DATABASE MANAGEMENT OF DEFLUORIDATION WORKS AS AN ESSENTIAL TOOL IN MINIMISING EXPOSURE TO FLUORIDE THROUGH WATER

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ABSTRACT: A rational management of defluoridation works must include surveillance of defluoride filters, estimation of individual operation periods, and on-time recharge of saturated filters. This is done best in a database, where all necessary information is included, i.e., about the client, the site, the raw water, the water analyses, the filter, its recharges, and, most importantly, its first expected date of exhaustion and recharge. Automatically, the database would produce up-to-date lists of installed filters that would need recharge and further merge E-mails to clients indicating to them the length of time their filters have been operating, offering them new recharges on time, and stating to them the prices and conditions. Our experience shows that the database and the E-mail reminders made the maintenance and the surveillance of the filters more efficient and this has contributed to a higher sustainability of defluoridation works. The principles and setup of the Defluoridation Technology Project database are explained further. It is concluded that defluoridation works can only be sustainable if managed efficiently through a database system.

Keywords: Database; Defluoridation; Defluoridation Technology Project; Defluoride filters; Fluoride analysis; Maintenance; Queries; Structured Query Language (SQL); Surveillance; Sustainability.

INTRODUCTION

Since water wells may have different fluoride concentrations, even if they are installed within same geographical area, and since the capacities of defluoride filters would further depend on the water use, defluoride filters may have different operation periods, even if the filters are of the same design and installed at a household level. Institutional filters are normally larger and designed differently, so that the estimated operation periods are meant to be ½, 1, or 2 years. The factual operation period may then show a higher multitude of variation. Proper recharge of filters, i.e., not much later or much earlier than the medium saturation and the fluoride breakthrough, is essential to avoid unintentional fluoride exposure or, on the other hand, waste of valuable defluoridation medium.

A de-fluoride filter cannot therefore be launched in the market as a normal tool, an instrument, or a machine. Firstly, as the fluoride is not recognisable to the user's taste, smell, or vision, the filter users do not have a reliable possibility of continually checking whether the filter does remove the fluoride, and to what extent it does. Secondly, as in the case of bone char filters,[1,2] a filter is known, upon use, to get saturated and to cease defluoridation at its exhaustion point. In water works, a filter like this would be monitored by a water works or a laboratory technician to indicate the time of exhaustion of the filter and its need for a recharge. Such a solution is not feasible for drinking water filters that normally serve only a small group of people, as in a family, a company, or even a larger institution.

The Defluoridation Technology Project tried to solve this problem by developing the tools to estimate the filter capacity in terms of the potential removal of the amount

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of fluoride up to saturation, assuming a standard flow pattern of fluoride water through the filter (the capacity *ab fabric*).[3] By dividing this *ab fabric* filter capacity with the user's concentration of fluoride in the raw water, we get the estimated filter capacity at the user site, the *In-Situ* Capacity, in terms of potential water treatment in litres. Then the filters were supplied with water flow meters and it was left to the users to react to the indication of exhaustion or overuse. This system failed completely. In part, it was suspected that the available water meters were unable to measure the flows in the small filters precisely and, in addition, it was because the users failed to react to the meters on time.

The Defluoridation Technology Project then developed the present approach, depending on a database, in which all filters are treated individually, and the project clients are given warnings about their "due" filters through E-mail.

In the following, the set-up of the database of the Defluoridation Technology Project is explained, so that it may give inspiration to similar initiatives.

MAIN COMPONENTS

Database: A database is an organised collection of data allowing retrieval of specific information according to the need. The Input data of defluoridation works may include data concerning: 1) Clients, 2) Filters, 3) Water Tests or lab records and 4) Filter Recharges. On the output side the database may retrieve 1) Reminders to be E-mailed. 2) Lab reports to be evaluated and submitted to clients, 3) Invoices to be mailed and 4) Investigation of potential water sources and supply set ups (Figure 1). The Defluoridation Technology Project utilises the MS Access-software.

