Project 11b, Maintenance of Water Quality Database Report on 2004/2005 Activities

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1. Introduction

The record of groundwater and surface water quality data collected at the Anvil Range Mine in Faro, Yukon is contained in an electronic, relational water quality database. To date, the database has been managed through a commercial software program entitled EQWin. The database was initially compiled for Anvil Range Mining Corporation in 1995/96 as part of the development of the Integrated Comprehensive Abandonment Plan. The data was taken from all available sources and entered manually into the database by a contractor. The data entry process was conducted largely by contract personnel working from numerous reports and isolated printouts of various ages and from various sources. It is believed that a rigorous quality control check was not able to be conducted at that time due to cost and time constraints.

Gartner Lee has updated the database monthly since mid-2000 and performs routine maintenance and backups in the course of managing the database. Gartner Lee, in the course of managing the database for the purpose of preparing monthly and annual environmental reports for the Yukon Water Board and for other project purposes, has occasionally observed errors in the database; ranging from minor or non-substantive to serious and potentially misleading errors. Gartner Lee responded to these numerical errors on an individual, as-identified basis.

In 2004, Gartner Lee observed that the demands placed on the database had grown in scope to well beyond the preparation of the monthly and annual Water Board reports. For example in 2003/2004, the database also provided critical data for the Water Licence Renewal and for closure projects. Gartner Lee anticipated that as the closure planning projects and environmental assessment progressed the demands on the database would continue to grow.

In light of the increased demands on the Water Quality Database, Deloitte and Touche approved Project 11b Maintenance of Water Quality Database (letter, August 17, 2004). The overall objective of the project is to identify, resolve and document as many data errors within the database as can reasonably be identified and to recommend an on-going program for quality control regarding the database.

As work progressed a need for either an upgrade of the current database interface program (EQWin) or conversion of the database into MS-Access become apparent. The primary issue was the transferability of the data to the various data users, such as Deloitte & Touche, other consultants and regulatory agencies. Through research conducted by Gartner Lee and the input of other parties, it was determined that MS-Access offered the best solution to the issue. At that time, Environment Canada, one of the users of the Anvil Range Water Quality database, undertook an initiative to develop an MS-Access interface for their own datasets. Therefore, it was decided that some aspects of maintenance of the EQWin database would be postponed so that the conversion of the EQWin database to an MS-Access interface (that would be

compatible with the Environment Canada work) could be initiated. This report outlines the progress of both tasks; the maintenance of the EQWin Database and the conversion to MS-Access.

2. EQWin Database Structure

2.1 Overview

Within the Anvil Range EQWin Water Quality Database the data is subdivided into three databases: *faro*, *farogw*, and *vang*. The *faro* database contains all surface water quality stations located on the Faro-side of the mine area. The *farogw* database contains all groundwater quality stations located on the Faro-side of the mine area. The *vang* database contains all water quality stations located on the Vangorda-side of the mine, including surface and groundwater quality stations. Within each database the data tied to each station varies. Appendix A provides the full station list with corresponding data for each station from each database. Each database includes a large number of stations, only some of which are considered "active". For the purposes of this report, "active" stations are those for which there is at least one data record in the database for 2003 and/or 2004 (Appendix B). Within each database there is a list of parameters. Currently, all three databases contain a slightly different list of parameter codes for the parameters. Therefore, while many parameters are repeated in each database they may appear under a slightly different parameter code (Appendix C). This is usually the case with parameters other than total and dissolved metals. The variation in parameter codes probably grew over the life of the database and may be due to different laboratory reporting and different database operators. Table 1 summarizes the number of stations, active stations and parameters in each database.

Table 1. Summary of Stations and Parameters in Each EQWin Database

Database	Number of Stations	Number of Active Stations *	Number of Parameters
Faro	114	63	211
Farogw	181	136	215
vang	77	40	207
TOTAL	372	239	633

* the number of active stations was approximated by identifying all stations for which data exists from 2003 or 2004

2.2 Stations

In each database, each station has an ID, code and description assigned to it. Depending on the database there may be two descriptions and column headings also associated to the station. The station code is the

reference, which the database uses to identify the station to the user. The station ID is what the database uses to reference the station for queries and other database functions. The station ID is unique, however more than one station can have the same Station Code. Typically, however, stations do not have the same Station Code, as this would cause confusion for the user. The description or the column headings are used in the data export function

2.3 Parameters

In each database, each parameter has a code, description, units, and, usually, a detection limit assigned to it. Depending on the database, the parameter may also have a class, column headings, a flag if the parameter is calculated, and a field to permit text to be entered. In all three databases, there is only capacity for one value each to be associated with the parameter for the units and detection limit fields. When data is imported into EQWin, if the input unit for the parameter does not match the EQWin unit for that parameter the database will automatically convert the units for the user. However, if the units are not imported with the data then any errors in units are overlooked.

3. QA/QC Protocol

The following methodology was submitted and approved in the project workplan. A copy of the protocol is provided in Appendix D. The protocol was developed to provide a framework to use when reviewing the water quality data including error identification, statistical analysis for outliers, treatment of errors/outliers and tracking all changes made to the database. The protocol ensures consistency in the review and correction of data in the database and a template for documenting the entire process.

The protocol includes a template for general database clean up to deal with non-numerical errors and problems such as duplicate station name. In addition a framework for the investigation and documentation of changes in laboratory detection limits was provided.

3.1 Prioritization

To facilitate the QA/QC of the database the stations were given the following order of priority.

1. Adaptive Management Plan (AMP) Related Stations (trigger and monitoring).
2. Tailings Area Groundwater Stations (not included in leakage testing).
3. Remaining Water Licence Monitoring Stations.
4. Others.

This approach addresses current needs in a prioritized manner.

3.2 Numerical Errors and Outliers

When reviewing the Anvil Range Database, there are several extreme values that are separated from the majority of the data set. These values are called outliers. The EPA Practical Methods for Data Analysis (EPA QA/G-9) defines outliers as "…measurements that are extremely large or small relative to the rest of the data and, therefore, are suspected of misrepresenting the population from which they were collected."

Outliers in the Anvil Range Database may be the result of:

- transcription errors during historic database development;
- misreported or undetected changes in detection limits in data received from the laboratory;
- transcription errors during monthly database update; or
- measurement problems during sample collection such as sample contamination or mislabeling of sample.

These are termed "true outliers". They may, however, represent actual extreme values of the various parameters (hot spots or peak events) and be an indication of the "natural" variability of the data set: "false outliers". It is essential to determine if an outlier is a true outlier to ensure proper handling of the data and ultimate interpretation of the results. Removing a false outlier instead of a true outlier can lead to a misrepresentation of the site water quality data.

There are a variety of statistical tests available to identify data points that are outliers. These tests are used only to identify outliers that need further investigation. They do not determine whether the outlier should be discarded, corrected or replaced. This is done based on a detail analysis of the source of the outlier. Outlier tests should be used with care and data only removed if a sound technical reason can be found (Burke, 2003). The following sections outline the four primary steps that are used to deal with outliers in the Anvil Range Database. An example reporting form is provided in Appendix E.

3.2.1 Step 1 - Graphical Identification

Preliminary identification of potential extreme values are done using graphical methods. The first method is time series plots of the data directly using EQWIN. Each plot is visually screened for outliers. The station data is also exported to EXCEL and tables of all the station data are produced.

3.2.2 Step 2 – Statistical Analysis

Once a potential outlier has been identified, the next step is to apply a statistical test, if necessary, to the data to provide confirmation of Step 1. This is done using a relatively simple statistical test in EXCEL

using the distance from the mean in multiples of the standard deviation. This is based on Grubbs' method for detecting outliers:

$$G_1 = (|\text{mean-value}|)/SD \text{ where SD is the Standard Deviation}$$

If the test values (G_1) are greater than the Grubbs' critical value obtained from statistical tables then the extreme values are unlikely to have occurred by chance alone and may be an outlier. For the purposes of this test a 95% confidence level is used (P-value < 0.05). The critical value increases with sample size. For large sample sizes (greater than 140) the program identifies data points with the Grubbs' test values that correspond to a P-value less than 0.05.

3.2.3 Step 3 – Detailed Analysis of Source

The next step is the review of statistical outliers as to their source. Where available (1999 and on), a review the actual laboratory analytical results provide the best check for possible transcription errors. For instance, in many cases outliers identified may be solely due to using the wrong units: parts per million instead of parts per billion. This error is readily seen in extreme values being out by a factor of 1000. Review of other site data is also be carried out to investigate possible sources of extreme values. Extreme or incorrect values occurring for all sample parameters during the same sampling event in similarly named sites may be the result of the samples simply being switched or parameters being switched. For example X21C mislabeled at X24C or mercury entered incorrectly as hardness. As well, the occurrence of extreme values in several related sample locations may be indicative of peak events or hot spots such as elevated levels of key parameters occurring at X14, X10, and X2 during the same sampling event.

3.2.4 Step 4 – Treatment of Outlier/Error

After the source of the outlier has been determined, the next step is to determine if the data point should be maintained, corrected or discarded. This step must be done with extreme caution as incorrect removal of data can result in a distortion of the data set and limits its applicability. Water Quality data sets can often contain legitimate extreme values. For the Anvil Range Database, it is recommended to only correct or discard a data point if there is adequate justification to do so such as "hard" confirmation using laboratory sheets or the outlier is obviously due to unit or sample mix up. The modification of the data point will be flagged in the database. For cases where it is not possible to determine the source of the extreme values, it is recommended that the point be maintained and flagged as an outlier. The flagging will be achieved through the use of a comment field in the Ms-Access database. The decision of whether to discard this point will then be left to the discretion of the individuals using the data. Any modifications made to the database must be approved by the Project Manager (Leslie Gomm).

4. Current Progress

Work on this project was commenced in the fall of 2004. Deloitte & Touche received a memo up-date on the project on October 31, 2004. At that time the QA/QC protocol (Section 3) had been completed. The initial phase of the database review had been initiated. Time series graphs had been developed for some of the key stations and potential outliers/errors had been identified for those stations. Two forms were developed for the database review: a QA/QC Form and a General Database Maintenance Form. (Appendix E).

Since October 31, 2004, time series graphs and tables of the complete records at over 40 AMP related stations have been produced. The graphical identification of outliers, detailed analysis of source and treatment of outliers/errors has been completed for 40 AMP related stations. Stoneleigh Associates has been hired as a sub-contractor to develop the MS-Access interface for the Water Quality database and has developed a final draft for review.

4.1 Maintenance of Water Quality Database

The AMP stations were given first priority. Of the 66 AMP related stations, 40 stations have been comprehensively reviewed according to the established protocol (Tables 2 to 5). Eleven stations in the original AMP are the P01 series wells that are currently under another study. These have been excluded from the AMP related stations for the purposes of this project because they are undergoing a comprehensive review as part of a separate project. The review includes the graphical identification of obvious outliers, changes in detection levels, and dissolved concentrations greater than total concentrations. For each outlier one QA/QC form is completed. Typically, for each station there are approximately 20 – 50 outliers, depending on the period of record and frequency of sampling at that station. For approximately half of these outliers either the original lab reports are not available or the data in the database is the same as those in the hard copy of the laboratory results and the reason for the outlier is not readily apparent. Gartner Lee has been using original laboratory reports dating back to 1999 as a resource and it has recently been determined that original lab reports dating further back have been identified and will be made available to Gartner Lee. This new data may reduce the number of outliers that currently are unexplained. It is likely that some of these outliers are naturally occurring. Also, as more stations are reviewed it is possible that more errors will be explained. For example, if samples have been switched or mis-entered these instances may become apparent as further stations are reviewed. The most common source of outliers/errors is the incorrect units. Over the years different labs have reported certain parameters in a variety of units. For example, cadmium was reported in ppb only in 2002. Another source of apparent outliers is a one-time change in detection limit. These are easily identified using the tabular record of the station data.

There is a very high incidence of dissolved metals greater than total metals for the same parameter and sample. All of these instances have been flagged on the QA/QC forms and found to correspond correctly to the laboratory data sheets.

Table 2. AMP surface water stations for which review is complete

Station Name	Station Location
X4	Intermediate Pond at Spillway
FAROCR	Outlet of Faro Creek Diversion
R3	Rose Creek Mid- length
R4	Rose Creek upstream of Anvil Creek
R5	Anvil Creek downstream of Rose Creek
R6	Anvil Creek upstream of Rose Creek
R7	N. Fork upstream of Faro Creek Diversion
R8	N. Fork downstream of Faro Creek Diversion
R9	N. Fork adjacent Zone 2 dumps
R10	N. Fork downstream Zone 2 dumps
V1	Main Stem Vangorda u.s. Pit
V2	Grum Creek to Vangorda Creek
V2A	Grum Dump to Moose Pond
V4	Shrimp Creek
V5	West Fork at gravel pit
V8	Lower Vangorda Creek at the footbridge
V27	Vangorda Creek u.s. Shrimp Creek
X2	North Fork of Rose Creek
X3	Pumphouse Pond
X5	Cross Valley Pond at surface outflow
X5P	Cross Valley Pond at Spillway
X10	Lower End Rose Creek Diversion
X11	Cross Valley Dam North Seep
X12	Cross Valley Dam South Seep
X13	Cross Valley Dam Total Seepage
X14	Rose Creek downstream of diversion channel confluence

Table 3. AMP groundwater stations for which review is complete

Station Name	Station Location
X16 B	Downstream of Tailings Facility
X17 B	Downstream of Tailings Facility
X18 A/B	Downstream of Tailings Facility
X21	Secondary Impoundment Dam
X24 A/B/C/D	Intermediate Dam
X25 A/B	Intermediate Dam
P01-02	Downstream of Tailings Facility
X16	Downstream of Tailings Facility
X17	Downstream of Tailings Facility
X18	Downstream of Tailings Facility
X21	Secondary Impoundment Dam
X24	Intermediate Dam
X25	Intermediate Dam
P01-02	Downstream of Tailings Facility

Table 4. AMP surface water stations awaiting review

Station Name	Station Location
GDHSECK	Guardhouse Creek at Intermediate Pond
NE1	N. Seep to N. Fork from NE Dumps
NE2	Central Seep to N. Fork from NE Dumps
NE3	S. Seep to N. Fork from NE Dumps
NF1	Upstream/Downstream side of Rock Drain
NF2	Upstream/Downstream side of Rock Drain
V14	Grum Rock Dump N. Toe Seep
V15	Grum Rock Dump Central Toe Seep
V16	Grum Rock Dump S. Toe Seep
V19	Vangorda Pit NW ditch
V20	Vangorda Pit NE ditch
V25BSP	Grum Ditch below Sheep Ponds
V29	Vangorda Dump Drains
V30	
V31	
V32	
V33	
GDHSECK	Guardhouse Creek at Intermediate Pond

Table 5. AMP groundwater stations awaiting review

Station Name	Station Location
BH1	Zone 2 Rock Dumps
BH2	Zone 2 Rock Dumps
BH4	Zone 2 Rock Dumps
BH12	N. East Rock Dumps
BH13	N. East Rock Dumps
BH14	N. East Rock Dumps
P01-51	Vangorda
P01-52	Vangorda
P03-04, P03-08, P03- 09	Rose Creek Tailings Facility Multi-levels
P03-09	Downstream of Tailings Facility
P96-09	Grum Rock dump
P96-6	Main/Intermediate Dumps
S1	Main/Intermediate Dumps
S2	Main/Intermediate Dumps
S3	Main/Intermediate Dumps
P96-9	Grum Rock Dump
V37	Vangorda Rock Dump Wells
V38	Vangorda Rock Dump Wells
V39	Vangorda Rock Dump Wells
V40	Vangorda Rock Dump Wells

In addition to the 40 AMP stations that have been reviewed three other stations have been reviewed: X23, X22B and VGMAIN. The time series and data tables of these stations were completed and printed prior to the commencement of this project; therefore they have been reviewed out of priority. It should be noted that all three stations fall into the 2nd priority category.

Additionally, eight stations have been identified in the *faro* database as containing two or less data records. It appears that the data associated with these stations is actually data corresponding to different station codes within the database with more complete records of the same station. For example, there are two station codes X13. The station ID is different. The station with ID 000: contains a record of data from 1986 to 2005. The station with ID 0046 contains only one line of data. These anomalies in station names have been flagged for correction in the new MS-Access version of the database. These more general database issues are being tracked as the data for each station is accessed and reviewed. Therefore, as more stations are reviewed, further general database clean-up can be expected.

Errors commonly found throughout the database include:

- Duplicate parameter names (i.e. SO4-T and SO4-D are used interchangeably throughout the database);
- Parameter data incorrectly entered (i.e in 2002 lanthium data incorrectly entered as lithium, strontium entered incorrectly as thallium);
- Parameters incorrectly named (i.e. thallium occurs twice in the parameter list as Tl and Th (later should be thorium); and,
- Units for silver, beryllium and cadmium entered incorrectly in 2002.

4.2 Conversion of Database to MS-Access

Stoneleigh Associates has developed a final draft MS-Access interface, using a common Access database application. The basic relational design has been in use for almost 20 years and typically includes a separate linked database for common reference look up tables. Stoneleigh has produced a database titles "WATER" for the Water Quality Database, which will be tailored to the specific needs of the Anvil Range data. The current data has been imported into the WATER database (Version 1.2). This version of the WATER database is attached in electronic executable format and includes base pre-programmed queries, preliminary data entry QA/QC routines, QA/QC data editing procedures and base pre-formatted output report templates. This executable version is a replica of the actual database that is design protected for forms and reports. Table and queries are still editable and all procedures will work as designed. A copy of the user manual is provided in Appendix F. Stoneleigh Associates has liased with Environment Canada to ensure that the WATER version will be compatible with the tools that Environment Canada is currently developing.

5. Next Steps

The following outlines the recommended next steps in the ongoing QA/QC of the Anvil Range Water Quality Database:

1. Continued review of data within the database and identification of required data changes as per the QA/QC protocol (as previously "postponed" in favour of conversion to MS-Access).
2. Modifications to the data in the MS-Access database.
   All errors identified in the review of the data in the database should be corrected in the MS-Access database as per the QA/QC protocol. These edits will be done using the QA/QC Editing Dataview in the Access database. If a value is changed, the updated data is automatically set to the date of edit and the QA/QC Review Flag is set to " the valued is modified". A comment will also be added to the Update Note Field. The original data value will be stored in the Sample Remark Field.

   Note: Steps 1 and 2 should be carried out concurrently.

3. Consultation on and Refinement of the MS-Access Database
   An executable version of the Water Database (Version 1.2) should be placed on the eRoom for review. Followup meetings would be arranged to gather feedback on the database and suggestions for further refinement.
4. Final Summary Report
   A comprehensive summary report should be prepared outlining all changes made to the database as part of the ongoing QA/QC. All QA/QC forms would be appended to this final report.

Gartner Lee will forward a proposal for continuing this work per the recommended next steps at your convenience.

Appendices

Appendix A

Database Stations

Appendix A
Faro Station List

	Station code	Description
1	A25	A25
2	A26-7	Upper Pit Wall Area MPA3
3	A30	A30, Upper Pit Wall Zone MPA6 Sump
4	A31	A31, Upper Pit Wall near A30
5	A8	Main Pit Sump Zone MPC1
6	BXLPOND	Holding Pond at BXL/Stanchem Plants
7	D1	Upper Pit Wall Area MPA6 - D1
8	D2	Upper Pit Wall Area MPA6 - D2
9	D3	Upper Pit Wall Area MPA6 - D3
10	D4	Upper Pit Wall Area MPA6 - D4
11	D5	Upper Pit Wall Area MPA6 - D5
12	D6	Upper Pit Wall Area MPA6 - D6
13	DI	Distilled Water
14	DSRESWEIR	D/S Reservoir weir, flow station
15	F-ROCK	F-ROCK From seep survey
16	FAROCR	FAROCR, Faro Cr u/s of confluence NFRose
17	FC	Faro Creek above diversion channel
18	FCD	FCD, Faro Creek Diversion adjacent NE Waste Dumps
19	FCO	FCO, Old Faro Creek U/S Valley Dump
20	FCOB	FCOB, Inlet to upstream of pond
21	FDL	Faro Creek Diversion
22	FDU	FDU, Faro Creek Diversion U/S Valley Dump
23	FDU2	FDU2, Faro Ck Diversion at corner
24	FVW	Faro Valley Intercept
25	FWSD1	Fresh Water Supply Dam - Station One
26	FWSD2	Fresh Water Supply Dam - Station Two
27	FWSD5	Fresh Water Supply Dam - Station Five
28	FWSD5-REP	FWSD5 - Duplicate sample
29	FWSD6	Fresh Water Supply Dam - Station Six
30	GCULV	Grum Culvert-Ross River resident usage
31	GCULV-REP	Grum Culvert - Duplicate sample
32	GHCWD	Guardhouse Creek at Waste Dump
33	GHSCR1	GHSCR1, Guardhouse Creek below Waste Dump
34	GHSCR2	GHSCR2, Guardhouse Creek u/s of Int. Impoundment
35	GRUMCR	Grum Corner
36	IDSEEP1	IDSEEP, Int. Dam Seep near west abutment
37	IDSEEP2	IDSEEP2, Int. Dam Seep near West Abutment
38	K8	K8-Ross River resident usage
39	K8-REP	K8-REP-Duplucate sample of K8
40	MPA8	Upper Pit Wall Area NE Corner
41	MPA8-13	Upper Pit Wall Area NE Corner
42	MPA8-14	Upper Pit Wall Area NE Corner
43	MPA8-16	Upper Pit Wall Area NE Corner
44	MPA8-16F	Upper Pit Wall Area MPA8 NE Corner
45	MPA8-17	Upper Pit Wall Area NE Corner
46	MPA8-18	Upper Pit Wall Area NE Corner
47	MPA8-19	Upper Pit Wall Area NE Corner
48	NE1	NE1, flow to N.Fork from NE Dumps (closer to R7)
49	NE2	NE2, flow to N.Fork from NE Dumps (mid NE1&3)
50	NE3	NE3, flow to N.Fork from NE Dumps (further from R7
51	NF1	NF1, North Fork Rose Creek Site 1 u/s of Haul Road

