VEOLIA WATER PROJECTS LTD
DRAFT FT WATER RESOURCE MANAGEMENT PLAN 2024
ANNEX THREE - WATER RESOURCE ZONE AND INTEGRITY ASSESSMENT

1. Water Resource Zone Assessment

1.1. Water Resource Zone (WRZ)

A Water Resource Zone (hereby referenced as 'WRZ') is the geographical area used to develop forecasts of supply and demand and supply/demand balances. The WRZ describes an area within which supply infrastructure and demand centres are linked such that customers in the same WRZ experience the same risk of supply failure. WRZs tend to have the following features:

- Represent the largest area in which all resources can be shared effectively;
- Customers within the same WRZ receive the same overall risk to public supply;
- There is no significant number of people at a higher risk of supply failure;
- WRZs are defined by infrastructure connectivity and geographic physical boundaries;
- WRZs are scaled up from smaller water balance units used for supply management; and
- WRZs contain an integrated supply network that delivers a defined level of service to customers.

1.2. Methodology of WRZ Assessment

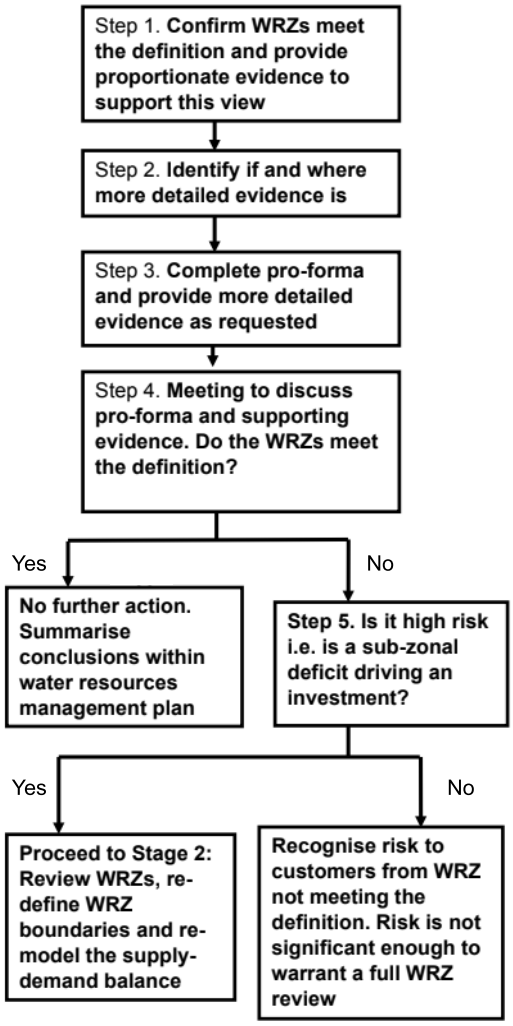
As per section 63 of the Water Industry Act 1991, it is the water supply company's responsibility to make sure that they meet the requirements of their WRZ definition. The EA, in accordance with other regulatory bodies, has published WRMP guidance to assist with the production of the WRZ assessment. The guidance applies to all WRZ where the population is in excess of 5,000 and/or where the total water available for use (WAFU) supplied from source is in excess of 1 ml/d.

The assessment process is presented in Figure 1 and consists of a review of:

- Scale and size of the operational WRZ. The designated WRZ needs to represent the largest area that all resources can be shared effectively and contain an integrated supply network, providing secure supplies to meet demand under defined levels of service;
- Connectivity and the ability to share resources across the WRZ. The WRZ is self-contained and defined by infrastructure connectivity and geographical or physical boundaries;

- Potential risks of supply failure within the WRZ. All customers within the designated WRZ should receive the same overall risk to public supply so there is no significant number of people at a higher or lower risk of supply failure;
- WRZ Supply management. The WRZ should be built up from the smaller water balance units used for supply management. These will vary from company to company. The smaller units could include, for example, district metered areas, water quality zones, control groups, accountability zones or planning zone;
- Groundwater quality. The same level of water quality must be shared across the designated WRZ;
- Groundwater sources and transfers (including raw water and bulk transfers).

Figure 1 - Environment Agency's WRZ Integrity guidance flow chart.



This annex describes VWPL's decision making process to determine the extent of WRZ within the WRMP 2024 and provides additional information on the use of WRZs in its water resource planning.

2. VWPL Water Resource Zone & Integrity Assessment

VWPL has assessed the integrity of the WRZ in accordance with this regulatory guidance, as outlined in Figure 1.

Due to the small nature of the VWPL operated WRZ, steps 2 and 3 of the EA guidance flow chart (Figure 1) have not been undertaken as they have been deemed not required following the step 1 assessment.