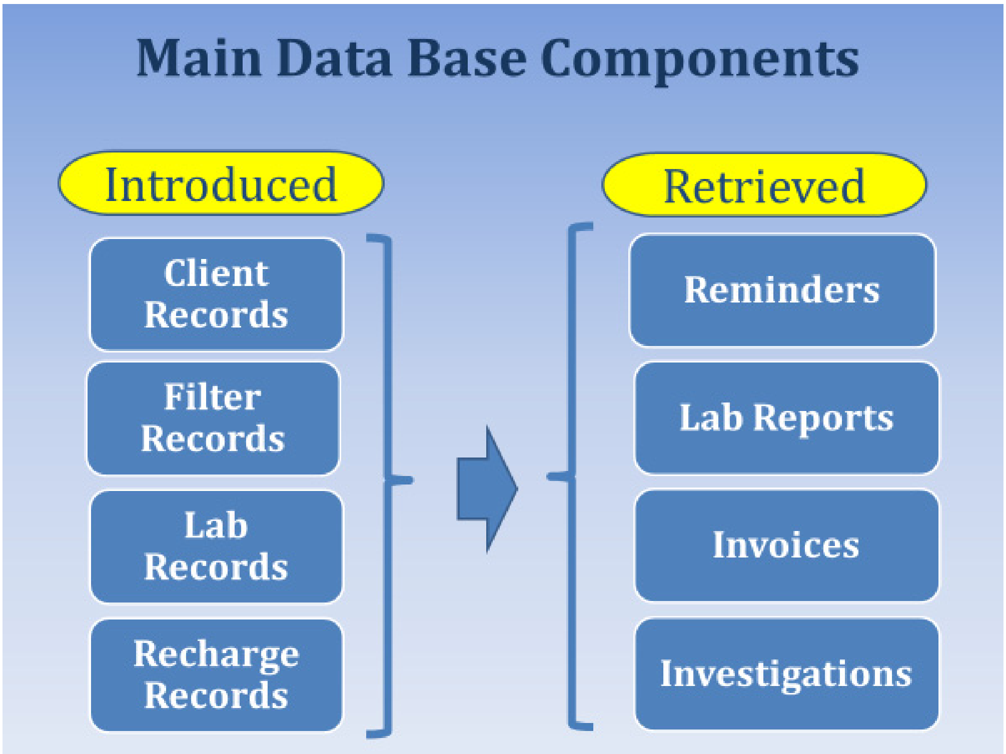
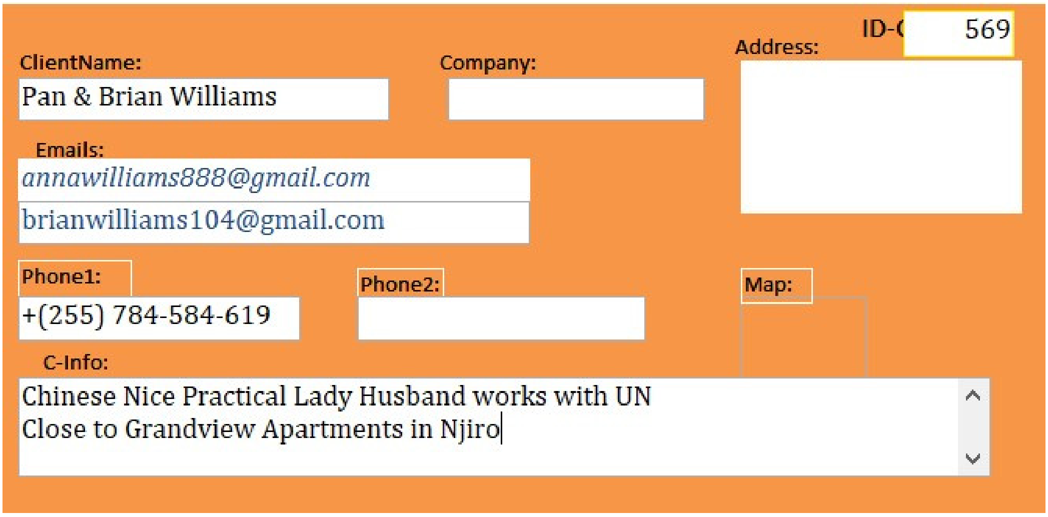
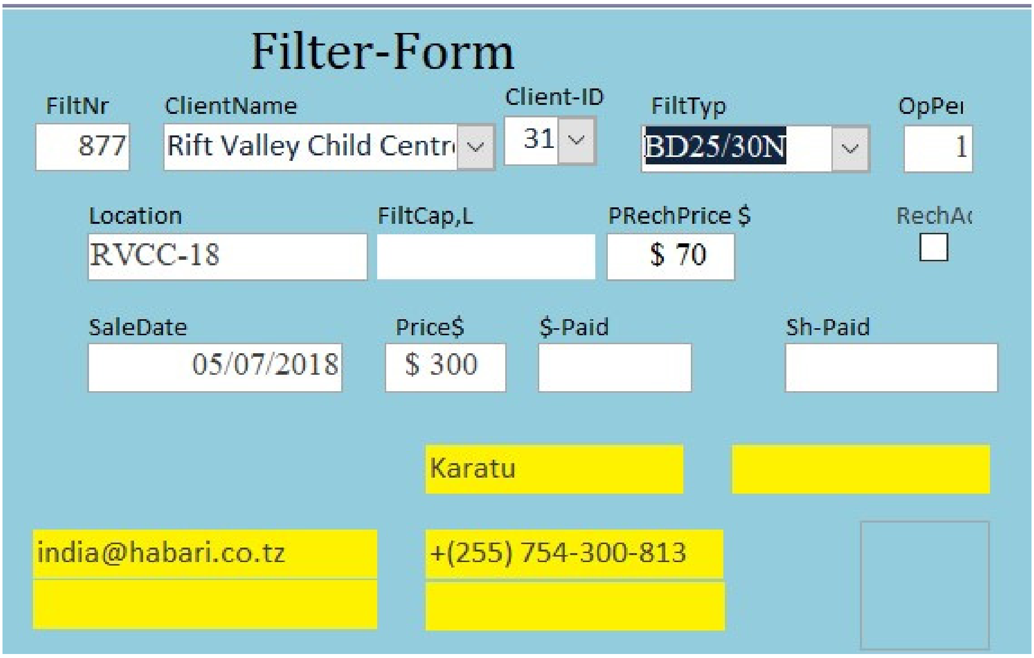


Figure 1. The main introduced records and retrieved reports in the Defluoridation Technology Project database.

Introduced client records: The introduced client records are simply a Table, where each raw input is a record concerning a certain client. The client table contains all necessary information on the client. These data are organised in columns, where each column represents a field. The fields are selected individually with different data types, e.g. an Autonumber, a Text, a Number, a Hyperlink, a Yes/No, a Date, an Attachment, a Currency, or a Lookup Wizard. The list of clients normally gets too long and complicated to look at record-wise. The utilised software provides for a special Form to view the records separately. The forms are, most conveniently, also used as windows to introduce new records in to the database. Some of the forms designed in the Defluoridation Technology Project are shown in Figures 2A–2E.

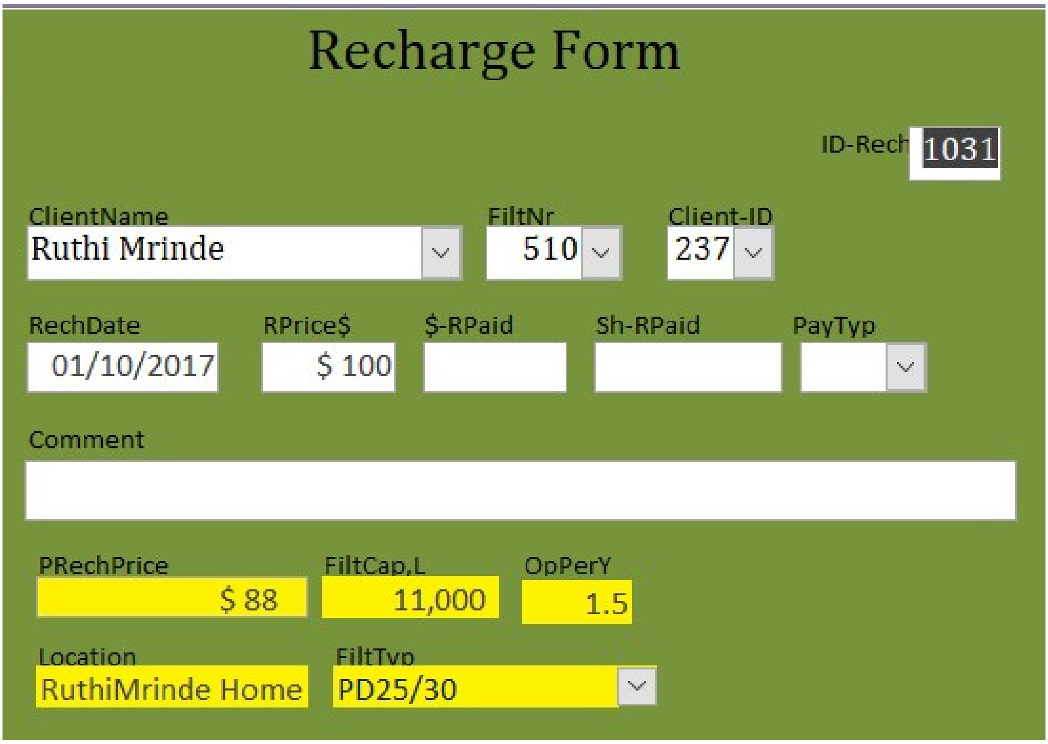


2A



2B

Figures 2A and 2B. Two of five forms frequently used in the Defluoridation Technology Project. 2A: Client data form; 2B: Filter form.



