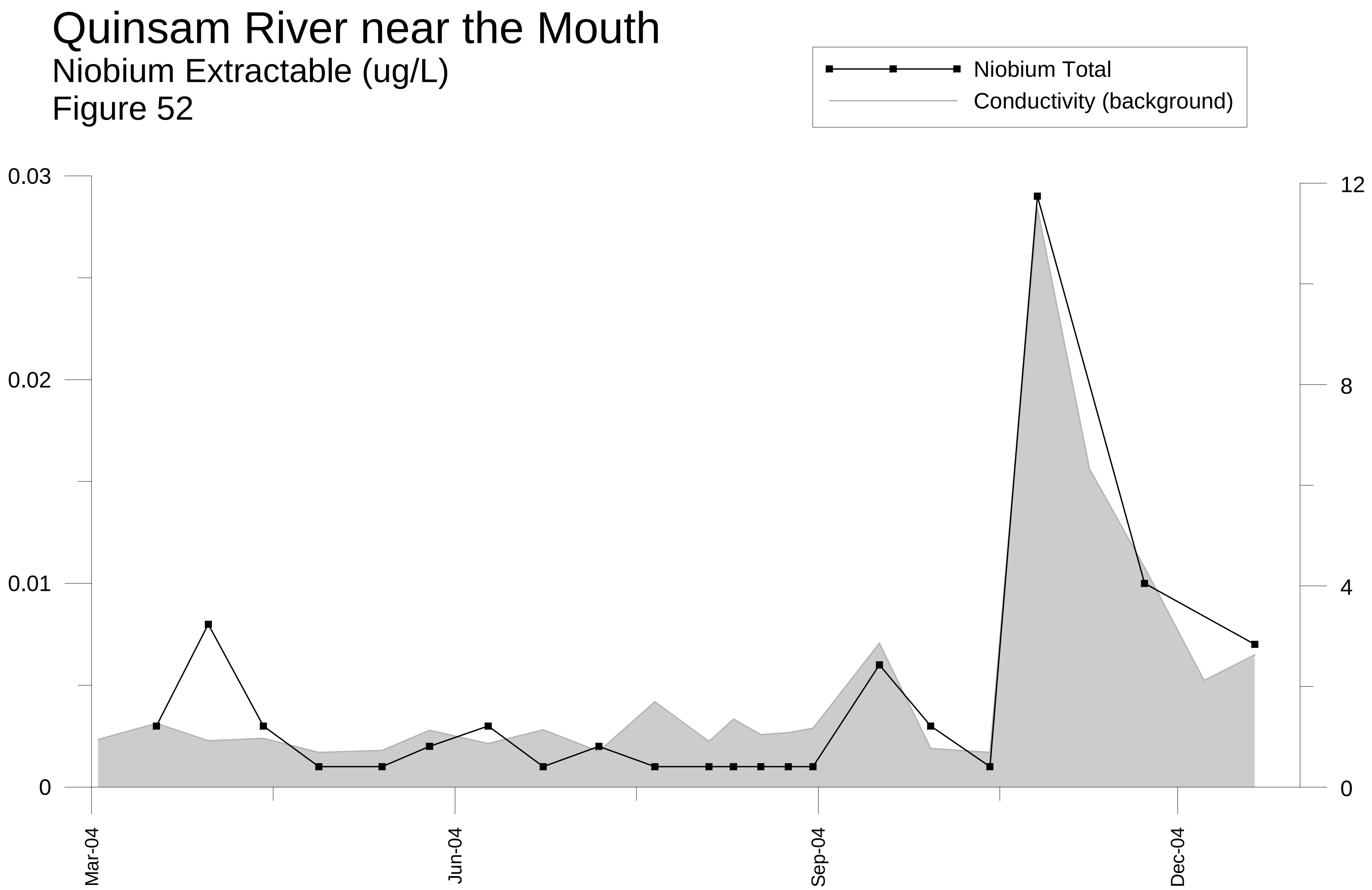


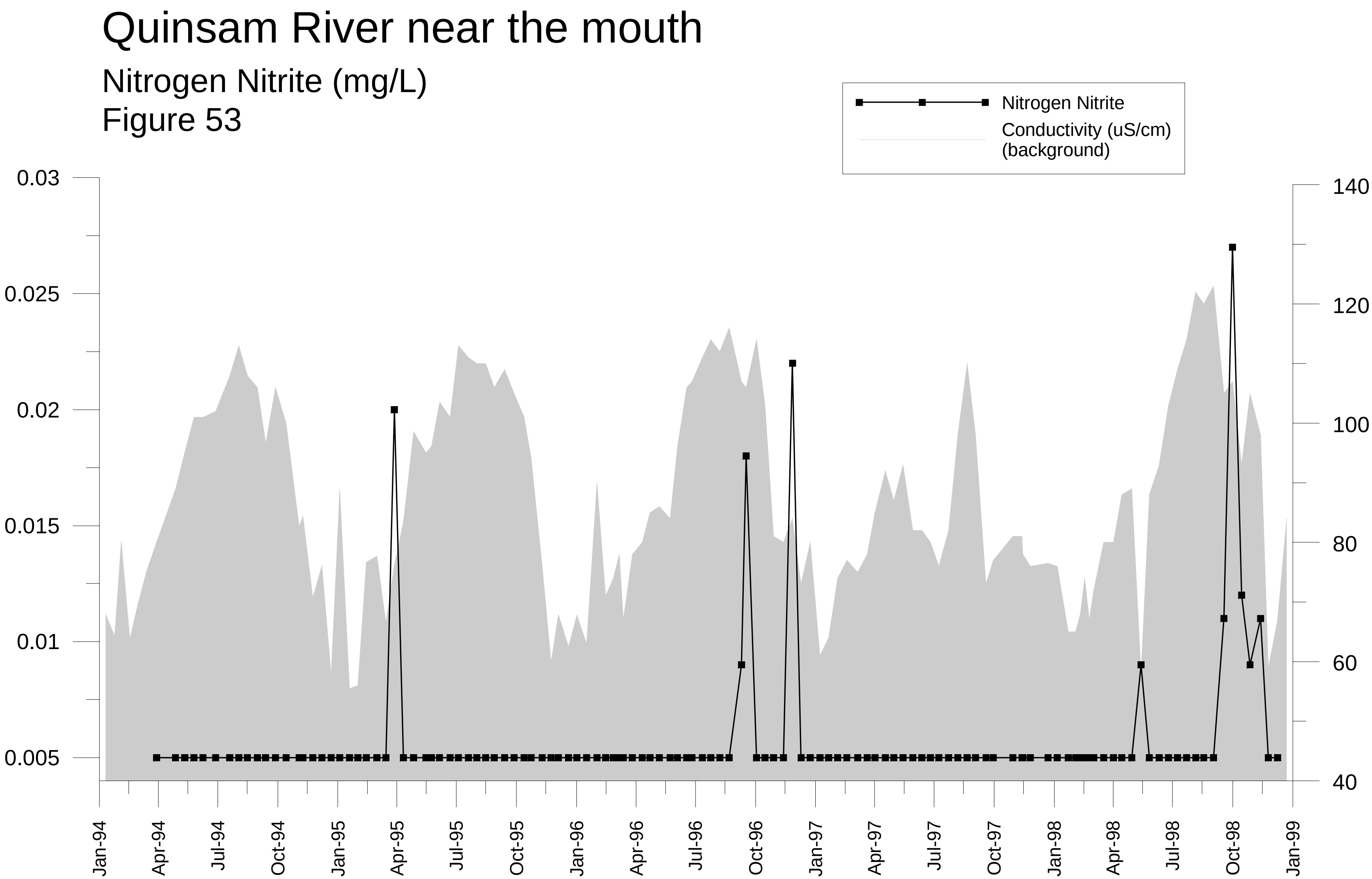

Quinsam River near the mouth
Nitrogen Total Dissolved (mg/L)
Figure 49
Nitrogen Total Dissolved
Conductivity (uS/cm) (background)
CCME NO2 AW Guideline
BC NO2+NO3 DW Guideline
Outlier removed at 1/15/91 - 34 mg/L
1/7/03 - 4.6 mg/L
1.2
0.8
0.4
0
200
160
120
80
40
0
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

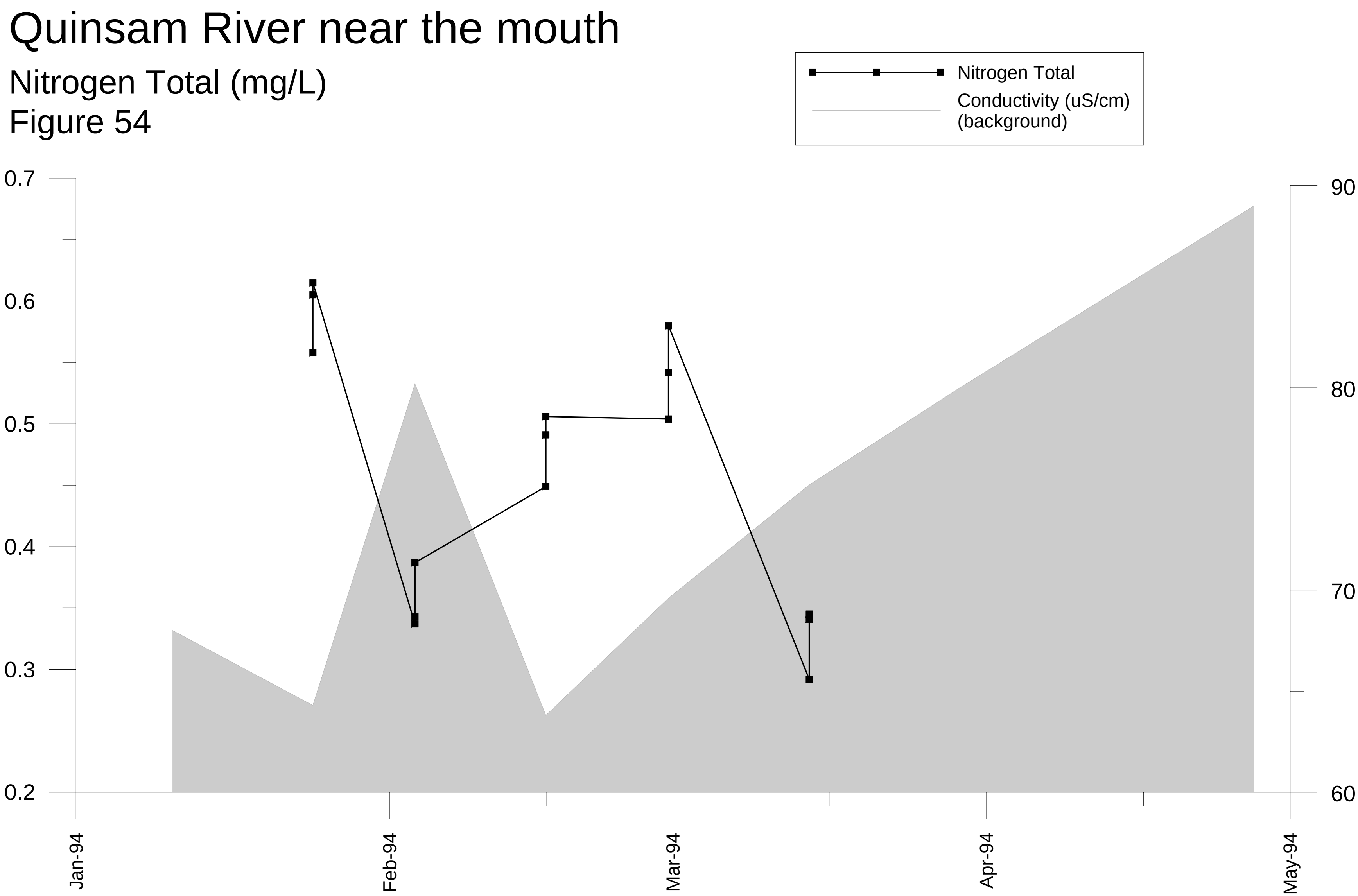

Quinsam River near the mouth
Nickel Total (ug/L)
Figure 50
BC/CCME AW Ni Guideline range 1.2 - 142.3 ug/L
Nickel Total
Nickel Extractable
Turbidity (NTU)
(background)
10
8
6
4
2
0
80
60
40
20
0
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