2.1. VWPL Water Resource Zone (WRZ)

In Tidworth, water is abstracted from three (3) groundwater abstraction boreholes, known as Borehole 2 (BH2), Borehole 3 (BH3) and Chalkpit (CKP) and operated under an EA abstraction licence (SW/043/0024/006).

The abstracted water is treated at Tidworth and Chalkpit water treatment works and distributed from two strategic reservoirs (Clarendon and Mathew Tanks) through the potable water distribution network to the following areas:

- VWPL Inset area which includes:
    - Tidworth and Perham Down MOD garrisons;
    - Service family accommodation (SFA) and private housing in Tidworth town, Ludgershall and Perham Down;
- Three (3) Wessex water enclaves within Tidworth town, and
- Leckford Bridge potable water bulk supply to a Wessex Water area.

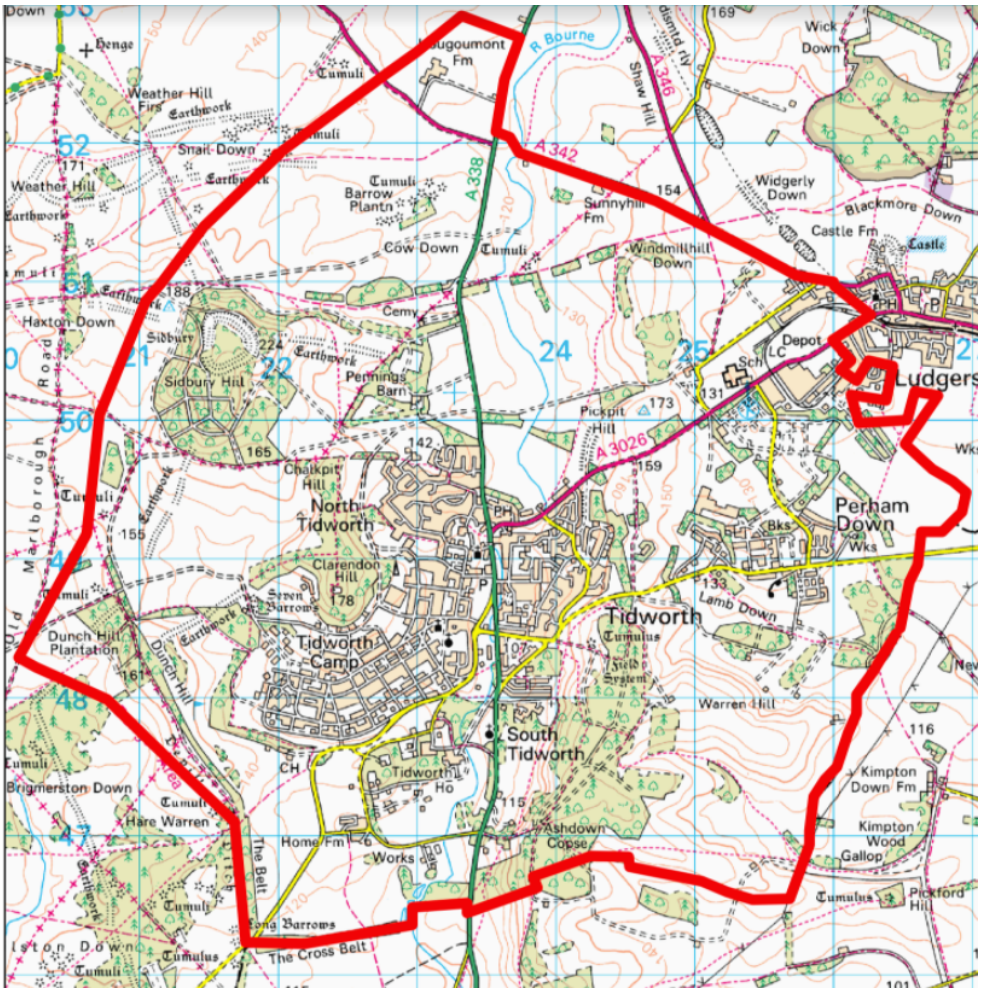
There is no import of any potable water supply into the VWPL operated WRZ.

Figure 2 - Abstraction borehole locations within the wider Tidworth Network.

All customers in the above listed areas receive their water supply through a single interconnected supply system, hence they share the same risk of supply failure. The Leckford Bridge bulk supply is operated through a single supply point fed from VWPL's distribution network, so the risk of supply failure to this export is considered the same.

On that basis, the inset area, including Wessex enclaves and the bulk supply point to Leckford Bridge, has been grouped as one single WRZ, as illustrated in Figure 3 below.