Appendix A
Faro Station List

	Station code	Description
52	NF2	NF2, North Fork Rose Creek Site 2 d/s of Haul Road
53	NWI	North Wall Interceptor
54	NWINT	NWINT, NW Interceptor ditch u/s of X5
55	R1	R1, Rose Creek upstream of Pumphouse Pond
56	R10	R10, North Fork of Rose Creek u/s of rock drain
57	R11	R11 - Mouth of Anvil Creek
58	R2	R2, Rose Creek near X14
59	R3	R3, Rose Creek between X14 and R4
60	R4	R4, Rose Creek upstream of Anvil Creek
61	R5	R5, Anvil Creek downstream of Rose Creek
62	R6	R6, Anvil Creek upstream of Rose Creek
63	R7	R7, N Fork of Rose Creek above Faro Ck Diversion
64	R8	R8, N Fork of Rose Creek 900 m below Faro Ck Div.
65	R9	R9, N Fork of Rose Creek adjacent BH1 and BH2
66	RES.WEIR	Reservoir weir, flow station
67	ROSESTVREC	Rose Cr D/S Stevens Recorder
68	SFORKROSE	S Fork of Rose Cr
69	SP5-6	SP5-6, Ditch to Main pit from NE Dumps
70	W10	W10, Upper Guardhouse Ck u/s of NW Dump
71	W11	South Main Waste Dump Toe - W11
72	W2	East Waste Dump Toe - W2
73	W3	East Waste Dump Toe - W3
74	W5	East Waste Dump Toe - W5
75	W8	W8, Upper Guardhouse Creek d/s of NW Dump
76	WE16	Seep Monitoring ????????
77	WEIR3	WEIR3, seepage from central area of X-Valley Dam
78	X1	Old Tailings Pond decant
79	X10	X10, Rose Creek Diversion Channel below weirs
80	X10-REP	X10 replicate sample - field duplicate
81	X10A	Rose Creek just u/s confluence with X13/X5 water
82	X10B	Rose Creek just d/s confluence with X13/X5 water
83	X11	X11, Seepage from north toe of Cross Valley Dam
84	X12	X12, Seepage from south toe of Cross Valley Dam
85	X13	X13, Combined seepage from Cross Valley Dam
86	X13	X13
87	X13-REP	X13-Replicate Sample
88	X13-Rep	X13 - Filed Duplicate of Station X13
89	X13B	X13/X5 water just u/s of confluence with Rose Ck
90	X14	X14, Rose Cr downstream of the diversion channel
91	X14-Rep	X14 - Field Duplicate of Station X14
92	X2	X2, N Fork of Rose Creek u/s of mine access road
93	X22	Faro Pit dewatering (from bottom of pit)
94	X22A	Faro Pit dewatering (from Sump A30)
95	X22B	X22B, Faro Pit water while filling with tailings
96	X22B-REP	X22B replicate sample - field duplicate
97	X22L	X22L, Faro Main Pit at Depth in O2 Depleted Layer
98	X23	X23, Old Faro Creek channel at toe of waste dumps
99	X26	X26, Zone II Pit water (from well)
100	X3	X3, S Fork Rose Creek at the pumphouse reservoir
101	X3-REP	X3 replicate sample - field duplicate

Appendix A
Faro Station List

	Station code	Description
102	X4	X4, Intermediate Dam decant
103	X4-REP	X4 replicate sample - field duplicate
104	X4A	Overflow from Int. Pond After Lime Addition
105	X5	X5, Cross Valley Pond outflow
106	X5-REP	X5 - Field Duplicate of Station X5
107	X5C	X5, without rinsing plastic bottle
108	X5L	Cross Valley Pond at Depth
109	X5P	X5P
110	X5P-REP	X5P - Replicate Sample
111	X7	X7, Old Faro Creek Channel at mine access road
112	X7A	X7A, Seep below mine access road
113	X9	Tailings Slurry discharge???
114	X9F	Decant of tailings slurry from mill

Appendix A
Faro Groundwater Station List

	Station code	Description
1	BH1	BH1, W of Zone II, by NFR Cr. (5.18m)
2	BH10A	BH10A, W of Zone II, by NFR Cr. (34.17m)
3	BH10B	BH10B, W of Zone II, by NFR Cr. (52.92m)
4	BH11	BH11, W of Zone II, by NFR Cr. (54.80m)
5	BH12A	BH12A, W of Zone II, by NFR Cr. (2.85m)
6	BH12B	BH12B, W of Zone II, by NFR Cr. (8.05m)
7	BH13A	BH13A, W of Zone II, by NFR Cr. (3.64m)
8	BH13B	BH13B, W of Zone II, by NFR Cr. (4.25m)
9	BH14A	BH14A, W of Zone II, by NFR Cr. (6.22m)
10	BH14B	BH14B, W of Zone II, by NFR Cr. (10.00m)
11	BH15A	BH15A, Area by SP5/6 seep site (13.70m)
12	BH15B	BH15B, Area by SP5/6 seep site (damaged)
13	BH15C	BH15C, Area by SP5/6 seep site (damaged)
14	BH16A	BH16A,Left side of access road to Faro Pit (6.46m)
15	BH16B	BH16B,Left side of access road to Faro Pit (6.90m)
16	BH16C	BH16C,Left side of access road to Faro Pit (6.28m)
17	BH2	BH2, W of Zone II, by NFR Cr. (5.55m)
18	BH4	BH4, W of Zone II, by NFR Cr. (3.20m)
19	BH5	BH5, W of Zone II, by NFR Cr. (8.33m)
20	BH6	BH6, W of Zone II, by NFR Cr. (6.55m)
21	BH7A	BH7A, W of Zone II, by NFR Cr. (9.00m)
22	BH7B	BH7B, W of Zone II, by NFR Cr. (6.78m)
23	BH8	BH8, Wof Zone II, by NFR Cr. (21.00m)
24	BH83-4B	BH83-4B, 2ND IMPOUNDMENT
25	BH83-4C	BH83-4C, 2ND IMPOUNDMENT
26	BH88-2.2A	BH88-2.2A, 2ND IMPOUNDMENT TAILINGS
27	BH88-2.2B	BH88-2.2B, 2ND IMPOUNDMENT TAILINGS
28	BH88-2.2C	BH88-2.2C, 2ND IMPOUNDMENT TAILINGS
29	BH88-2.5	BH88-2.5, 2ND IMPOUNDMENT TAILINGS
30	BH9	BH9, W of Zone II, by NFR Cr. (approx 55m)
31	BH3	BOREHOLE - damaged
32	CVDC-4D	CVDC-4D, CV-D CREST NORTH
33	CVDC-7D	CVDC-7D, CV-D CREST CENTER
34	CVDC-7S	CVDC-7S, CV-DCREST CENTER
35	CVDC-9D	CVDC-9D, CV-D CREST SOUTH
36	CVDC-9S	CVDC-9S, CV-D CREST SOUTH
37	CVDT-1	CVDT-1, CV-D TOE NORTH
38	CVDT-2	CVDT-2, CV-D TOE CENTER
39	P03-08-1	Deepest point in aquifer. Sampling from 85.2ft.
40	ID4-D	ID4-D, INT-D CENTER
41	P01-01A	P01-01A d.s. of cross valley dam N. side, 21.4m
42	P01-01B	P01-01B d.s. of Cross Valley Dam, N. side, 34.9m
43	P01-02A	P01-02A toe of Cross Valley Dam, S. side, 13.9m
44	P01-02B	P01-02B toe of Cross Valley Dam, S. side, 27.7m
45	P01-03	P01-03 toe of Intermediate Dam, N. side, 9.2m
46	P01-04A	P01-04A toe of Intermediate Dam, S. side, 33.2m
47	P01-04B	P01-04B toe of Intermediate dam, S. side, 52.5m
48	P01-05A	P01-05A Intermediate Impoundment (tailings), 10.5m
49	P01-05B	P01-05B Intermediate Impoundment, 15.6m
50	P01-06	P01-06 toe of Second Dam, 10.5m
51	P01-07A	P01-07A Second Impoundment (tailings), 18.0m
52	P01-07B	P01-07B Second Impoundment (tailings), 23.3m
53	P01-07C	P01-07C Second Impoundment, 27.7m
54	P01-07D	P01-07D Second Impoundment, 34.1m

Appendix A
Faro Groundwater Station List

	Station code	Description
55	P01-07E	P01-07E Second Impoundment, 40.2m
56	P01-08A	P01-08A Original Impoundment (tailings), 15.1m
57	P01-08B	P01-08B Original Impoundment, 25.6m
58	P01-08C	P01-08C Original Impoundment, 29.7m
59	P01-09A	P01-09ASecond Impoundment(tailings) upstream 11.2m
60	P01-09B	P01-09B Second Impoundment upstream, 16.0m
61	P01-09C	P01-09C Second Impoundment upstream, 21.2m
62	P01-09D	P01-09D Second Impoundment, upstream, 27.9m
63	P01-10A	P01-10AOriginal Impoundment(tailings)upstream14.9m
64	P01-10B	P01-10B Original Impoundment, upstream, 21.2m
65	P01-11	P01-11 toe of Cross Valley Dam N. side, 10.6m
66	P03-03-01	P03-01-01
67	P03-01-01	P03-01-01
68	P03-01-02	P03-01-02
69	P03-01-03	P03-01-03
70	P03-01-04	P03-01-04
71	P03-01-05	P03-01-05
72	P03-01-06	P03-01-06
73	P03-01-07	P03-01-07
74	P03-01-08	P03-01-08
75	P03-01-09	P03-01-09
76	P03-02-01	P03-02-01
77	P03-02-02	P03-02-02
78	P03-02-03	P03-02-03
79	P03-02-04	P03-02-04
80	P03-02-05	P03-02-05
81	P03-02-06	P03-02-06
82	P03-02-07	P03-02-07
83	P03-02-08	P03-02-08
84	P03-02-09	P03-02-09
85	P03-03-02	P03-03-02
86	P03-03-03	P03-03-03
87	P03-03-04	P03-03-04
88	P03-03-05	P03-03-05
89	P03-03-06	P03-03-06
90	P03-03-07	P03-03-07
91	P03-03-08	P03-03-08
92	P03-04-01	P03-04-01
93	P03-04-02	P03-04-02
94	P03-04-03	P03-04-03
95	P03-04-04	P03-04-04
96	P03-04-05	P03-04-05
97	P03-04-06	P03-04-06
98	P03-04-07	P03-04-07
99	P03-04-08	P03-04-08
100	P03-04-09	P03-04-09
101	P03-05-01	P03-05-01
102	P03-05-02	P03-05-02
103	P03-05-03	P03-05-03
104	P03-05-04	P03-05-04
105	P03-05-05	P03-05-05
106	P03-05-06	P03-05-06
107	P03-05-07	P03-05-07
108	P03-05-08	P03-05-08

Appendix A
Faro Groundwater Station List

	Station code	Description
109	P03-05-09	P03-05-09
110	P03-06-01	P03-06-01
111	P03-06-02	P03-06-02
112	P03-06-03	P03-06-03
113	P03-06-04	P03-06-04
114	P03-06-05	P03-06-05
115	P03-06-06	P03-06-06
116	P03-06-07	P03-06-07
117	P03-07-01	P03-07-01
118	P03-07-02	P03-07-02
119	P03-07-03	P03-07-03
120	P03-07-04	P03-07-04
121	P03-07-05	P03-07-05
122	P03-07-06	P03-07-06
123	P03-07-07	P03-07-07
124	P03-07-08	P03-07-08
125	P03-08-01	P03-08-01
126	P03-08-02	P03-08-02
127	P03-08-03	P03-08-03
128	P03-08-04	P03-08-04
129	P03-08-05	P03-08-05
130	P03-08-06	P03-08-06
131	P03-08-07	P03-08-07
132	P03-08-08	P03-08-08
133	P03-09-01	P03-09-01
134	P03-09-02	P03-09-02
135	P03-09-03	P03-09-03
136	P03-09-04	P03-09-04
137	P03-09-05	P03-09-05
138	P03-09-06	P03-09-06
139	P03-09-07	P03-09-07
140	P03-09-08	P03-09-08
141	P03-09-09	P03-09-09
142	P81-4S	P81-4C, 2nd impound into tailings (shallow)
143	P81-4D	P81-4D,2nd impound into sand/gravel aquifer (deep)
144	P81-5	P81-5, 1974 DAM
145	P81-9	P81-9, U/S TAILINGS IMPOUNDMENTS
146	P96-1	P96-1, S crest Int Dam. Intended for SWL (23.00m)
147	P96-2	P96-2, N crest Int Dam. Intended for SWL (20.87m)
148	P96-6	P96-6, Toe Int Dump above Rock Drain (20.85m)
149	P96-7	P96-7, Toe Main Dump, below Haul Road (9.90m)
150	P96-8A	P96-8A, Old Faro Cr channel by X23 (4.87m)
151	P96-8B	P96-8B, Old Faro Cr channel by X23 (9.30m)
152	PW3	PW3, NEAR PUMPHOUSE POND
153	PW4	PW4, U/S TAILINGS IMPOUNDMENT
154	PW5	PW5, GROUNDWATER WELL
155	PW6	PW6, NEAR PUMPHOUSE POND
156	S1A	S1A, S of Sulphide Waste Dump (12.80m)
157	S1B	S1B, S of Sulphide Waste Dump (5.37m)
158	S2A	S2A, S of Sulphide Waste Dump (8.04m)
159	S2B	S2B, S of Sulphide Waste Dump (10.60m)
160	S3	S3, S of Sulphide Waste Dump (6.56m)
161	TH86-17	TH86-17
162	TH86-26	TH86-26

Appendix A
Faro Groundwater Station List

	Station code	Description
163	X16A	X16A, By Rose Cr d/s CVDam (5m)
164	X16B	X16B, By Rose Cr d/s CVDam (30m)
165	X17A	X17A, d/s CVdam & u/s of X14 across diversion (5m)
166	X17B	X17B,d/s CVDam & u/s of X14 across diversion (20m)
167	X18A	X18A,N of CVDam, & right of access rd to X14 (10m)
168	X18B	X18B,N of CVDam, & right of access rd to X14 (20m)
169	X19A	X19A, d/s CVDam by X13 (12m)
170	X19B	X19B, d/s CVDam by X13 (27m)
171	X20	X20, Groundwater d/s CVDam and across diversion
172	X21A-96	X21A-96, Toe 2nd Impoundment (9.22m), P96-5A
173	X21B-96	X21B-96, Toe 2nd Impoundment (15.43m), P96-5B
174	X21C-96	X21C-96, Toe 2nd Impoundment (30.18m), P96-5C
175	X24A-96	X24A-96, N abutment Int Dam (5.88m), P96-4A
176	X24B-96	X24B-96, N abutment Int Dam (10.80m), P96-4B
177	X24C-96	X24C-96, N abutment Int Dam (15.87), P96-4C
178	X24D-96	X24D-96, N abutment Int Dam (28.22m), P96-4D
179	X25A-96	X25A-96, S abutment Int Dam (9.65m),P96-3A
180	X25B-96	X25B-96, S abutment Int Dam (19.80m),P96-3B
181	P03-03-09	

Appendix A
Vangorda Station List

	Station code	Description
1	GD1	GD1, Grum Dump toe seep just west of V15
2	GD2	GD2,seep/marsh near west end of Grum dump toe road
3	INSPOND	INSPOND, Inflow to the Sheep Pad Pond
4	LCD	LCD, Little Creek Dam Pond Water
5	OUTSPOND	OUTSPOND, Outflow from the Sheep Pad Pond
6	P01-51	
7	P01-52A	
8	P01-52B	
9	P2001-02A	Groundwater Well P2001-02A (27.3m)
10	P2001-02B	Groundwater Monitoring Well P2001-02B (13.9m)
11	P2001-03	Groundwater Monitoring Well P2001-03 (61.6m)
12	P96-9A	96-9A, Groundwater at the toe of Grum dump
13	P96-9B	96-9B, Groundwater at toe of Grum dump
14	SLOT	Slot Cut Water
15	V1	V1, Vangorda Creek, upstrm of mine & Blind Cr. Rd
16	V10	??
17	V11	??
18	V14	V14, Grum Dump southwest sump
19	V15	V15, Sulphide cell sump, Grum Dump
20	V16	V16, Grum Dump, southeast sump
21	V17	Grum Dump, NW interceptor ditch (V17)
22	V17A	V17A, Runoff from ore transfer pad
23	V18	V18, Grum Dump, SE interceptor ditch
24	V19	V19, Vangorda pit, NW interceptor ditch
25	V19CULVERT	V19CULVERT, Vangorda Cr below haul road crossing
26	V2	V2, Grum Creek, upstr. of Vangorda Ck
27	V20	V20, Vangorda pit, NE interceptor ditch
28	V21	V21, Vangorda dump, collector sump
29	V21A	V21A, VG Dump Collector Ditch @ LCD
30	V22	V22, Vangorda pit water
31	V23	V23, Grum Pit Water
32	V23A	V23A, Grum Pit Water Holding Pond
33	V24	V24, Influent to water treatment plant
34	V25	V25, Effluent from treatment plant, clarification
35	V25AF	V25AF, Effluent from treatment plant, after flume
36	V25BF	V25BF, Effluent from treatment, before flume
37	V25BSP	V25BSP, Below Sheep Pond at the weir
38	V25DS	Downstream of V25?
39	V25PP	Vangorda Creek Plunge Pool
40	V26	V26, Little Creek between pit and dumps
41	V27	V27, Vangorda Creek, just upstr. of Shrimp
42	V28	V28, Vangorda Dump drain #1
43	V29	V29, Vangorda Dump drain #2
44	V2A	V2A, Grum Creek Diversion to Moose Pond
45	V3	?
46	V30	V30, Vangorda Dump drain #3
47	V31	V31, Vangorda Dump drain #4
48	V32	V32, Vangorda Dump drain #5
49	V33	V33, Vangorda Dump drain #6
50	V34	V34, groundwater well GW94-01
51	V35	V35, groundwater well GW94-02

Appendix A
Vangorda Station List

	Station code	Description
52	V36	V36, groundwater well GW94-03
53	V37	V37, groundwater well GW94-04
54	V38	V38, groundwater well GW94-05
55	V39	V39, Vangorda till berm, P-94-01A
56	V4	V4, Shrimp Creek, upstr. of Vangorda Creek
57	V40	V40, Vangorda till berm, P-94-01B
58	V41	V41, Vangorda till berm, P-94-02A
59	V42	V42, Vangorda till berm, P-94-02B
60	V43	V43, Vangorda till berm, P-94-02C
61	V44	V44, Vangorda till berm, P-94-03A
62	V45	V45, Vangorda till berm, P-94-03B
63	V46	V46, Vangorda till berm, P-94-04A
64	V47	V47, Vangorda till berm, P-94-04B
65	V5	V5, west fork Vangorda Creek
66	V6A	V6A, AEX Creek
67	V7	Grum exploration portal decant (V7)
68	V8	V8, lower Vangorda Creek
69	V8-REP	V8 Blind duplicate sample
70	VANGCK	Various locations in West Fork Vangorda Creek
71	VG1	VG dump ditch above drain #6
72	VGGR	VGGR, VG Creek at Grum turn off
73	VGMAIN	VGMAIN, Main Fork Vangorda Creek
74	VGMAIN-REP	VGMAIN Blind duplicate sample
75	VGSEEP	VGSEEP, VG pit ramp ditch/seepage
76	VXX	MAIN FORK V.G. CK. CALC. @ 67% OF V8
77	96-1	Grum underground workings

Appendix B

Database “Active” Stations

Appendix B
Faro Active Stations

	Station code	Description
1	A25	A25
2	A30	A30, Upper Pit Wall Zone MPA6 Sump
3	FAROCR	FAROCR, Faro Cr u/s of confluence NFRose
4	FCD	FCD, Faro Creek Diversion adjacent NE Waste Dumps
5	FCO	FCO, Old Faro Creek U/S Valley Dump
6	FDL	Faro Creek Diversion
7	FDU	FDU, Faro Creek Diversion U/S Valley Dump
8	FWSD1	Fresh Water Supply Dam - Station One
9	FWSD5	Fresh Water Supply Dam - Station Five
10	FWSD5-REP	FWSD5 - Duplicate sample
11	FWSD6	Fresh Water Supply Dam - Station Six
12	GCULV	Grum Culvert-Ross River resident usage
13	GCULV-REP	Grum Culvert - Duplicate sample
14	GHSCR1	GHSCR1, Guardhouse Creek below Waste Dump
15	GRUMCR	Grum Corner
16	IDSEEP1	IDSEEP, Int. Dam Seep near west abutment
17	K8	K8-Ross River resident usage
18	K8-REP	K8-REP-Duplucate sample of K8
19	NE1	NE1, flow to N.Fork from NE Dumps (closer to R7)
20	NE2	NE2, flow to N.Fork from NE Dumps (mid NE1&3)
21	NF1	NF1, North Fork Rose Creek Site 1 u/s of Haul Road
22	NF2	NF2, North Fork Rose Creek Site 2 d/s of Haul Road
23	R1	R1, Rose Creek upstream of Pumphouse Pond
24	R10	R10, North Fork of Rose Creek u/s of rock drain
25	R11	R11 - Mouth of Anvil Creek
26	R2	R2, Rose Creek near X14
27	R3	R3, Rose Creek between X14 and R4
28	R4	R4, Rose Creek upstream of Anvil Creek
29	R5	R5, Anvil Creek downstream of Rose Creek
30	R6	R6, Anvil Creek upstream of Rose Creek
31	R7	R7, N Fork of Rose Creek above Faro Ck Diversion
32	R8	R8, N Fork of Rose Creek 900 m below Faro Ck Div.
33	R9	R9, N Fork of Rose Creek adjacent BH1 and BH2
34	SP5-6	SP5-6, Ditch to Main pit from NE Dumps
35	W10	W10, Upper Guardhouse Ck u/s of NW Dump
36	W3	East Waste Dump Toe - W3
37	W5	East Waste Dump Toe - W5
38	W8	W8, Upper Guardhouse Creek d/s of NW Dump
39	WEIR3	WEIR3, seepage from central area of X-Valley Dam
40	X10	X10, Rose Creek Diversion Channel below weirs
41	X10-REP	X10 replicate sample - field duplicate
42	X11	X11, Seepage from north toe of Cross Valley Dam
43	X12	X12, Seepage from south toe of Cross Valley Dam
44	X13	X13, Combined seepage from Cross Valley Dam
45	X13	X13
46	X13-REP	X13-Replicate Sample
47	X13-Rep	X13 - Filed Duplicate of Station X13
48	X14	X14, Rose Cr downstream of the diversion channel
49	X14-Rep	X14 - Field Duplicate of Station X14
50	X2	X2, N Fork of Rose Creek u/s of mine access road
51	X22B	X22B, Faro Pit water while filling with tailings