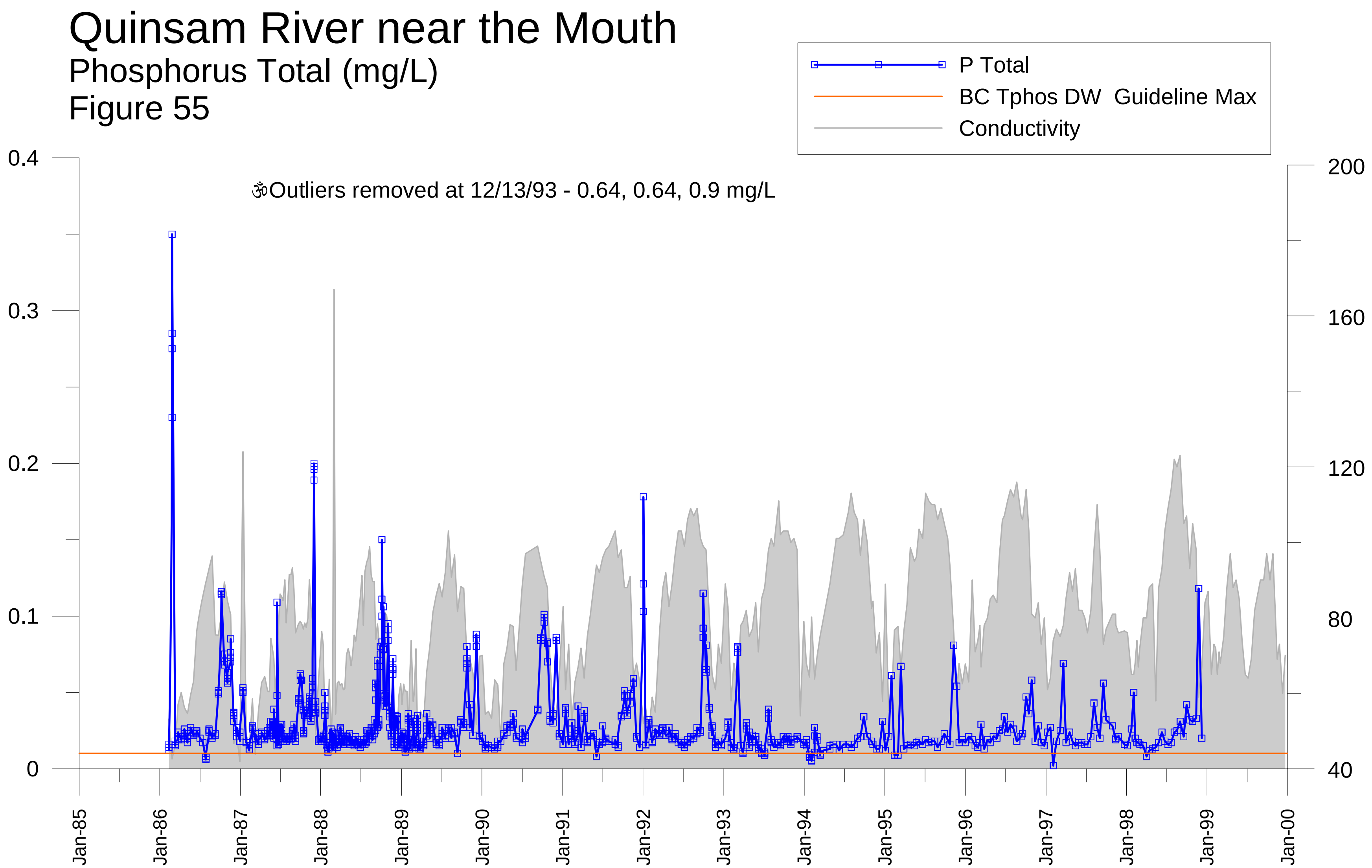


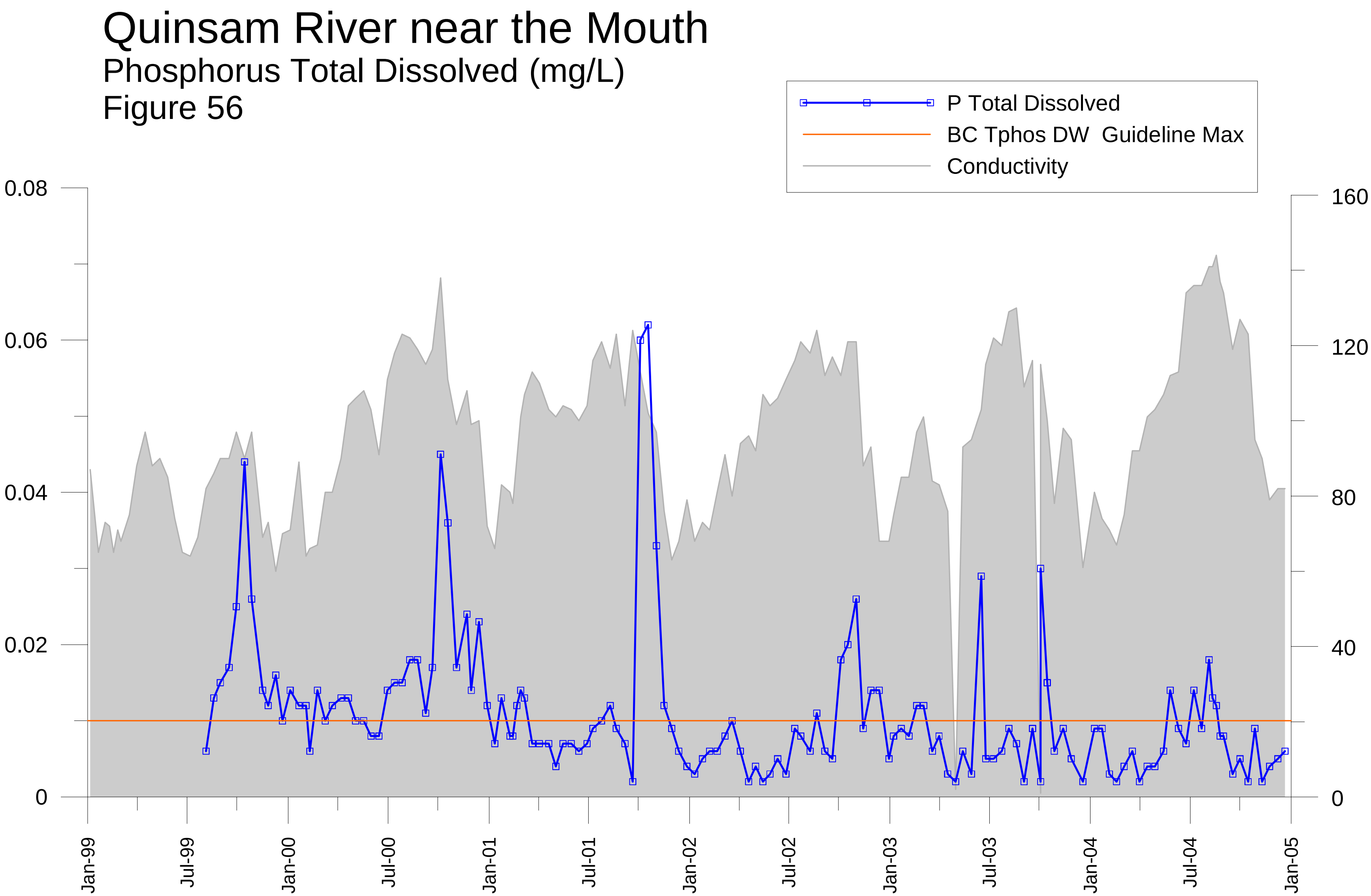
Quinsam River near the mouth
Nickel Total (ug/L)
Figure 51
ॐBC/CCME AW Ni Guideline range 1.2 - 142.3 ug/L
Nickel Total
Nickel Extractable
Turbidity (NTU) (background)
8
6
4
2
0
80
60
40
20
0
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

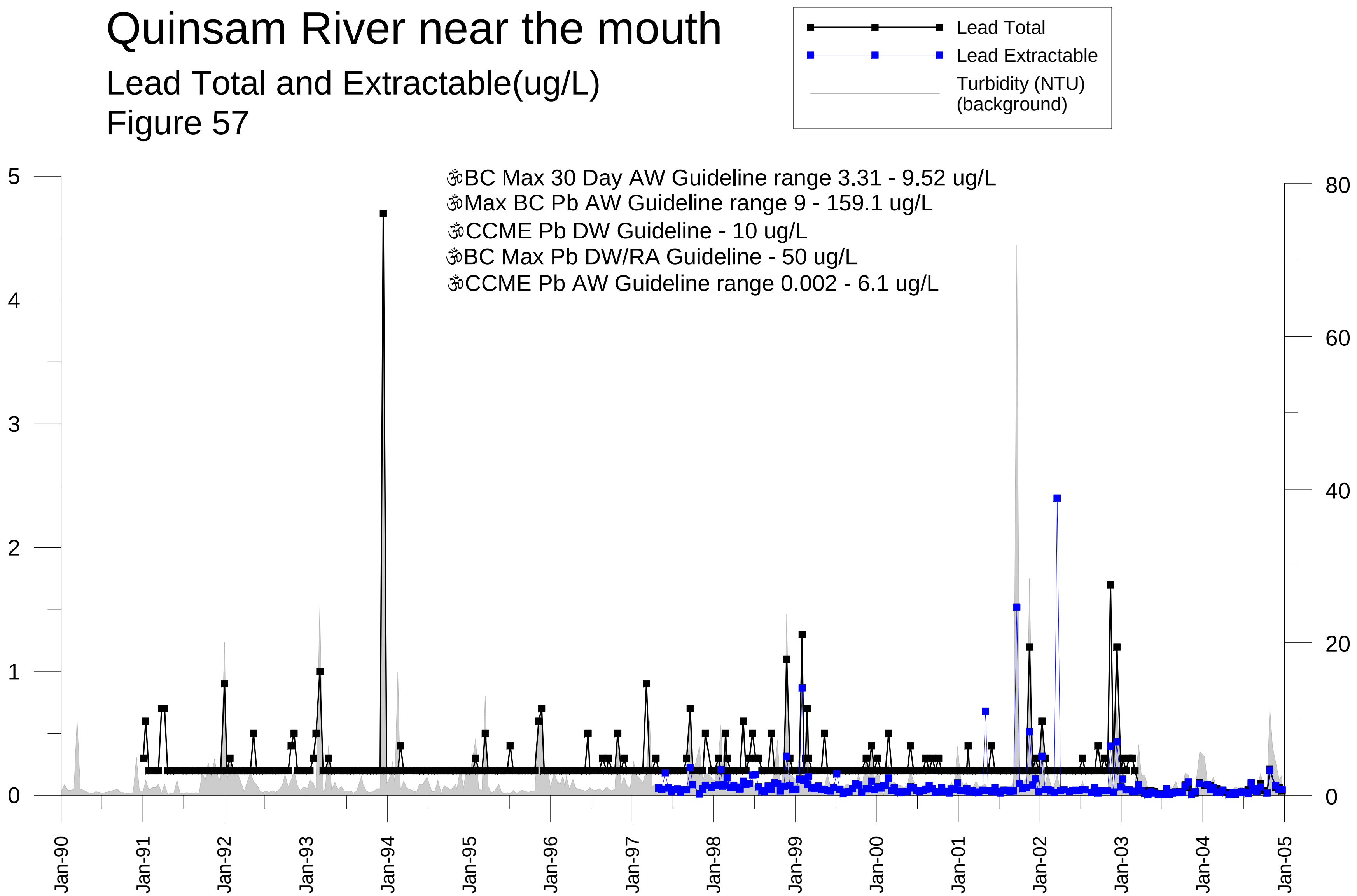

Quinsam River near the Mouth
Niobium Extractable (ug/L)
Figure 52
Niobium Total
Conductivity (background)
0.03
0.02
0.01
0
12
8
4
0
Mar-04
Jun-04
Sep-04
Dec-04

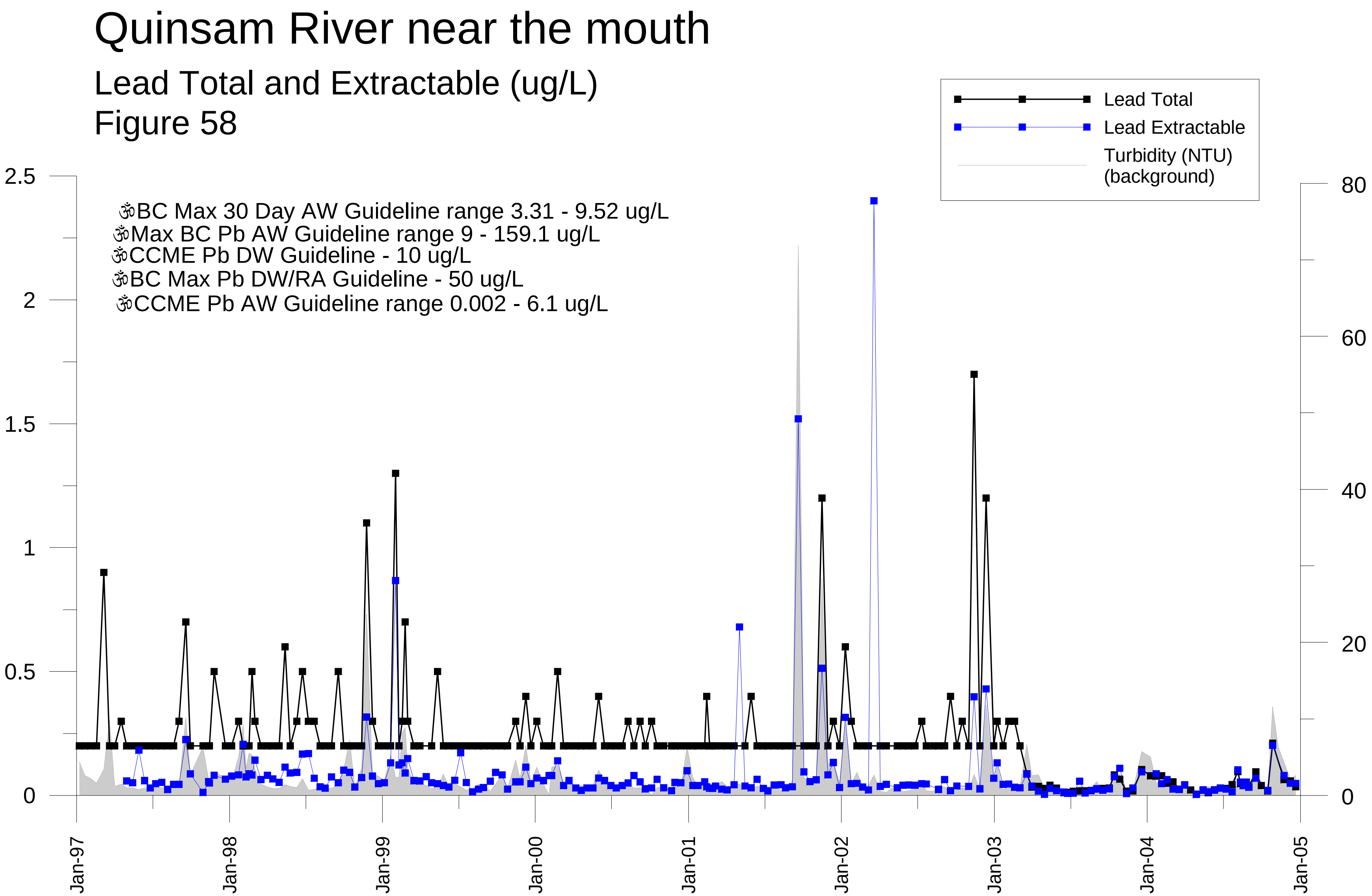

Quinsam River near the mouth
Nitrogen Nitrite (mg/L)
Figure 53
Nitrogen Nitrite
Conductivity (uS/cm)
(background)
0.03
0.025
0.02
0.015
0.01
0.005
140
120
100
80
60
40
Jan-94
Apr-94
Jul-94
Oct-94
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99