Figure 3- The red line boundary of the VWPL operated WRZ.



2.2. Resilience of VWPL Water Resource Zone

The water supply within VWPL WRZ is resilient to drought, including a 1 in 500 year event, as presented in Annex 2 of the WRMP24. The following describes the daily operational resilience within the Tidworth network:

- The strategic reservoirs are mainly fed from Borehole 2 and Borehole 3 but, in case of major plant outage or increased demand, Clarendon can be also fed from Chalkpit.
- Tidworth water treatment works receives raw water from Borehole 2 and Borehole 3. In case of major plant outage or a water quality issue at one of the boreholes, Tidworth water

treatment works can continue to operate and Chalkpit can supply the additional water required to maintain the water levels within the reservoirs to their targeted operation levels.

- The configuration of the distribution network enables rezoning of the water supply in case of major bursts

Note: if VWPL experiences a particularly high demand or a major plant/network outage the terms and conditions of the Leckford Bridge bulk supply agreement allow VWPL to request that Wessex Water reduce the transfer volume to a minimum.

The overall quality of the water supply is of a high standard due to the nature of the underlying chalk fed environment, and is consistent across the whole distribution network. This is discussed further within section 3 of this annex.

In accordance with Step 4 of the EA guidance flow chart (Figure 1), VWPL have liaised with the EA and OFWAT to discuss the requirements of the WRZ and VWPL's daily operations and it was confirmed during the pre-consultation meetings that the requirements of the WRZ had not changed compared to WRMP 2019 and that no further delineation work would be required within the water resource zone assessment.

3. Water Quality within VWPL Water Resource Zone

All water supplied by the water company must be adequately treated and disinfected so that it is 'wholesome', it complies with the Prescribed Concentrations or Values (PCVs) listed in the Drinking Water Inspectorate (DWI) Regulation 27, and it does not contain any other substance, micro-organism or parasite, at a concentration or value, which would constitute a potential danger to human health. It is considered to be an offence by the DWI if this requirement has not been adequately achieved by a water company.

3.1. Risks to VWPL WRZ water quality

As part of the water integrity assessment, VWPL undertook a desk based study that reviewed industrial or MoD land uses and activities within the network and wider catchment area of the abstraction boreholes. The identified hazards and activities are summarised within Table 1.

Table 1- Activities identified in Tidworth network

Hazard or activity	Hazard category	Potential risk to water quality
Petrol station	Petrol station	Underground storage of fuel
Mechanical garages	Other	Oil and chemical spills
Developer services site	Other	Oil and chemical spills
MOD POL (petroleum, oil and lubricants)	MOD	Oil and chemical spills
Vehicle wash down area	MOD	Oil and chemical spills
Goat	Farming/animals	Animal waste

Ram pumping station (Wessex Water)	Waste water	Waste water
Tank obstacle course (military training ground)	MOD	Oil and chemical spills
Cows and sheep	Farming/animals	Animal waste
Wheat crops	Agriculture	Pesticides
Horses, cows and sheep	Farming/animals	Animal waste
Developer services site	Other	Oil and chemical spills
Tidworth military cemetery	Other	
Wessex Water sewage treatment works	Waste water	Waste water
Tidworth sewage treatment works	Waste water	Waste water
Wastewater network	Waste water	Waste water
Septic tanks	Waste water	Waste water

The study has identified that an Esso petrol station is located within Tidworth town up-hydraulic gradient of abstraction boreholes BH2 and BH3. The underground storage of fuel poses a potential risk to water quality from spillages. However, VWPL has been informed that the maintenance of the underground fuel cells is regulated by the EA under the Control of Pollution (Oil Storage) (England) Regulations 2001.

In addition to this, the MoD have refuelling stations located within the Tidworth garrison up-hydraulic gradient of abstraction boreholes BH2 and BH3. The underground storage of fuel poses a potential risk to water quality from spillages. The MoD vehicle wash down facilities are located within the Tidworth garrison and across Sailsbury plain within the catchment area of the WRZ. The chemicals and oils pose a risk to water quality. The MOD has Standard Operating Procedures (SOPs) which satisfy Joint Service Publication (JSP) 317. JSP 317 outlines MOD safety regulations for the safe storage and handling of fuels and lubricants. The MOD is audited to ensure these regulations are adhered to.

There are several fields located within the catchment of the WRZ, which house livestock, including horses, sheep and cows. Animal wastes can cause elevated levels of bacteria in the groundwater.

3.2. Water quality of VWPL groundwater sources

The overall water quality within the WRZ is considered to be of a high standard due to the nature of the chalk fed environment. The water quality is, in general, very similar across the three boreholes however land use activities can have an effect on the groundwater quality at individual boreholes; this includes the abstraction of groundwater from one borehole having an impact on the ground water quality of another, so each abstraction borehole is monitored for different contaminants. The historical data has indicated that abstraction borehole 2 has the most variable water quality.