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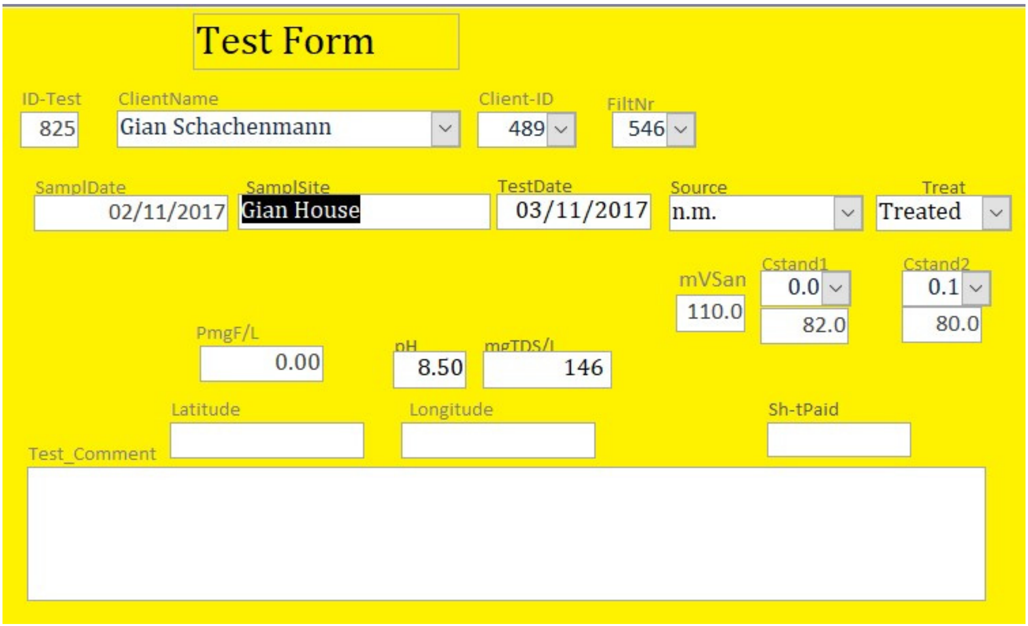
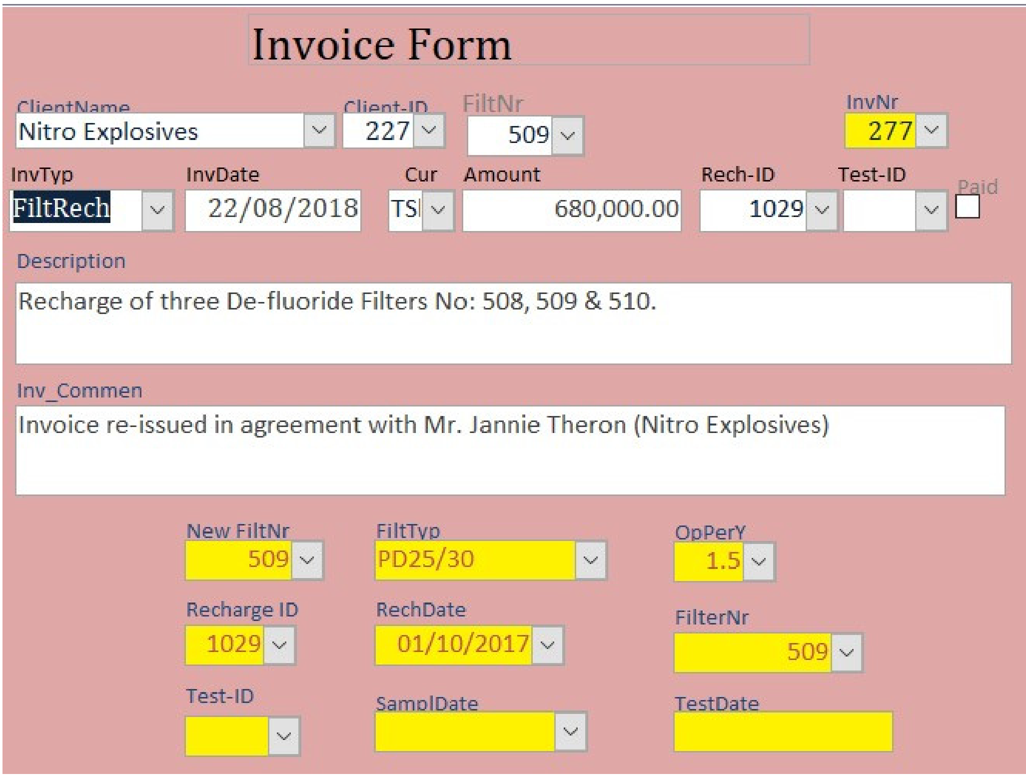


2D

Figures 2C and 2D. Two of five forms frequently used in the Defluoridation Technology Project. 2C: Recharge form; 2D: Test form.

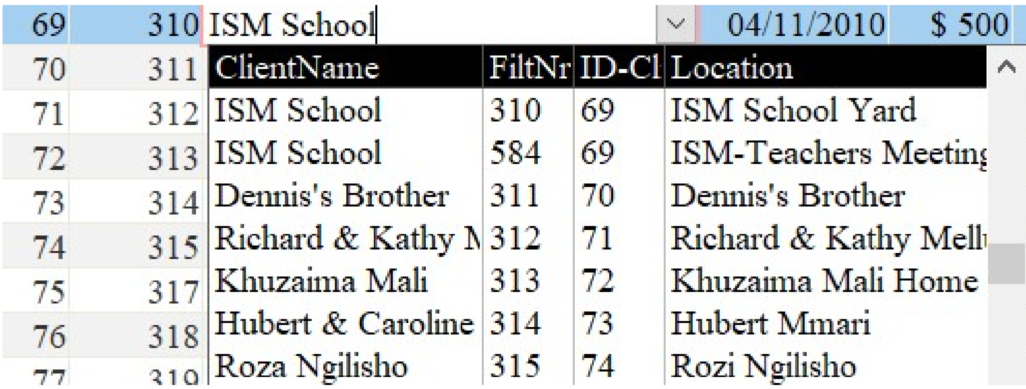


2E

Figure 2E. One of five forms frequently used in the Defluoridation Technology Project. 2E: Invoice form.

DROP-DOWN TABLES

The filter form, Figure 2B, shows how a filter has its own unique filter identity number, Filt-ID. It also shows how a filter is related to a certain client: The client Name and the client-ID are included as data fields in the filter table. Most conveniently the name of the client and his/her client-ID do not need to be re-written in the filter table. They are selected from a drop down in the table and table form (Figure 3).