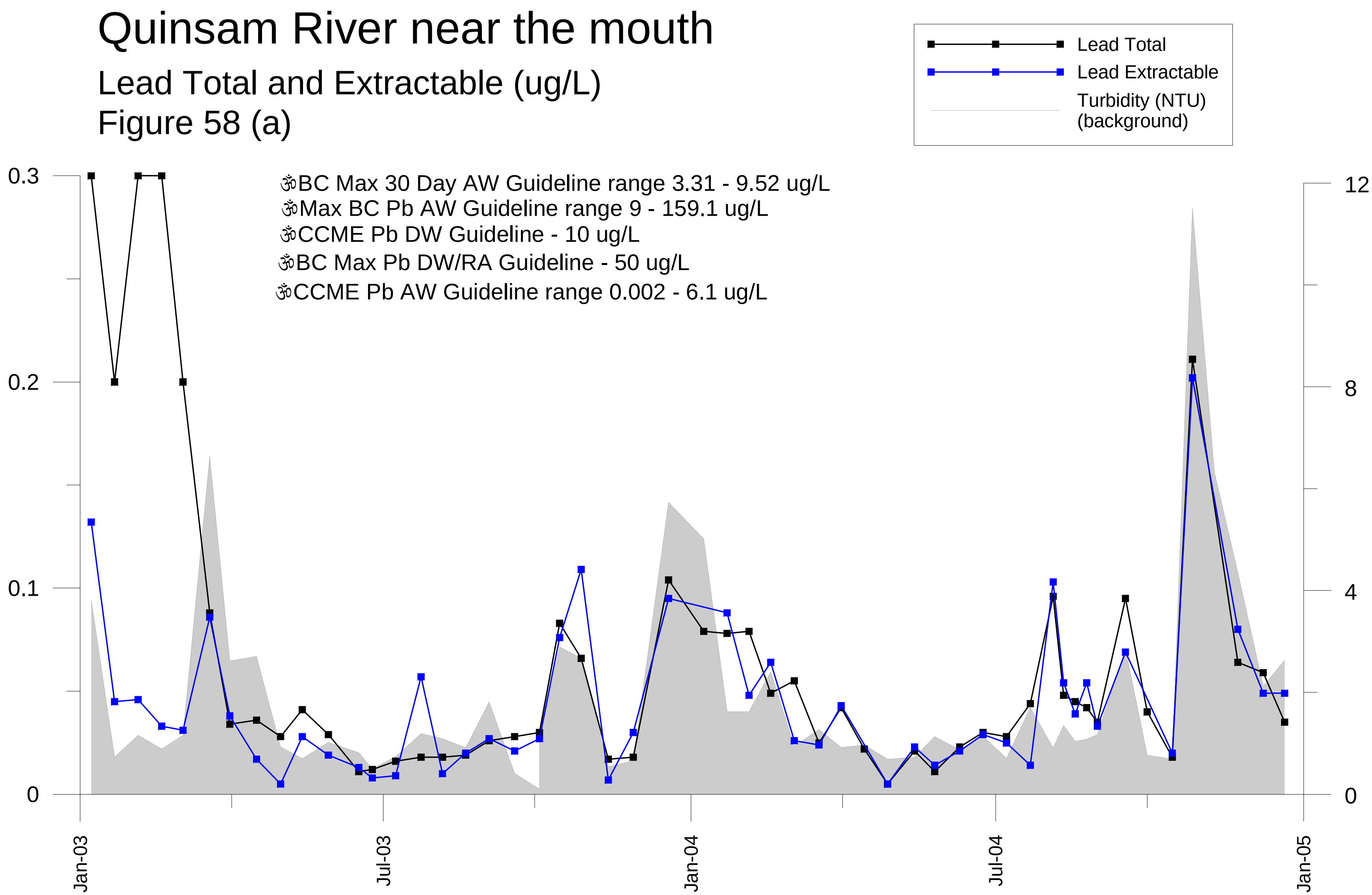

Quinsam River near the mouth
Nitrogen Total (mg/L)
Figure 54
Nitrogen Total
Conductivity (uS/cm)
(background)
0.7
0.6
0.5
0.4
0.3
0.2
90
80
70
60
Jan-94
Feb-94
Mar-94
Apr-94
May-94

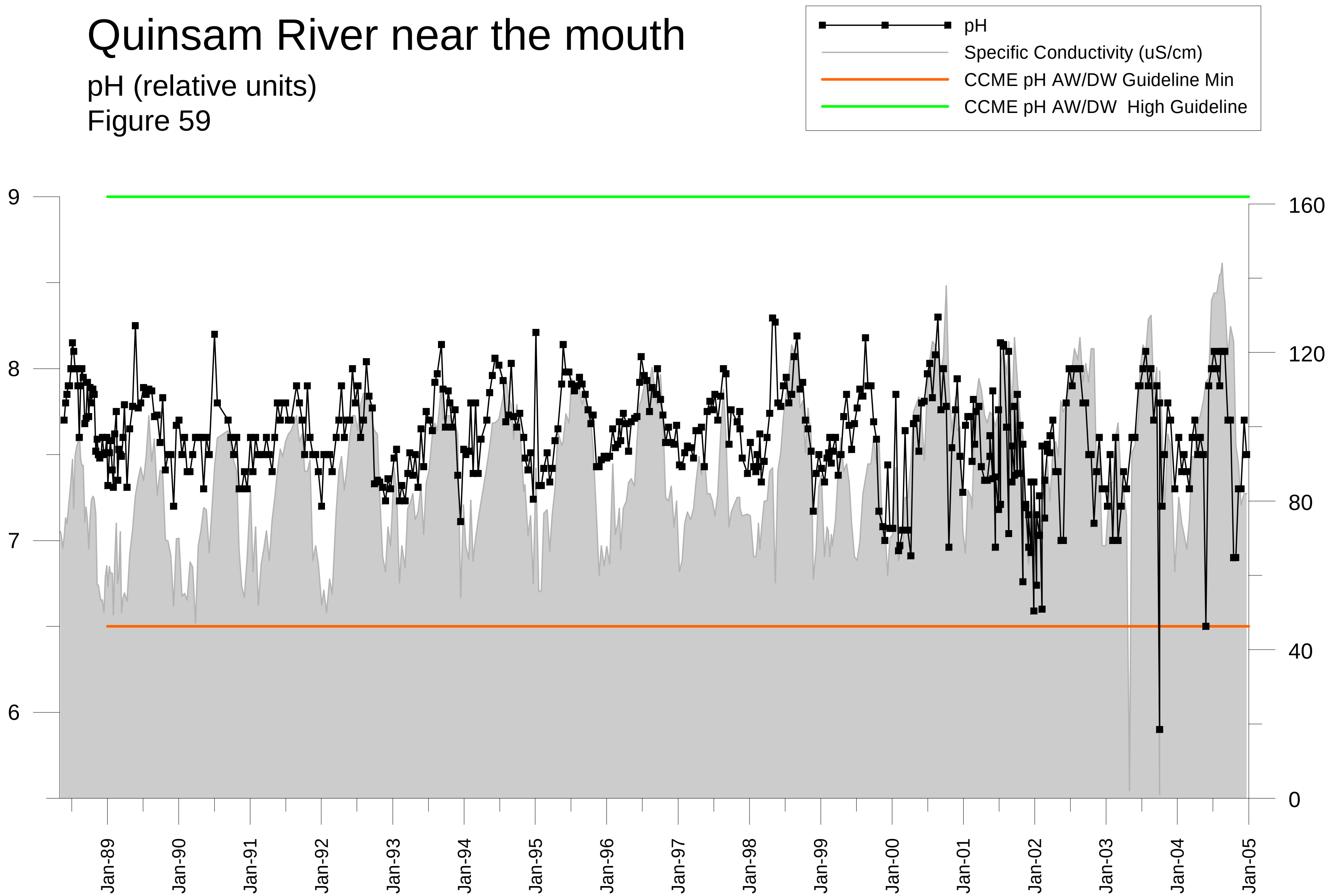

Quinsam River near the Mouth
Phosphorus Total (mg/L)
Figure 55
P Total
BC Tphos DW Guideline Max
Conductivity
ॐOutliers removed at 12/13/93 - 0.64, 0.64, 0.9 mg/L
0.4
0.3
0.2
0.1
0
200
160
120
80
40
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00

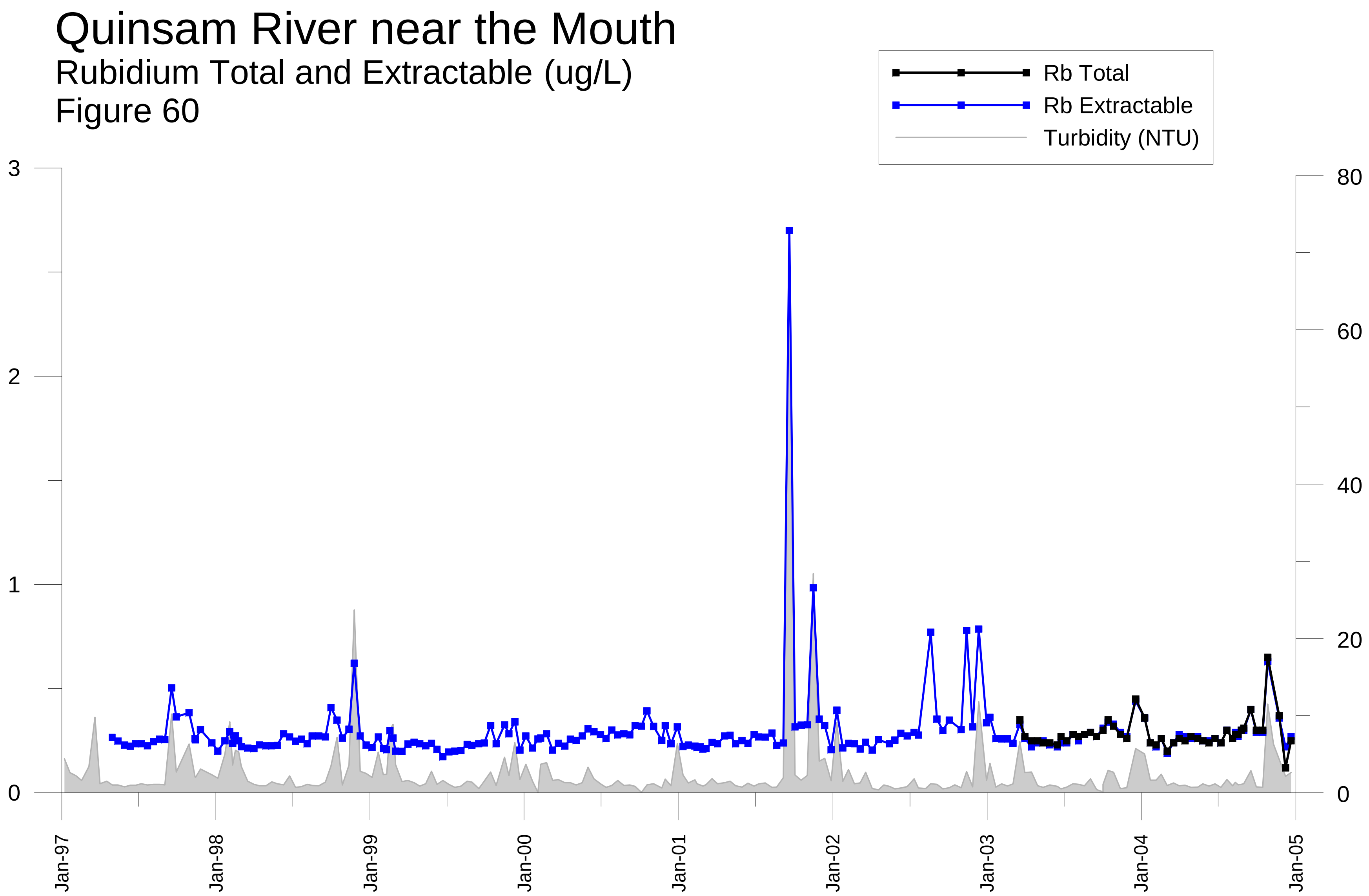

Quinsam River near the Mouth
Phosphorus Total Dissolved (mg/L)
Figure 56
P Total Dissolved
BC Tphos DW Guideline Max
Conductivity
0.08
0.06
0.04
0.02
0
160
120
80
40
0
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05

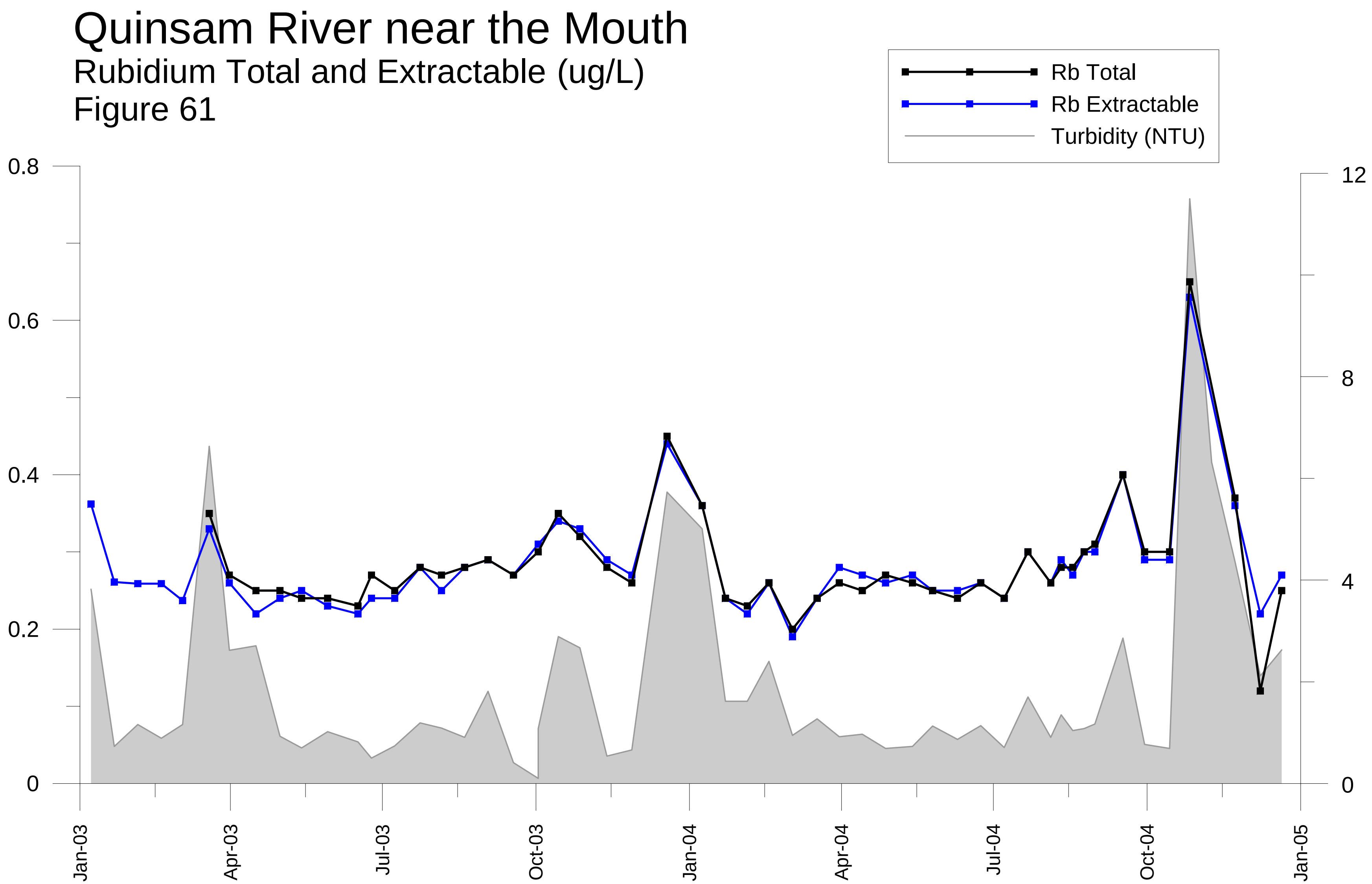

Quinsam River near the mouth
Lead Total and Extractable(ug/L)
Figure 57
Lead Total
Lead Extractable
Turbidity (NTU)
(background)
ॐBC Max 30 Day AW Guideline range 3.31 - 9.52 ug/L
ॐMax BC Pb AW Guideline range 9 - 159.1 ug/L
ॐCCME Pb DW Guideline - 10 ug/L
ॐBC Max Pb DW/RA Guideline - 50 ug/L
ॐCCME Pb AW Guideline range 0.002 - 6.1 ug/L
0
1
2
3
4
5
0
20
40
60
80
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