Within localised areas of the underlying aquifer, the chalk bedrock is fractured allowing for secondary migration forming from dual porosity, which enables flow throughout the aquifer. This

subsequently increases the connectivity within the aquifer allowing for contaminants to migrate within the water table.

Recent operations have indicated the connectivity of the aquifer; when the pumping of borehole 2 was temporarily stopped due to elevated coliform levels the level of coliforms in borehole 3 subsequently increased. The groundwater recovered from the Chalkpit abstraction borehole has been recorded to have an overall higher standard, this is likely due to its geographical location as the borehole is not positioned within or down hydrological gradient of farmland like abstraction boreholes BH2 and BH3.

VWPL monitors contaminants considered to be of concern within the network, these include nitrates and desethyl atrazine as after periods of heavy rainfall, unsustained concentrations can be encountered within the raw water samples. It is considered likely that these spikes in concentrations within the raw water samples are the result of surface water run off ingress to the boreholes.

VWPL experiences elevated levels of enterococci concentrations within the raw water samples after periods of sustained heavy rainfall. It is believed that this is due to the preferential pathways within the weathered profile of the underlying chalk allowing surface water ingress to infiltrate the unsaturated zone. However, the investigation into the root cause is still ongoing as the pattern is unpredictable with negligible concentrations recorded by VWPL between June 2015 and December 2018 and then three significant spikes recorded between December 2018 and December 2019.

The DWI list of Prescribed Concentration Value (PCV) for the WRZ is shown in Tables 2, 3 and 4. The contaminants are analysed every week or every quarter depending on the severity of the potential risk. The analysis is undertaken within the both raw and treated water samples.

Table 2- Prescribed Concentration Value for required contaminants of concern.

Wholesomeness Parameters		
Parameter	**PCV**	**Unit**
1,2 dichloroethane	3.0	ug/l
Aldrin	0.030	ug/l
Ammonium	0.5	mg/l
Antimony	5.0	ug/l
Arsenic	10	ug/l
Benzene	1.0	ug/l
Benzo[a]pyrene	0.010	ug/l
Boron	10	ug/l
Bromate	10	ug/l
Cadmium	5.0	ug/l
Chromium	50	ug/l
Copper	2.0	mg/l
Cyanide	50	ug/l
Dieldrin	0.030	ug/l
E.coli	0	/100ml
Enterococci	0	/100ml
Fluoride	1.5	mg/l
Heptachlor	0.030	ug/l
Heptachlor Epoxide	0.030	ug/l
Lead	25 / 10	ug/l
Mercury	1.0	ug/l
Metaldehyde	0.1	ug/l
Nickel	20	ug/l
Nitrate	50	mg/l
Nitrate	50	mg/l
Nitrate Formula	<=1	(ratio)
Nitrite	0.5 / 0.1	mg/l
Nitrite	0.5 / 0.1	mg/l
Other individual pesticides	0.1	ug/l
Selenium	10	ug/l
Sum of tetrachloroethene + trichloroethene	10.0	ug/l
Total PAH	0.10	ug/l
Total pesticides	0.5	ug/l
Total THM	100	ug/l

Table 3- Prescribed Concentration Value for inorganic contaminants.

National Requirements		
Parameter	**PCV**	**Unit**
Aluminium	200	ug/l
Colour	20	mg/l Pt/Co
Iron	200	ug/l
Manganese	50	ug/l
Odour	*NAC	
Sodium	200	mg/l
Taste	*NAC	
Tetrachloromethane	3	ug/l
Turbidity	4	NTU
* NAC - No abormal change		

Table 4 - Prescribed Concentration Value for organic contaminants, including coliforms.

Indicators		
Parameter	**PCV**	**Unit**
2d colony count	*NAC	/ml
3d colony count	*NAC	/ml
Chloride	250	mg/l
Clostridium perfringens	0	/100ml
Conductivity	2500	uS/cm
pH (Hydrogen ion concentration)	6.5 - 9.5	pH units
Sulphate	250	mg/l
TID	0.10	mSv/year
TOC	*NAC	mg/l
Total coliforms	0	/100ml
Tritium	100	Bq/l
Turbidity	1	NTU
* NAC - No abornormal change		

3.3. Water disinfection at VWPL water treatment works

3.3.1. Disinfection Policy

VWPL currently uses disinfection by chlorination for the required log reduction (assessment required, but as a minimum of 2 log reduction 99% removal).