Appendix B
Faro Active Stations

	Station code	Description
52	X22B-REP	X22B replicate sample - field duplicate
53	X23	X23, Old Faro Creek channel at toe of waste dumps
54	X26	X26, Zone II Pit water (from well)
55	X3	X3, S Fork Rose Creek at the pumphouse reservoir
56	X3-REP	X3 replicate sample - field duplicate
57	X4	X4, Intermediate Dam decant
58	X4-REP	X4 replicate sample - field duplicate
59	X5	X5, Cross Valley Pond outflow
60	X5-REP	X5 - Field Duplicate of Station X5
61	X5P	X5P
62	X5P-REP	X5P - Replicate Sample
63	X7	X7, Old Faro Creek Channel at mine access road

Appendix B
Faro Groundwater Active Stations

	Station code	Description
1	BH1	BH1, W of Zone II, by NFR Cr. (5.18m)
2	BH12A	BH12A, W of Zone II, by NFR Cr. (2.85m)
3	BH12B	BH12B, W of Zone II, by NFR Cr. (8.05m)
4	BH13A	BH13A, W of Zone II, by NFR Cr. (3.64m)
5	BH13B	BH13B, W of Zone II, by NFR Cr. (4.25m)
6	BH14A	BH14A, W of Zone II, by NFR Cr. (6.22m)
7	BH14B	BH14B, W of Zone II, by NFR Cr. (10.00m)
8	BH2	BH2, W of Zone II, by NFR Cr. (5.55m)
9	BH4	BH4, W of Zone II, by NFR Cr. (3.20m)
10	P01-01A	P01-01A d.s. of cross valley dam N. side, 21.4m
11	P01-01B	P01-01B d.s. of Cross Valley Dam, N. side, 34.9m
12	P01-02A	P01-02A toe of Cross Valley Dam, S. side, 13.9m
13	P01-02B	P01-02B toe of Cross Valley Dam, S. side, 27.7m
14	P01-03	P01-03 toe of Intermediate Dam, N. side, 9.2m
15	P01-04A	P01-04A toe of Intermediate Dam, S. side, 33.2m
16	P01-04B	P01-04B toe of Intermediate dam, S. side, 52.5m
17	P01-05A	P01-05A Intermediate Impoundment (tailings), 10.5m
18	P01-05B	P01-05B Intermediate Impoundment, 15.6m
19	P01-06	P01-06 toe of Second Dam, 10.5m
20	P01-07A	P01-07A Second Impoundment (tailings), 18.0m
21	P01-07B	P01-07B Second Impoundment (tailings), 23.3m
22	P01-07C	P01-07C Second Impoundment, 27.7m
23	P01-07D	P01-07D Second Impoundment, 34.1m
24	P01-07E	P01-07E Second Impoundment, 40.2m
25	P01-08A	P01-08A Original Impoundment (tailings), 15.1m
26	P01-08B	P01-08B Original Impoundment, 25.6m
27	P01-08C	P01-08C Original Impoundment, 29.7m
28	P01-09A	P01-09ASecond Impoundment(tailings) upstream 11.2m
29	P01-09B	P01-09B Second Impoundment upstream, 16.0m
30	P01-09C	P01-09C Second Impoundment upstream, 21.2m
31	P01-09D	P01-09D Second Impoundment, upstream, 27.9m
32	P01-10A	P01-10AOriginal Impoundment(tailings)upstream14.9m
33	P01-10B	P01-10B Original Impoundment, upstream, 21.2m
34	P01-11	P01-11 toe of Cross Valley Dam N. side, 10.6m
35	P03-03-01	P03-01-01
36	P03-01-01	P03-01-01
37	P03-01-02	P03-01-02
38	P03-01-03	P03-01-03
39	P03-01-04	P03-01-04
40	P03-01-05	P03-01-05
41	P03-01-06	P03-01-06
42	P03-01-07	P03-01-07
43	P03-01-08	P03-01-08

Appendix B
Faro Groundwater Active Stations

	Station code	Description
44	P03-01-09	P03-01-09
45	P03-02-01	P03-02-01
46	P03-02-02	P03-02-02
47	P03-02-03	P03-02-03
48	P03-02-04	P03-02-04
49	P03-02-05	P03-02-05
50	P03-02-06	P03-02-06
51	P03-02-07	P03-02-07
52	P03-02-08	P03-02-08
53	P03-02-09	P03-02-09
54	P03-03-02	P03-03-02
55	P03-03-03	P03-03-03
56	P03-03-04	P03-03-04
57	P03-03-05	P03-03-05
58	P03-03-06	P03-03-06
59	P03-03-07	P03-03-07
60	P03-03-08	P03-03-08
61	P03-04-01	P03-04-01
62	P03-04-02	P03-04-02
63	P03-04-03	P03-04-03
64	P03-04-04	P03-04-04
65	P03-04-05	P03-04-05
66	P03-04-06	P03-04-06
67	P03-04-07	P03-04-07
68	P03-04-08	P03-04-08
69	P03-04-09	P03-04-09
70	P03-05-01	P03-05-01
71	P03-05-02	P03-05-02
72	P03-05-03	P03-05-03
73	P03-05-04	P03-05-04
74	P03-05-05	P03-05-05
75	P03-05-06	P03-05-06
76	P03-05-07	P03-05-07
77	P03-05-08	P03-05-08
78	P03-05-09	P03-05-09
79	P03-06-01	P03-06-01
80	P03-06-02	P03-06-02
81	P03-06-03	P03-06-03
82	P03-06-04	P03-06-04
83	P03-06-05	P03-06-05
84	P03-06-06	P03-06-06
85	P03-06-07	P03-06-07
86	P03-07-01	P03-07-01

Appendix B
Faro Groundwater Active Stations

	Station code	Description
87	P03-07-02	P03-07-02
88	P03-07-03	P03-07-03
89	P03-07-04	P03-07-04
90	P03-07-05	P03-07-05
91	P03-07-06	P03-07-06
92	P03-07-07	P03-07-07
93	P03-07-08	P03-07-08
94	P03-08-01	P03-08-01
95	P03-08-02	P03-08-02
96	P03-08-03	P03-08-03
97	P03-08-04	P03-08-04
98	P03-08-05	P03-08-05
99	P03-08-06	P03-08-06
100	P03-08-07	P03-08-07
101	P03-08-08	P03-08-08
102	P03-09-01	P03-09-01
103	P03-09-02	P03-09-02
104	P03-09-03	P03-09-03
105	P03-09-04	P03-09-04
106	P03-09-05	P03-09-05
107	P03-09-06	P03-09-06
108	P03-09-07	P03-09-07
109	P03-09-08	P03-09-08
110	P03-09-09	P03-09-09
111	P96-6	P96-6, Toe Int Dump above Rock Drain (20.85m)
112	P96-7	P96-7, Toe Main Dump, below Haul Road (9.90m)
113	P96-8A	P96-8A, Old Faro Cr channel by X23 (4.87m)
114	P96-8B	P96-8B, Old Faro Cr channel by X23 (9.30m)
115	S1A	S1A, S of Sulphide Waste Dump (12.80m)
116	S1B	S1B, S of Sulphide Waste Dump (5.37m)
117	S2A	S2A, S of Sulphide Waste Dump (8.04m)
118	S2B	S2B, S of Sulphide Waste Dump (10.60m)
119	S3	S3, S of Sulphide Waste Dump (6.56m)
120	TH86-17	TH86-17
121	X16A	X16A, By Rose Cr d/s CVDam (5m)
122	X16B	X16B, By Rose Cr d/s CVDam (30m)
123	X17A	X17A, d/s CVdam & u/s of X14 across diversion (5m)
124	X17B	X17B,d/s CVDam & u/s of X14 across diversion (20m)
125	X18A	X18A,N of CVDam, & right of access rd to X14 (10m)
126	X18B	X18B,N of CVDam, & right of access rd to X14 (20m)
127	X21A-96	X21A-96, Toe 2nd Impoundment (9.22m), P96-5A
128	X21B-96	X21B-96, Toe 2nd Impoundment (15.43m), P96-5B
129	X21C-96	X21C-96, Toe 2nd Impoundment (30.18m), P96-5C

Appendix B
Faro Groundwater Active Stations

	Station code	Description
130	X24A-96	X24A-96, N abutment Int Dam (5.88m), P96-4A
131	X24B-96	X24B-96, N abutment Int Dam (10.80m), P96-4B
132	X24C-96	X24C-96, N abutment Int Dam (15.87), P96-4C
133	X24D-96	X24D-96, N abutment Int Dam (28.22m), P96-4D
134	X25A-96	X25A-96, S abutment Int Dam (9.65m),P96-3A
135	X25B-96	X25B-96, S abutment Int Dam (19.80m),P96-3B
136	P03-03-09	

Appendix B
Vangorda Active Stations

	Station code	Description
1	LCD	LCD, Little Creek Dam Pond Water
2	P01-51	
3	P01-52A	
4	P01-52B	
5	P2001-02A	Groundwater Well P2001-02A (27.3m)
6	P2001-02B	Groundwater Monitoring Well P2001-02B (13.9m)
7	P2001-03	Groundwater Monitoring Well P2001-03 (61.6m)
8	P96-9A	96-9A, Groundwater at the toe of Grum dump
9	V1	V1, Vangorda Creek, upstrm of mine & Blind Cr. Rd
10	V14	V14, Grum Dump southwest sump
11	V15	V15, Sulphide cell sump, Grum Dump
12	V16	V16, Grum Dump, southeast sump
13	V17A	V17A, Runoff from ore transfer pad
14	V19	V19, Vangorda pit, NW interceptor ditch
15	V2	V2, Grum Creek, upstr. of Vangorda Ck
16	V20	V20, Vangorda pit, NE interceptor ditch
17	V22	V22, Vangorda pit water
18	V23	V23, Grum Pit Water
19	V24	V24, Influent to water treatment plant
20	V25	V25, Effluent from treatment plant, clarification
21	V25BSP	V25BSP, Below Sheep Pond at the weir
22	V27	V27, Vangorda Creek, just upstr. of Shrimp
23	V28	V28, Vangorda Dump drain #1
24	V29	V29, Vangorda Dump drain #2
25	V2A	V2A, Grum Creek Diversion to Moose Pond
26	V30	V30, Vangorda Dump drain #3
27	V31	V31, Vangorda Dump drain #4
28	V32	V32, Vangorda Dump drain #5
29	V33	V33, Vangorda Dump drain #6
30	V34	V34, groundwater well GW94-01
31	V35	V35, groundwater well GW94-02
32	V36	V36, groundwater well GW94-03
33	V37	V37, groundwater well GW94-04
34	V4	V4, Shrimp Creek, upstr. of Vangorda Creek
35	V5	V5, west fork Vangorda Creek
36	V6A	V6A, AEX Creek
37	V8	V8, lower Vangorda Creek
38	V8-REP	V8 Blind duplicate sample
39	VGMAIN	VGMAIN, Main Fork Vangorda Creek
40	VGMAIN-REP	VGMAIN Blind duplicate sample

Appendix C

Database Parameters

Appendix C
Faro Parameter List

Parameter code	Description	Units	Class
ACID-C	ACIDITY (CaCO3)	mg/L	ANIONS
ACID-T	TOTAL ACIDITY	mg/L	ANIONS
ACID4.5	Acidity at pH 4.5	mg/L	ANIONS
ACID8.3	Acidity at pH 8.3	mg/L	ANIONS
AG-D	SILVER: DISSOLVED Ag	mg/L	Metals - Dissolved
AG-E	SILVER: EXTRACTABLE Ag	mg/L	Metals - Extractable
AG-T	SILVER: TOTAL Ag	mg/L	Metals - Total
AL-D	ALUMINIUM: DISSOLVED Al	mg/L	Metals - Dissolved
AL-E	ALUMINUM: EXTRACTABLE Al	mg/L	Metals - Extractable
AL-T	ALUMINIUM: TOTAL Al	mg/L	Metals - Total
ALK-C	ALKALINITY: CARBONATE AS CaCO3	mg/L	ANIONS
ALK-D	ALKALINITY:DISSOLVED CaCO3	mg/L	ANIONS
ALK-H	ALKALINITY: HYDROXIDE	mg/L	ANIONS
ALK-P	ALKALINITY:PHENOLTHALEIN		ANIONS
ALK-T	ALKALINITY:TOTAL CaCO3	mg/L	ANIONS
AREA1	SO4 PRODUCTION RATE BY SURFACE AREA	mg/L	HUMIDITY C
AREA2	CUMULATIVE S04 RATE BY AREA	mg/L	HUMIDITY C
AS-D	ARSENIC: DISSOLVED As	mg/L	Metals - Dissolved
AS-E	ARSENIC: EXTRACTABLE As	mg/L	Metals - Extractable
AS-T	ARSENIC: TOTAL As	mg/L	Metals - Total
AU-D	GOLD: DISSOLVED Au	mg/L	Metals - Dissolved
AU-T	GOLD: TOTAL Au	mg/L	Metals - Total
B-D	BORON: DISSOLVED B	mg/L	Metals - Dissolved
B-E	BORON: EXTRACTABLE B	mg/L	Metals - Extractable
B-T	BORON: TOTAL B	mg/L	Metals - Total
BA-D	BARIUM: DISSOLVED Ba	mg/L	Metals - Dissolved
BA-E	BARIUM: EXTRACTABLE Ba	mg/L	Metals - Extractable
BA-T	BARIUM: TOTAL Ba	mg/L	Metals - Total
BE-D	BERYLLIUM: DISSOLVED Be	mg/L	Metals - Dissolved
BE-E	BERYLLIUM: EXTRACTABLE Be	mg/L	Metals - Extractable
BE-T	BERYLLIUM: TOTAL Be	mg/L	Metals - Total
BI-D	BISMUTH: DISSOLVED Bi	mg/L	Metals - Dissolved
BI-T	BISMUTH: TOTAL Bi	mg/L	Metals - Total
BOD	BIOCHEMICAL OXYGEN DEMAND	mg/L	MISCELLAN
CA-D	CALCIUM: DISSOLVED Ca	mg/L	Metals - Dissolved
CA-E	CALCIUM: EXTRACTABLE Ca	mg/L	Metals - Extractable
CA-T	CALCIUM: TOTAL Ca	mg/L	Metals - Total
CARCUM	CUMULATIVE CARBONATE DEPLETION	mg/kg	HUMIDITY C
CARDEP	CUMULATIVE CARBONATE DEPLETION	mg/L	HUMIDITY C
CD-D	CADMIUM: DISSOLVED Cd	mg/L	Metals - Dissolved
CD-E	CADMIUM: EXTRACTABLE Cd	mg/L	Metals - Extractable
CD-T	CADMIUM: TOTAL Cd	mg/L	Metals - Total
CL-D	CHLORIDE: DISSOLVED Cl	mg/L	ANIONS
CL-T	CHLORIDE: TOTAL Chloride	mg/L	ANIONS
CN-AMN	CYANIDE - AMENABLE TO CHLORINATION	mg/L	CYANIDES
CN-T	CYANIDE: TOTAL CN	mg/L	CYANIDES
CN-WAD	CYANIDE: WEAK ACID DISSOCIABLE	mg/L	CYANIDES
CNFREE	CYANIDE: FREE	mg/L	CYANIDES
CNO	CYANATE(CNO)	mg/L	CYANIDES
CNTHIO	CYANIDE THIO ????	mg/L	CYANIDES
CO-D	COBALT: DISSOVED Co	mg/L	Metals - Dissolved
CO-E	COBALT: EXTRACTABLE Co	mg/L	Metals - Extractable
CO-T	COBALT: TOTAL Co	mg/L	Metals - Total
COL-F	COLIFORM:FECAL	MPN/100 m	MISCELLAN
COL-T	COLIFORM:TOTAL	MPN/100 m	MISCELLAN
COLOR	COLOUR	Color Unit	PHYSICAL

Appendix C
Faro Parameter List

Parameter code	Description	Units	Class
COMMENTS	Sample Comments		
COND	SPECIFIC CONDUCTANCE	µS/cm	PHYSICAL
COND-F	SPECIFIC CONDUCTANCE - FIELD	µS/cm	PHYSICAL
COND-L	SPECIFIC CONDUCTANCE - LAB	µS/cm	PHYSICAL
COND-MG	Cond mg/L	mg/L	
CR-D	CHROMIUM: DISSOLVED Cr	mg/L	Metals - Dissolved
CR-E	CHROMIUM: EXTRACTABLE Cr	mg/L	Metals - Extractable
CR-T	CHROMIUM: TOTAL Cr	mg/L	Metals - Total
CRX-D	HEXAVALENT CHROMIUM: DISSOLVED CR	mg/L	Metals - Dissolved
CU-D	COPPER: DISSOLVED Cu	mg/L	Metals - Dissolved
CU-E	COPPER: EXTRACTABLE Cu	mg/L	Metals - Extractable
CU-T	COPPER: TOTAL Cu	mg/L	Metals - Total
DAYS	Time Represented by Sample	Days	MISCELLAN
DEBIT	DEBIT (FLOW M^3/min)	m^3/min	MISCELLAN
DEPTH	WATER LEVEL ELEVATION	meters	MISCELLAN
DO-F	DISSOLVED OXYGEN	mg/L	PHYSICAL
ELEV	MEASURED WATER ELEVATION	mg/L	MISCELLAN
F-D	FLUORIDE: DISSOLVED F	mg/L	ANIONS
F-T	FLOURIDE: TOTAL F	mg/L	ANIONS
FE-D	IRON: DISSOLVED Fe	mg/L	Metals - Dissolved
FE-E	IRON: EXTRACTABLE Fe	mg/L	Metals - Extractable
FE-T	IRON: TOTAL Fe	mg/L	Metals - Total
FLOW	FLOW RATE (m^3/day)	m^3/day	MISCELLAN
FLOWLS	FLOW RATE (L/s)	L/s	PHYSICAL
FLOWM3S	FLOW RATE M3/SEC	m3/sec	PHYSICAL
GA-T	GALLIUM: TOTAL Ga	mg/L	Metals - Total
HARD	HARDNESS: TOTAL (CACO3)	mg/L	PHYSICAL
HARD-C	Calculated Hardness (Ca + Mg)	mg/L	CALCULATE
HARD-D	HARDNESS: Dissolved	mg/L	PHYSICAL
HCO3	BICARBONATE	mg/L	ANIONS
HG-D	MERCURY: DISSOLVED Hg	mg/L	Metals - Dissolved
HG-T	MERCURY: TOTAL Hg	mg/L	Metals - Total
K-D	POTASSIUM: DISSOLVED K	mg/L	Metals - Dissolved
K-E	POTASSIUM: EXTRACTABLE K	mg/L	Metals - Extractable
K-T	POTASSIUM: TOTAL K	mg/L	Metals - Total
LA-D	LANTHANUM: DISSOLVED La	mg/L	Metals - Dissolved
LA-T	LANTHANUM: TOTAL La	mg/L	Metals - Total
LAB	Laboratory Used		
LC50	96-h MEDIAN LETHAL CONCENTRATION	%v/v	MISCELLAN
LI-D	LITHIUM: Dissolved Li	mg/L	Metals - Dissolved
LI-T	LITHIUM: TOTAL Li	mg/L	Metals - Total
LOADFE	Total Iron Loading	mg/s	CALCULATE
LOADSO4	SO4 Loading	mg/s	CALCULATE
LOADZN	Total Zinc Loading	mg/s	CALCULATE
MASS-1	WATER FLOW	m^3/day	MISCELLAN
MASS-2	SOLIDS MASS FLOW	kg/day	MISCELLAN
MASS-3	RECLAIM MASS WATER FLOW	mg/L	MISCELLAN
MG-D	MAGNESIUM: DISSOLVED Mg	mg/L	Metals - Dissolved
MG-E	MAGNESIUM: EXTRACTABLE Mg	mg/L	Metals - Extractable
MG-T	MAGNESIUM: TOTAL Mg	mg/L	Metals - Total
MN-D	MANGANESE: DISSOLVED Mn	mg/L	Metals - Dissolved
MN-E	MANGANESE: EXTRACTABLE Mn	mg/L	Metals - Extractable
MN-T	MANGANESE: TOTAL Mn	mg/L	Metals - Total
MO-D	MOLYBDENUM: DISSOLVED Mo	mg/L	Metals - Dissolved
MO-E	MOLYBDENUM: EXTRACTABLE Mo	mg/L	Metals - Extractable
MO-T	MOLYBDENUM: TOTAL Mo	mg/L	Metals - Total