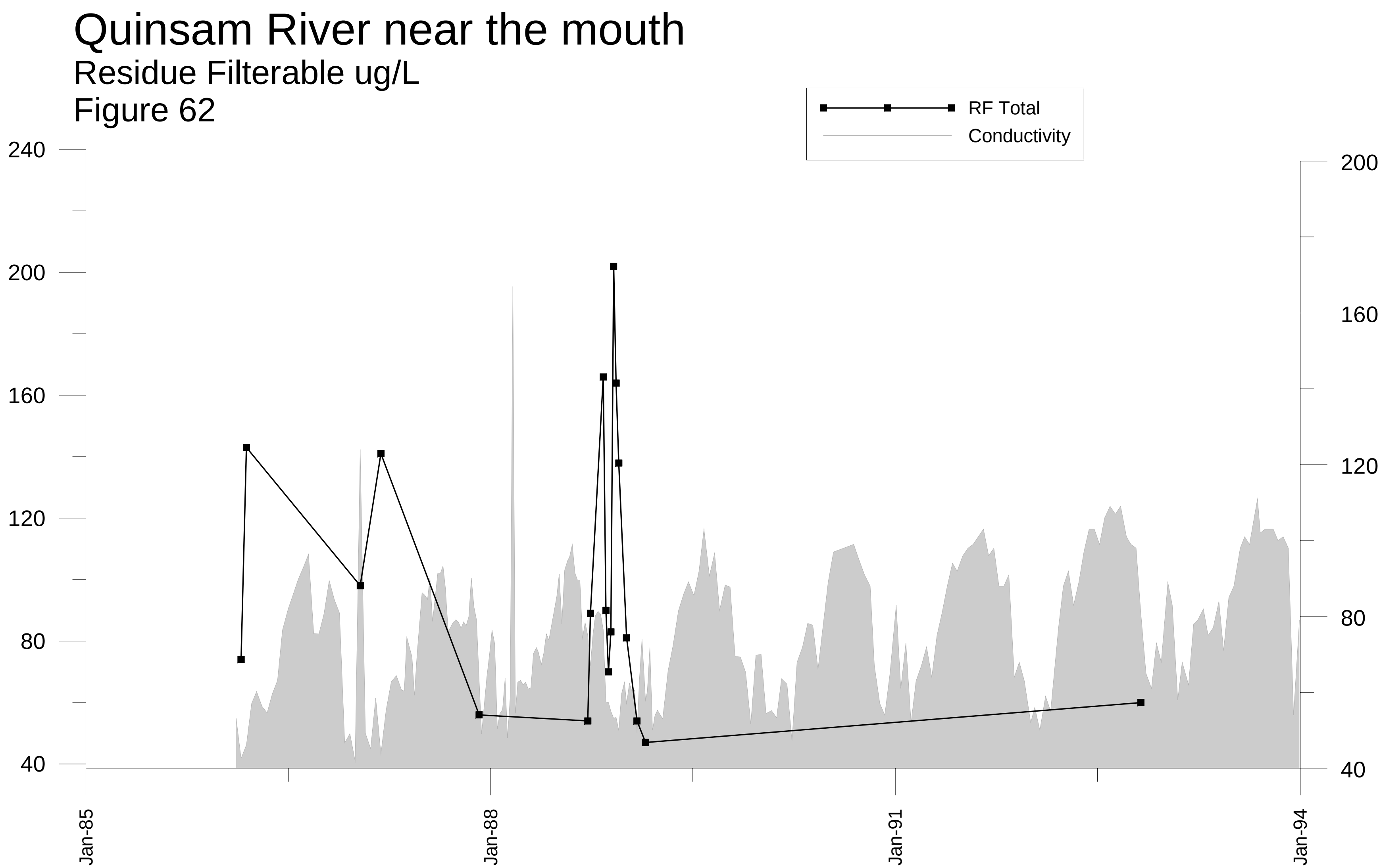

Quinsam River near the mouth
Lead Total and Extractable (ug/L)
Figure 58
Lead Total
Lead Extractable
Turbidity (NTU) (background)
ॐBC Max 30 Day AW Guideline range 3.31 - 9.52 ug/L
ॐMax BC Pb AW Guideline range 9 - 159.1 ug/L
ॐCCME Pb DW Guideline - 10 ug/L
ॐBC Max Pb DW/RA Guideline - 50 ug/L
ॐCCME Pb AW Guideline range 0.002 - 6.1 ug/L
2.5
2
1.5
1
0.5
0
80
60
40
20
0
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

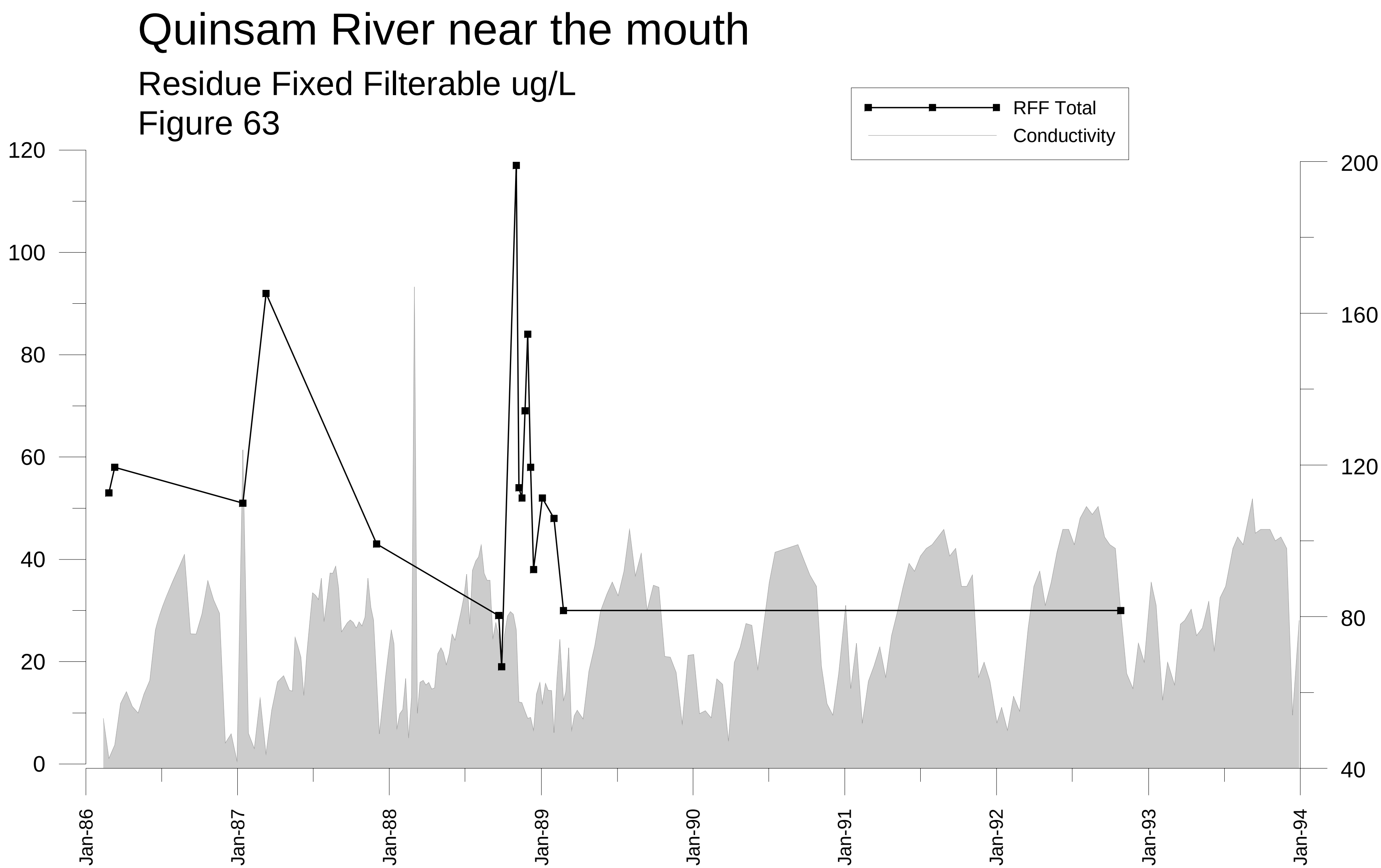

Quinsam River near the mouth
Lead Total and Extractable (ug/L)
Figure 58 (a)
Lead Total
Lead Extractable
Turbidity (NTU) (background)
ॐBC Max 30 Day AW Guideline range 3.31 - 9.52 ug/L
ॐMax BC Pb AW Guideline range 9 - 159.1 ug/L
ॐCCME Pb DW Guideline - 10 ug/L
ॐBC Max Pb DW/RA Guideline - 50 ug/L
ॐCCME Pb AW Guideline range 0.002 - 6.1 ug/L
0.3
0.2
0.1
0
12
8
4
0
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05

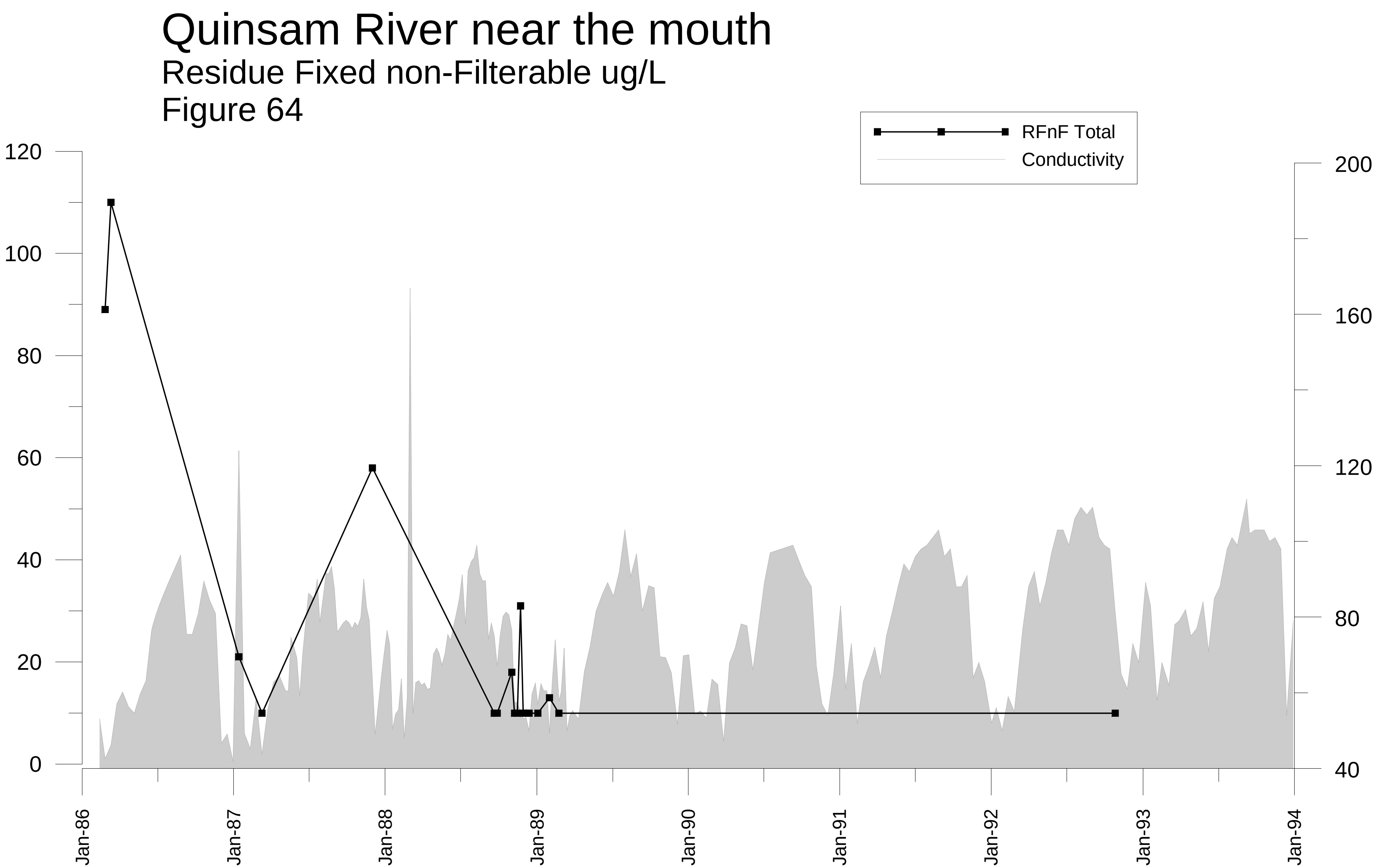

Quinsam River near the mouth
pH (relative units)
Figure 59
pH
Specific Conductivity (uS/cm)
CCME pH AW/DW Guideline Min
CCME pH AW/DW High Guideline
9
8
7
6
160
120
80
40
0
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