69	310	ISM School		04/11/2010	$ 500
70	311	ClientName	FiltNr	ID-Cl	Location
71	312	ISM School	310	69	ISM School Yard
72	313	ISM School	584	69	ISM-Teachers Meeting
73	314	Dennis's Brother	311	70	Dennis's Brother
74	315	Richard & Kathy M	312	71	Richard & Kathy Mell
75	317	Khuzaima Mali	313	72	Khuzaima Mali Home
76	318	Hubert & Caroline	314	73	Hubert Mmari
77	319	Roza Ngilisho	315	74	Rozi Ngilisho

Figure 3. An example of a drop down table. The client's name, the filter number, the client ID, and the filter location show up in the drop-down table and can be selected for adding a recharge record.

When a filter is sold, the filter record must include the filter type. Again, the filter type does not need to be written but only to be selected from a drop-down table showing the potential filter types installed by the Defluoridation Technology Project. The list of filter types developed so far in the Defluoridation Technology Project is shown in Table 1.

Table 1. List of filter types developed and installed by the Defluoridation Technology Project. (BC = bone char, Integrated = connected to the water supply)

ID	Filler type	Description
		Bucket filters
ID	Filler type	Description
1	BC10B	Bucket + column 10 L BC + bucket
21	B2C10B	Bucket + 2 columns 10 L BC + bucket
19	BC10BN	Bucket + column 10 L (non-defluoridating) + bucket
3	BD25/30	Bucket connected to drum filter of 30 L & 25 L BC
4	BD25/30N	As in No 3, but non-defluoridating
11	Portable	Portable bucket + 3 special columns
18	B3D230/250	Fill & draw bucket + 3 250 L drums each with 230 L BC
		Drum filters
ID	Filler type	Description
2	ID25/30	Integrated drum of 30 L volume & 25 L BC
5	ID90/120	Integrated drum of 120 L & 90 L BC
6	T100D25/30	100 L raw water tank & drum of 30 L & 25 L BC
7	ID200/220	Integrated drum of 220 L vol & 200 L BC
8	I2D200/220T220	Integrated 2 drums of 220 L vol & 200 L BC + tank of 220 L
9	I2D200/220T1000	Integrated 2 drums of 220 L vol & 200 L BC+ tank of 1000 L
10	ID50/60	Integrated drum of 60 L vol & 50 L BC
12	PD25/30	Pipe-connected drum filter 30 L & 25L BC with in-built tap
13	I2D55/60T220	Integrated 2 drums of 60 L vol & 55 BC + tank of 220
14	ID140/160	Integrated tall drum of 160 L & 140 L BC
15	ID120/130	Connected drum of 130 L & 120 L BC
16	ID230/250T1000	Integrated drum of 250 L vol & 230 L BC + tank of 1000 L
17	ID230/250N	Integrated drums of 250L vol & 230 L BC (non-defluoridating)
20	I2D230/250T1000	Integrated 2 drums of 250 L vol & 230 L BC+ tank 1000 L
22	I2D140/160T1000	Two tall drums of 160 L each with 140 L BC + tank of 1000 L
23	I2D25/30	Integrated 2 drums of 30 L vol & 25 L BC
25	I2D140/160T2x250	Integrated drums of 160 L each with 140 L BC+ 2 tanks a 550 L
26	I2D55/60	Integrated 2 drums of 60 L vol & 55 L BC

FILTER TYPES

These filter types were innovated directly through design and installation in accordance with the a client's immediate need. Typically, some clients, such as a family, withdraw cooking and drinking water at a rate that can be matched by the filtration rate. To the contrary, school filters withdraw water suddenly at a high rate, much higher than the filtration rate. In such cases, the defluoride filter needs to be supplied with a safe water tank as a buffer system to compensate for the daily fluctuations in the water consumption while the filtration rate is kept as stationary as possible.

Some clients in the project area did not have a continuous water supply, due to either the remoteness of the place or frequent water supply interruptions. In such cases, the defluoride filter was designed to be fed from a raw water reservoir tank.

Some clients in the project area had access to raw waters that with a low fluoride concentration, but with a high content of suspended solids and microbial contamination, e.g., rain water run-off water. It was discovered that such waters could be treated quite successfully in bone char filters. Normally a specially cleansed bone char medium is utilised for use in such filters. Also, the grain size of the bone char medium is selected to be able to accommodate the large amounts of suspended solids removed from the raw water. These filters were designated with a letter "N" in the filter type view (Table 1).

Being able to select the most appropriate filter to cover the specific need of the client provided a large degree of freedom in supplying the appropriate defluoridation system. Moreover, as the number of filter types and filters increased, the contribution of the database became more significant for maintaining the sustainability of the project.

THE QUERY CONCEPT

Both the drop down tables and the other data retrievals are done through Queries. These queries are written in the Structured Query Language, SQL. SQL is the "backbone" in the database and it is also used in the performance of the database functions as well as in the updating of the database. The basics of the SQL is to be found elsewhere (https://www.tutorialspoint.com/sql/sql_tutorial.pdf).[4] However, some of the SQL-statements utilized in the Defluoridation Technology Project are shown in Tables 2A and 2B.

Table 2A. Important combo boxes with SQL statements in the Defluoridation Technology Project with explanations of the functions of the combo boxes

Combo box position	Function: Drop-down	Function: Viewing	SQL-statement/expression
Filter table & form and recharge table & form	Client-ID	Client name	SELECT ClientT.[ID-Client], ClientT.ClientName FROM ClientT;
	Client name	Client-ID	SELECT ClientT.ClientName, ClientT.[ID-Client] FROM ClientT;
	Filter type	-	SELECT FiltTypT.FiltTyp FROM FiltTypT;
	Filter –ID	Client name & filter Location	SELECT FiltT.FiltNr, FiltT.ClientID, FiltT.ClientName, FiltT.Location FROM FiltT;
Recharge table & torm	Client name	Filter-ID, client-ID, & filter location	SELECT ClientT.ClientName, FiltT.FiltNr, ClientT.[ID-Client], FiltT.Location FROM ClientT INNER JOIN FiltT ON ClientT.[ID-Client] = FiltT.ClientID;
	List of payment mode	List of payment mode	"Cheque";"Cash";"M-Pesa";"AirTel-M";"BankTransf"
Test table & form	Client-ID	Client name & filter location	SELECT ClientT.[ID-Client], ClientT.ClientName, FiltT.Location FROM ClientT LEFT JOIN FiltT ON ClientT.[ID-Client] = FiltT.[ClientID] ORDER BY ClientT.ClientName;
	Filter-ID	Client name & filter location	SELECT FiltT.FiltNr, ClientT.ClientName, FiltT.Location FROM ClientT LEFT JOIN FiltT ON ClientT.[ID-Client] = FiltT.[ClientID] ORDER BY ClientT.ClientName;
	Client name	Client-ID, filter location, and filter-ID	SELECT ClientT.ClientName, ClientT.[ID-Client], FiltT.Location, FiltT.FiltNr FROM ClientT LEFT JOIN FiltT ON ClientT.[ID-Client] = FiltT.[ClientID] ORDER BY ClientT.ClientName;
	Calculating the fluoride concentration from the mV reading of two close standards*	-	Exp(Log([Cstand1])+(Log([Cstand2])-Log([Cstand1]))*([mVSample]-[mVstand1])/([mVstand2]-[mVstand1]))