Appendix C
Faro Parameter List

Parameter code	Description	Units	Class
MOLAR1	SO4/ALK	mg/L	HUMIDITY C
MOLAR2	ALK/Ca+Mg	mg/L	HUMIDITY C
MOLAR3	SO4/Ca	mg/L	HUMIDITY C
MOLAR4	CRITICAL SO4/Ca	mg/L	HUMIDITY C
MOLAR5	SO4/(Ca+Mg)		MISCELLAN
NA-D	SODIUM: DISSOLVED Na	mg/L	Metals - Dissolved
NA-E	SODIUM: EXTRACTABLE Na	mg/L	Metals - Extractable
NA-T	SODIUM: TOTAL Na	mg/L	Metals - Total
NACN	SODIUM CYANIDE	mg/L	CYANIDES
NH3	AMMONIA NITROGEN: NH3 AS N	mg/L	NUTRIENTS
NH3+4	AMMONIA + AMMONIUM	mg/L	NUTRIENTS
NI-D	NICKEL: DISSOLVED Ni	mg/L	Metals - Dissolved
NI-E	NICKEL: EXTRACTABLE Ni	mg/L	Metals - Extractable
NI-T	NICKEL: TOTAL Ni	mg/L	Metals - Total
NO2	NITRITE NITROGEN: NO2 AS N	mg/L	NUTRIENTS
NO2NO3	NITRITE + NITRATE	mg/L	NUTRIENTS
NO3	NITROGEN:NITRATE NO3 AS N	mg/L	NUTRIENTS
NP-REM	REMAINING NP	m^3/day	HUMIDITY C
O&G	OIL AND GREASE	mg/L	MISCELLAN
ORP	ORP - OXIDATION REDUCTION POTENTIAL	mg/L	HUMIDITY C
P-D	PHOSPHORUS: DISSOLVED P	mg/L	Metals - Dissolved
P-E	PHOSPHORUS: EXTRACTABLE P ??	mg/L	Metals - Extractable
P-ORTH	PHOSPHATE: ORTHO P ??	mg/L	NUTRIENTS
P-T	PHOSPHORUS: TOTAL P	mg/L	Metals - Total
P-TD	PHOSPHATE:TOTAL DISSOLVED ??	mg/L	NUTRIENTS
PAX	POTTASIUM AMYL ZANTHANTE	mg/L	MISCELLAN
PB-D	LEAD: DISSOLVED Pb	mg/L	Metals - Dissolved
PB-E	LEAD: EXTRACTABLE Pb	mg/L	Metals - Extractable
PB-T	LEAD: TOTAL Pb	mg/L	Metals - Total
PD-T	PALLADIUM: TOTAL Pd	mg/L	Metals - Total
PH-F	pH FIELD	pH unit	PHYSICAL
PH-L	pH LAB	pH unit	PHYSICAL
PHEN-T	PHENOL: TOTAL	mg/L	MISCELLAN
PHUS-D	PHOSPHORUS: DISSOLVED P	mg/L	NUTRIENTS
PHUS-T	PHOSPHORUS: TOTAL P	mg/L	NUTRIENTS
PO4	PHOSPHATE: PO4 AS P ??	mg/L	NUTRIENTS
PT-T	PLATINUM: TOTAL Pt	mg/L	Metals - Total
S-D	SULPHUR: DISSOLVED S	mg/L	Metals - Dissolved
S-E	SULPHUR: EXTRACTABLE S	mg/L	Metals - Extractable
S-REM	REMAINING SULPHUR	mg/L	HUMIDITY C
S-T	SULPHUR: TOTAL S	mg/L	Metals - Total
SAR	SODIUM ADSORPTION RATIO	No Unit	HUMIDITY C
SB-D	ANTIMONY: DISSOLVED Sb	mg/L	Metals - Dissolved
SB-E	ANTIMONY: EXTRACTABLE Sb	mg/L	Metals - Extractable
SB-T	ANTIMONY: TOTAL Sb	mg/L	Metals - Total
SC-T	SCANDIUM: TOTAL Sc	mg/L	Metals - Total
SCN	THIOCYANATE: SCN	mg/L	CYANIDES
SE-D	SELENIUM: DISSOLVED	mg/L	Metals - Dissolved
SE-E	SELENIUM: EXTRACTABLE Se	mg/L	Metals - Extractable
SE-T	SELENIUM: TOTAL Se	mg/L	Metals - Total
SI-D	SILICON: DISSOLVED Si	mg/L	Metals - Dissolved
SI-E	SILICON: EXTRACTABLE Si	mg/L	Metals - Extractable
SI-T	SILICON: TOTAL Si	mg/L	Metals - Total
SN-D	TIN: DISSOLVED Sn	mg/L	Metals - Dissolved
SN-E	TIN: EXTRACTABLE Sn	mg/L	Metals - Extractable
SN-T	TIN: TOTAL Sn	mg/L	Metals - Total

Appendix C
Faro Parameter List

Parameter code	Description	Units	Class
SO4-D	SULPHATE: DISSOLVED SO4	mg/L	ANIONS
SO4-T	SULPHATE: TOTAL SO4	mg/L	ANIONS
SO4CUM	CUMULATIVE SO4 RATE	mg/L	HUMIDITY C
SO4PRO	SO4 PRODUCTION RATE	mg/L	HUMIDITY C
SOLEXT	SOLVENT EXTRACTABLES	mg/L	MISCELLAN
SR-D	STRONTIUM: DISSOLVED Sr	mg/L	Metals - Dissolved
SR-E	STRONTIUM: EXTRACTABLE Sr	mg/L	Metals - Extractable
SR-T	STRONTIUM: TOTAL Sr	mg/L	Metals - Total
SWL	Staff Gauge or SWL	meters	
TDS	RESIDUE: FILTRABLE	mg/L	PHYSICAL
TDSRAT	TDS RATIO	No Unit	HUMIDITY C
TE-D	TELLURIUM: DISSOLVED Te	mg/L	Metals - Dissolved
TE-T	TELLURIUM: TOTAL Te	mg/L	Metals - Total
TEMP-C	TEMPERTURE	deg C	PHYSICAL
TEMP-F	TEMPERATURE	deg C	PHYSICAL
TH-D	THALLIUM:DISSOLVED Th	mg/L	Metals - Dissolved
TH-T	THALLIUM: TOTAL Th	mg/L	Metals - Total
TI-D	TITANIUM: DISSOLVED Ti	mg/L	Metals - Dissolved
TI-E	TITANIUM: EXTRACTABLE Ti	mg/L	Metals - Extractable
TI-T	TITANIUM: TOTAL Ti	mg/L	Metals - Total
TKN	NITROGEN:T KJELDAHL AS N	mg/L	NUTRIENTS
TL-D	THALLIUM: DISSOLVED Tl	mg/L	Metals - Dissolved
TL-T	THALLIUM: TOTAL Tl	mg/L	Metals - Total
TOC	TOTAL ORGANIC CARBON	mg/L	MISCELLAN
TS	RESIDUE: TOTAL	mg/L	PHYSICAL
TSS	TSS - RESIDUE: NONFILTRABLE	mg/L	PHYSICAL
TURB	TURBIDITY - LAB	NTU	PHYSICAL
TURB-F	FIELD TURBIDITY (Nephelometric Turb.)	mg/L	PHYSICAL
U-D	URANIUM: DISSOLVED U	mg/L	Metals - Dissolved
U-T	URANIUM: TOTAL U	mg/L	Metals - Total
V-D	VANADIUM: DISSOLVED V	mg/L	Metals - Dissolved
V-E	VANADIUM: EXTRACTABLE V	mg/L	Metals - Extractable
V-T	VANADIUM: TOTAL V	mg/L	Metals - Total
VOLUME	VOLUME (HUMIDITY CELL)	ml	HUMIDITY C
W-D	TUNGSTEN: DISSOLVED W	mg/L	Metals - Dissolved
W-T	TUNGSTEN: TOTAL W	mg/L	Metals - Total
WEEK	WEEK	No Unit	MISCELLAN
ZN-D	ZINC: DISSOLVED Zn	mg/L	Metals - Dissolved
ZN-E	ZINC: EXTRACTABLE Zn	mg/L	Metals - Extractable
ZN-IH	In-House Zinc	mg/L	
ZN-T	ZINC: TOTAL Zn	mg/L	Metals - Total
ZR-D	Dissolved Zirconium	mg/L	Metals - Dissolved
ZR-T	Total Zirconium	mg/L	Metals - Total

Appendix C
Faro Groundwater Parameter List

Parameter code	Description	Units	Class
ACID-C	ACIDITY (CaCO3)	mg/L	ANIONS
ACID-T	TOTAL ACIDITY	mg/L	ANIONS
ACID4.5	ACIDITY 4.5	mg/L	
ACID8.3	ACIDITY 8.3	mg/L	
AG-D	SILVER: DISSOLVED Ag	mg/L	METALS
AG-E	SILVER: EXTRACTABLE Ag	mg/L	METALS
AG-T	SILVER: TOTAL Ag	mg/L	METALS
AL-D	ALUMINIUM: DISSOLVED Al	mg/L	METALS
AL-E	ALUMINUM: EXTRACTABLE Al	mg/L	METALS
AL-T	ALUMINIUM: TOTAL Al	mg/L	METALS
ALK-C	ALKALINITY: CARBONATE AS CaCO3	mg/L	ANIONS
ALK-H	ALKALINITY: HYDROXIDE	mg/L	ANIONS
ALK-P	ALKALINITY:PHENOLTHALEIN		ANIONS
ALK-T	ALKALINITY:TOTAL CaCO3	mg/L	ANIONS
AREA1	SO4 PRODUCTION RATE BY SURFACE AREA	mg/L	HUMIDITY C
AREA2	CUMULATIVE S04 RATE BY AREA	mg/L	HUMIDITY C
AS-D	ARSENIC: DISSOLVED As	mg/L	METALS
AS-E	ARSENIC: EXTRACTABLE As	mg/L	METALS
AS-T	ARSENIC: TOTAL As	mg/L	METALS
AU-D	GOLD: DISSOLVED Au	mg/L	METALS
AU-T	GOLD: TOTAL Au	mg/L	METALS
B-D	BORON: DISSOLVED B	mg/L	METALS
B-E	BORON: EXTRACTABLE B	mg/L	METALS
B-T	BORON: TOTAL B	mg/L	METALS
BA-D	BARIUM: DISSOLVED Ba	mg/L	METALS
BA-E	BARIUM: EXTRACTABLE Ba	mg/L	METALS
BA-T	BARIUM: TOTAL Ba	mg/L	METALS
BE-D	BERYLLIUM: DISSOLVED Be	mg/L	METALS
BE-E	BERYLLIUM: EXTRACTABLE Be	mg/L	METALS
BE-T	BERYLLIUM: TOTAL Be	mg/L	METALS
BI-D	BISMUTH: DISSOLVED Bi	mg/L	METALS
BI-T	BISMUTH: TOTAL Bi	mg/L	METALS
BOD	BIOCHEMICAL OXYGEN DEMAND	mg/L	MISCELLAN
BR-T	BROMIDE		
CA-D	CALCIUM: DISSOLVED Ca	mg/L	METALS
CA-E	CALCIUM: EXTRACTABLE Ca	mg/L	METALS
CA-T	CALCIUM: TOTAL Ca	mg/L	METALS
CARCUM	CUMULATIVE CARBONATE DEPLETION	mg/kg	HUMIDITY C
CARDEP	CUMULATIVE CARBONATE DEPLETION	mg/L	HUMIDITY C
CD-D	CADMIUM: DISSOLVED Cd	mg/L	METALS
CD-E	CADMIUM: EXTRACTABLE Cd	mg/L	METALS
CD-T	CADMIUM: TOTAL Cd	mg/L	METALS
CL-D	CHLORIDE: DISSOLVED Cl	mg/L	ANIONS
CL-T	CHLORIDE: TOTAL Chloride	mg/L	ANIONS
CN-AMN	CYANIDE - AMENABLE TO CHLORINATION	mg/L	CYANIDES
CN-T	CYANIDE: TOTAL CN	mg/L	CYANIDES
CN-WAD	CYANIDE: WEAK ACID DISSOCIABLE	mg/L	CYANIDES
CNFREE	CYANIDE: FREE	mg/L	CYANIDES
CNO	CYANATE(CNO)	mg/L	CYANIDES
CNTHIO	CYANIDE THIO ????	mg/L	CYANIDES
CO-D	COBALT: DISSOVED Co	mg/L	METALS
CO-E	COBALT: EXTRACTABLE Co	mg/L	METALS
CO-T	COBALT: TOTAL Co	mg/L	METALS
COL-F	COLIFORM:FECAL	MPN/100 m	MISCELLAN
COL-T	COLIFORM:TOTAL	MPN/100 m	MISCELLAN
COLOR	COLOUR	Color Unit	PHYSICAL
COMMENT	COMMENT		
COND	COND	µS/cm	PHYSICAL
COND-F	COND-F	µS/cm	PHYSICAL
COND-L	COND-L	µS/cm	PHYSICAL
CR-D	CHROMIUM: DISSOLVED Cr	mg/L	METALS
CR-E	CHROMIUM: EXTRACTABLE Cr	mg/L	METALS
CR-T	CHROMIUM: TOTAL Cr	mg/L	METALS
CRX-D	HEXAVALENT CHROMIUM: DISSOLVED CR	mg/L	METALS

Appendix C
Faro Groundwater Parameter List

Parameter code	Description	Units	Class
CU-D	COPPER: DISSOLVED Cu	mg/L	METALS
CU-E	COPPER: EXTRACTABLE Cu	mg/L	METALS
CU-T	COPPER: TOTAL Cu	mg/L	METALS
DAYS	Time Represented by Sample	Days	MISCELLAN
DEBIT	DEBIT (FLOW M^3/min)	m^3/min	MISCELLAN
DEPTH	PIEZOMETER DEPTH	meters	MISCELLAN
DO	DISSOLVED OXY - FIELD MEAS	mg/L	
DO-%	DISSOLVED OXY PERCENT SAT FIELD MEAS	%	MISCELLAN
DO-F	DISSOLVED OXYGEN	mg/L	PHYSICAL
F-D	FLUORIDE: DISSOLVED F	mg/L	ANIONS
F-T	FLOURIDE: TOTAL F	mg/L	ANIONS
FE-D	IRON: DISSOLVED Fe	mg/L	METALS
FE-E	IRON: EXTRACTABLE Fe	mg/L	METALS
FE-T	IRON: TOTAL Fe	mg/L	METALS
FLOW	FLOW RATE (m^3/day)	m^3/day	MISCELLAN
FLOWLS	FLOW	L/s	PHYSICAL
FLOWM3S	FLOW M^3/SEC	m^3/sec	MISCELLAN
GA-T	GALLIUM: TOTAL Ga	mg/L	METALS
HARD	HARDNESS: TOTAL (CACO3)	mg/L	PHYSICAL
HARD-C	Calculated Hardness (Ca + Mg)	mg/L	CALCULATE
HARD-CA	HARDNESS (CALCIUM)		
HCO3	BICARBONATE	mg/L	ANIONS
HG-D	MERCURY: DISSOLVED Hg	mg/L	METALS
HG-T	MERCURY: TOTAL Hg	mg/L	METALS
K-D	POTASSIUM: DISSOLVED K	mg/L	METALS
K-E	POTASSIUM: EXTRACTABLE K	mg/L	METALS
K-T	POTASSIUM: TOTAL K	mg/L	METALS
LA-D	LANTHANUM: DISSOLVED La	mg/L	METALS
LA-T	LANTHANUM: TOTAL La	mg/L	METALS
LAB	Indication of lab		MISCELLAN
LC50	96-h MEDIAN LETHAL CONCENTRATION	%v/v	MISCELLAN
LI-D	LITHIUM: Dissolved Li	mg/L	METALS
LI-T	LITHIUM: TOTAL Li	mg/L	METALS
LOADFE	Total Iron Loading	mg/s	CALCULATE
LOADSO4	SO4 Loading	mg/s	CALCULATE
LOADZN	Total Zinc Loading	mg/s	CALCULATE
MASS-1	WATER FLOW	m^3/day	MISCELLAN
MASS-2	SOLIDS MASS FLOW	kg/day	MISCELLAN
MASS-3	RECLAIM MASS WATER FLOW	mg/L	MISCELLAN
METHOD	SAMPLE METHOD		
MG-D	MAGNESIUM: DISSOLVED Mg	mg/L	METALS
MG-E	MAGNESIUM: EXTRACTABLE Mg	mg/L	METALS
MG-T	MAGNESIUM: TOTAL Mg	mg/L	METALS
MN-D	MANGANESE: DISSOLVED Mn	mg/L	METALS
MN-E	MANGANESE: EXTRACTABLE Mn	mg/L	METALS
MN-T	MANGANESE: TOTAL Mn	mg/L	METALS
MO-D	MOLYBDENUM: DISSOLVED Mo	mg/L	METALS
MO-E	MOLYBDENUM: EXTRACTABLE Mo	mg/L	METALS
MO-T	MOLYBDENUM: TOTAL Mo	mg/L	METALS
MOLAR1	SO4/ALK	mg/L	HUMIDITY C
MOLAR2	ALK/Ca+Mg	mg/L	HUMIDITY C
MOLAR3	SO4/Ca	mg/L	HUMIDITY C
MOLAR4	CRITICAL SO4/Ca	mg/L	HUMIDITY C
MOLAR5	SO4/(Ca+Mg)		MISCELLAN
N-T	NITROGEN		
NA-D	SODIUM: DISSOLVED Na	mg/L	METALS
NA-E	SODIUM: EXTRACTABLE Na	mg/L	METALS
NA-T	SODIUM: TOTAL Na	mg/L	METALS
NACN	SODIUM CYANIDE	mg/L	CYANIDES
NH3	AMMONIA NITROGEN: NH3 AS N	mg/L	NUTRIENTS
NH3+4	AMMONIA + AMMONIUM	mg/L	NUTRIENTS
NI-D	NICKEL: DISSOLVED Ni	mg/L	METALS
NI-E	NICKEL: EXTRACTABLE Ni	mg/L	METALS

Appendix C
Faro Groundwater Parameter List

Parameter code	Description	Units	Class
NI-T	NICKEL: TOTAL Ni	mg/L	METALS
NO2	NITRITE NITROGEN: NO2 AS N	mg/L	NUTRIENTS
NO2NO3	NITRITE + NITRATE	mg/L	NUTRIENTS
NO3	NITROGEN:NITRATE NO3 AS N	mg/L	NUTRIENTS
NP-REM	REMAINING NP	m^3/day	HUMIDITY C
O&G	OIL AND GREASE	mg/L	METALS
ORP	ORP - OXIDATION REDUCTION POTENTIAL	mg/L	HUMIDITY C
P-D	PHOSPHORUS: DISSOLVED P ??	mg/L	NUTRIENTS
P-E	PHOSPHORUS: EXTRACTABLE P ??	mg/L	METALS
P-ORTH	PHOSPHATE: ORTHO P ??	mg/L	NUTRIENTS
P-T	PHOSPHORUS: TOTAL P ??	mg/L	NUTRIENTS
P-TD	PHOSPHATE:TOTAL DISSOLVED ??	mg/L	NUTRIENTS
PAX	POTTASIUM AMYL ZANTHANTE	mg/L	MISCELLAN
PB-D	LEAD: DISSOLVED Pb	mg/L	METALS
PB-E	LEAD: EXTRACTABLE Pb	mg/L	METALS
PB-T	LEAD: TOTAL Pb	mg/L	METALS
PD-T	PALLADIUM: TOTAL Pd	mg/L	METALS
PH-F	pH FIELD	pH unit	PHYSICAL
PH-L	pH LAB	pH unit	PHYSICAL
PHEN-T	PHENOL: TOTAL	mg/L	MISCELLAN
PHUS-D	PHOSPHORUS: DISSOLVED P	mg/L	NUTRIENTS
PHUS-T	PHOSPHORUS: TOTAL P	mg/L	NUTRIENTS
PO4	PHOSPHATE: PO4 AS P ??	mg/L	NUTRIENTS
PT-T	PLATINUM: TOTAL Pt	mg/L	METALS
S-D	SULPHUR: DISSOLVED S	mg/L	METALS
S-E	SULPHUR: EXTRACTABLE S	mg/L	METALS
S-REM	REMAINING SULPHUR	mg/L	HUMIDITY C
S-T	SULPHUR: TOTAL S	mg/L	METALS
SAR	SODIUM ADSORPTION RATIO	No Unit	HUMIDITY C
SB-D	ANTIMONY: DISSOLVED Sb	mg/L	METALS
SB-E	ANTIMONY: EXTRACTABLE Sb	mg/L	METALS
SB-T	ANTIMONY: TOTAL Sb	mg/L	METALS
SC-T	SCANDIUM: TOTAL Sc	mg/L	METALS
SCN	THIOCYANATE: SCN	mg/L	CYANIDES
SE-D	SELENIUM: DISSOLVED	mg/L	METALS
SE-E	SELENIUM: EXTRACTABLE Se	mg/L	METALS
SE-T	SELENIUM: TOTAL Se	mg/L	METALS
SG	STAFF GAGE	meters	PHYSICAL
SI-D	SILICON: DISSOLVED Si	mg/L	METALS
SI-E	SILICON: EXTRACTABLE Si	mg/L	METALS
SI-T	SILICON: TOTAL Si	mg/L	METALS
SN-D	TIN: DISSOLVED Sn	mg/L	METALS
SN-E	TIN: EXTRACTABLE Sn	mg/L	METALS
SN-T	TIN: TOTAL Sn	mg/L	METALS
SO4-D	SULPHATE: DISSOLVED SO4	mg/L	ANIONS
SO4-T	SULPHATE: TOTAL SO4	mg/L	ANIONS
SO4CUM	CUMULATIVE SO4 RATE	mg/L	HUMIDITY C
SO4PRO	SO4 PRODUCTION RATE	mg/L	HUMIDITY C
SOLEXT	SOLVENT EXTRACTABLES	mg/L	MISCELLAN
SR-D	STRONTIUM: DISSOLVED Sr	mg/L	METALS
SR-E	STRONTIUM: EXTRACTABLE Sr	mg/L	METALS
SR-T	STRONTIUM: TOTAL Sr	mg/L	METALS
SWL	MEASURED WATER ELEVATION	meters	MISCELLAN
TDS	RESIDUE: FILTRABLE	mg/L	PHYSICAL
TDSRAT	TDS RATIO	No Unit	HUMIDITY C
TE-T	TELLURIUM: TOTAL Te	mg/L	METALS
TEMP	Water Temperature	deg C	PHYSICAL
TEMP-C	TEMPERTURE	deg C	PHYSICAL
TEMP-F	TEMPERATURE	deg C	PHYSICAL
TH-D	THALLIUM:DISSOLVED Th	mg/L	METALS
TH-T	THALLIUM: TOTAL Th	mg/L	METALS
TI-D	TITANIUM: DISSOLVED Ti	mg/L	METALS
TI-E	TITANIUM: EXTRACTABLE Ti	mg/L	METALS