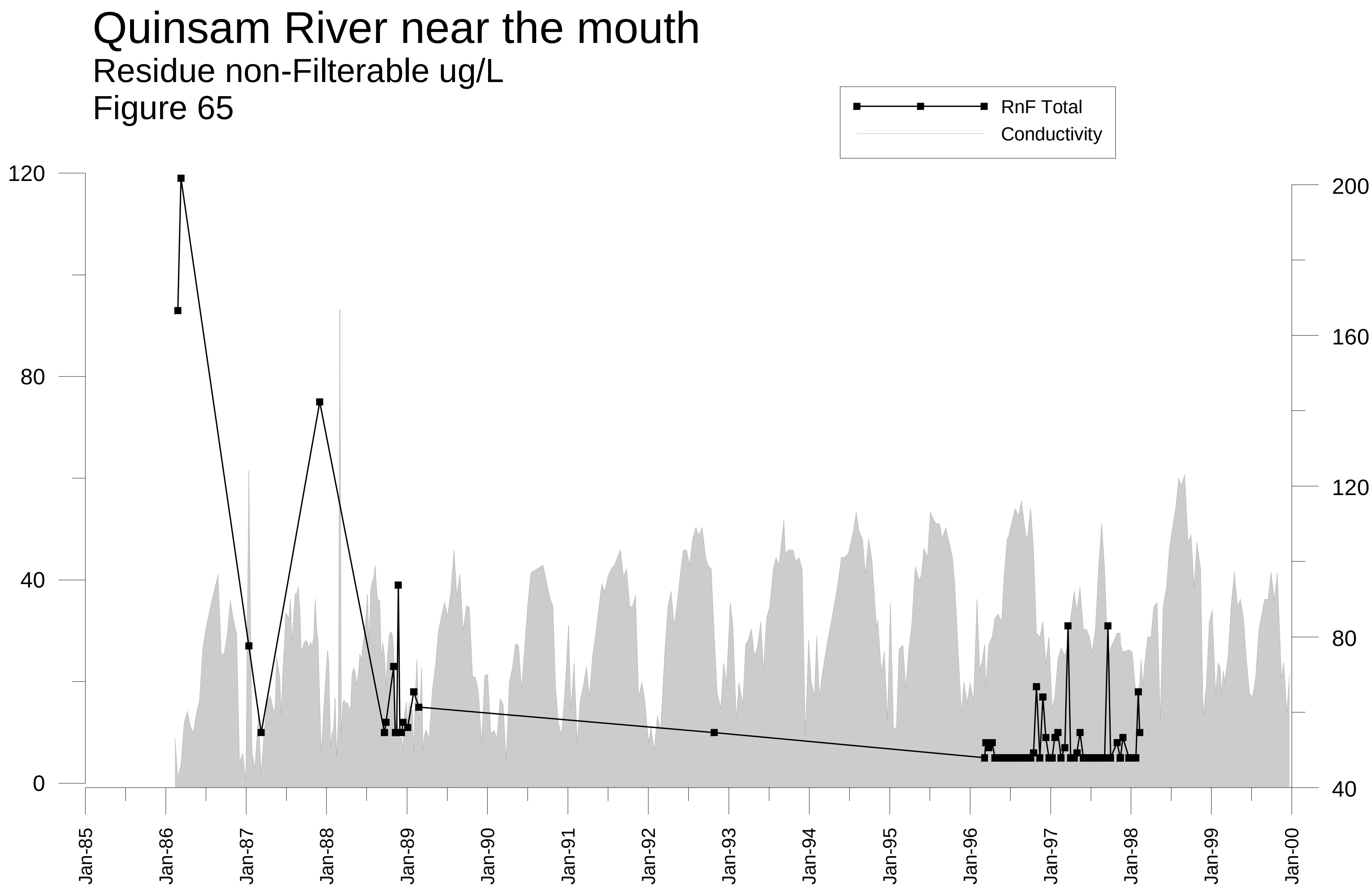

Quinsam River near the Mouth
Rubidium Total and Extractable (ug/L)
Figure 60
Rb Total
Rb Extractable
Turbidity (NTU)
0
1
2
3
0
20
40
60
80
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

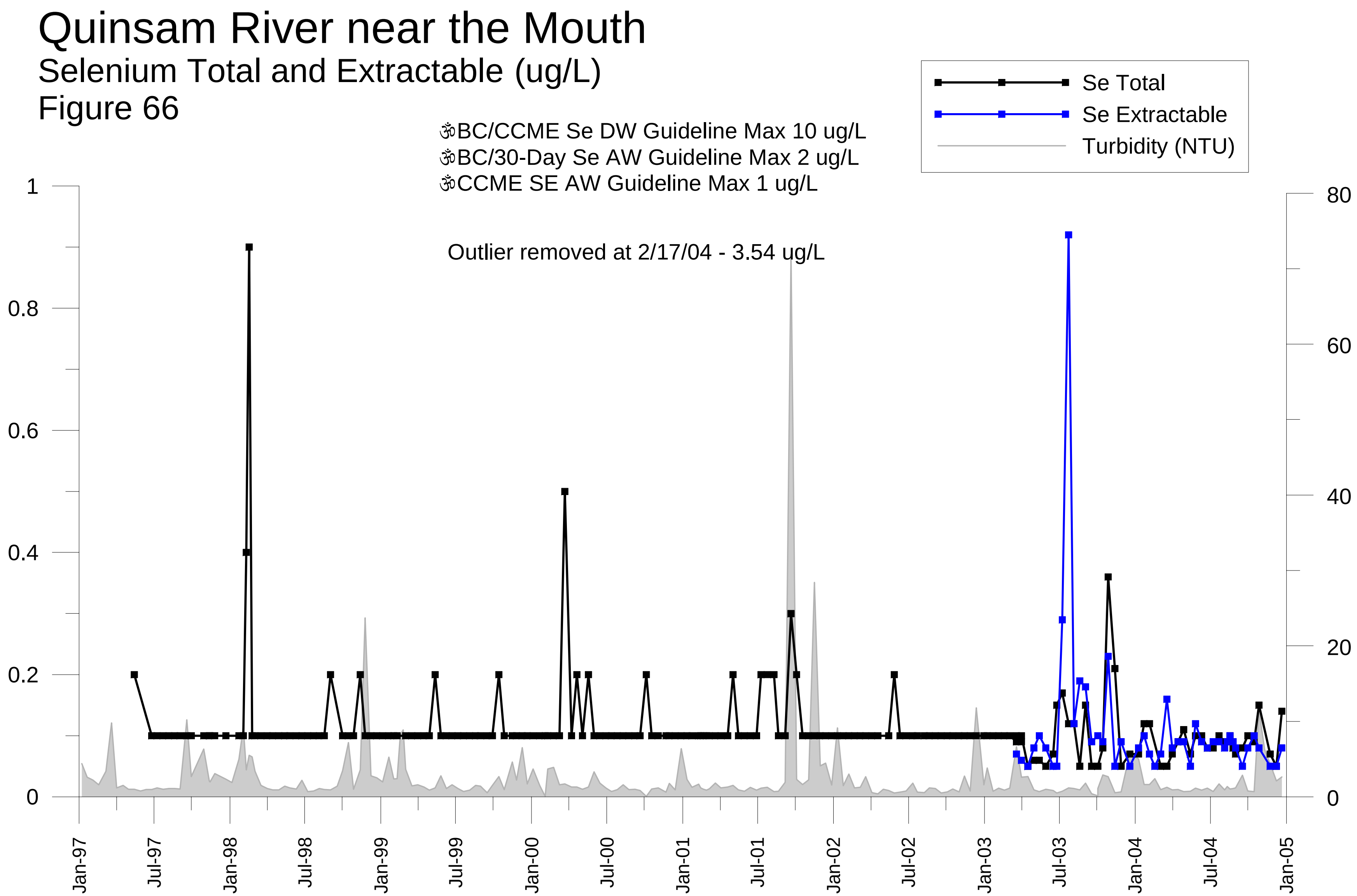

Quinsam River near the Mouth
Rubidium Total and Extractable (ug/L)
Figure 61
Rb Total
Rb Extractable
Turbidity (NTU)
0.8
0.6
0.4
0.2
0
12
8
4
0
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05


Quinsam River near the mouth
Residue Filterable ug/L
Figure 62
RF Total
Conductivity
240
200
160
120
80
40
200
160
120
80
40
Jan-85
Jan-88
Jan-91
Jan-94

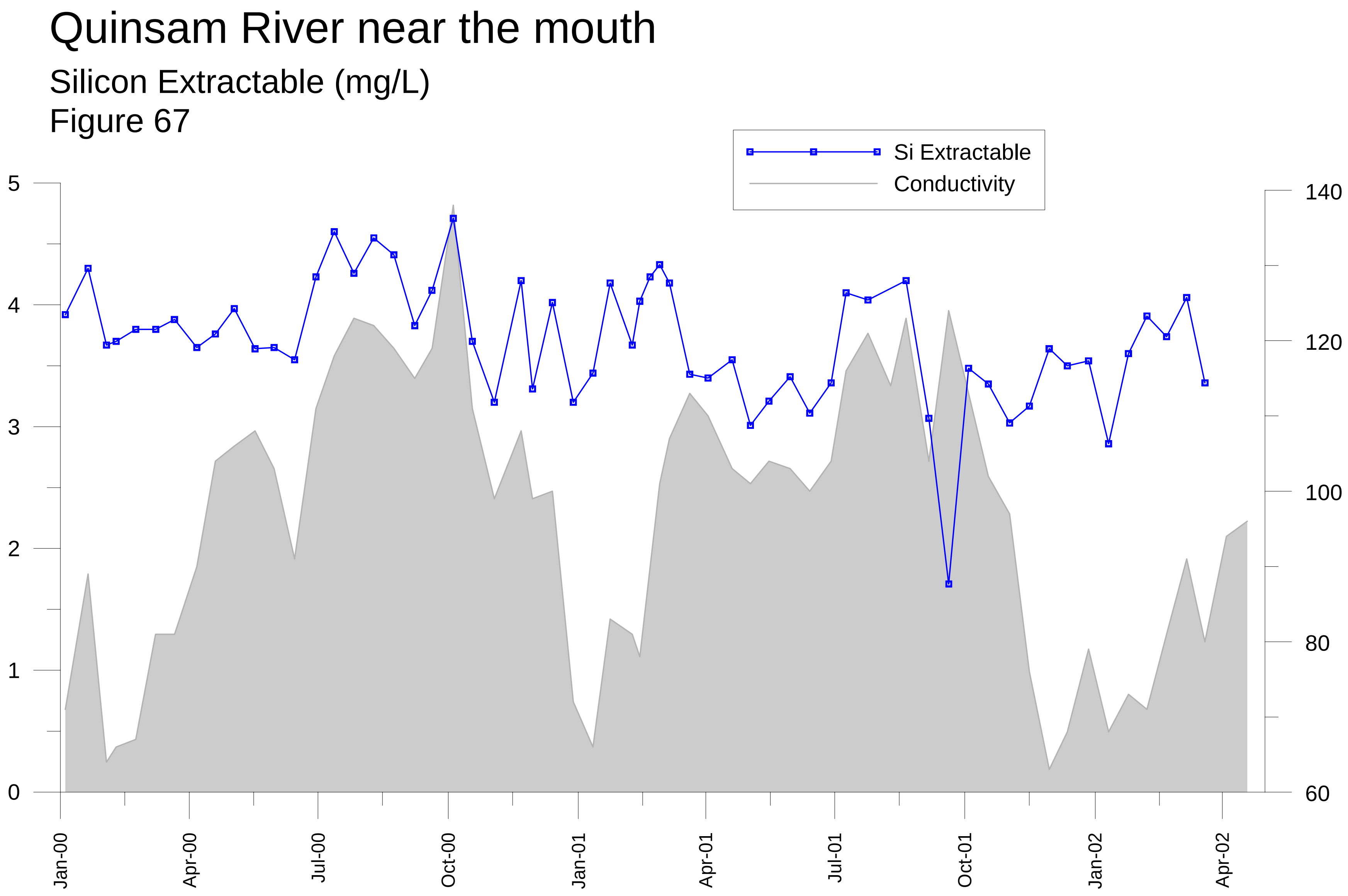

Quinsam River near the mouth
Residue Fixed Filterable ug/L
Figure 63
RFF Total
Conductivity
120
100
80
60
40
20
0
200
160
120
80
40
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94


Quinsam River near the mouth
Residue Fixed non-Filterable ug/L
Figure 64
RFnF Total
Conductivity
120
100
80
60
40
20
0
200
160
120
80
40
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94


Quinsam River near the mouth
Residue non-Filterable ug/L
Figure 65
RnF Total
Conductivity
120
80
40
0
200
160
120
80
40
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00



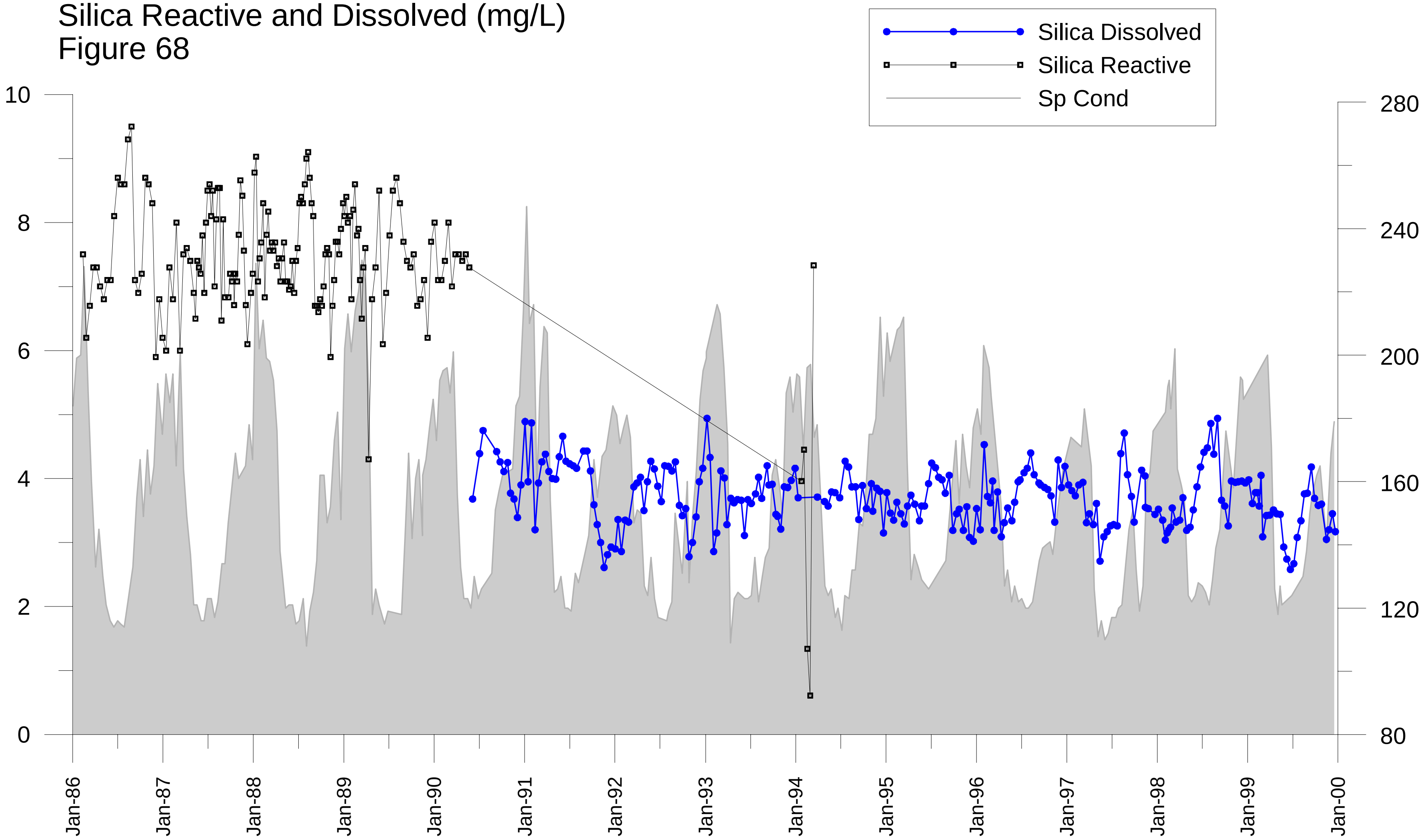
Quinsam River near the Mouth
Selenium Total and Extractable (ug/L)
Figure 66
ॐBC/CCME Se DW Guideline Max 10 ug/L
ॐBC/30-Day Se AW Guideline Max 2 ug/L
ॐCCME SE AW Guideline Max 1 ug/L
Outlier removed at 2/17/04 - 3.54 ug/L
Se Total
Se Extractable
Turbidity (NTU)
1
0.8
0.6
0.4
0.2
0
80
60
40
20
0
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05