The fluoride concentration (mg F/L) is calculated according to the following formula:

$$C_{Sample} = e^{\left\{LnC_{Standard1}+\left[Ln_{Standard2}-Ln_{Standard1}\right]\left[\frac{mV_{Standard2}-mV_{Sample}}{mV_{Standad2}-mV_{Standard1}}\right]\right\}}$$

Table 2B. Important combo boxes with SQL statements in the Defluoridation Technology Project with explanations of the functions of the combo boxes

Combo box position	Function		SQL-statement/expression
	Drop-down	Viewing	
Invoice table & form	Client-ID	Client name, Filter-ID, & filter location	SELECT ClientT.[ID-Client], ClientT.ClientName, FiltT.FiltNr, FiltT.Location FROM ClientT LEFT JOIN FiltT ON ClientT.[ID-Client]=FiltT.[ClientID] ORDER BY ClientT.ClientName;
	Most recently sold filter-ID	Client name, client-ID, & filter location	SELECT FiltT.FiltNr, FiltT.ClientName, FiltT.ClientID, FiltT.Location FROM ClientT INNER JOIN FiltT ON ClientT.[ID-Client] = FiltT.ClientID;
	Most recent recharge-ID	Filter-ID, client name, & filter location	SELECT RechT.[ID-Rech], FiltT.FiltNr, FiltT.ClientName, FiltT.Location FROM FiltT RIGHT JOIN RechT ON FiltT.FiltNr = RechT.FiltNr ORDER BY RechT.[ID-Rech] DESC;
	Client name	Client-ID	SELECT ClientT.ClientName, ClientT.[ID-Client] FROM ClientT;
	Test-ID	Client name	SELECT TestT.[ID-Test], TestT.ClientName FROM TestT RIGHT JOIN InvT ON TestT.[ID-Test]=InvT.[TestID] ORDER BY TestT.[ID-Test] DESC;
	Repair-ID	Client name, filter-ID, and filter location	SELECT RepT.[ID-Rep], RepT.ClientName, RepT.FiltNr, RepT.Location FROM RepT;
	Consultation-ID	Client name & client-ID	SELECT ConsultT.[ID-Consult], ConsultT.ClientName, ConsultT.ClientID FROM ConsultT;
	List of invoice type		"FiltSale";"FiltRech";"FiltRep";"WatTest";"FiltWatTest";"Consultancy"
	Type of Currency		"US$";"TShs"

Building up queries can get complicated, because one query may only contain one or very few functions. For example,. to retrieve a list of due filters of a certain type, one has first to retrieve data concerning the most recent of the filter-recharges. The Max function is utilised on numeric data, in this case, the ID and the date of the recharge. These data are then retrieved in another query to bring forward all the data on the most recent recharges for the (old) filters, LRDateQ. As there are always filters which have been sold recently and which have never been recharged before, but which may need to be recharged now, the LRDateQ has again to be related the more comprehensive FiltClientQ to compare the Last Recharge Dates with the Sale Dates. The most recent of these two days is prompted as representing the earliest day when the filter has been taken into operation in this operation period. This day is designated the Last Filtration Date which is now retrieved for all the filters.

Table 3. The sequence of 9 Queries utilised to select the "Due" filters

Query designation	Basic table	Core parameter	Expression	Function
MaxOfRechID DateQ	Recharge table	Recharge-ID	Max "Of Recharge-ID"	Select the highest recharge-ID for all filter recharges
MaxOfRechID DateQ	Recharge table	Recharge Date	Max "Of Recharge Date"	Select the most recent recharge date for filter recharges
LRDateQ	MaxOfRec hDateQ	LRDate	LRDate: MaxOfRechDate	Retrieve most recent Recharge Date
LFDateQ	LRDateQ	Operation period in years	OpPerD: Round([OpPerY]*365,0)	Changes the Operation Period in years into Operation Period in days
LFDateQ		Operation period in days and sale date	LFDate: IIf([LRDateQ]![MaxOfRechDate]=True, [LRDateQ]![MaxOfRechDate],[LRDateQ]![SaleDate])	Compares the Sale Date with most recent Recharge Date (if available) and states the most recent of these dates.
eDateQ	LFDateQ	LFDate & LRDate	eDate: DateAdd("d",[LFDate],[LFDateQ]![OpPerD])	Calculates the expected Exhaustion Date by adding the Operation Period to the sale date or to the most recent Recharge Date
DueQ	eDateQ	LRDate, LFDate & eDate	Status: IIf([eDate]<Date(),"Due","-")	States that the filter is due if the exhaustion date is before today's date
DueColumnFiltQ	eDateQ	eDate FiltTyp RechActiv	Criteria: "Due" Criteria: "BC10B", Criteria: Yes	Retrieve only filters which are due, of type BC!0B and are Recharge Active
DueDrumFiltQ	eDateQ	eDate FiltTyp RechActiv	Criteria: "Due" Criteria: <>"BC10B" Criteria: Yes	Retrieve only filters which are due, and are not of type BC!0B and are Recharge Active

It can be seen from Table 3 how this query, LFDateQ, calculates the estimated operation period in days, OpPerD, by multiplying the operation period in years, OpPerY, by 365 and rounding up the number of days. In the exhaustion date query, eDateQ, the last filtration date is "Date-Added" to the estimated operation period in days to calculate the estimated exhaustion date, eDate. Finally, the due query, DueQ, checks if the eDate is lower than today's date and prompts "Due" for all the filters that need new recharges.

It is found to be convenient to select the due filters which belong to certain type, e.g., the domestic "BC10B"-filters. This is done in the Due-Column-Filter Query, DueColumnFillQ, by using the Criteria function and simply adding the "BC10B" (Figure 4).