Appendix C
Faro Groundwater Parameter List

Parameter code	Description	Units	Class
TI-T	TITANIUM: TOTAL Ti	mg/L	METALS
TIME	Time the sample was taken		MISCELLAN
TKN	NITROGEN:T KJELDAHL AS N	mg/L	NUTRIENTS
TL-D	THALLIUM: DISSOLVED Tl	mg/L	METALS
TL-T	THALLIUM: TOTAL Tl	mg/L	METALS
TOC	TOTAL ORGANIC CARBON	mg/L	MISCELLAN
TS	RESIDUE: TOTAL	mg/L	PHYSICAL
TSS	RESIDUE: NONFILTRABLE	mg/L	PHYSICAL
TURB	TURBIDITY (FTU) LAB (Same as NTU?)	mg/L	PHYSICAL
TURB-F	FIELD TURBIDITY (Nephelometric Turb.)	mg/L	PHYSICAL
U-D	URANIUM: DISSOLVED U	mg/L	METALS
U-T	URANIUM: TOTAL U	mg/L	METALS
V-D	VANADIUM: DISSOLVED V	mg/L	METALS
V-E	VANADIUM: EXTRACTABLE V	mg/L	METALS
V-T	VANADIUM: TOTAL V	mg/L	METALS
VOLUME	VOLUME (HUMIDITY CELL)	ml	HUMIDITY C
VOLUME-P	Volume purged from well	ml	PHYSICAL
W-D	TUNGSTEN: DISSOLVED W	mg/L	METALS
W-T	TUNGSTEN: TOTAL W	mg/L	METALS
WEEK	WEEK	No Unit	MISCELLAN
WL	Water Level - Taken from top of casing	feet	PHYSICAL
WL-M	WATER LEVEL FROM T.O.C. (METRES)	meters	MISCELLAN
ZN-D	ZINC: DISSOLVED Zn	mg/L	METALS
ZN-E	ZINC: EXTRACTABLE Zn	mg/L	METALS
ZN-T	ZINC: TOTAL Zn	mg/L	METALS

Appendix C
Vangorda Parameter List

Parameter code	Description	Units	Class
ACID4.5	Acidity 4.5	mg/L	ANIONS
ACID8.3	Acidity 8.3	mg/L	ANIONS
ACIDITY	ACIDITY (CaCO3)	mg/L	ANIONS
AG-D	SILVER: DISSOLVED Ag	mg/L	METALS
AG-E	SILVER: EXTRACTABLE Ag	mg/L	Metals - Extractable
AG-T	SILVER: TOTAL Ag	mg/L	Metals - Total
AL-D	ALUMINIUM: DISSOLVED Al	mg/L	METALS
AL-E	ALUMINUM: EXTRACTABLE Al	mg/L	METALS
AL-T	ALUMINIUM: TOTAL Al	mg/L	METALS
ALK-C	ALKALINITY: CARBONATE AS CaCO3	mg/L	ANIONS
ALK-H	ALKALINITY: HYDROXIDE	mg/L	ANIONS
ALK-P	ALKALINITY:PHENOLTHALEIN		ANIONS
ALK-T	ALKALINITY:TOTAL CaCO3	mg/L	ANIONS
AREA1	SO4 PRODUCTION RATE BY SURFACE AREA	mg/L	HUMIDITY C
AREA2	CUMULATIVE S04 RATE BY AREA	mg/L	HUMIDITY C
AS-D	ARSENIC: DISSOLVED As	mg/L	METALS
AS-E	ARSENIC: EXTRACTABLE As	mg/L	METALS
AS-T	ARSENIC: TOTAL As	mg/L	METALS
AU-D	GOLD: DISSOLVED Au	mg/L	METALS
AU-T	GOLD: TOTAL Au	mg/L	METALS
B-D	BORON: DISSOLVED B	mg/L	METALS
B-E	BORON: EXTRACTABLE B	mg/L	METALS
B-T	BORON: TOTAL B	mg/L	METALS
BA-D	BARIUM: DISSOLVED Ba	mg/L	METALS
BA-E	BARIUM: EXTRACTABLE Ba	mg/L	METALS
BA-T	BARIUM: TOTAL Ba	mg/L	METALS
BE-D	BERYLLIUM: DISSOLVED Be	mg/L	METALS
BE-E	BERYLLIUM: EXTRACTABLE Be	mg/L	METALS
BE-T	BERYLLIUM: TOTAL Be	mg/L	METALS
BI-D	BISMUTH: DISSOLVED Bi	mg/L	METALS
BI-T	BISMUTH: TOTAL Bi	mg/L	METALS
BOD	BIOCHEMICAL OXYGEN DEMAND	mg/L	MISCELLAN
CA-D	CALCIUM: DISSOLVED Ca	mg/L	METALS
CA-E	CALCIUM: EXTRACTABLE Ca	mg/L	METALS
CA-T	CALCIUM: TOTAL Ca	mg/L	METALS
CARCUM	CUMULATIVE CARBONATE DEPLETION	mg/kg	HUMIDITY C
CARDEP	CUMULATIVE CARBONATE DEPLETION	mg/L	HUMIDITY C
CD-D	CADMIUM: DISSOLVED Cd	mg/L	METALS
CD-E	CADMIUM: EXTRACTABLE Cd	mg/L	METALS
CD-T	CADMIUM: TOTAL Cd	mg/L	METALS
CL-D	CHLORIDE: DISSOLVED Cl	mg/L	ANIONS
CL-T	CHLORIDE: TOTAL Chloride	mg/L	ANIONS
CN-AMN	CYANIDE - AMENABLE TO CHLORINATION	mg/L	CYANIDES
CN-T	CYANIDE: TOTAL CN	mg/L	CYANIDES
CN-WAD	CYANIDE: WEAK ACID DISSOCIABLE	mg/L	CYANIDES
CNFREE	CYANIDE: FREE	mg/L	CYANIDES
CNO	CYANATE(CNO)	mg/L	CYANIDES
CO-D	COBALT: DISSOVED Co	mg/L	METALS
CO-E	COBALT: EXTRACTABLE Co	mg/L	METALS
CO-T	COBALT: TOTAL Co	mg/L	METALS
COL-F	COLIFORM:FECAL	MPN/100 m	MISCELLAN
COL-T	COLIFORM:TOTAL	MPN/100 m	MISCELLAN
COLOR	COLOUR	Color Unit	PHYSICAL
COMMENT	COMMENT		
COND	SPECIFIC CONDUCTANCE	µS/cm	PHYSICAL
COND-F	SPECIFIC CONDUCTANCE - FIELD	µS/cm	PHYSICAL

Appendix C
Vangorda Parameter List

Parameter code	Description	Units	Class
COND-L	SPECIFIC CONDUCTANCE - LAB	µS/cm	PHYSICAL
CR-D	CHROMIUM: DISSOLVED Cr	mg/L	METALS
CR-E	CHROMIUM: EXTRACTABLE Cr	mg/L	METALS
CR-T	CHROMIUM: TOTAL Cr	mg/L	METALS
CRX-D	HEXAVALENT CHROMIUM: DISSOLVED CR	mg/L	METALS
CU-D	COPPER: DISSOLVED Cu	mg/L	METALS
CU-E	COPPER: EXTRACTABLE Cu	mg/L	METALS
CU-T	COPPER: TOTAL Cu	mg/L	METALS
DAYS	Time Represented by Sample	Days	MISCELLAN
DEBIT	DEBIT (FLOW M^3/min)	m^3/min	MISCELLAN
DEPTH	WATER LEVEL ELEVATION	meters	MISCELLAN
DO-F	DISSOLVED OXYGEN	mg/L	PHYSICAL
ELEV	MEASURED WATER ELEVATION	mg/L	MISCELLAN
F-D	FLUORIDE: DISSOLVED F	mg/L	ANIONS
F-T	FLOURIDE: TOTAL F	mg/L	ANIONS
FE-D	IRON: DISSOLVED Fe	mg/L	METALS
FE-E	IRON: EXTRACTABLE Fe	mg/L	METALS
FE-T	IRON: TOTAL Fe	mg/L	METALS
FLOW	FLOW RATE (m^3/day)	m^3/day	MISCELLAN
FLOWEP	Flow - need to check units		
FLOWLS	FLOW RATE (L/s)	L/s	MISCELLAN
FLOWM3S	FLOW M3/SEC	m3/sec	PHYSICAL
GA-T	GALLIUM: TOTAL Ga	mg/L	METALS
HARD	HARDNESS: TOTAL (CACO3)	mg/L	PHYSICAL
HARD-C	Calc. Hardness	mg/L	CALCULATE
HARD-D	HARDNESS: Dissolved	mg/L	PHYSICAL
HCO3	BICARBONATE	mg/L	ANIONS
HG-D	MERCURY: DISSOLVED Hg	mg/L	METALS
HG-T	MERCURY: TOTAL Hg	mg/L	METALS
K-D	POTASSIUM: DISSOLVED K	mg/L	METALS
K-E	POTASSIUM: EXTRACTABLE K	mg/L	METALS
K-T	POTASSIUM: TOTAL K	mg/L	METALS
LA-D	LANTHANUM: DISSOLVED La	mg/L	METALS
LA-T	LANTHANUM: TOTAL La	mg/L	METALS
LAB	Indication of lab		MISCELLAN
LC50	96-h MEDIAN LETHAL CONCENTRATION	%v/v	MISCELLAN
LI-D	LITHIUM: Dissolved Li	mg/L	METALS
LI-T	LITHIUM: TOTAL Li	mg/L	METALS
MASS-1	WATER FLOW	m^3/day	MISCELLAN
MASS-2	SOLIDS MASS FLOW	kg/day	MISCELLAN
MASS-3	RECLAIM MASS WATER FLOW	mg/L	MISCELLAN
MG-D	MAGNESIUM: DISSOLVED Mg	mg/L	METALS
MG-E	MAGNESIUM: EXTRACTABLE Mg	mg/L	METALS
MG-T	MAGNESIUM: TOTAL Mg	mg/L	METALS
MN-D	MANGANESE: DISSOLVED Mn	mg/L	METALS
MN-E	MANGANESE: EXTRACTABLE Mn	mg/L	METALS
MN-T	MANGANESE: TOTAL Mn	mg/L	METALS
MO-D	MOLYBDENUM: DISSOLVED Mo	mg/L	METALS
MO-E	MOLYBDENUM: EXTRACTABLE Mo	mg/L	METALS
MO-T	MOLYBDENUM: TOTAL Mo	mg/L	METALS
MOLAR1	SO4/ALK	mg/L	HUMIDITY C
MOLAR2	ALK/Ca+Mg	mg/L	HUMIDITY C
MOLAR3	SO4/Ca	mg/L	HUMIDITY C
MOLAR4	CRITICAL SO4/Ca	mg/L	HUMIDITY C
NA-D	SODIUM: DISSOLVED Na	mg/L	METALS
NA-E	SODIUM: EXTRACTABLE Na	mg/L	METALS

Appendix C
Vangorda Parameter List

Parameter code	Description	Units	Class
NA-T	SODIUM: TOTAL Na	mg/L	METALS
NACN	SODIUM CYANIDE	mg/L	CYANIDES
NH3	AMMONIA NITROGEN: NH3 AS N	mg/L	NUTRIENTS
NH3+4	AMMONIA + AMMONIUM	mg/L	NUTRIENTS
NI-D	NICKEL: DISSOLVED Ni	mg/L	METALS
NI-E	NICKEL: EXTRACTABLE Ni	mg/L	METALS
NI-T	NICKEL: TOTAL Ni	mg/L	METALS
NO2	NITRITE NITROGEN: NO2 AS N	mg/L	NUTRIENTS
NO2NO3	NITRITE + NITRATE	mg/L	NUTRIENTS
NO3	NITROGEN:NITRATE NO3 AS N	mg/L	NUTRIENTS
NP-REM	REMAINING NP	m^3/day	HUMIDITY C
O&G	OIL AND GREASE	mg/L	METALS
ORP	ORP - OXIDATION REDUCTION POTENTIAL	mg/L	HUMIDITY C
P-D	PHOSPHORUS: DISSOLVED P	mg/L	METALS
P-E	PHOSPHORUS: EXTRACTABLE P	mg/L	METALS
P-ORTH	PHOSPHATE: ORTHO P	mg/L	NUTRIENTS
P-T	PHOSPHORUS: TOTAL P	mg/L	METALS
P-TD	PHOSPHATE:TOTAL DISSOLVED	mg/L	NUTRIENTS
PAX	POTTASIUM AMYL ZANTHANTE	mg/L	MISCELLAN
PB-D	LEAD: DISSOLVED Pb	mg/L	METALS
PB-E	LEAD: EXTRACTABLE Pb	mg/L	METALS
PB-T	LEAD: TOTAL Pb	mg/L	METALS
PD-T	PALLADIUM: TOTAL Pd	mg/L	METALS
PH-F	pH FIELD	pH unit	PHYSICAL
PH-L	pH LAB	pH unit	PHYSICAL
PHEN-T	PHENOL: TOTAL	mg/L	MISCELLAN
PHUS-D	PHOSPHORUS: DISSOLVED P	mg/L	NUTRIENTS
PHUS-T	PHOSPHORUS: TOTAL P	mg/L	NUTRIENTS
PO4	???	mg/L	
PT-T	PLATINUM: TOTAL Pt	mg/L	METALS
S-D	SULPHUR: DISSOLVED S	mg/L	NUTRIENTS
S-E	SULPHUR: EXTRACTABLE S	mg/L	NUTRIENTS
S-REM	REMAINING SULPHUR	mg/L	HUMIDITY C
S-T	SULPHIDE: TOTAL S	mg/L	ANIONS
SAR	SODIUM ADSORPTION RATIO	No Unit	HUMIDITY C
SB-D	ANTIMONY: DISSOLVED Sb	mg/L	METALS
SB-E	ANTIMONY: EXTRACTABLE Sb	mg/L	METALS
SB-T	ANTIMONY: TOTAL Sb	mg/L	METALS
SC-T	SCANDIUM: TOTAL Sc	mg/L	METALS
SCN	THIOCYANATE: SCN	mg/L	CYANIDES
SE-D	SELENIUM: DISSOLVED	mg/L	METALS
SE-E	SELENIUM: EXTRACTABLE Se	mg/L	METALS
SE-T	SELENIUM: TOTAL Se	mg/L	METALS
SI-D	SILICON: DISSOLVED Si	mg/L	METALS
SI-E	SILICON: EXTRACTABLE Si	mg/L	METALS
SI-T	SILICON: TOTAL Si	mg/L	METALS
SN-D	TIN: DISSOLVED Sn	mg/L	METALS
SN-E	TIN: EXTRACTABLE Sn	mg/L	METALS
SN-T	TIN: TOTAL Sn	mg/L	METALS
SO4-D	SULPHATE: DISSOLVED SO4	mg/L	ANIONS
SO4-T	SULPHATE: TOTAL SO4	mg/L	ANIONS
SO4CUM	CUMULATIVE SO4 RATE	mg/L	HUMIDITY C
SO4PRO	SO4 PRODUCTATION RATE	mg/L	HUMIDITY C
SOLEXT	SOLVENT EXTRACTABLES	mg/L	MISCELLAN
SR-D	STRONTIUM: DISSOLVED Sr	mg/L	METALS
SR-E	STRONTIUM: EXTRACTABLE Sr	mg/L	METALS

Appendix C
Vangorda Parameter List

Parameter code	Description	Units	Class
SR-T	STRONTIUM: TOTAL Sr	mg/L	METALS
SWEL	Piezometric Elevation	meters	
SWL	Static Water Level	meters	PHYSICAL
TDS	RESIDUE: FILTRABLE	mg/L	PHYSICAL
TDSRAT	TDS RATIO	No Unit	HUMIDITY C
TE-D	TELLURIUM: Dissolved Te	mg/L	METALS
TE-T	TELLURIUM: TOTAL Te	mg/L	METALS
TEMP-C	Temperature C		
TEMP-F	TEMPERATURE	deg C	PHYSICAL
TH-D	THALLIUM:DISSOLVED Th	mg/L	METALS
TH-T	THALLIUM: TOTAL Th	mg/L	METALS
TI-D	TITANIUM: DISSOLVED Ti	mg/L	METALS
TI-E	TITANIUM: EXTRACTABLE Ti	mg/L	METALS
TI-T	TITANIUM: TOTAL Ti	mg/L	METALS
TKN	NITROGEN:T KJELDAHL AS N	mg/L	NUTRIENTS
TL-D	THALLIUM: DISSOLVED Tl	mg/L	METALS
TL-T	THALLIUM: TOTAL Tl	mg/L	METALS
TOC	TOTAL ORGANIC CARBON	mg/L	MISCELLAN
TS	RESIDUE: TOTAL	mg/L	PHYSICAL
TSS	Suspended solids or NFR	mg/L	PHYSICAL
TURB	TURBIDITY (Nephelometric Turb. Units)LAB	NTU	PHYSICAL
TURB-F	FIELD TURBIDITY (Nephelometric Turb.)	mg/L	PHYSICAL
U-D	URANIUM: DISSOLVED U	mg/L	METALS
U-T	URANIUM: TOTAL U	mg/L	METALS
V-D	VANADIUM: DISSOLVED V	mg/L	METALS
V-E	VANADIUM: EXTRACTABLE V	mg/L	METALS
V-T	VANADIUM: TOTAL V	mg/L	METALS
VOLUME	VOLUME (HUMIDITY CELL)	ml	HUMIDITY C
VOLUME-P	Purged Volume	ml	PHYSICAL
W-D	TUNGSTEN: DISSOLVED W	mg/L	METALS
W-T	TUNGSTEN: TOTAL W	mg/L	METALS
WEEK	WEEK	No Unit	MISCELLAN
WL-M	WATER LEVEL T.O. C. (m)		
ZN-D	ZINC: DISSOLVED Zn	mg/L	METALS
ZN-E	ZINC: EXTRACTABLE Zn	mg/L	METALS
ZN-IH	In House Zinc	mg/L	
ZN-T	ZINC: TOTAL Zn	mg/L	METALS
ZR-D	Total Zirconium	mg/L	METALS
ZR-T	Total Zirconium	mg/L	METALS

Appendix D

QA/QC Protocol

Anvil Range Mine Water Quality Database QA/QC Protocol Manual

prepared for:

Deloitte & Touche Inc.
(in their capacity as interim receiver of Anvil Range Mining Corporation)

prepared by:

Gartner Lee Limited

reference: **GLL 40690**

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distribution:

1 **Deloitte & Touche Inc. (plus electronic)**
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1. Introduction

This QA/QC protocol has been developed for Project 11b, Maintenance of Water Quality Database, to provide a framework that will be used when reviewing the water quality data in existing database including error identification, statistical analysis for outliers, treatment of errors/outliers and tracking all changes made to the database. The development and subsequent use of this protocol will ensure consistency in the review and correction of data in the database and a template for documenting the entire process.

The protocol also provides a template to be used for general database clean up to deal with non-numerical errors and problems such as duplicate station name. In addition a framework for the investigation and documentation of changes in laboratory detection limits is provided.

2. Prioritization of Stations

Within the Anvil Range Water Quality Database there are over 300 stations. The facilitate the QA/QC of the database the stations will be reviewed in the following order of priority.

1. AMP Trigger Stations.
2. Tailings Area Groundwater Stations (not included in leakage testing).
3. Remaining Water Licence Monitoring Stations.
4. Others.

3. Numerical Errors and Outliers

When reviewing the Anvil Range Database, there are several extreme values that are separated from the majority of the data set. These values are called outliers. The EPA Practical Methods for Data Analysis (EPA QA/G-9) defines outliers as "…measurements that are extremely large or small relative to the rest of the data and, therefore, are suspected of misrepresenting the population from which they were collected."

Outliers in the Anvil Range Database may be the result of:

- transcription errors during historic database development;
- misreported or undetected changes in detection limits in data received from the laboratory;
- transcription errors during monthly database update; or
- measurement problems during sample collection such as sample contamination or mislabeling of sample.

These are termed "true outliers". They may, however, represent actual extreme values of the various parameters (hot spots or peak events) and be an indication of the "natural" variability of the data set: "false outliers". It is essential to determine if an outlier is a true outlier to ensure proper handling of the

data and ultimate interpretation of the results. Removing a false outlier instead of a true outlier can lead to a misrepresentation of the site water quality data.

There are a variety of statistical tests available to identify data points that are outliers. These tests are used only to identify outliers that need further investigation. They do not determine whether the outlier should be discarded, corrected or replaced. This is done based on a detail analysis of the source of the outlier. Outlier tests should be used with care and data only removed if a sound technical reason can be found (Burke, 2003). The following sections outline the four primary steps that will be used to deal with outliers (errors) in the Anvil Range Database.

3.1 Step 1 - Graphical Identification

Preliminary identification of potential extreme values will be done using graphical methods. The first method will be time series plots of the data directly using EQWIN. Each plot will be visually screened for outliers. The station data will also be exported to EXCEL and tables of all the station data will also be produced.

3.2 Step 2 – Statistical Analysis

Once a potential outlier has been identified, the next step will be to apply a statistical test to the data to provide confirmation of Step 1. This will be done using a relatively simple statistical test in EXCEL using the distance from the mean in multiples of the standard deviation. This is based on Grubbs' method for detecting outliers:

$$G_1 = (|\text{mean-value}|)/\text{SD}$$ where SD is the Standard Deviation

If the test values (G_1) are greater than the Grubbs' critical value obtained from statistical tables then the extreme values are unlikely to have occurred by chance alone and may be an outlier. For the purposes of this test a 95% confidence level will be used (P-value < 0.05). The critical value increases with sample size. For large sample sizes (greater than 140) the program identifies data points with the Grubbs' test values that correspond to a P-value less than 0.05.

3.3 Step 3 – Detailed Analysis of Source

The next step is the review of statistical outliers as to their source. Where available (1999 and on), a review the actual laboratory analytical results will provide the best check for possible transcription errors. For instance, in many cases outliers identified may be solely due to using the wrong units: parts per million instead of parts per billion. This error is readily seen in extreme values being out by a factor of 1000. Review of other site data will also be carried out to investigate possible sources of extreme values. Extreme or incorrect values occurring for all sample parameters during the same sampling event in similarly named sites may be the result of the samples simply being switched or parameters being switched. For example X21C mislabeled at X24C or mercury entered incorrectly as hardness. As well, the occurrence of extreme values in several related sample locations may be indicative of peak events or

hot spots such as elevated levels of key parameters occurring at X14, X10, and X2 during the same sampling event.