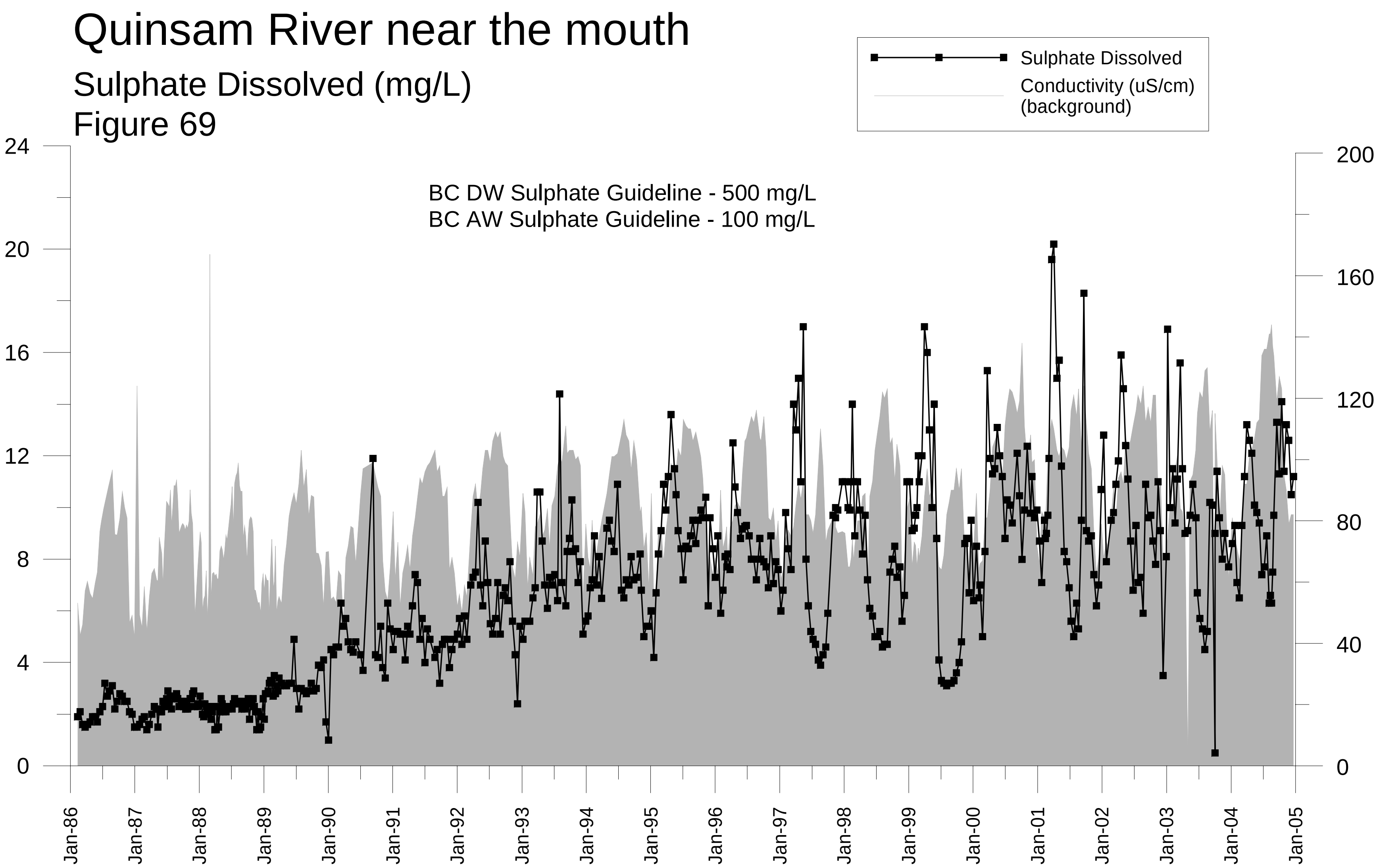

Quinsam River near the mouth
Silicon Extractable (mg/L)
Figure 67
Si Extractable
Conductivity
0
1
2
3
4
5
60
80
100
120
140
Jan-00
Apr-00
Jul-00
Oct-00
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02

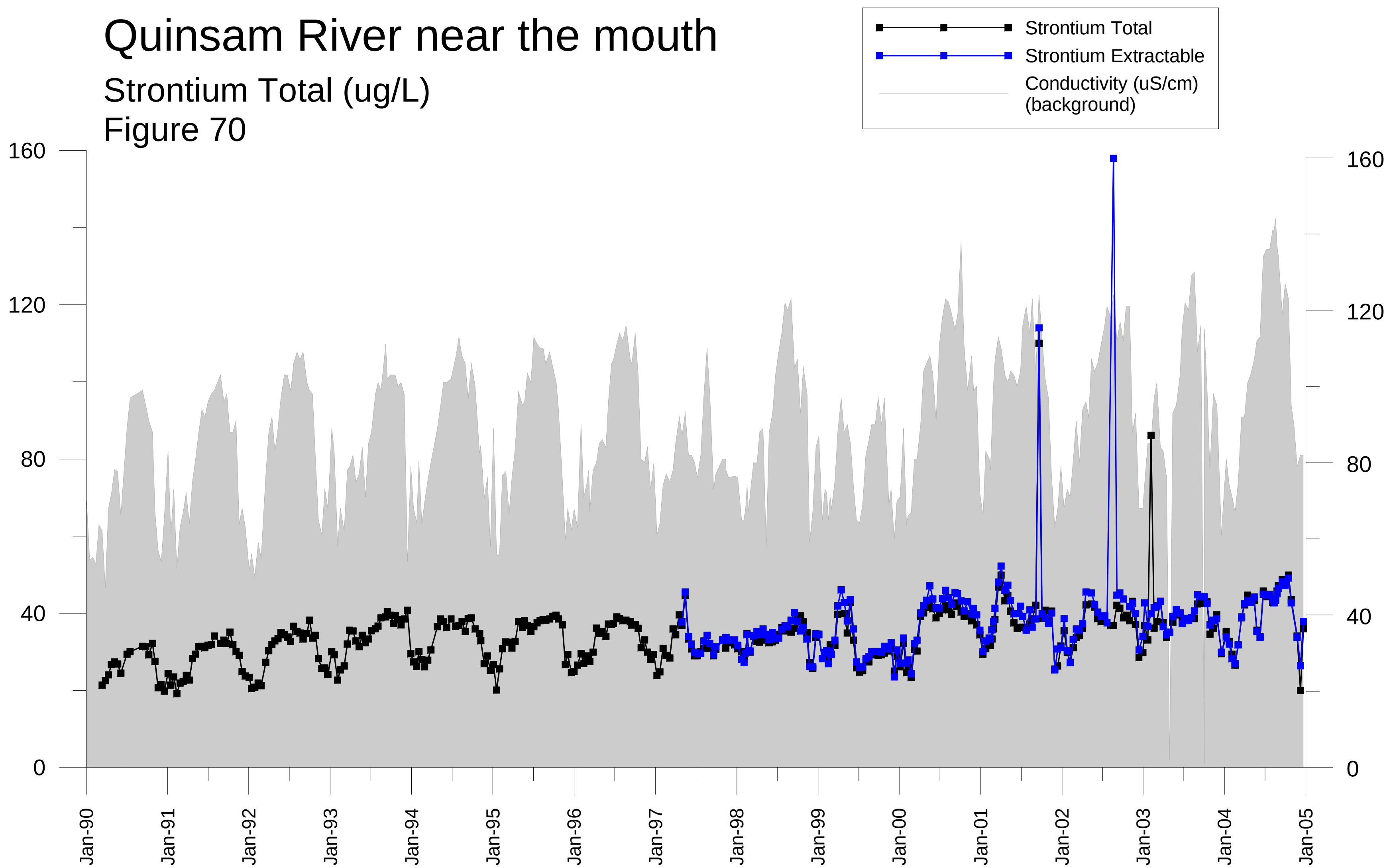
Quinsam River near the mouth

Silica Reactive and Dissolved (mg/L)

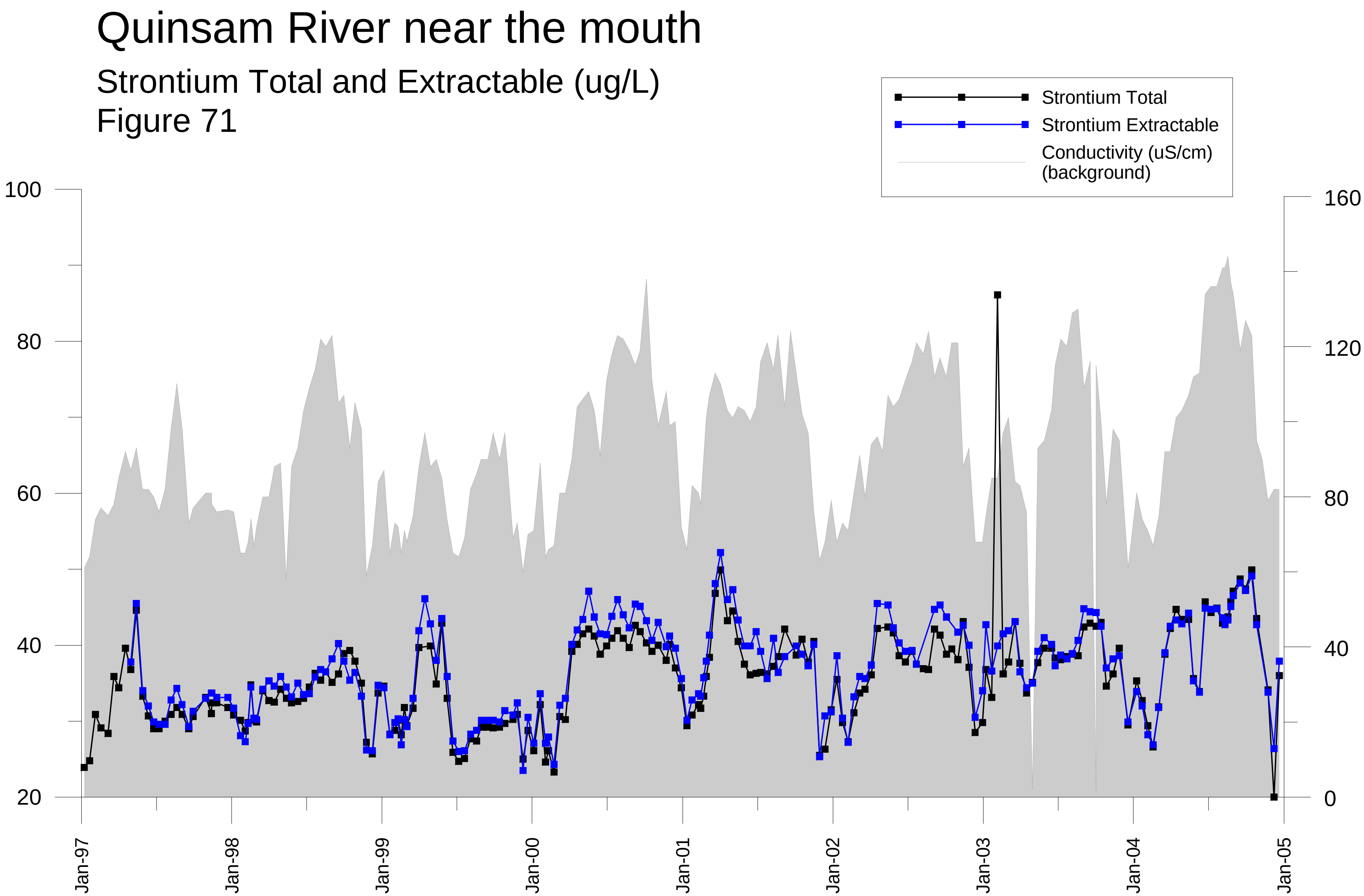
Figure 68

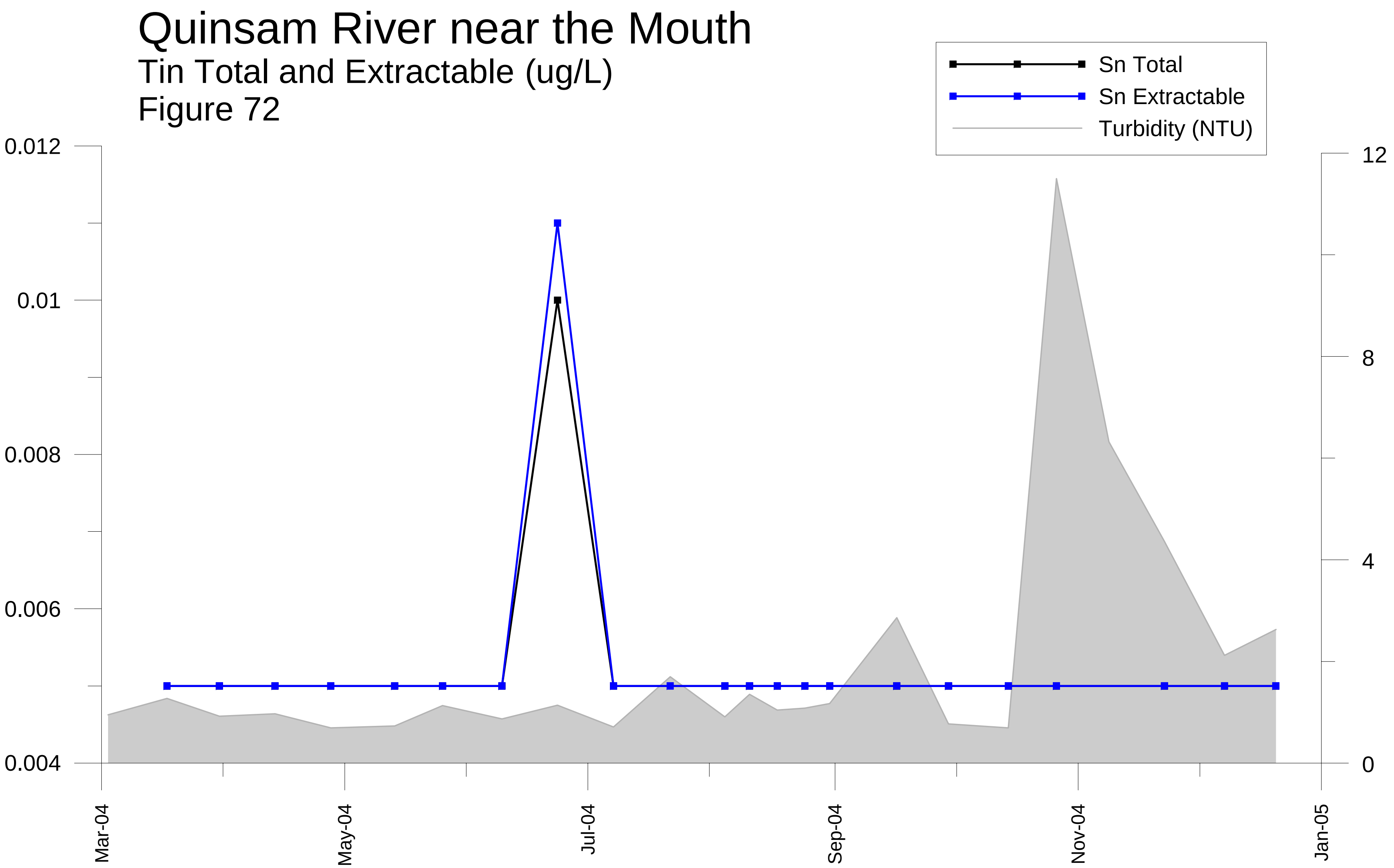



Quinsam River near the mouth
Sulphate Dissolved (mg/L)
Figure 69
Sulphate Dissolved
Conductivity (uS/cm) (background)
BC DW Sulphate Guideline - 500 mg/L
BC AW Sulphate Guideline - 100 mg/L
24
20
16
12
8
4
0
200
160
120
80
40
0
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