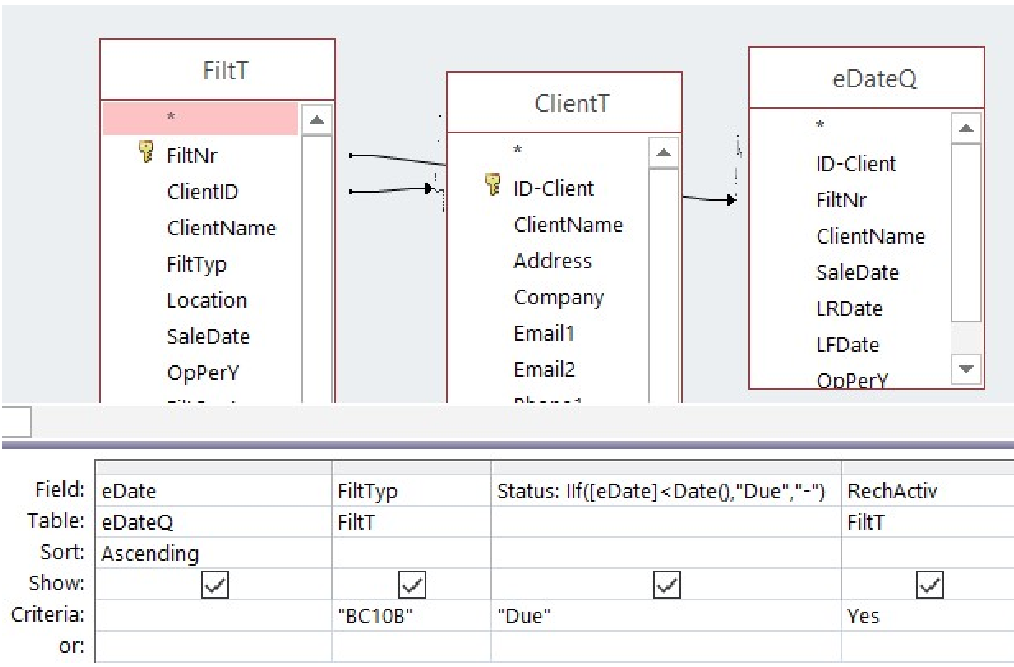


Figure 4. Example of utilising the Sort and the Criteria Inbuilt Function of queries to retrieve the Daily Updated List of Filters which need to be recharged.

Figure 4 illustrates the use of the Sort- and the Criteria-inbuilt functions in the queries. It states "Due" should be prompted if the eDate is less than today's date and if not "-" should be prompted. Further, only the Bucket-10 L-Column-Bucket-filters should be selected and only if the filters are Recharge-Active. The last function is convenient to neglect filters which are not in use any more, or just for the time being, without deleting the whole filter record.

RELATIONSHIPS

Queries not only determine the retrieved data but also determine relationships. In Table 2, it is seen that the SQL contain both the SELECT function as well as the LEFT JOIN and the RIGHT JOIN of the tables. An example of these JOINS is shown in Figure 5.

In the Filter-Client-Query the relation is between the two tables goes FROM the Client Table to the Filter Table as an INNER JOIN. The data retrieved from this query will contain all the filters and their owners. While in the Client-Filter-Query, the relation goes FROM the Client Table as LEFT JOIN to the Filter Table. The data retrieved from this query will contain all clients, including of course, not only the ones who are have filters but also those who have ordered investigations of a water source and those who just wanted to test their raw water. Naturally, when updating the database with respect to a new filter, one would select the information about the client from the Filter-Client-Query, while, when updating the database with respect to a water test, it is good to know whether or not the client has a filter. In the case where the client does not have a filter, the name of the client is selected from a Client-Filter-Query.

It may be understood that Join Property 3, where only filter records with corresponding clients are selected, is not utilised, as there are no filters without clients (Figure 5).

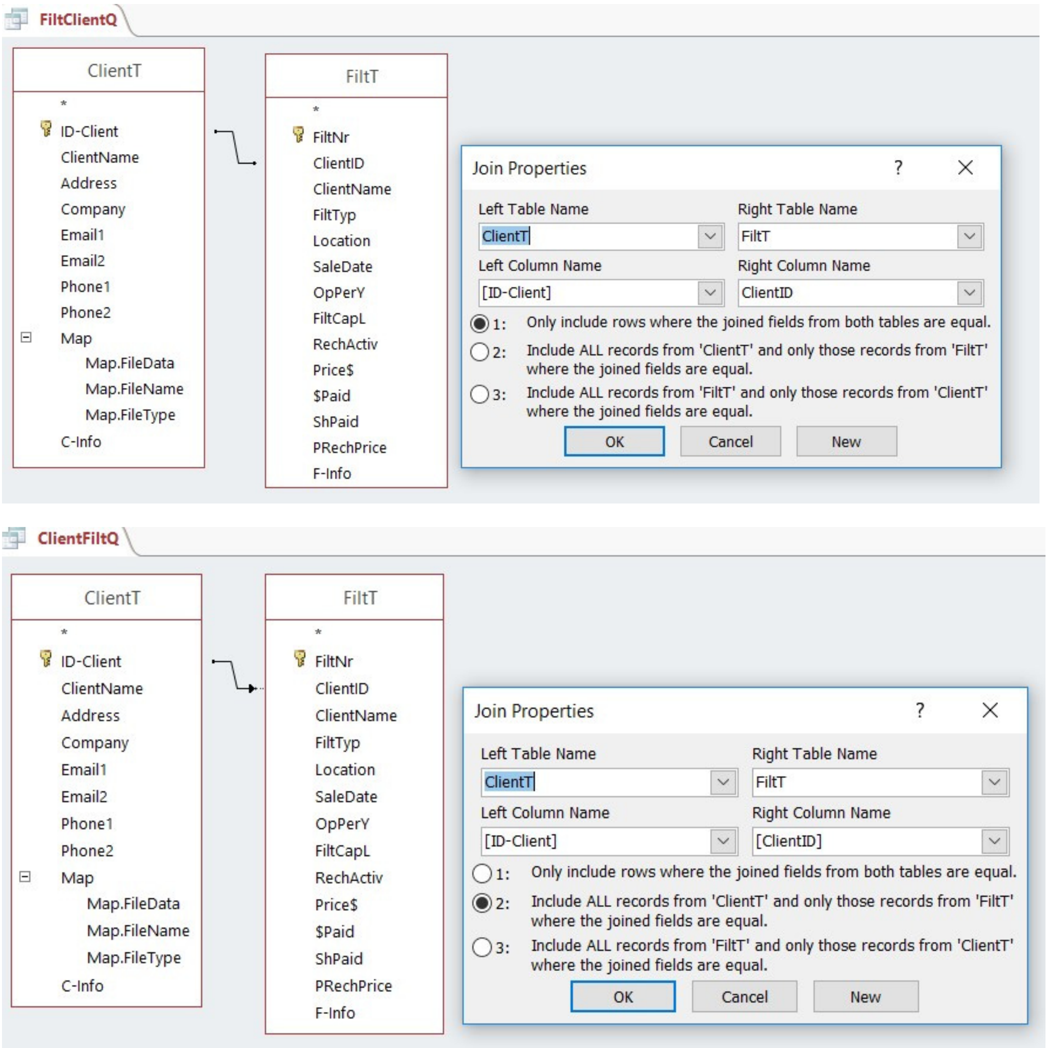


Figure 5. Two different queries including two different relations between the Client Table and the Filter Table.