3.4 Step 4 – Treatment of Outlier/Error

After the source of the outlier has been determined, the next step is to determine if the data point should be maintained, corrected or discarded. This step must be done with extreme caution as incorrect removal of data can result in a distortion of the data set and limits its applicability. Water Quality data sets can often contain legitimate extreme values. For the Anvil Range Database, it is recommended to only correct or discard a data point if there is adequate justification to do so such as "hard" confirmation using laboratory sheets or the outlier is obviously due to unit or sample mix up. The modification of the data point will be flagged in the database using a comment field in EQWIN. For cases where it is not possible to determine the source of the extreme values, it is recommended that the point be maintained and flagged as an outlier. The flagging will be achieved through the use of a comment field in EQWIN. Any modifications made to the database must be approved by the Project Manager. The decision of whether to discard this point will then be left to the discretion of the individuals using the data. The impact of the potential modification will be assessed by carrying out statistical analysis (descriptive statistics) on the data set with and without the modification.

4. Variable Detection Limits

Another area in the database that requires investigation and documentation are changes in laboratory detection limits. The database contains time series of data with variable detection limits, primarily due to improvements in analytical methods. These variable detection limits have a substantial effect on the interpretation of low concentrations and long-term trends in background data. In some cases historic data has detection limits higher that the existing CCME Guidelines. The changes in the detection limits for the various parameters will be documented by:

1. Making reference to the original laboratory analytical sheets where available; and
2. Documenting changes in the detection limits in the database.

This review will provide a time-based documentation of when changes to detection limits where made which can then be used to supplement the interpretation of the data, especially the older data.

5. General Database Clean-up

Gartner Lee, in the course of managing the database has occasionally observed several non-numerical errors and problems. Although these do not pose a threat to the integrity of the water quality data held in the database, they do cause significant problems when working with the database on a day-to-day basis and generating monthly report tables. These include:

1. Duplicate parameter names.

For various parameters in the database there are multiple names, such as Dissolved Sulphate and Total Sulphate, which have been used interchangeably. These need to be consolidated under one parameter heading.

2. Duplicate station names.

For various stations there are multiple names which need to be rectified.

3. Inconsistent parameter names.

There is an inconsistency in parameter names between the three databases which needs to be rectified.

4. Formalize the entering of replicate samples.

In the database there are station names for replicate samples (i.e. X23-Rep). In many cases the results that are received from the laboratory don't identify replicate samples and they are entered as another data set under the primary station name. Replicate sample results should be identified as such so that, if required, the results can be assessed for repeatability and longer term QA/QC. The process for entering replicated data into the database will be formalized as part of this process. The existence of any replicate samples will be flagged using a comment field in EQWIN.

As part of this review, these errors/inconsistencies will be corrected. All modifications will be documented.

There are a significant number of stations that are presently not monitored, many of which have been decommissioned. It is recommended that once the database has been reviewed and all errors resolved that an archive be generated. After archival, a more streamlined working database should be created, removing the various decommissioned stations.

6. QA/QC Documentation

The entire process of QA/QC of the database must be well documented. A Database QA/QC Form has been developed for this purpose. In this form all information pertaining to the QA/QC investigations will be documented, regardless of whether any data points are changed. This information is critical for effective review of the process and ensures consistency. Further, this will provide future users of the database with a clear and detailed record of work completed and the rationale for any changes made. A copy of the form can be found in Appendix A and the following outlines its key components.

A form has also been developed for general database clean up. A copy can be found in Appendix B.

Appendix E

QA/QC Forms

Gartner Lee

Anvil Range Database QA/QC Form

Reviewer Name:		Date:	
Site:			
Station ID:		From:	to
Station Description:			

Step 1: Visual Check for Outliers

Plot out time series for each parameter and print out a historical record of the station data (export to EXCEL to produce tables). This tables will be used for subsequent statistical analysis including outliers. Document changes in method detection levels. Attach plots and tables to this form. If necessary create box-whisker plots to facilitate the assessment of outliers.

Are there any potential outliers? ☐ yes ☐ no

If yes, which parameters?

Step 2: Confirmation of Outliers - Application of Statistical Test in EXCEL

Using the parameter table produces for the station in Step 1, use the add-in program WINSTAT to run the required statistical test for outliers in EXCEL. Initially this test will be run using a multiplier of 4. Document all the confirmed outliers in the table below in chronological order. Assign each outlier a tracking identification number that will be used to track the analysis and possible modification of the data point. The ID should be assigned using the following numbering system: Station ID-Outlier number i.e. X21C-1.

Confirmed Statistical Outliers

Sample Date	Parameter	ID	Value

Step 3: Analysis of Outliers

For each outlier identified in the previous analysis, carry out a detailed analysis of the data set to determine the source as outlined in Step 3 of the QA/QC Protocol Manual. For each outlier fill out the following documenting your analysis. Use one table for each analysis.

Results of Detailed Analysis and Source Identification

ID:	
Station:	
Date:	
Parameter:	

Are there original laboratory sheets available?: yes: ☐ no: ☐

Are there original field notes available?: yes: ☐ no: ☐

Are the units entered correctly (i.e. out by a factor of 1000)?: yes: ☐ no: ☐

Are there outliers found with other parameters for this station on the same sample date? yes: ☐ no: ☐

Are there outliers found with similarly named samples on the same sample date? yes: ☐ no: ☐

Comments/Details of Analysis included recommended action:

Step 4: Treatment of Outlier

For each outlier identify the action to be taken: maintained, corrected or discarded. Approval must be received from the Project Manager prior to any modification.

Maintain
yes: ☐
no: ☐

Corrected:
yes: ☐
no: ☐
If yes to what value: ☐

Discarded:
yes: ☐
no: ☐

PM's Approval: _____

Gartner Lee

Anvil Range Database General Clean up Form

Date	Error	Resolution	Reviewer

Appendix F

Water Database Version 1.2 Manual

User Manual for the

WATER database

ANVIL RANGE Project, Yukon

Updated: May 2005

Barbara A. Hutchinson
Stoneleigh Associates Inc

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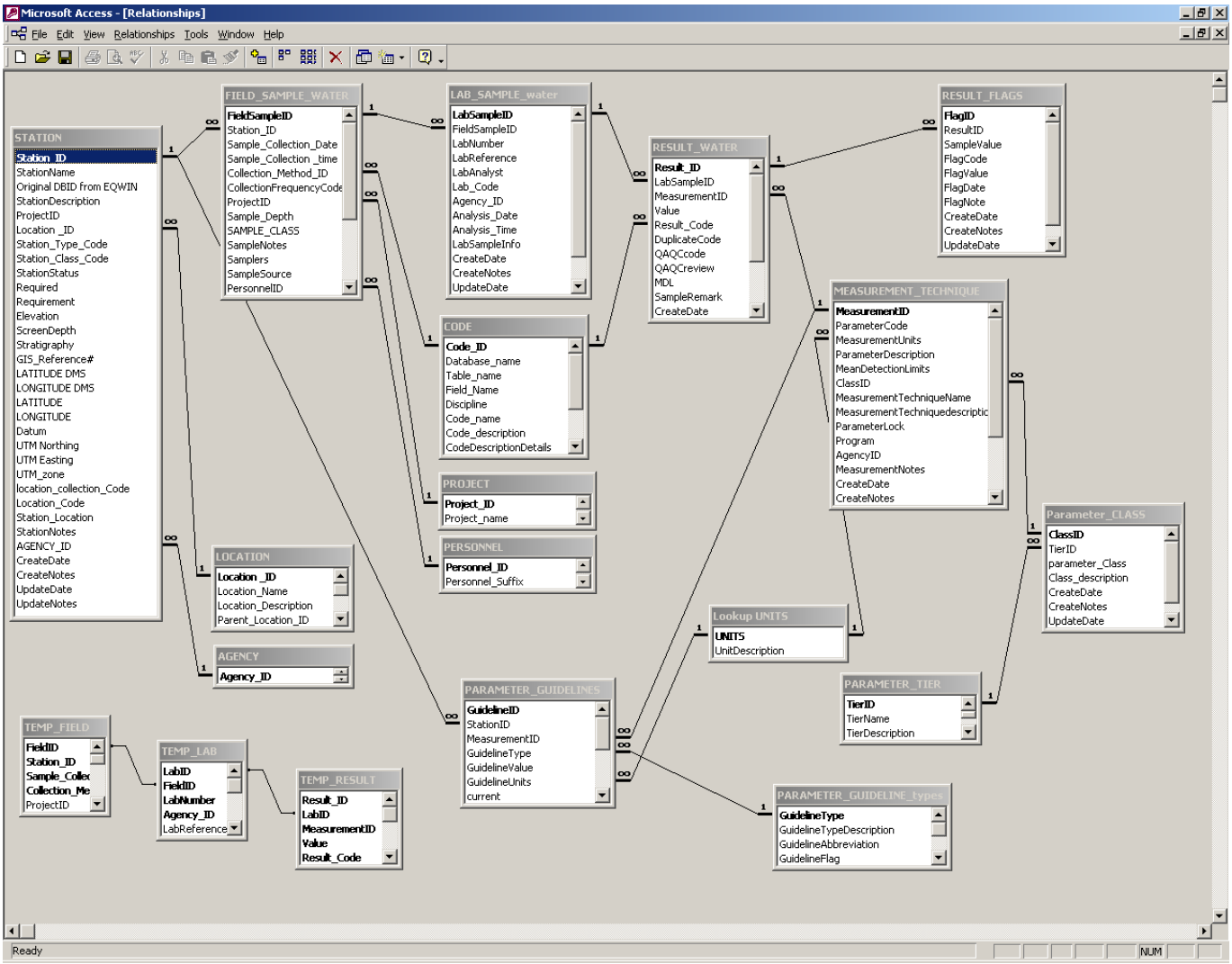
Introduction

This database application warehouses water quality measures and can be in turn linked to other associated monitoring and assessment type databases. The database file is called WATER and should be located on a LAN to make the fullest use of this results database. Version 1.2 views are read-write to all. A hyperlink to an electronic version of this manual exists on the main screen. The relationships between the tables in the database are shown in Figure 1 below.



Database Design

This database is a relational database, with tables constructed to third normal design. Simply put, each table has a unique primary key, and contains no redundant data values. Station information is in the station table and is not replicated elsewhere. Any other data table that

requires a relationship (or link) to the station table will contain the unique Station ID and be constrained to only values found in the station table… thus enforcing referential integrity.

A review of each of the tables (and content of each field) follows. The primary key (unique field) is identified in bold font. Any required fields are shown with gray shading. Audit fields with create date and text and update date and text have been added to all tables. The create date and text are added during batch import of all data records. The Update date is also added during import and will be updated along with the associated text when any values are changed for a record using application forms. This is accomplished using event procedure code on any read-write data forms that reacts to data changes.

WATER Core Database Tables

There are several data stores used as part of this data application. The first group includes data tables that contain all sample values by Station, date, time, parameter and collection method. The second group are used during batch appends processes. The third includes all reference data.

Table: FIELD_SAMPLE_WATER

The design of this table incorporates the unique station, date, time and collection method combination. Samplers then typically submit multiple samples for analysis (often at different labs). The link to results then is by the Field Sample ID and then the Lab Sample ID.

Field Name	Content	Type	Size
FieldSampleID	Unique field sample number and is assigned by the db as an auto number	Long Integer	4
Station_ID	Required Station ID – found in STATION	Text	50
Sample_Collection_Date	Required sample date (dd-MMM-yy)	Date/Time	8
Sample_Collection _Time	Optional sample time (hh:mm)	Date/Time	8
Collection_Method_ID	Required collection method, default value for PWQ samples (CODE 358)	Long Integer	4
CollectionFrequencyCode	Select from list of: annual, quarterly, monthly or weekly – historical samples need to be updated – related to number found in CODE table	Long Integer	4
ProjectID	Required project identifier – related to Project table	Long Integer	4
Sample_CLASS	Select from list of available choices found in CODE table – some codes imported with original data from EQWIN db	Long Integer	4
SampleNotes	Sample notes	Memo	-
SampleSource	Name/origin of the source data file	Text	255
Sample_Depth	Depth of the sample	Long Integer	4
CreateDate	Date the record was created (default of	Date/Time	8

	system date on append)		
CreateNote	Notes about the record creation – no further edits possible, required	Text	255
Update_date	Date the record was updated (default of system date on append), is automatically updated when values are changed using any of the data review/edit forms	Date/Time	8
UpdateNote	Notes about updates to the record and is automatically set to the current date when a value is changed using the data edit form	Text	255
DBID	Optional EQWIN identification number	Text	50
Personnel_ID	Person who collected the sample	Long Integer	4
AgencyID	Agency who collected the sample	Long Integer	4
TempFieldID	Used during the IMPORT data procedure and not otherwise viewed by the user	Long Integer	4

Table: LAB_SAMPLE_WATER

The design of this table allows for multiple labs for a single field sample, though often for regular sampling protocol a single lab is used (or assumed). Thus the field and lab sample ID relationship is often 1-to-1 instead of 1-to-many. Historical records often have little supporting lab information. This can be added/updated at any time.

Field Name	Content	Type	Size
LabSampleID	Unique lab sample number and is assigned by the db as an auto number	Long Integer	4
FieldSampleID	Relationship to the Field Sample table	Long Integer	4
LabNumber	Lab sample number assigned by analysis lab - may be duplicated if replicate sampling	Text	50
LabReference	Lab reference number - batch number for a lab for a suite of parameter analyses	Text	50
LabAnalyst	Lab analyst name	Text	50
LabCode	FK to CODE table for the lab code - especially used if 'lab' is actually circumvented for field analysis (temp, pH for example)	Long Integer	4
AgencyID	Lab sample agency identification	Long Integer	4
Analysis_Date	Date of the analysis	Date/Time	8
Analysis_Code	Analytical code – see CODE table	Long Integer	4
LabSampleInfo	Notes about the analysis	Text	255
Analytical_Method	Analytical method used (general)	Long Integer	4
CreateDate	Date the record was created (default of	Date/Time	8

	system date on append)		
CreateNote	Notes about the record creation – no further edits possible, required	Text	255
Update_date	Date the record was updated (default of system date on append), is automatically updated when values are changed using any of the data review/edit forms	Date/Time	8
UpdateNote	Notes about updates to the record and is automatically set to the current date when a value is changed using the data edit form	Text	255
TempLabID	Used during IMPORT procedures and not otherwise viewed by the user	Long Integer	4

Table: RESULT_WATER

This table contains all sample results sampled using all available sampling protocol. Multiple result values are typically obtained for a single field sample visit and are stacked in this table by measurement ID (the unique parameter and unit combination).

Field Name	Content	Type	Size
ResultID	Unique result number and is assigned by the db as an auto number	Long Integer	4
LabSampleID	Foreign key Relationship to the Lab Sample table	Long Integer	4
Measurement_ID	Parameter and unit identification, foreign key to Measurement Technique table	Long Integer	4
Value	Numeric result value, NULLS are possible, but are not routine	Double	8
Remark_Code	Remark code for the result – the default is valid sample (CODE 361)	Long Integer	4
DuplicateCode	Duplicate code for the result – historically and entire new station number has been assigned for essentially field replicates, these values could be recoded and then would show during routine analysis and be identified as duplicates/replicates	Long Integer	4
QAQCcode	Code set during data Comparison against +/- 3 STD of existing values by Station and Parameter – select from the list of choices: OK, Value is high, value is low, value is modified, unknown (default) and is required	Long Integer	4
QAQCreview	Code set during user data review of	Long Integer	4

	values and is automatically set to' value is modified' if the value is changed while viewed using any of the data forms – select from the list of choices: OK, Value is high, value is low, value is modified, unknown (default) and is required		
MDL	Mean detection limit as reported - may differ from Measurement Technique advertised value, not currently used in this application version	Double	8
SampleRemark	Sample notes added by the user during import routine and can be used over and above the create and update notes that are used for other specific purposes	Text	255
Update_Date	Date the record was updated and is adjusted automatically when a value is changed using data entry/view forms	Date/Time	8
CreateDate	Date the record was created	Date/Time	8
UpdateNote	Notes about updates to the record and is automatically set to the current date when a value is changed using the data edit form	Text	255
CreateNote	Create notes and includes the sample source file name during the import routine, cannot be edited using data entry/view forms	Text	255
RecordLock	Check if this record is locked against edits or deletes – use to protect values against changes for data reviewed using database forms, will be ignored if data viewed in raw table format	Yes/no	1
TempResultID	Used during data IMPORT procedures and not otherwise viewed by the user	Long Integer	4

WATER Update/Append Database Tables

There are several data tables used as part of regular updates to this data application. These temporary tables are used first as a template to append pre-defined format lab generated data files to import. Various update and append action queries are then used in sequence to process, format and add any new data to the WATER database tables. These follow the design and sampling protocol path of field samples submitted to various labs, which then report results for a variety of parameters. The actual steps required by the user to run the IMPORT procedure are described in a separate section later in this document. The following section elaborates on the design of the tables used during this procedure.

Table: RAW LAB DATA

This table is directly imported from the EXCEL file provided by the lab. It must be of consistent format. An example (for the first 9 fields) is shown below in data view. The design view is shown on the following page. There can be no blank rows or columns. The first 3 rows for the first 3 columns are assumed to be blank. Spaces do not count as blank (and were found in some files during testing). These should be removed by selecting cells A1..C3 and use the delete key.

Data View:

F1	F2	F3	F4	F5	F6	F7	F8	F9
			Conductivity	True Color	Turbidity	Hardness (Total) CaCO3	Total Suspended Solids	Dissolved Sulphate SO4
			COND	COLOR	TURB	HARD	TSS	SO4-D
			uS/cm	CU	NTU	mg/L	mg/L	mg/L
V1	503100049	3/7/2005	95	< 5	0.1	56	< 1	10.7
V6A	503100051	3/7/2005	218	< 5	0.31	182	< 1	52.1
V22	503100053	3/7/2005	1090	-	-	889	< 1	932
V23	503100057	3/7/2005	631	-	-	455	< 1	252
X5	503100066	3/8/2005	1050	< 5	3.4	1230	< 1	755
X14	503100090	3/8/2005	748	< 5	2.5	639	< 1	409

The first 3 rows of this table (beginning in column 4) contain the parameter identification information. The parameter descriptive name is first, followed by the parameter code, and the third row contains the units. Occasionally some of the descriptive names are missing. You should add a value for a placeholder only as these are ignored during the import match. Their absence however will cause an import error table to be created during Step 1. This will not affect the import of the data and this error table can be deleted should you miss this step. The parameter code and units will be used to find matches in the Measurement Technique table. Deviation in spelling for the parameter code will cause this match to fail. Occasionally some parameters will be reported in different units. You may either add these new units for the parameter as a new acceptable measurement or convert all reported values to existing valid

units. During the import routine, there will be a step that will enable this conversion as well as correcting any missing parameter matches. At this time you can also add a sample remark that the data has been unit converted. A drop-down value has been added for that purpose. You can add any other information as required for individual records.

Rows 4 through to the end of each individual file will contain sample data. There is no limit to the number of rows of data in the input file. Columns 4 though 200 will contain sample data. There must be at least one column of data (field F4). Any input files that contain more than 196 parameters must be accompanied by changes to this temporary table. The limit for any Access data table is 255 fields. Currently, this design is not expected to be a limitation.

Design View:

Field Name	Content	Type	Size
F1	Station ID value to match	Text	255
F2	Lab reference number	Double	8
F3	Sample date	Date/Time	8
F4	Result data in the format described above – the first three rows are reserved for parameter information and all rows following will contain sample results. The measured value will follow any remark code assigned by the lab. Any blank fields will be ignored	Text	255
F5	Each field following (to F200) is identical in format to field F4.	Text	255
F6	As for F4	Text	255
F7	As for F4	Text	255
F8	As for F4	Text	255
F9	As for F4	Text	255
F10	As for F4	Text	255
… etc to…			
F200	As for F4	Text	255

Table: RAW NORMALIZED LAB DATA

The contents of this table are filled and manipulated during the import routine. Data are reformatted (normalized) from the spreadsheet format of the raw input file described previously. Sample results are thus stacked by parameter for each station and date field and lab sample. The Station ID will be marked yes in the StationFound column if it exists in the STATION table. The Measurement ID will be derived from the matching of the Parameter Code and Units in the Measurement Technique table. Any values that are missing for either of these fields will be displayed to the user for corrections. If these corrections are not made, these records will be excluded from the import. The value and remark code (such as < or >) will be parsed to separate fields from the raw value. Values given as '-' or NULL will be ignored during the final appends to the RESULT table.

Field Name	Content	Type	Size
StationID	Station ID that must exist in STATION	Text	255
LabID	Optional Lab Sample number	Double	8
SampleDate		Date/Time	8
ParameterCode	Parameter code that must exist in the MEASUREMENT TECHNIQUE table	Text	255
Units	Units that must exist as paired with the parameter code in the MEASUREMENT TECHNIQUE table	Text	255
RawValue	May contain a prefix remark code, or may be denoted as '-' for missing or n/a	Text	50
ParameterName	Descriptive name of the parameter	Text	255
MeasurementID	IMPORT routine interpolated ID value from the parameter code and unit match and will be missing for non-matches. If it is not filled in during a review step, these records will be ignored during import.	Long Integer	4
RemarkCode	Descriptive code (< or >) if applicable	Long Integer	4
Value	Sample result	Double	8
StationFound		Yes/No	1
SampleRemark	Add any comments (µg/L converted to mg/L is available as a choice) if values are changed during the IMPORT	Text	50

The following three tables are identical to the three main data tables. Data are added in sequence to these tables during the final step of the IMPORT procedure.