In order to achieve a 2 log reduction of bacteria through inactivation with chlorine, a contact time (Ct) of 0.08 mg.min/l is required at pH 7 at 1-2°C. In order to achieve a 2 log reduction of viruses through inactivation with chlorine, a Ct of 8 mg.min/l is required in the range pH 7 – 7.5 at 10°C*.

**Note: taken from WHO Water Treatment and Pathogen Control: Process Efficiency in Achieving Safe Drinking Water (2004).*

3.3.2. Primary disinfection by chlorination at Tidworth WTW

At Tidworth Water Treatment Works (WTW), primary chlorination is undertaken with the purpose to remove pathogenic and indicator organisms from the raw water source. Chlorine is dosed into the abstracted groundwater to produce hypochlorous acid, which is a strong disinfectant. The contact time (Ct) required to enable the disinfection reactions to take place is achieved in the Tidworth WTW contact tank.

Groundwater sites using chlorination for primary disinfection where the raw abstracted groundwater quality is a medium risk should achieve a Ct value equivalent to a minimum of 10 mg.min/litre to achieve 2 log reduction of bacteria at a pH value less than 8 pH units. There should be a contact time of a minimum of 20 minutes and a minimum post-contact free chlorine value of 0.5mg/l.

Recorded data obtained from pH testing has illustrated that the measured pH values at Tidworth WTW are steady and are routinely between 7.0 to 8.0 pH units. This pH value range is consistent with a chalk fed water environment where pH values between 7.0 to 8.5 pH units can be encountered.

3.3.3. Marginal chlorination at Chalkpit WTW

Marginal chlorination is a form of disinfection used to provide a chlorine residual in the network. This is appropriate where the raw water quality is very good and the risk of microbiological contamination is assessed to be negligible. This chlorination does not have a Ct value, but meets the minimum WHO guidelines of 0.2 mg/l for recommended chlorine residual.

At Chalkpit WTW marginal chlorination is used due to the high standard quality of the raw water.

3.3.4. Verification of efficiency of disinfection by chlorination

At both VWPL Water Treatment Works, online monitoring (turbidity and chlorine) and spot sampling (microbiological indicators, physical and chemical parameters that influence disinfection efficiency) are used to verify the effectiveness of the disinfection process. High and low alarm and automatic failsafe shutdowns will be in place at each site to ensure minimum disinfection process control. Chlorine dosing and analysing equipment as well as online turbidity analysers are adequately maintained and calibrated.

3.3.5. Water Quality Testing Regime

To ensure the quality of the abstracted groundwater after the disinfection process has been implemented, the VWPL water quality team samples the water throughout the supply process.

The groundwater is sampled and analysed for a range of commonly occurring contaminants specified by the DWI. These include TCNs, nitrate, benzene, coliforms, E-coli and aluminium.

As the WRZ is located within a rural area with operational military land, pesticides were historically recorded within the groundwater. As such, the DWI have requested the groundwater to be tested for pesticides, including atrazine and desethyl atrazine to monitor background concentrations.

The recorded concentrations of atrazine and desethyl atrazine in the groundwater within the WRZ have decreased over time and it is likely that this trend will continue as the MOD have stopped using pesticides within their active land. The measured trends between 2016 and 2022 for abstraction boreholes BH2 and BH3 are shown in Figures 4 and 5. Negligible concentrations (at or below the laboratory level of detection) of atrazine and desethyl atrazine were recorded between 2016 and 2022 in the groundwater samples recovered from the Chalkpit abstraction borehole.

Figure 4 - Graph showing the concentrations of atrazine and desethyl atrazine recorded in abstraction boreholes BH 2 and BH 3. The PCV for atrazine and desethyl atrazine is 0.1 ug/l and any concentrations that exceed that level will be reported to VWPL by the analytical laboratory.