As the database develops many queries are added and they contain delicate relations. Some of the relations in the Defluoridation Technology Project database are one-to-one relations (Figure 6). For example, a filter recharge has a corresponding filter with a corresponding client. On the other hand, a Client-Filer relation is a one-to-many relationship, allowing a client, e.g., a school, to have more than one filter. The same is naturally valid for clients who can test their water repeatedly.

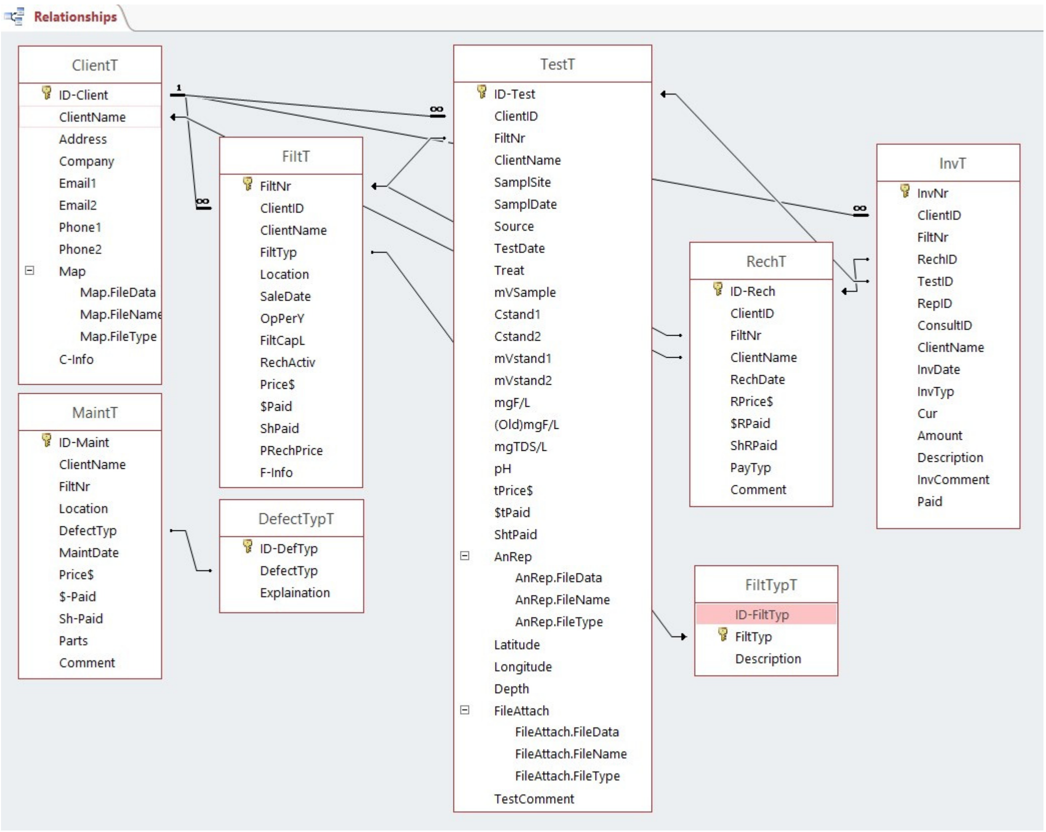
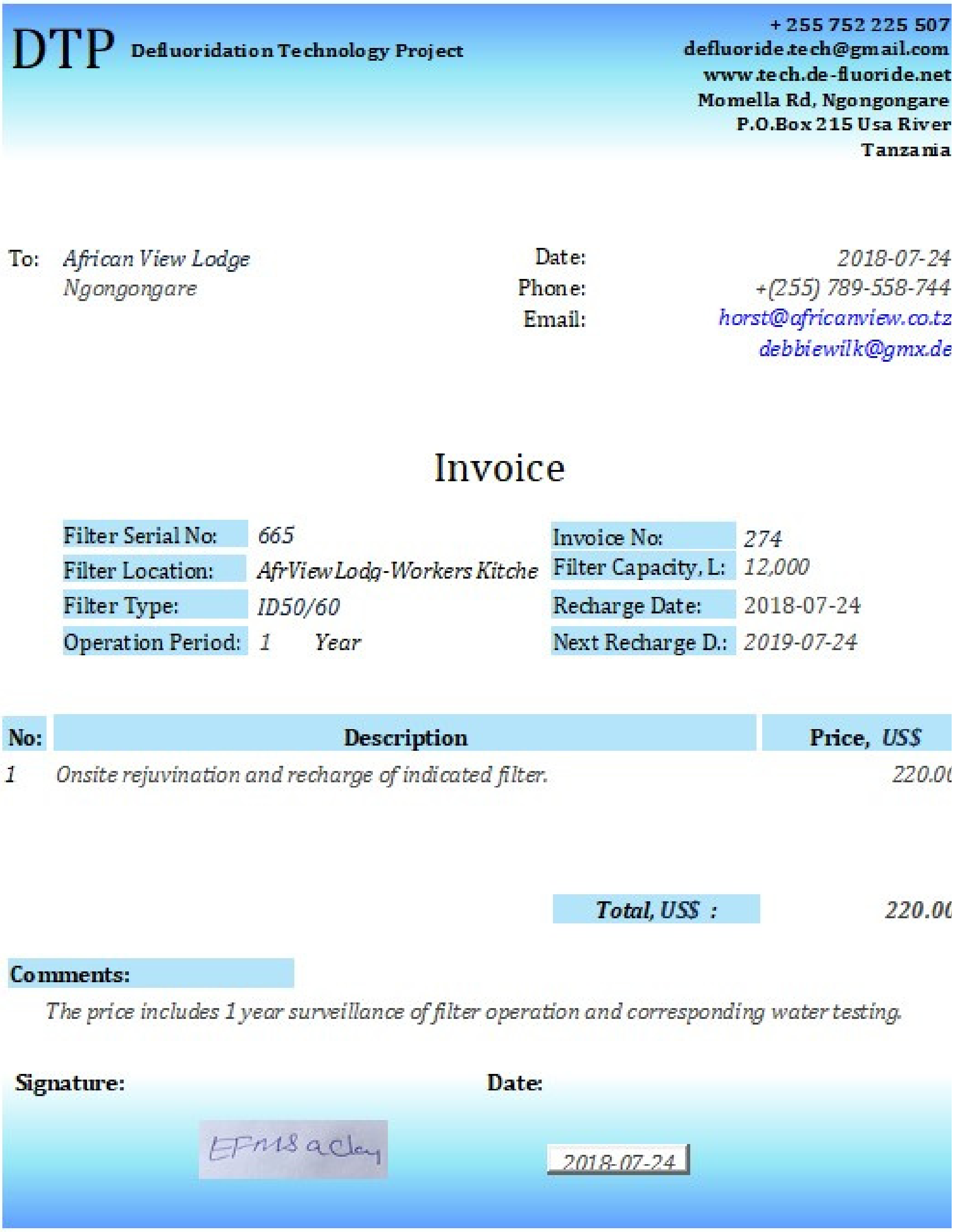


Figure 6. Some relationships between the tables in the Defluoridation Technology Project database.