Table: TEMP_FIELD

Field Name	Content	Type	Size
FieldID	Autonumber and added to TempFieldID	Long Integer	4
Station_ID	Station ID number	Text	50
Sample_Collection_Date	Sample date	Date/Time	8
Collection_Method_ID	Collection method added as unknown	Long Integer	4
Sample_Collection _time	Sample time – not typically provided and can be updated from field notes	Date/Time	8
Sample_Depth	Sample depth	Double	8
SAMPLE_CLASS	Sample class – added from user selection	Long Integer	4
SampleNotes		Memo	-
Samplers	Will be NULL	Text	50
SampleSource		Text	255
PersonnelID	Will be NULL	Long Integer	4
AgencyID	Will be NULL	Long Integer	4

ProjectID	Project - added from user selection	Long Integer	4
CreateDate	Added as system date	Date/Time	8
CreateNotes	Will contain name of source file	Text	255
UpdateDate	Added as system date	Date/Time	8
UpdateNotes	Will be NULL	Text	255

Table: TEMP_LAB

Field Name	Content	Type	Size
LabID	Autonumber and added to TempLabID	Long Integer	4
FieldID	Matched with TempFieldID	Long Integer	4
LabNumber	Optional lab number	Text	50
Agency_ID	Default lab CanTest used	Long Integer	4
LabReference	Will be NULL	Text	50
LabAnalyst	Will be NULL	Text	50
Lab_Code	Default need to be established	Long Integer	4
Analysis_Date	Will be NULL	Date/Time	8
Analysis_Time	Will be NULL	Date/Time	8
LabSampleInfo	Will be NULL	Text	255
CreateDate	Added as system date	Date/Time	8
CreateNotes	Will contain name of source file	Text	255
UpdateDate	Added as system date	Date/Time	8
UpdateNotes	Will be NULL	Text	255

Table: TEMP_RESULT

Field Name	Content	Type	Size
Result_ID	Autonumber and added to TempResultID	Long Integer	4
LabID	Matched with TempLabID	Long Integer	4
MeasurementID	Parameter identification	Long Integer	4
Value	Numeric result value	Double	8
Result_Code	Default is CODE 343 – sample valid	Long Integer	4
DuplicateCode	Will be NULL	Long Integer	4
QAQCcode	Default of unknown added	Long Integer	4
MDL	Will be NULL	Double	8
SampleRemark	User added during	Text	50
CreateDate	Added as system date	Date/Time	8
CreateNotes	Will contain name of source file	Text	50
UpdateDate	Added as system date	Date/Time	8
UpdateNotes	Will be NULL	Text	255
RecordLock	Will be NO as default	Yes/No	1

Reference Lookup Database Tables

These tables all function as reference lookups to the core data tables. Data within these tables is read-write to ensure that they are kept current, and are accessed through the Reference Lookup Data tab on the main screen. Typically only the primary key field and perhaps several other descriptive fields are displayed to the user in the application. You may not delete any records in these tables where a corresponding match exists in a related table (e.g. you can't delete a station if data for it exists). On the other hand, if you change a value in any reference table, the corresponding update will be made to all other related tables. As an example if you change the Station ID or name value, this will appear on all other data views.

Table: AGENCY

This table is used to store all agency related information used in both the collection and analysis of data.

Field Name	Content	Type	Size
Agency_ID	Unique agency number, db auto number	Long Integer	4
Agency_Type_CODE	Type of agency – selected from CODE	Text	50
Agency_Name	Name of the agency	Text	50
Contact_Personnel	Contact name	Text	50
Agency_Street_ Address	Contact address	Text	50
Agency_City_Address	Contact city	Text	50
Agency_Country	Contact country	Text	50
Agency_PostalCode	Contact postal code	Text	7
Agency_TelephoneNumber	Contact phone number	Text	10
Agency_FaxNumber	Contact fax number	Text	10
Agency_Email	Contact email	Text	50
UpdateDate	Date this record first added or updated	Date/Time	8
UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255

Table: CODE

All codes (such as collection methods, sample remarks, etc.) are stored in this single table. Code values are related to a variety of tables and fields by the numeric CODE ID, and there are restrictions in both the table and form view restricting the code values shown by the name of the database, table and field. As such these are required fields.

Field Name	Content	Type	Size
Code_ID	Unique code number, db auto number	Long Integer	4
Database_Name	Name of the database the code valid for	Text	50
Table_Name	Name of the table the code valid for	Text	50
Field_Name	Name of the field the code valid for	Text	50
Discipline	Discipline value used to restrict code view	Text	50
Code_Name	Name (or symbol) of the code	Text	50
Code_description	Description of the code	Text	255
UpdateDate	Date this record first added or updated	Date/Time	8
UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255

Table: LOCATION

There are a number of ways to designate regions or geographical areas aside from a specific station location. These may include catchments or watersheds, and larger locations or regions. A generic LOCATION table is used to fit any of these criteria. This table contains no geographic location coordinates. This table is different from the PROJECT table, despite the fact that projects can encompass separate locations.

Field Name	Content	Type	Size
Location _ID	Unique location number, db auto number	Long Integer	4
Location_Name	Name of the location	Text	50
Location_Description	Description of the location	Text	50
Parent_Location_ID	Reference back to Location ID	Long Integer	4
Location_Type_Code	Type of location code – found in CODE	Text	50
Notes	Notes on the location	Text	255
UpdateDate	Date this record first added or updated	Date/Time	8
UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255

Several tables are used to ‘lookup’ a textual value for a table with a format that is not conducive to central storage in the CODE table.

Table: Lookup MONTHS

Field Name	Content	Type	Size
MonthNumber	Number of the month (1-12)	Long Integer	4
Months	month name– used for report display	Text	50

Table: Lookup UNITS

This table provides the reference values for the unit field in the Measurement Technique table.

Field Name	Content	Type	Size
UNITS	Unit value – often symbols	Text	50
UnitDescription	Full description of the unit value	Text	50
UpdateDate	Date this record first added or updated	Date/Time	8
UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255

Several linked tables are used to store parameter measurement technique and reference guideline information. There is one central table (Measurement Technique) that houses all parameter, unit and analytical technique combinations. Unit variances for a parameter may be strictly classed as a measure qualifier and not a change in technique. Storing the unit value here in this central table, rather than in all related result tables fulfills the design criteria avoiding redundancy. It also makes data analysis more straightforward as users can chart only measures with the same units (or readily see those results where the units are misidentified) and statistics can also be confined to a single parameter, technique and unit combination. All related parameter information (such as groups and guidelines) is related to a Measurement Technique ID value.

Table: MEASUREMENT_TECHNIQUE

The contents of this table require continual review to update the units and technique descriptions. The parameter code is typically laboratory assigned and should be consistent among data partners. This is often not the case.

Field Name	Content	Type	Size
Measurement_ID	Unique measurement technique ID – combination of parameter, units and technique, db auto number assigned	Long Integer	4
ParameterCode	Parameter code name – may be lab assigned, or periodic table based. It typically has a 2-4 character abbreviation followed by a method qualifier (e.g. – D for dissolved)	Text	20
MeasurementUnits	Units the parameter is reported in	Text	50
ParameterDescription	Parameter descriptive name	Text	50
MeanDetectionLimits	Mean detection limits	Single	4
ClassID	Class this parameter belongs to – lookup value in Parameter Class table	Text	50
MeasurementTechniqueName	Name of the technique	Text	50

MeasurementTechniqueDescription	Description of the technique	Text	50
ParameterLock	Yes/no check to mark whether this parameter (for all results) is protected against any edits/deletes, default is no	Yes/no	1
Program	May be used for restricted view	Text	50
AgencyID	Agency responsible for this measure	Long Integer	4
MeasurementNotes	Notes about this parameter	Memo	-
UpdateDate	Date this record first added or updated	Date/Time	8
UpdateText	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateText	Note on creation of this record – no edits	Text	255
Annual	Yes/no field used for annual reports	Yes/no	1
Quarterly	Yes/no field used for quarterly reports	Yes/no	1
MonthlyF	Yes/no field used in routine data report format for Faro	Yes/no	1
MonthlyV	Yes/no field used in routine data report format for Vangorda	Yes/no	1

Table: ParameterClass Match

This table contains a single field used by a user select form in displaying parameters by class. This summary procedure is accessed from the main screen using the Data Reports and Summaries tab and then clicking on the 'View data by Parameter Class' button.

Field Name	Content	Type	Size
ParameterClass Name	Name of the parameter class	Text	50

Table: ParameterClass

This table contains the names of parameter class. A parameter may only belong to one class, but a class may have many parameters. The parameter class is used extensively to group data for customized reports. Parameters may thus be periodically re-assigned to be ex/included in various data views.

Field Name	Content	Type	Size
ClassID	Parameter class ID – unique database assigned auto-number	Long Integer	4
TierID	Required upper parameter tier ID	Long Integer	4
Parameter_Class	Class name	Text	255
Class_Description	Class description	Text	255
ReportSelect	Denote whether the parameter class is shown for user selection	Yes/no	1

UpdateDate	Date this record first added or updated	Date/Time	8
UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255

Table: ParameterTier

This table contains the names of parameter tiers. A parameter class may only belong to one tier. A tier may have many classes.

Field Name	Content	Type	Size
TierID	Parameter tier ID – unique database assigned auto-number	Long Integer	4
TierName	Name of the Tier	Text	255
TierDescription	Description of the tier	Text	255
UpdateDate	Date this record first added or updated	Date/Time	8
UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255

The following three tables related to guideline or reference values that can be derived or assigned for each parameter (Measurement ID) and/or Station in the database.

Table: Parameter_Guideline_Types

This table contains the guideline type values. The type is a required entry for the parameter guideline reference table.

Field Name	Content	Type	Size
GuidelineType	Unique type of guideline/reference	Text	50
GuidelineTypeDescription	Description of the guideline/reference	Text	255
GuidelineAbbreviation	Abbreviation	Text	50
GuidelineFlag	Single Text value	Text	1
UpdateDate	Date this record first added or updated	Date/Time	8
UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255

The current contents of the first two required fields of this table are:

GuidelineType	GuidelineTypeDescription
ALIV	AUSTRALIAN WATER QUALITY LIVESTOCK WATERING (1992)
ANZ1	AUSTRALIAN WQ AQUATIC ECOSYSTEMS (1992) -FRESH WATERS

GuidelineType	GuidelineTypeDescription
ANZ2	AUSTRALIAN WQ AQUATIC ECOSYSTEMS (1992) -MARINE WATERS
BC-1	B.C. PROVINCIAL EFFLUENT DISCHARGE OBJECTIVES-LOWER
BC-2	B.C. PROVINCIAL EFFLUENT DISCHARGE OBJECTIVES-UPPER
CANF	CANADIAN SURFACE FRESH WATER OBJECTIVES-AQUATIC LIFE
CANP	CANADIAN SURFACE OBJECTIVES-PUBLIC WATER SUPPLY
CCRE	CCREM CANADIAN WATER QUALITY GUIDELINES
CDW1	CANADIAN DRINKING WATER QUALITY OBJECTIVES LOWER
CDW2	CANADIAN DRINKING WATER QUALITY OBJECTIVES UPPER
NDEP	NEVADA D.E.P. (EPA DRINKING WATER STANDARD)
ONTE	DRAFT EFFLUENT LIMITS REGULATION (ONT. METAL MINE)
ONTM	ONTARIO MOE MINERAL PROCESSING INDUSTRY
ONTW	ONTARIO WATER QUALITY STANDARDS
QUEB	QUEBEC DIRECTIVE 019 - UNDILUTED FINAL EFFLUENT
Reference - LOWER	Lowest value accepted - may be continually revised based on Station by Parameter Results
Reference - UPPER	Highest value accepted - may be continually revised based on Station by Parameter Results
WHOD	WORLD HEALTH ORANIZATION DRINKING WATER GUIDELINE
WHOE	FARO Water License. January 1998 - December 2003
WHOF	DRAFT EFFLUENT LIMITS REGULATION (ONT. METAL MINE) (IL)
WHOG	Canadian Council of Ministers of the Environment 2002 Water: Aquatic Life Guidelines
WHOH	Water License QZ03-059 (VANGORDA WATER LICENCE)

Table: Parameter_Guideline_Reference

This table contains the guideline type reference data. This information is an optional entry for the parameter guideline reference table and was imported from the legacy EQWIN data store.

Field Name	Content	Type	Size
ReferenceID	Unique reference ID	Text	50
ReferenceCode	Description of the guideline/reference	Text	255
ReferenceAbbreviation	Abbreviation name		
ReferenceDescription	Description		
GuidelineFlag	Single flag – is not unique		

Table: PARAMETER_GUIDELINES

This table used to store all reference value guidelines for a parameter/unit combination. There is no limit to the number of guidelines for a parameter, though only one value per guideline type can be valid (current) at any one time. Various charts and summary reports can then select a parameter and guideline value (by type) to compare data against.

Field Name	Content	Type	Size
GuidelineID	Unique guideline/reference number	Long Integer	4
StationID	Is required only for upper and lower +/- 3 STD reference value derivation by parameter	Text	50
MeasurementID	Measurement the guideline refers to and is required – FK to Measurement Technique table	Long Integer	4
GuidelineType	Type of guideline – select and are restricted to the list of choices	Text	50
GuidelineValue	Numeric guideline value	Double	8
GuidelineUnits	Units for the guideline value – must match the Measurement ID units – this match is ensured during derivation and data entry forms and thus is pertinent only for visual information	Text	15
Reference	Reference information for this guideline as selected from the list of choices from the Parameter guideline reference table	Text	255
Current	Is the guideline current – yes is default. This value is re-set for outdated values during the derivation of +/- 3 STD upper and lower reference values	Yes/No	1
ValidGuidelineDate	Date the guideline became valid	Date/Time	8
UpdateDate	Date this record first added or updated	Date/Time	8
UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255
Source	Source for the guideline value	Text	255
AgencyID	Agency responsible for the guideline	Long Integer	4

Table: PERSONNEL

Field Name	Content	Type	Size
Personnel_ID	Unique person ID, db auto assigned	Long Integer	4
Personnel_LastName	Last name	Text	50
Personnel_FirstName	First name	Text	50
Personnel_Title	Title	Text	50
Personnel_Suffix	Suffix (like degrees)	Text	50
Personnel_PhoneNumber	Phone number	Text	50
Personnel_FaxNumber	Fax number	Text	50
Personnel_Email	email	Text	50
UpdateDate	Date this record first added or updated	Date/Time	8

UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255

Table: PROJECT

This table warehouses various project codes, and is added to records in both the Station and Field Sample tables. Stations are assigned and field samples collected on a project-by-project basis. The project field in both tables is used to group and restrict stations and samples for routine reports. Ensure that each field sample in the data to import is assigned a valid and correct Project ID value.

Field Name	Content	Type	Size
Project_ID	Unique textual Project ID	Text	50
Project_Name	Name of the Project	Text	100
Project_Description	Description of the Project	Text	255
AgencyID	Agency responsible for this Project		
UpdateDate	Date this record first added or updated	Date/Time	8
UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255

Table: STATION

The central STATION table is linked to all corporate data stores. Keeping this table up-to-date and complete is an important consideration. The key fields are the descriptive name of the station; it's location within the watershed/sub-watershed boundaries and the station type. The station type code is often used to restrict station lists within databases. That said the same station could be used for multiple sampling disciplines/projects – and a field for that information exists. Future enhancements to this application will add various related fields and links to new tables for groundwater monitoring information.

Field Name	Content	Type	Size
Station_ID	Unique textual Station ID	Text	50
Station_Name	Name of the Station – it should be as descriptive as possible and will display on many data views	Text	100
Original DBID from EQWIN	This information added during creation of the WATER db from the corporate data stores in EQWIN and is available for legacy cross-reference only. It does not form part of any data application procedures	Text	50

Station_Description	Description of the Station	Text	255
Project _ID	Project identification	Long Integer	4
Location _ID	Location of the station – see LOCATION	Long Integer	4
Station_Type_Code	Type of station – see CODE	Long Integer	4
Station_Class_Code	Class of station – see CODE	Long Integer	4
StationStatus	Either active (default) or inactive (and thus protected against data edits for any field, lab or result data	Text	50
Required	Check yes if the station is required for monitoring	Yes/no	1
Requirement	If the station is required – what is the reason, Station data view form will force entry if required = yes	Text	255
Elevation	Site elevation in m ASL	Long Integer	4
ScreenDepth	Screen depth in meters	Single	4
Stratigraphy	Screen stratigraphy – will eventually be moved to a separate related table	Single	4
GIS_Reference#	Cross-reference to GIS reference ID	Text	50
LATITUDE DMS	Latitude in DMS (degree/minute/second)	Text	50
LONGITUDE DMS	Longitude in DMS	Text	50
LATITUDE	Latitude in DD (decimal degrees)	Text	50
LONGITUDE	Longitude in DD	Text	50
Datum	Lat/Long datum (NAD 83 is the default)	Text	50
UTM Northing	Northing value (with suffix N)	Text	50
UTM Easting	Easting value (with suffix E)	Text	50
UTM_zone	UTM zone (default is 17)	Long Integer	4
Area	Site area in hectares	Long Integer	4
Location_collection_Code	How was the station identified?	Long Integer	4
Location_Code	How were station coordinates established?	Long Integer	4
StationLocation	Description on how to get to the station	Test	255
StationNotes	Descriptive notes on this site	Text	255
AGENCY_ID	Agency responsible for this site	Long Integer	4
UpdateDate	Date this record first added or updated	Date/Time	8
UpdateNote	Note on updates to this record	Text	255
CreateDate	Date this record first added – no edits	Date/Time	8
CreateNote	Note on creation of this record – no edits	Text	255

Using the Database

This database opens to a MAIN switchboard-type form that directs the user to all features of the application. The database can be used as a stand alone application, and could also link in future to other related data monitoring disciplines (such as Hydrology or Meteorology data warehouses).

Users can create a shortcut on their desktop to this corporate data store. A link displays on the main screen to an electronic version of this user manual. To edit the hyperlink to the User Manual, open the main screen in design view and then right-click the hyperlink and select edit hyperlink. Find the user manual file and then click OK. Save the Main screen.

Data Extents

There are several pre-defined summaries on the main screen that can be used to asses the extent and scope of the data in the database. All of these summaries are dynamic in that they always show the current available data in the station, field and result tables. Displays may take a moment to display as the review the extensive cache of data and are read-only. They include:

- Annual field visits by Station
- Annual total samples by Station
- Parameters currently in RESULTS
- Result Codes currently in RESULTS
- Detection Limits by Parameter currently in RESULTS

Data Views: Add/Edit/Filter

Most data will be added during batch processes from lab-provided EXCEL spreadsheet files. There may be occasions when a record may be added or changed from the keyboard. You can mark STATIONS, PARAMETER and individual sample RESULTS as inactive or locked and as such protect them from either edit changes or deletions. Data view forms remove the ability of users to change this protection designation. They do however react to their presence and will disallow any changes or deletes to protected records.

Add New Data

Use the button on this form to add field, lab and sample results. No previous results display. You may mark a record as locked during the data entry, but then may not unmark it using this form. Ensure that all Field, then lab and then result data is entered as completely as possible.

Edit Existing Data

Use the button on this form to view/edit/add/delete field, lab and sample results for a station. A watermark will display as a splash banner for any stations that are marked inactive. No data for these stations can be altered in any way. To quickly find a station’s data use the top-most black

station selection drop-down box. The form will then move to the first field sample date for that station. To filter (or restrict) only that Station, click in the lower yellow Station ID field and then  apply the filter. You can click on the button 'filter by selection', right-click on select it or click on Records, then Filter, then filter by selection. The display will change to show only that station. To remove the filter, click on the funnel (remove filter) button.
The fields in yellow are required and you are restricted to the choices found on those lists. **CAUTION: When viewing data, if you scroll through these lists and then inadvertently make a change for any value – the record has been changed.** This is especially critical when using the station ID drop-down list. The black one at the top is used for searching and can be altered. The yellow one below is used to set the ID for the Field sample and must remain as valid for that record. You may re-assign field sample station ID's… but this will not be a regular edit change. Re-assigning both station and parameter ID values is more readily accomplished using wholesale data reviews (rather than a single field sample). These are described later in this document

The results for each field and lab sample are viewed in the table at the bottom of the screen. There are procedures that will react when a record is deleted or when any part of the record is changed. The station status, parameter record lock and result value record lock are checked, and changes or deletions will be disallowed if warranted. There is also a procedure on the value field. If a value is changed for any reason, then the Update date for this record is set to the current date. The user cannot change this date. The QAQC review flag is set to 'the value is modified' and a warning will display to the user. Any values that are edited using the raw tables (and not data view forms) will effectively circumvent these protection procedures.

Field data can be quickly entered for a station and date. Find the Station and then sort by the date (click in the date field and press the A-Z sort). Add the field parameters and any other relevant information. This data will show on routine reports and it is important that it be kept up to date. It should be added after other lab result data are imported. The presence of samples on this date will cause the IMPORT routine to skip this field sample. Do not add another field sample record for the same date when entering field data values and comments but use the existing one instead.

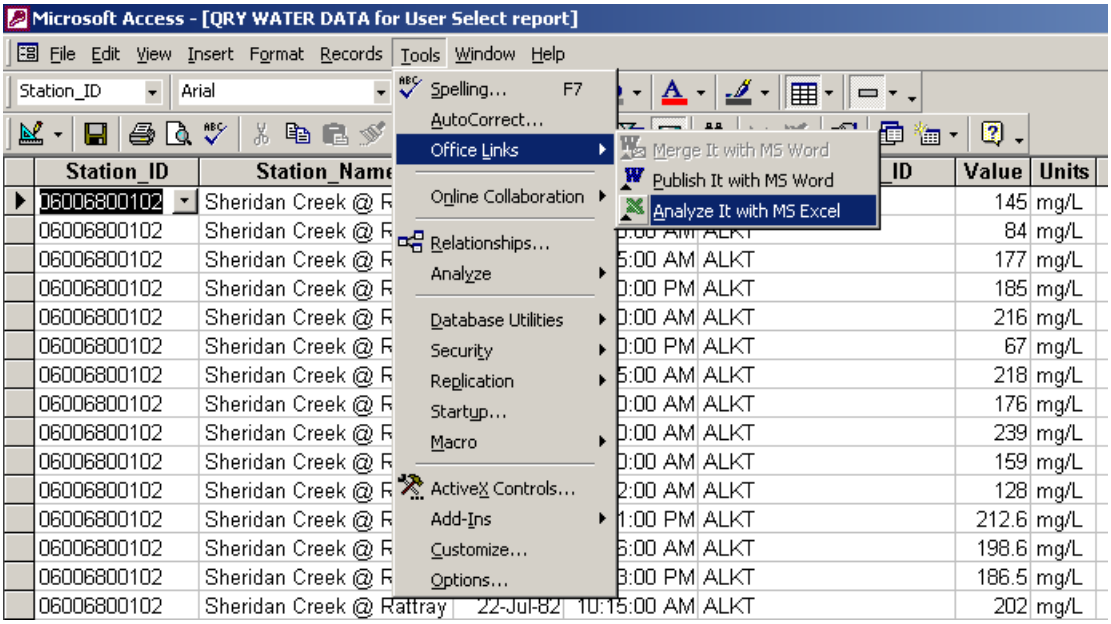
Filter (Find) Data

Use the button on this form to quickly filter sample results for a station and parameter. All data displays are read-only in this view. You must select both a station and a parameter from the drop down list. All sample results will display chronologically.