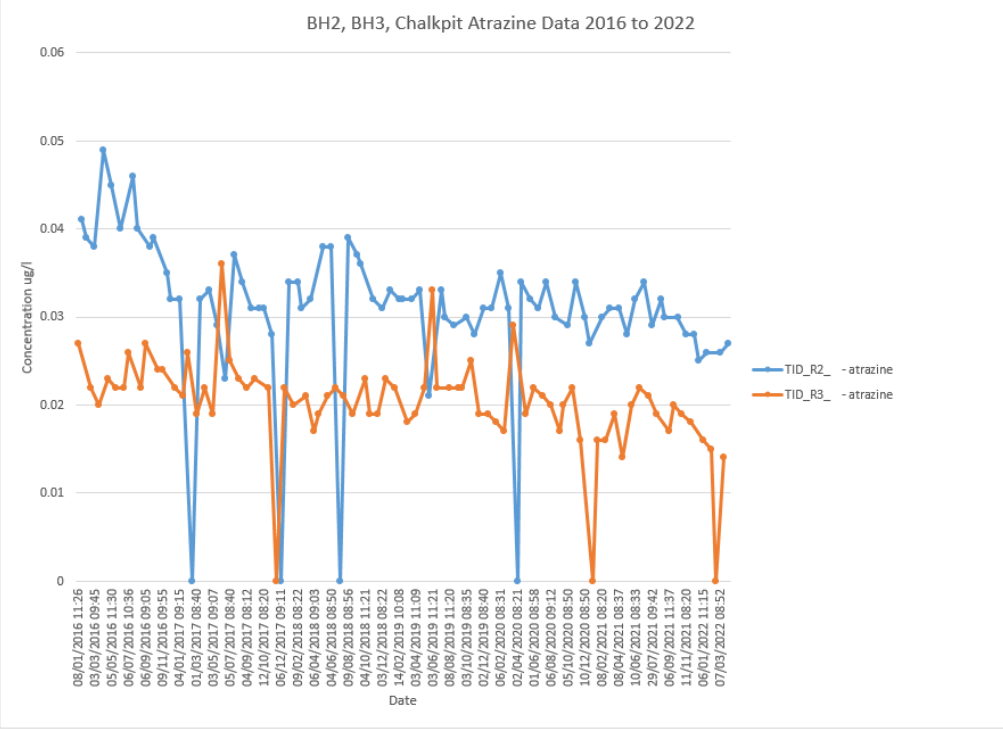


Figure 5 - Graph showing the concentrations of atrazine and desethyl atrazine recorded in abstraction borehole BH 2 and BH 3. The PCV for atrazine and desethyl atrazine is 0.1 ug/l and any concentrations that exceed that level will be reported to VWPL by the analytical laboratory.