LAB REPORTS AND INVOICES

The database is designed to produce lab reports and invoices to be E-mailed to clients. In technical database language these are retrieved Reports to be distinguished from the Tables, the Forms and the Queries, which are Project internal tools. An example of a Report is shown in Figure 7. The Report contains inbuilt Labels indicating the basic frame of the Report. Here, the Project Name, Logo, Address, Phone Number, Web Site, Explanation to Fields, Date, Signature and the like are plotted. Then special Fields are merged to the basic frame containing the relevant Data retrieved through a corresponding Query.

Special queries are developed to these Reports (Table 4). Also, these queries may be built up with several more elemental queries. Table 4 shows the seven utilised Reports, the name of the seven Queries behind them, and the core Data retrieved. When a client receives a report, e.g., a Water-Filter-Analysis Report, he/she would automatically get the Project Data and his/her filter data, including how long the time is that the filter has been operation and when it should be recharged. This multiple information included in the reports is much appreciated by the clients.



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Date: *2018-07-24*
Phone: *+(255) 789-558-744*
Email: *horst@africanview.co.tz*
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Invoice

Filter Serial No:	*665*	Invoice No:	*274*
Filter Location:	*AfrViewLodg-Workers Kitche*	Filter Capacity, L:	*12,000*
Filter Type:	*ID50/60*	Recharge Date:	2018-07-24
Operation Period:	*1 Year*	Next Recharge D.:	*2019-07-24*

No:	Description	Price, *US$*
1	*Onsite rejuvination and recharge of indicated filter.*	*220.0(*

Total, US$: ***220.0(***

Comments:

The price includes 1 year surveillance of filter operation and corresponding water testing.

Signature: **Date:** 2018-07-24

Figure 7. An example of a report, Other reports are described in Table 4.

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Table 4. Developed reports, the queries behind them, and the retrieved core data, in addition to the Project's basic data, contained in the reports

Report	Query behind	Retrieved data (In addition to Project's basic data)
Water Analysis	TestPClientQuery	Water Analysis Data: Analysis No, Analysis Date, Technician Initials, Controller Initials, Sample Site, Sample Date, Source, Water Treatment, Fluoride Concentration,* TDS, pH, Comments including Evaluation
Water Filter Analysis	TestPFiltereDateClientQuery	In addition to Water Analysis Data: Filter Serial Number, Filter Type, Last Recharge Date, New Recharge Date
Water Analysis Invoice	InvoiceTestClientQuery	Standard Invoice Data: Invoice Serial Number, Sample Site, Sample Date, Currency, Amount, Description & Eventual Comments
Consultancy Invoice	InvoiceConsulrtClientQuery	In Addition to Standard Invoice Data: Reference to Attached Report.
Filter Repair Invoice	InvoiceRepairClientQuery	In Addition to Standard Invoice Data: Filter Data: Filter Serial Number, Filter Type, Filter Location, Filter Capacity, Filter Operation Period.
Filter Invoice	Invoice Filter ClienteDateQuery	In Addition to Standard Invoice Data & Filter Data (As Above): Recharge Date, Exhaustion Date.
Recharge Invoice	InvoiceRechargeFilterClientQuery	In Addition to Standard Invoice Data & Filter Data (As Above): Next Recharge Date.

*The fluoride concentration (mg F/L) which is calculated in the formula given below, cannot be indicated directly in an analysis report without being rounded. Further any indication below the analysis limit must be neglected. The following expression is used for this purpose:

PmgF/L: IIf([TestT]![mgF/L]>0.03,Round([mgF/L],+2),"?0.03")

Formula for calculating the fluoride concentration (mg F/L):

$$C_{Sample} = e^{\left\{ LnC_{Standard1} + [Ln_{Standard2} - Ln_{Standard1}]\left[\frac{mV_{Standard2} - mV_{Sample}}{mV_{Standad2} - mV_{Standard1}}\right]\right\}}$$

MERGING LETTERS

Once in a month a reminder is E-mailed to all the clients who have filters where the filters have been in operation for a period more than the estimated operation period (Figure 8).

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Momella Rd, Ngongongare
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Tanzania

Re. Recharge of your defluoridation filter.

Ngongongare 2018-10-06

Dear ***«ClientName»***.

«EmailI»
+255 «PhoneI»

Your Defluoridation Filter is pending in our list of filters that need to be recharged:

Please check if the indications in our data base of your: filter number ***«FiltNr»***, and filter type ***«FiltTyp»*** at the location ***«Location»***.

From previous water testing and design your filter is estimated to have a treatment capacity of ***«FiltCapL»*** L/ Recharge in an operation period of ***«OpPerY»*** year.

Further it indicates that your filter has been operating since ***«LFDate»*** , with an expected exhaustion date: ***«eDate»***

Our price for recharging you filter is still ***«PRechPrice»*** US$ or its equivalent in Tz. Shs.

Please indicate to us a ***go ahead*** for recharge of the filter.

We will then come and take samples of the raw and the treated water, do the periodical clean up and repair (if needed) and we will recharge the filter.

The water samples will be analysed and the result will be used to adjust the next operation period. You will get a copy of the lab reports e-mailed.

Best Regards

PS.

- *In case you don't want the Defluoridation Technology Project to send you reminders, just indicate that to us and you will no longer receive a similar message.*
- *DTP has sat up a website, which you are most welcome to visit: www.tech.de-fluoride.net/*

Figure 8. An example of a letter E-mailed to clients as a reminder to give a go-ahead to recharge filters.

The operation period is estimated according to the bone char capacity for the small domestic filters and according to the first period of operation and the fluoride testing for the institutional filters. A merged letter provides for the client all the necessary information about how long time a filter is expected to operate before a new recharge is needed, how long a time that the filter has been running, and the date on which it is expected to be exhausted (Figure 8). Moreover, the price is given and the clients are assured that the Project will take the responsibility for maintenance during the new operation period. Thus, the price of eventual maintenance is included in the recharge

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PROJECT EXPERIENCES

The client's reactions to the mailed reminders are quite positive and most encouraging. Introducing the database to the Defluoridation Technology Project was beneficial in four different ways:

(i) It made the management of sold filters much easier for the Project workers;

(ii) It made the surveillance of the filters more efficient and economic;

(iii) It improved the services given to the clients significantly; and

(iv) As a direct reaction to the reminders E-mailed to the clients with filters due for recharging, it increased the sustainability of the filters and the requesting of the recharging of many more filters.

CONCLUSIONS

Our experience shows that the database and the E-mail reminders made the maintenance and the surveillance of the filters more efficient and this has contributed to a higher sustainability of defluoridation works. We conclude that defluoridation works can only be sustainable if managed efficiently through a database system

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