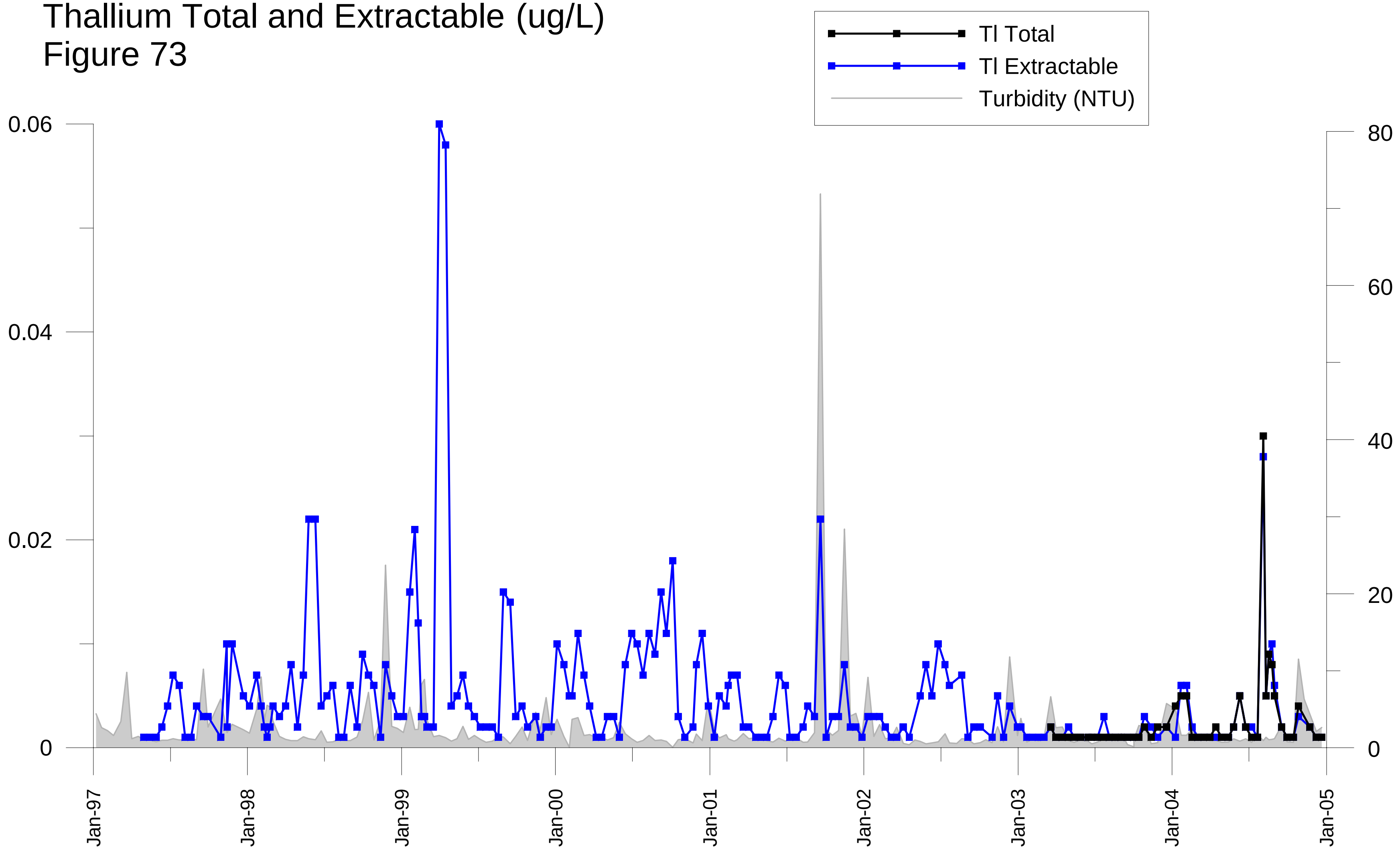


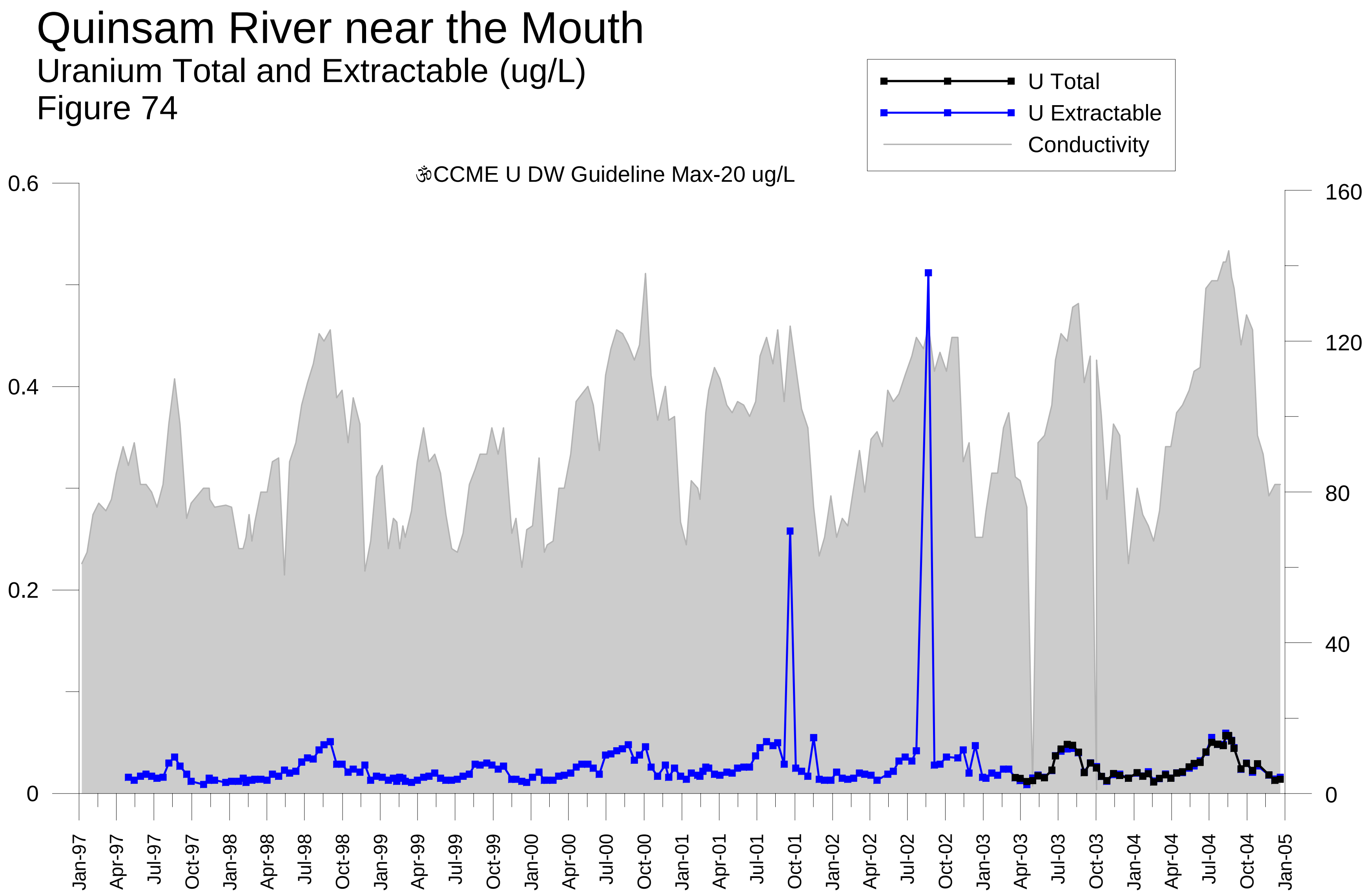
Quinsam River near the mouth
Strontium Total (ug/L)
Figure 70
Strontium Total
Strontium Extractable
Conductivity (uS/cm) (background)
160
120
80
40
0
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05

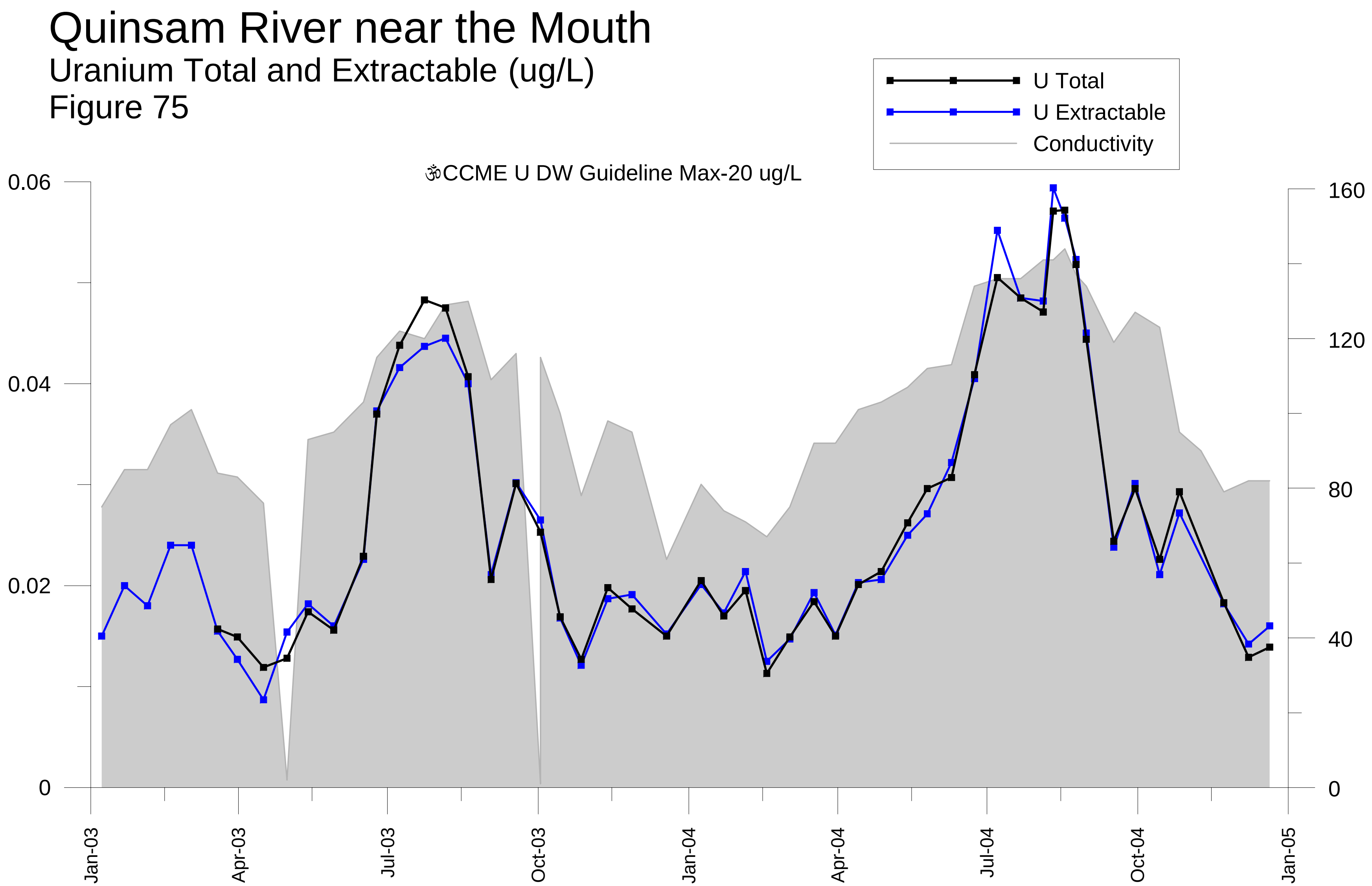

Quinsam River near the mouth
Strontium Total and Extractable (ug/L)
Figure 71
Strontium Total
Strontium Extractable
Conductivity (uS/cm)
(background)
100
80
60
40
20
160
120
80
40
0
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05


Quinsam River near the Mouth
Tin Total and Extractable (ug/L)
Figure 72
Sn Total
Sn Extractable
Turbidity (NTU)
0.012
0.01
0.008
0.006
0.004
12
8
4
0
Mar-04
May-04
Jul-04
Sep-04
Nov-04
Jan-05