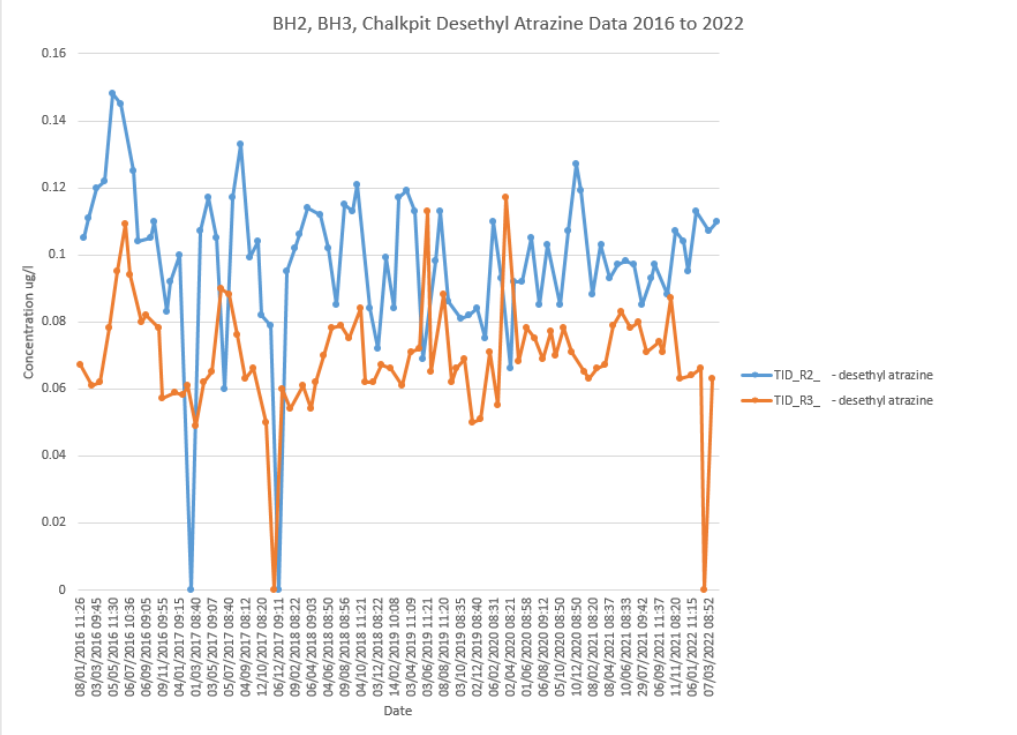
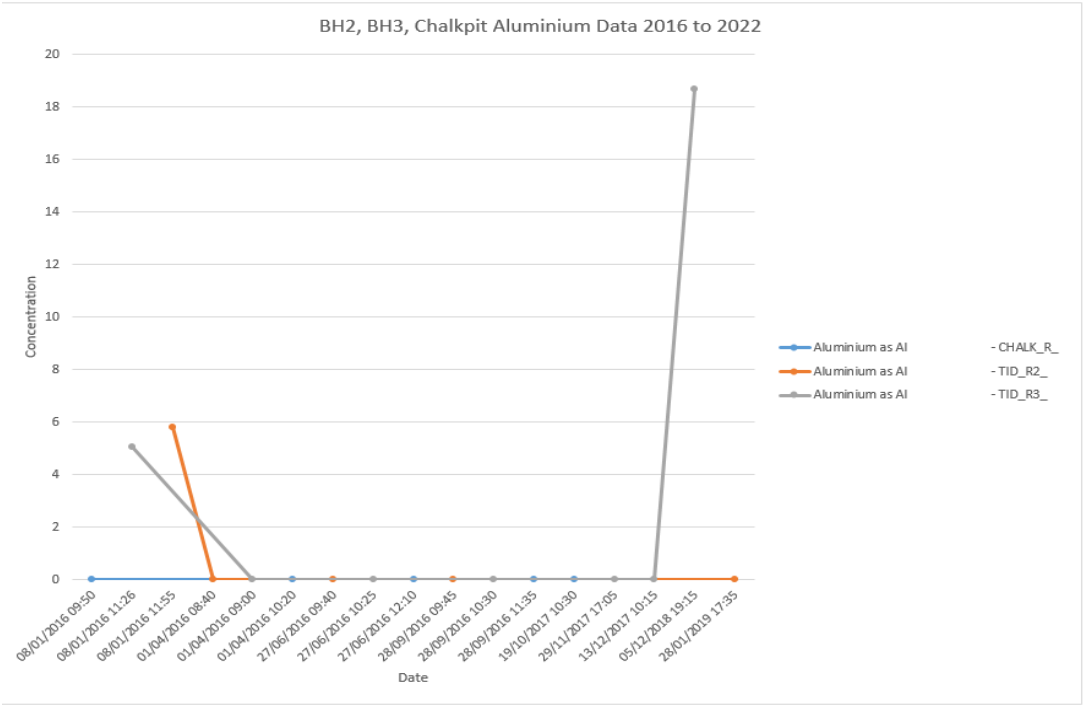
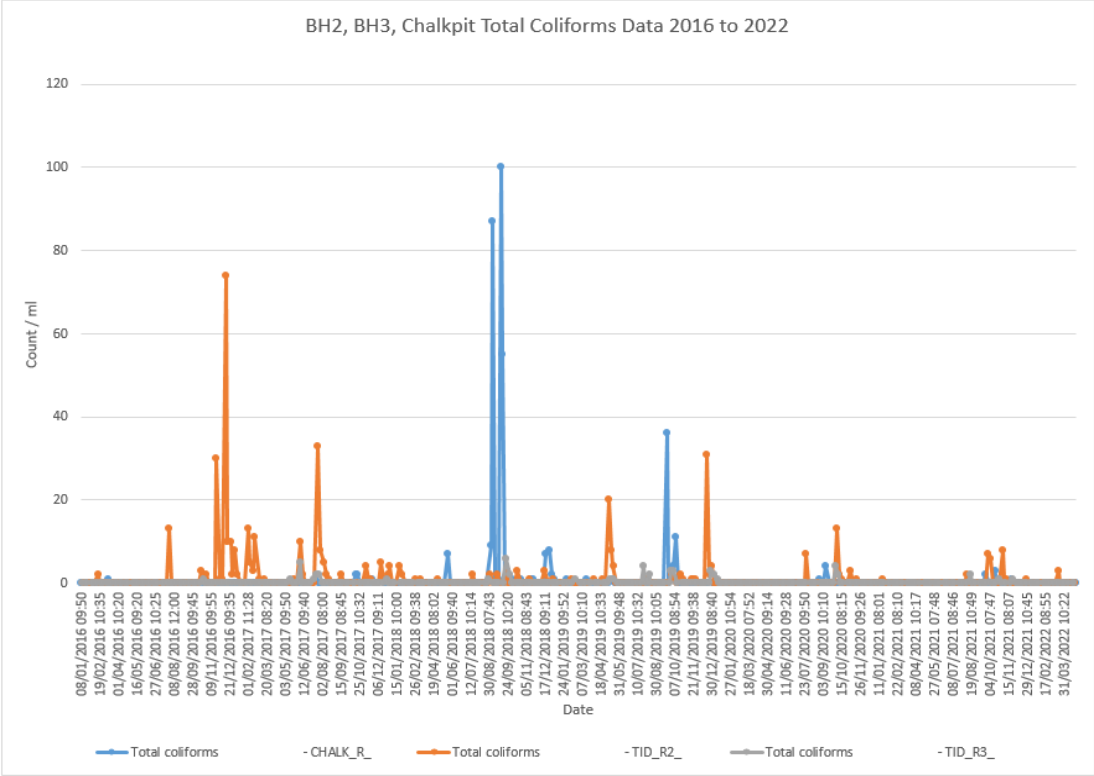


Figure 6 - Graph showing the concentrations of aluminium recorded in abstraction boreholes BH2 and BH3 and the Chalkpit abstraction borehole. The PCV for aluminium is 200 ug/l and any concentrations that exceed that level will be reported to VWPL by the analytical laboratory.