Data Reports and Summaries

There are several ways that users can view and summarize data. Some procedures produce the same output, though the user can arrive at the display using different means. Printable reports, sortable/filterable/exportable data displays and charts are all choices available to the user. Most of the data will be viewed via drop-down lists as user selected choices. Data display can be further sorted or filtered using available buttons on the standard Access menu and tool bars.

The following sections describe buttons by the same name located on the main form. They access various methods to view and summarize data. **Most data displays are read-write**. Data reports maintain all formatting when printed from the database, but if moved to WORD will become rich-text formatted and will loose all bit map graphics, shading and lines, though text font formats and spacing are maintained. Thus distributing reports as WORD documents may require some additional changes before sending. Reports converted to EXCEL have even more format changes.



Users can however quickly export data views to EXCEL using the command Tools – Office Links and then analyze with Excel. Once there more advanced summary analysis and charting can occur. There is no link maintained between the data here and the Access database.

VIEW Routine (Weekly/Monthly/Quarterly/Annual) REPORTS

Regular reporting of sample data by station and parameter class occurs on a monthly, quarterly and annual basis. Use the button on the tabbed form to access a user selection form. You must pick the report type, parameter class, project and year. You must pick at least one station. Multiple stations can be selected using the Ctrl and shift keys to extend the selection. Hold the Ctrl key down while picking stations to individually select. Holding the shift key down while clicking stations will cause an entire block to be picked.

Reports are individually formatted by the parameter class. Parameters are assigned a class in the Measurement Technique table (or view of that table using the Reference Lookup Data tab). You may see all parameters assigned to this class using the 'View data by parameter class' button on the 'Reports and Summaries' tab. These reports use a special query data source called a cross-tab query. The report column names are the parameter codes within the class and are hard-coded to the report. One of the drawbacks to this kind of report is that if any of the

parameter codes are missing, the report will show and error for the missing code and fail to open. Extra codes on the other hand will not be included unless they are re-designed into the report.

Separate data sources are used due to the extensive data cache to improve run-time performance. Separate reports are required for both Faro and Vangorda as different suites of parameters are displayed.

VIEW a Chart by Station, Parameter and Date

The user can enter a station, parameter, start or end date to refine the choices. The station and parameter are required entry. The station selection will then restrict the parameter measurement choices to those found in the database for that station. The parameter selected will then restrict the guideline values. An upper reference guideline value for that station and parameter will display above the chart. An input mask protects both the start and end date to entry as ‘dd-mmm-yyyy’ though the date selection is valid only for the data report and not the chart.

A station and parameter must be specified for charts, but are optional for the data view. Any of the charts may be printed – landscape is the default format.

VIEW data by Station, Parameter and Date

The user can enter any (or none) of a station, parameter, start or end date to refine the choices. An input mask protects the date to entry as ‘dd-mmm-yy’

A read-only data display, summary data report (with statistics) or a read-only data display are output options. There are other data views that present an editable version of the same data where data changes (or parameter re-assignment) can occur.

VIEW data by Parameter

The user can enter a parameter and optionally use a check box to include all unit combinations to refine the data selection.

A fully editable data display is the output option. This view is especially useful to quickly review and enable change a large selection of data for possible unit misidentifications. In particular many metals periodically switch reported units from mg/L to µg/L. This causes obvious problems in analysis and charting. Stations, Parameters and Results are protected against edit changes if edit lock fields in each core table are so defined..

VIEW data by Parameter Class

The user can enter a single parameter class using the top-most selection box or use the list box below to select more than one parameter class, This will refine the selection of data to only parameters found in this class. Classes are assigned by Measurement ID within the

Measurement Technique table (accessed from the Reference Lookup Data tab on the Main form).

Two choices of a editable data display (the third is read-only) are possible for a single parameter group selection. These include a summary data report (with statistics) or a filtered data view – either with all parameters stacked in a single field or as a read-only cross-tab query with parameters as separate fields. A multiple parameter group selection will only allow the filtered data display – with all parameters stacked in a single field. Use the sort or filter toolbar buttons to refine this view. Stations, Parameters and Results are protected against edit changes.

VIEW data by Parameter Guidelines

The user can enter a parameter guideline (sorted and filtered by the guideline type) and optionally select a station (or group of stations) to refine the choices. All current guidelines will display. The type of guideline will affect the data source and display of the report. Many reference guidelines are established on a broad basis by parameter. Another class of reference guidelines are derived by this application within both Station and Parameter. They are based on all available data for that station and derive an upper and lower limit value that can be compared against existing or new sample values. Currently comparisons using this screen view are made against any values that may be higher than a given guideline value. Thus, the lower reference limit is excluded from this procedure. The report comparing against an upper reference limit will show the limit established by Station, whereas all other guideline comparisons are done independently of station and solely by parameter.

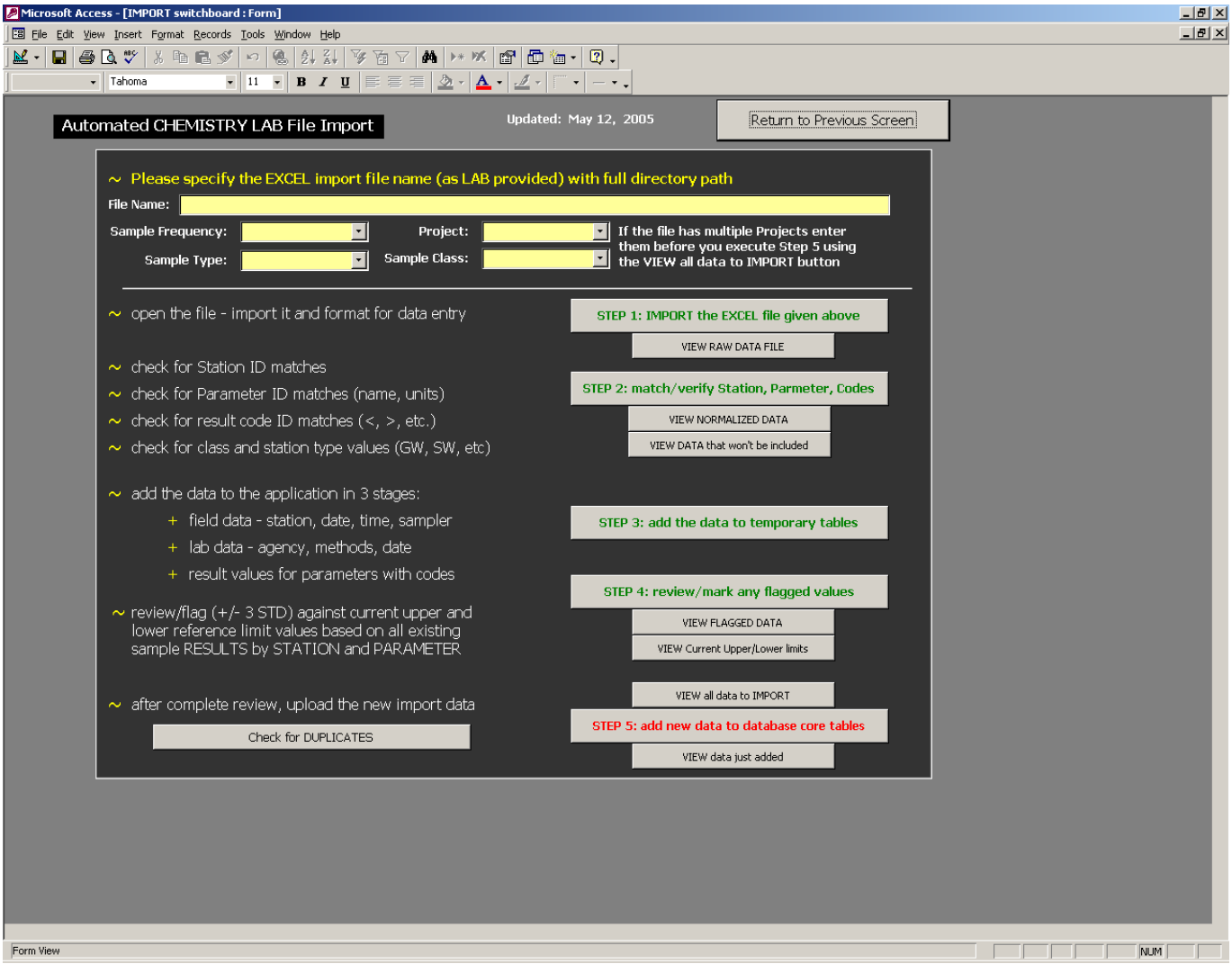
A read-only data display or summary data report (with statistics) is the output option. Both summary displays derive various variance fields. If a value exceeds the Upper guideline value, then the amount and % are derived. If the value is below detection, that is identified as well. If the value is below the Upper guideline, that is identified. Landscape is the default format for the summary report. To print selected pages, use the command File – Print and then enter the page(s) to print in the boxes provided.

Importing New Data Results

There are standardized methods for importing new field and lab data to this application. Due to some variance in file formats provided by labs, a single provided standard data file format was used to define an automated procedure. Typically sample result values are added in batch mode, though single results may be added as required. This will be especially true of corresponding field tests and notes. From the Main screen, click on the tab marked 'Data Import procedures' and then the button marked 'IMPORT…' A new screen will open. The user must ensure first that:

- The imported data files are formatted according to the conventions described previously (row and column content and layout of station, parameter, units, result codes, etc.)

Before starting, enter the name and full directory path of the EXCEL lab file. This will be used both to find the file to import and as a note used for the Create Note field during the append process. Enter the Frequency, type, Project and Class using the fields provided.



The append process can be executed in five steps for the data file as follows:

1. **Import the data file** to a template table (RAW LAB DATA). Previous data will first be deleted. The imported raw data table can be viewed using the command button below Step 1. As noted before, if any of the parameter descriptions are missing from the first row, and error$ table will be created. If this has happened because the user did not add placeholders for missing information, then simply delete this file. The import procedure will be unaffected by this error.

2. **Format the data** for data entry. This will normalize the information, repetitively taking each new parameter data column and append it as new records to a template table (RAW NORMALIZED LAB DATA). The design of this table makes it impossible to add the same station, date, time and measurement combination. The process then checks the data for existing:
    a. Stations (Station ID)
    b. Parameter and Unit combinations (Measurement ID)
    c. Parsing the data value from any result codes (like < or >)

    All data in this table as well as records that won't be included (due to missing matches or null values) can be seen using the buttons below Step 2.

3. Add the data to temporary tables for further review as:
    a. Field data (unique Station and date combinations)
    b. Lab data (unique Lab numbers provided for each Station/Date pair)
    c. Result data

4. **Review the data against existing values for a general QA/QC** overview by both station and parameter to flag any value that is either over or under 3 standard deviations about the mean value. These values are first re-derived using all existing data by parameter for each station currently in the database. The upper and lower limits are then stored in a parameter flag guideline table and then compared to this new data. The user can then review any flagged values as well as all limits for each parameter. The QAQC flag for any flagged values is updated automatically.

5. The final step is to **append data to the core tables** – in the 3 stages as described earlier for field, lab and results. Both the data that will be imported and the resultant appended data can be viewed at this step. Any final updates to the data can be made at this point using relevant drop-down lists of all reference lookup data. Data will be excluded if it already exists in the database. Failure to ensure that the correct station and project ID values are assigned may mean that data may be inadvertently entered twice. Use the check for duplicates button on the bottom of this form to review data by:
    a. Station
    b. Sample date
    c. Parameter
    d. Value and remark code
    e. Duplicate code

Review of Reference Data

There are review and edit forms to access all reference data for this application. Use the tab on the main screen to view these forms. All data are fully read-write. Several of the data displays can be used to lock records against edits. Both the STATION and MEASUREMENT TECHNIQUE forms have fields used to make this distinction. In most cases the reference values provide information to assist the users in entering data, and are restricted to only those values.

Changing Measurement ID (Parameter/unit) assignment for sample records

There are several ways to accomplish re-assigning parameter identification – you may use some of the existing summary views accessed from the main screen. Both the View Existing Results button on the Data Views tab and the View Data by Parameter button on the Reports and Summaries tab allow parameter re-assignment. The second button allows you to quickly see a specific parameter for all stations, while the first is station specific. If you use the View Data by Parameter method, once the data display opens you may then apply other filters (for station(s) or date ranges. To filter for dates the syntax is a bit different than simply entering the value or ranges of value to restrict by. Use the right-click mouse button while in a date field and then ensure that you enclose the date criteria within # marks as you enter them on the Filter for: line. An example to filter for only 1996 could look like: between #01-Jan-96# and #31-Dec-96#. You may also use other mathematical comparators such as:

> or <	greater than or less than a specified value
<>	is not equal to a specified value
is NULL	is blank or contains no value
BH*	use a wildcard to find all values that begin with BH

Changing Station ID assignment for sample records

The easiest way to do this is to open the Field Sample table directly. In this manner related lab and sample results can be seen for each station. You may reassign these lab and results for any station(s) by simply changing the station ID value in the STATION ID field of the Field Sample table. You may wish for certain cases (say field replicates) to first code the results for a replicate station as lab or field duplicates (using the field in the RESULT WATER table designed for this) and then re-assign the station ID. You must do it in this order or you'll lose track of which values were from the replicate station. You may then have the option of removing these completely re-assigned Station ID values from the STATION table. You may only do this if there is no related records in either the result, lab or field table for a station.

Changing sample values

Numerous data view forms allow result values to be changed. This will in turn set the QAQC review code to 'value is modified', the Update Date to the system date and a comment added to the Update Note field. The user could consider storing the old value in the Sample Remark field for legacy reference..

Exporting the Data to other users

Creating an EXCEL file

The data from this corporate store will be frequently distributed to partners, clients and stakeholders. You may wish to provide actual raw data files as exported data from the WATER application. As noted previously, any data view (not a formatted table or report) can readily be sent to EXCEL using the Tools – Office Links – Analyze with Excel command. The file is automatically saved in the current default folder and will be named what the data display source in WATER is called. To change the folder default use Tools – Options and then click on the General tab. You should always re-name or copy this file by using the Save As command if you will be using or distributing this file in future. This is because if you re-run the office links command on the same data display you will get a warning message that you will overwrite an existing file. Thus, your previous file (which may have been filtered in a different way) will be overwritten

Creating an MDE file

The entire database can be sent for distribution. The present design does not protect data against edits – in fact this is enabled as the data are edited, imported and reviewed as part of the on-going monitoring process and corrections of historical data storage and reporting problems. The database structures (tables, queries, forms, reports, etc.) are also not protected against design changes. You can alleviate this problem somewhat by creating a replica of the file that is design protected for forms and reports. Tables and Queries will still be editable in either view however, and all procedures will work as designed. This replica will have a different extension from the base application (.mde instead of .mdb). It is marked as an executable file.

To create an MDE file, first ensure that a backup copy of the database exists. As an administrative warning: **NEVER COPY OR MOVE AN OPEN ACCESS FILE**. Ensure all network users have closed the file before making copies or database object updates. The file will be corrupted and this file error is unrecoverable. Open the application and click on Tools – Database Utilities – Make MDE file. A dialogue box will open and ask you to specify a name for the new file and folder location. By default the MDE file name will have the same name as the current file (WATER), but will have a different extension. The folder location will be the default. Click save and the process will complete. This file can then be burned to CD, copied to a flash drive or posted to an FTP site. It is too large, even if zipped, to attach to an email.

Distributing Reports

Access reports function essentially as word processing mail merge templates. Thus, the report database object cannot be distributed without the underlying data source. This data source is typically a query (or series of queries) and is often filtered by the user from a calling form. The

printed report (or selected pages) can of course be printed and then paper copies distributed, but the digital versions are a bit more difficult. The print preview of any report can be exported to WORD using the command Tools – Office Links – Publish (not Merge) with WORD. All data, spacing, (but not via tabs) and calculations will be preserved, but graphics (like header bit maps), lines and shade formatting will be lost. The default export format is rich text, and the file will automatically be saved by the database source name in the default folder. As with the EXCEL file, you should re-save the document to a new folder, and/or with a new name. You may wish to add some of the formatting back in and you have the option of saving as a .rtf file or as a standard WORD .doc file. Some reports export to WORD quite well if the database design format is simple.

Database Updates: Importing new Database objects

There may be occasions when new database features (or changes to existing ones) will be required. The master version of the data will reside with the client and is often not necessary to transfer back and forth. New database objects (tables, queries, forms, reports, macros) can be sent easily via an additional database file (such as Update WATER.mdb). The objects in this file can then be imported to the master version of WATER.

Adding New Database Objects

Use the command File – Get External Data – Import to open the Import dialogue box. Find the update access file and click Import. The file will open and display a multi-tabbed form. Select the objects to import (there will always be accompanying instructions about this) and click OK. The new objects will be imported.

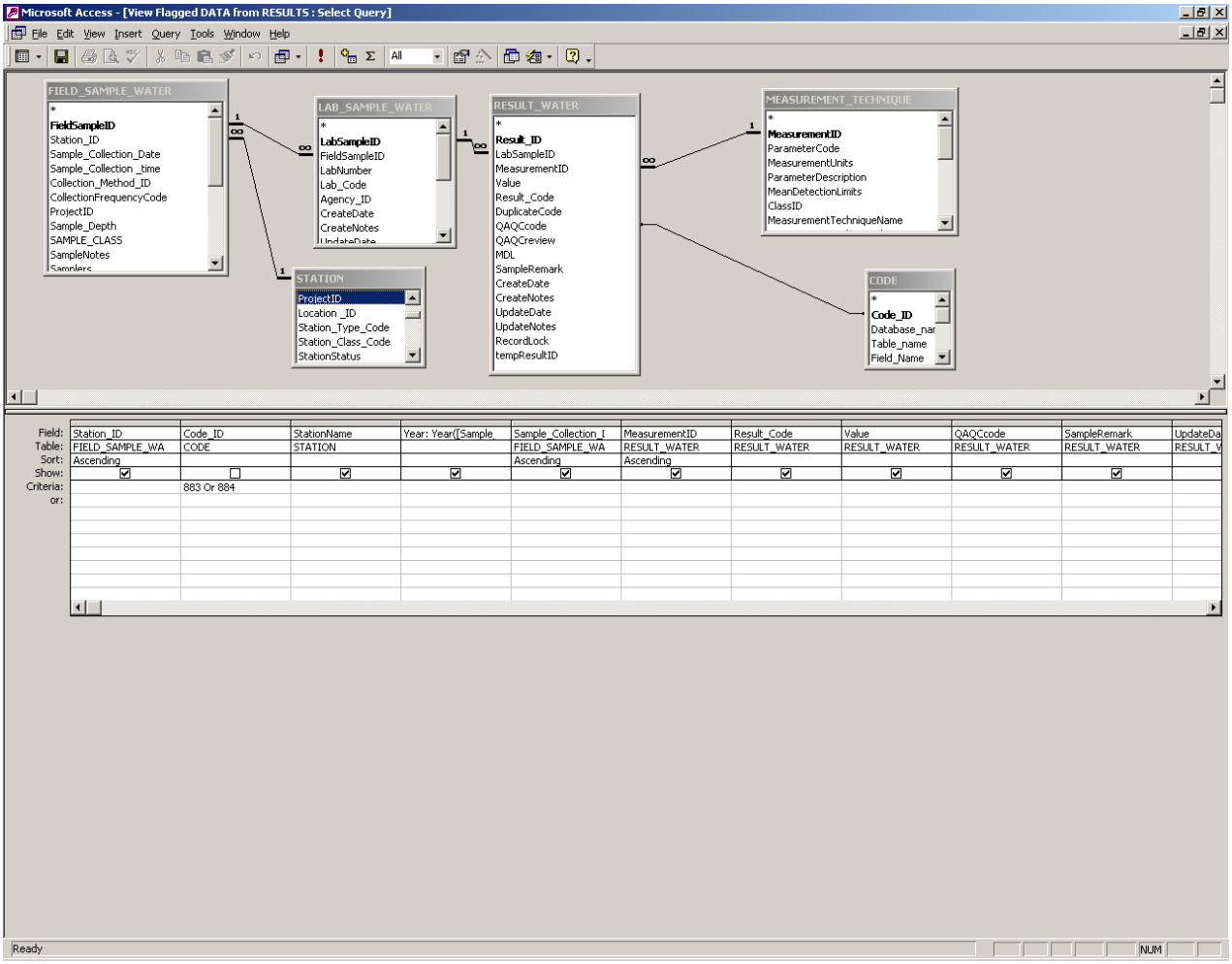
Replacement of Existing Database Objects

This will be more typical as a combination of both new and replacement objects are more likely to occur. Use the command as described above to import the objects from the update access file. You must switch to the database view to finish this import. Click on Window and then scroll down and select 1. WATER. You may also use the Database Window button (3rd from the right on the toolbar). Click on the appropriate Object tab on the left of your screen (tables, queries, etc. to show each class of objects) and then find the new items. Again, there will always be documentation about the required updates. Replacement objects will import but will always have the number 1 inserted after their name. The old object must be deleted, and the trailing ‘1’ removed from the replacement objects. Once this is done, all procedures will work normally.

Creating Queries

This manual is not meant to replace Access reference guides, but rather serve as a quick and useful tool to view and use the corporate water quality data store. There are numerous stored procedures to produce data views (queries). None of the stored queries can be altered in any way or pre-defined procedures may not work. Nonetheless, they can serve as a framework to modify and create your own data questions and views. NOTE that the view of data produced by queries is fully read-write – including record update and delete operations.

The figure below illustrates a sample select-type query joining data from related tables and then adding restrictive criteria.



You may wish to take an existing query and adjust it for your own use. Ensure that all database queries remain unchanged, as this will have ramifications for various application procedures. It may be tempting to create a multitude of new queries, each with different restrictive criteria. That is the purpose of most of the user selection forms. They allow a single query and/or display form/report to filter by the user selection criteria. In that way the application remains as small, straightforward and as robust as it can be.