Quinsam River near the Mouth
Thallium Total and Extractable (ug/L)
Figure 73



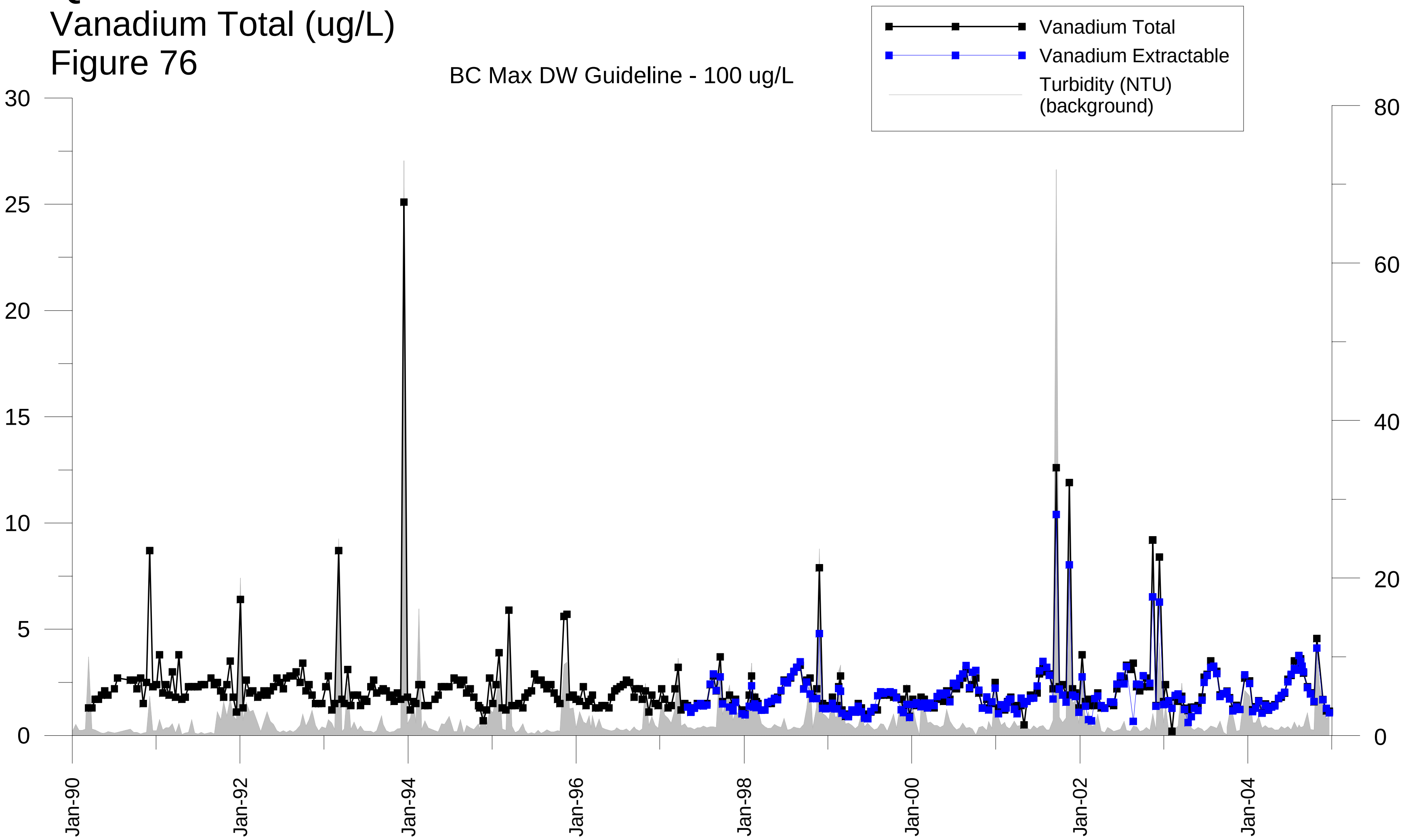

Quinsam River near the Mouth
Uranium Total and Extractable (ug/L)
Figure 74
U Total
U Extractable
Conductivity
ॐCCME U DW Guideline Max-20 ug/L
0.6
0.4
0.2
0
160
120
80
40
0
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99
Jan-00
Apr-00
Jul-00
Oct-00
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02
Jul-02
Oct-02
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05

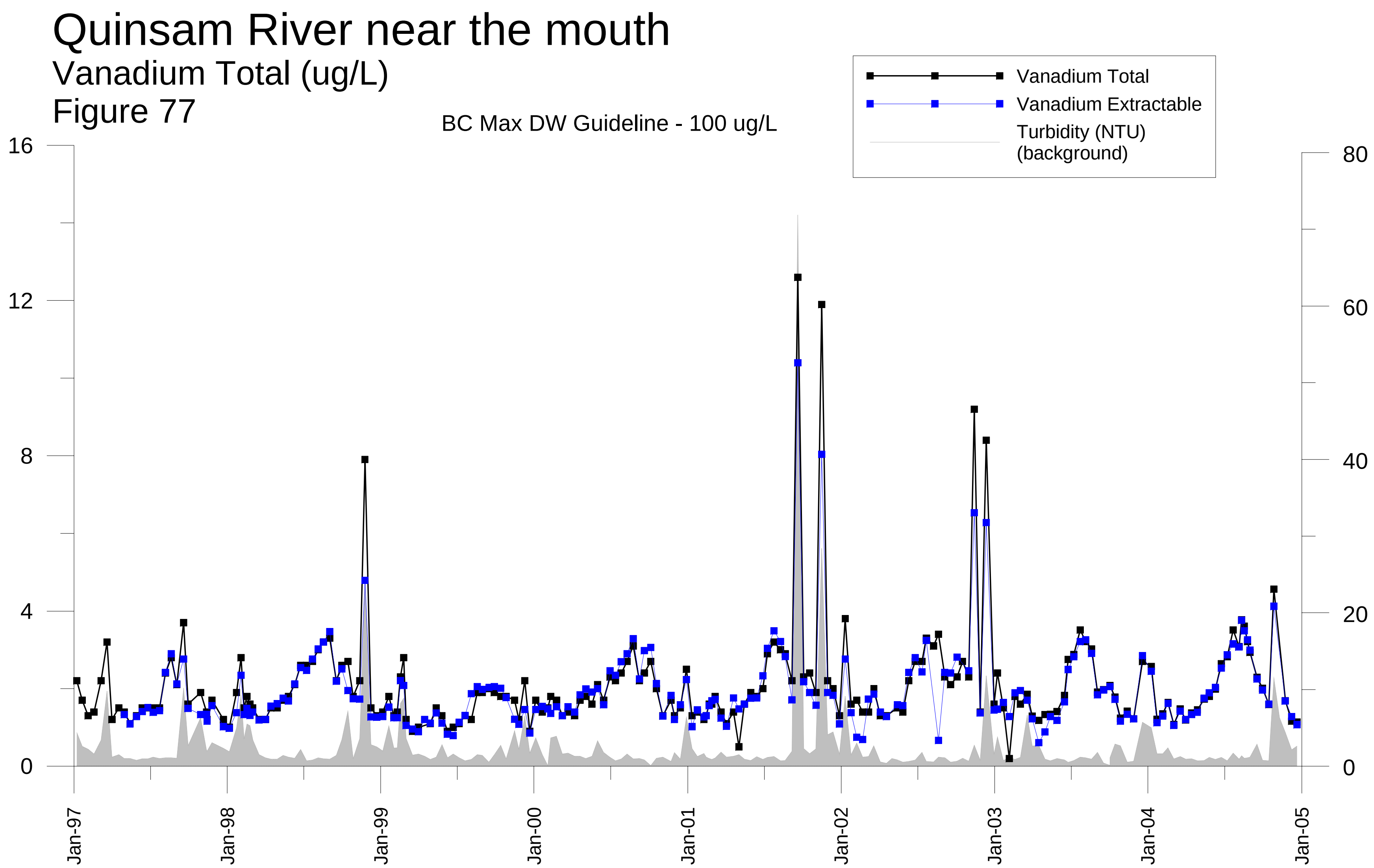

Quinsam River near the Mouth
Uranium Total and Extractable (ug/L)
Figure 75
U Total
U Extractable
Conductivity
CCME U DW Guideline Max-20 ug/L
0.06
0.04
0.02
0
160
120
80
40
0
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05

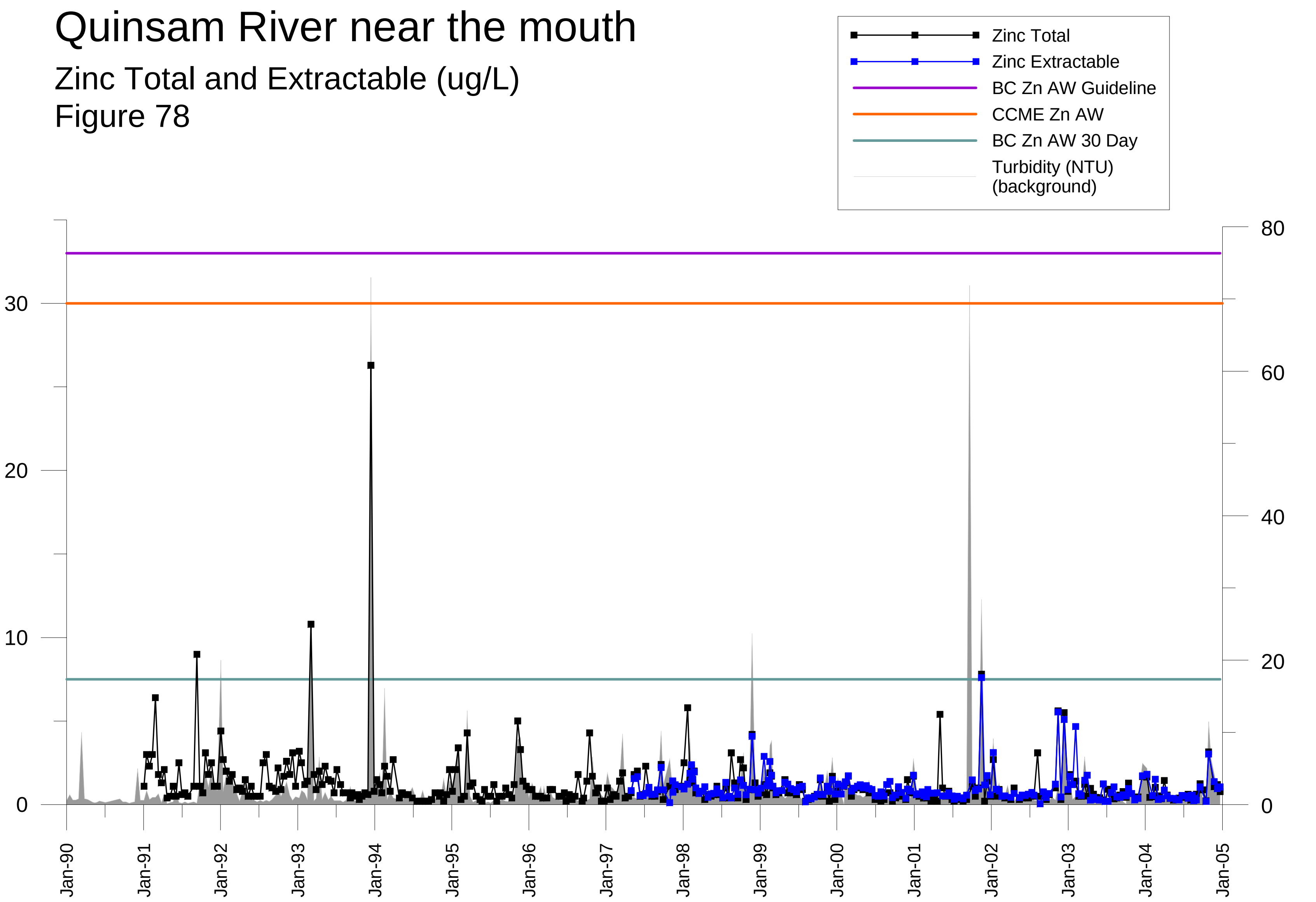
Quinsam River near the mouth

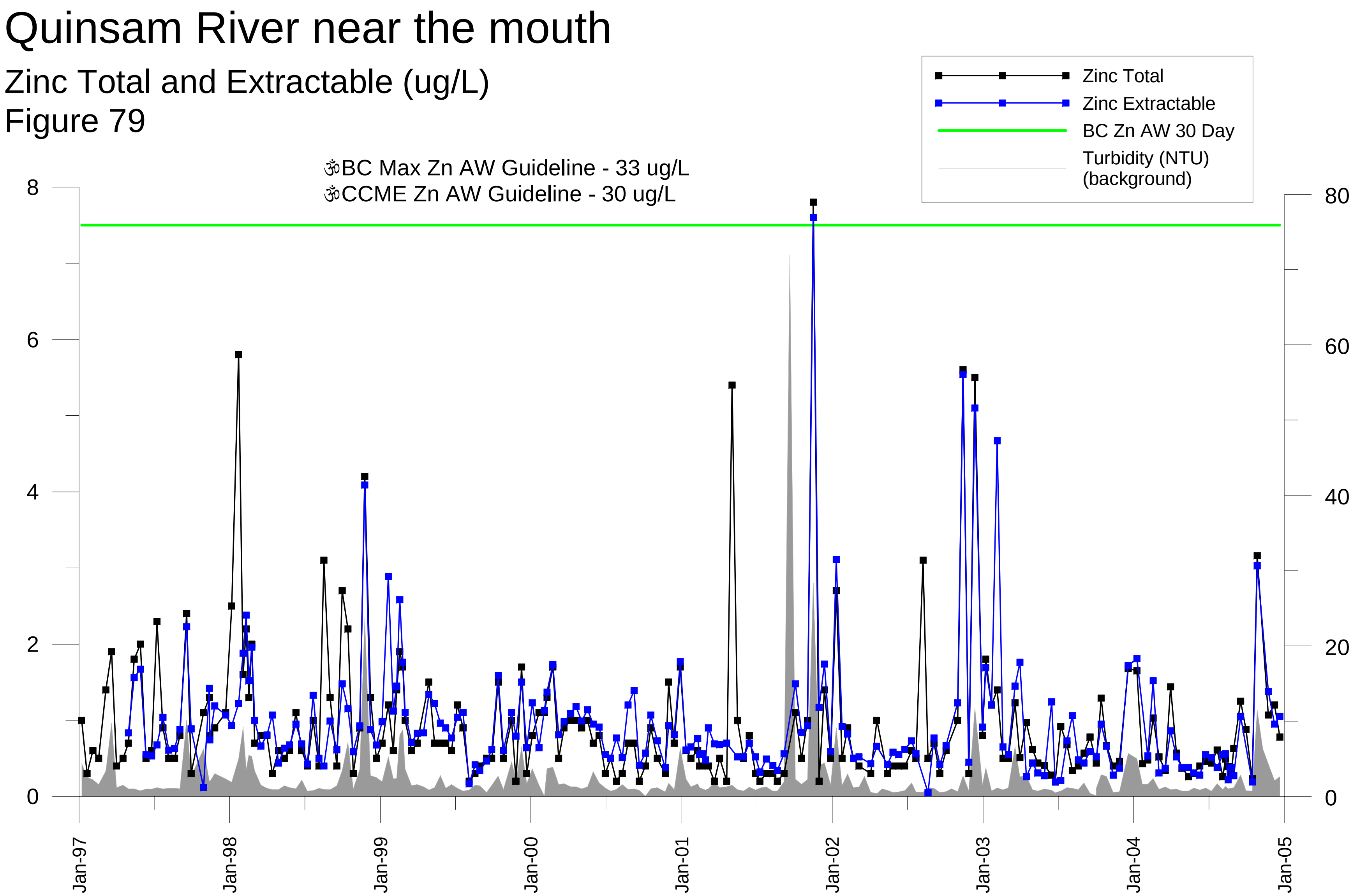
Vanadium Total (ug/L)

Figure 76




Quinsam River near the mouth
Vanadium Total (ug/L)
Figure 77
BC Max DW Guideline - 100 ug/L
Vanadium Total
Vanadium Extractable
Turbidity (NTU)
(background)
16
12
8
4
0
80
60
40
20
0
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05


Quinsam River near the mouth
Zinc Total and Extractable (ug/L)
Figure 78
Zinc Total
Zinc Extractable
BC Zn AW Guideline
CCME Zn AW
BC Zn AW 30 Day
Turbidity (NTU) (background)
0
10
20
30
0
20
40
60
80
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05



Quinsam River near the mouth
Zinc Total and Extractable (ug/L)
Figure 79
BC Max Zn AW Guideline - 33 ug/L
CCME Zn AW Guideline - 30 ug/L
Zinc Total
Zinc Extractable
BC Zn AW 30 Day
Turbidity (NTU) (background)
0
2
4
6
8
0
20
40
60
80
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05