The recorded concentrations of aluminium in groundwater samples recovered from the Chalkpit abstraction borehole and abstraction boreholes BH2 and BH3 between 2016 and 2019 are shown in Figure 6. Elevated concentrations of aluminium were recorded in samples recovered in January 2016 and January 2018 within abstraction borehole BH2 and in December 2017 within the Chalkpit abstraction borehole. However, these concentrations were not sustained and therefore these concentrations were considered to represent anomalies within the dataset.

Figure 7 - Graph showing the concentrations of total coliforms recorded in abstraction boreholes BH2 and BH3 and the Chalkpit abstraction borehole. The PCV for total coliforms is 0 per 100ml and any concentrations that exceed that level will be reported to VWPL by the analytical laboratory.



The recorded concentrations of nitrate in groundwater samples recovered from the Chalkpit abstraction borehole and abstraction boreholes BH2 and BH3 between 2016 and 2022 are shown on Figure 8. All concentrations show that nitrate is low across the Source Protection Zone (SPZ), due to the type of qualifier and the measures that are in place to remove these contaminants.

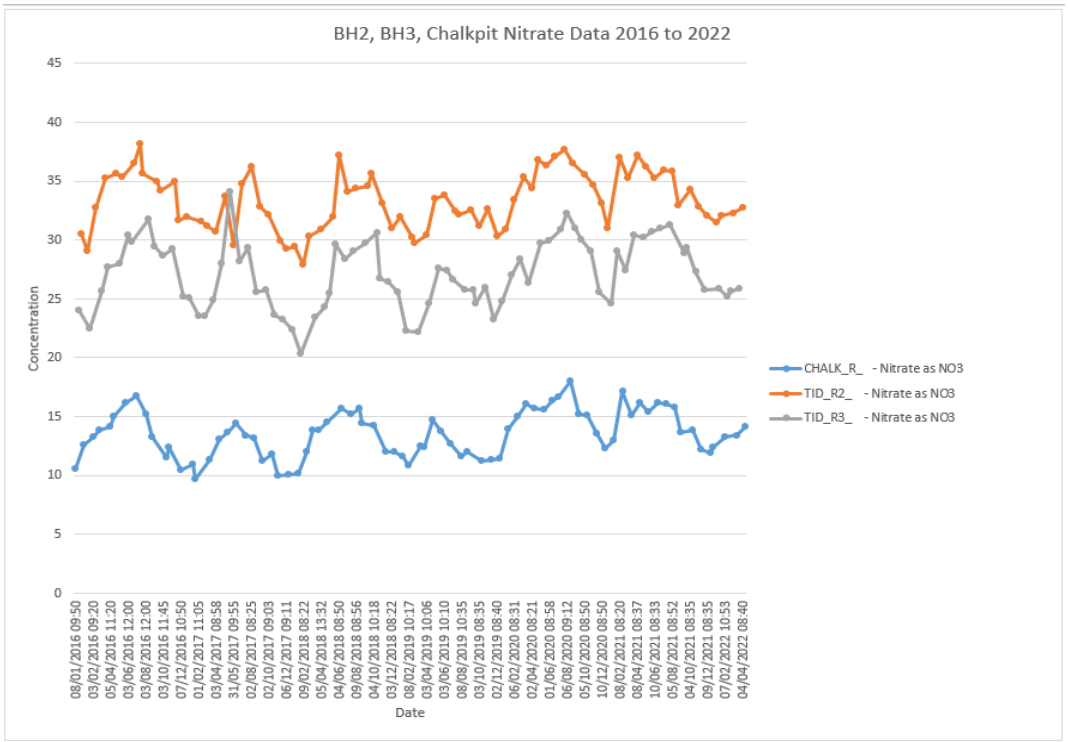


Figure 8 - Graph showing the concentrations of nitrate recorded in abstraction boreholes BH2 and BH3 and the Chalkpit abstraction borehole. The PCV for nitrate is 0.5 mg/l and concentrations that exceed that level will be reported to VWPL by the analytical laboratory.