Invicta Water Treatment
89 Castle Drive
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Email. sales@invictawatertreatment.co.uk www.invictawatertreatment.co.uk

Stuart Jolliff
Jolliff Developments Ltd

By email:
31/01/25

Dear Mr Jolliff,

Re: Private Water Supply at High Barn, Crays Lane Site – Raw Borehole Water Analyses (to date and inferences); Proposed Design and Compliance with PWS Regs 2016 Amended 2018 – Rev B

Rev B Amendments
Process Flow Diagram added for clarity of the water treatment process. We still recommend that HDC refer the water treatment process to their external consultant to confirm the design is acceptable. The rest of the report remains unchanged.

Further to the request that a raw borehole sample was taken by an accredited UKAS PWS Sampler, I can confirm that this was performed on 05/07/24 by Stefan Massingham. The borehole was allowed to flow for some 2 hours prior to sampling. It has been frequently flushed and allowed to develop during drilling prior to sampling. Visually, the water was turbid and grey in colour.

The samples were taken in accordance with DWI requirements (based on Group A & B Schedules PWS Regs 2016), with the correct bottles supplied by the UKAS Accredited lab, SE Water Scientific Services (SEWSS). and then duly transported to the lab thereafter, at the required transit temperatures (between 2^{o}C and 8^{o}C). Additional determinands were tested as it was highly likely that the raw water would require RO membrane treatment.

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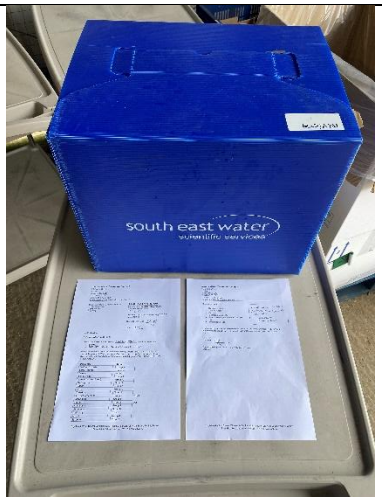

Signed acceptance of IWT Order by SEWSS

Determinands to Date	**Sample Number 1274019-2 Final, 01/08/24**
Alkalinity, mg/l	435.0
Ammonium (Ammonia and Ammonium ions), mg/l	0.698
Chloride, mg/l	274.30
Nitrate, mg/l	<0.9
Nitrite, mg/l	<0.004
Nitrite/nitrate, mg/l	0.002
Sulphate, mg/l	2.0
Total Hardness, mg/l	<10.0
Odour – Qualitative	None
Odour – Quantitative	0
Colony Count 3 days at 22°C, cfu/ml	>300
Colony Count 2 days @ 37°C, cfu/ml	>300
E coli, mpn/100 ml	0
Total Coliforms, mpn/100 ml	15
Pseudomonas aeruginosa, cfu/100 ml	<10
Clostridium perfringens (including spore), cfu/100 ml	0
Colour, mg/l Pt/Co	5
Conductivity, uS/cm	1,462
Hydrogen ion, pH	8.4
Turbidity, NTU	296.000
Bromate, ug/l	Not tested, sample stability issue
Antimony, ug/l	0.4
Arsenic, ug/l	4.9
Selenium, ug/l	1.6
Boron, mg/l	1.577

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Calcium, mg/l	6.2
Magnesium, mg/l	1.7
Sodium, mg/l	358.2
Fluoride, mg/l	1.920
Benzo(a)pyrene, ug/l	<0.003
Benzo(1,12)perylene, ug/l	<0.003
Benzo(11,12)fluoranthene, ug/l	<0.003
Benzo(3,4)fluoranthene, ug/l	<0.003
Indeno(1,2,3-cd)pyrene, ug/l	<0.003
PAH Total, ug/l	**0.000**
1,1,1 Trichloroethane, ug/l	<0.60
1,2-Dichloroethane, ug/l	<0.12
Benzene, ug/l	<0.02
Dibromochloromethane, ug/l	<0.50
Dichlorobromomethane, ug/l	<0.43
Tetrachloroethene	<0.15
Tetrachloroethen/Trichloroethene- SUM, ug/l	**0.00**
Tetrachloromethane, ug/l	<0.11
Total Trihalomethane, ug/l	**0.00**
Tribromomethane, ug/l	<0.60
Trichloroethene, ug/l	<0.10
Trichloromethane, ug/l	<0.50
Aluminium, ug/l	7,346.0
Copper, mg/l	<0.009
Iron, ug/l	15,600.4
Iron (free), ug/l	270.8
Lead, mg/l	8.3
Manganese, ug/l	236.4
Nickel, ug/l	3.7
Cadmium, ug/l	<0.12
Chromium, ug/l	9.2
Calc Pesticides – Total Substances	0.000
Aldrin, ug/l	<0.007
Dichlobenil, ug/l	<0.006
Gamma-HCH (Lindane), ug/l	<0.005
Heptachlor, ug/l	<0.008
Heptachlor Epoxide, ug/l	<0.005
Propyzamide, ug/l	<0.005
Tri-allate, ug/l	<0.005
2,4,5-T, ug/l	<0.007
2,4-D, ug/l	<0.007
Bentazone, ug/l	<0.007
Bromoxynil, ug/l	<0.007

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Dicamba, ug/l	<0.020
Dichlorprop, ug/l	<0.003
Fluroxypyr, ug/l	<0.008
MCPA, ug/l	<0.008
MCPB, ug/l	<0.008
Mecoprop(MCPP), ug/l	<0.005
Triclopyr, ug/l	<0.015
Epichlorohydrin, ug/l	<0.1
Atrazine, ug/l	<0.002
Carbendazim, ug/l	<0.001
Carbetamide, ug/l	<0.002
Chlorotoluron, ug/l	<0.003
Diuron, ug/l	<0.004
Epoxiconazole, ug/l	<0.003
Flutriafol, ug/l	<0.003
Isoproturon, ug/l	<0.003
Linuron, ug/l	<0.003
Oxadixyl, ug/l	<0.003
Pendimethalin, ug/l	<0.007
Prometryn, ug/l	<0.002
Simazine, ug/l	<0.003
Terbutryn, ug/l	<0.002
Trietazine, ug/l	<0.004
Mercury, ug/l	<0.04
% transmission	10.4
UV Abs (10 mm) @ 254 nm unfiltered	0.985 abs_unit
Bicarbonate Alkalinity, mg/l	424.19
Total Phosphate, ug/l	524
Total Organic Carbon, mg/l	1.5
Silica, mg/l	6.70
Suspended Solids, mg/l	151.6
Filtered Turbidity 0.45 um, NTU	2.01
Filtered Aluminium 0.45 um, ug/l	642.9

Treatment Prognosis
Based on the failures to date, the water treatment system will need to remove excess:

- iron (15,600.4 ug/l, maximum 200.0 ug/l)
- manganese (236.4 ug/l, maximum 50.0 ug/l)
- aluminium (7,346.0 ug/l, maximum 200.0 ug/l)
- sodium (358.2 mg/l, maximum 200.0 mg/l
- chloride (274.30 mg/l, maximum 250.00 mg/l)
- fluoride (1.920 mg/l, maximum 1.5 mg/l)

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- ammonium (0.698 mg/l, maximum 0.500 mg/l)
- turbidity (296.000 NTU, maximum 4.000 NTU)
- boron (1.577 mg/l, maximum 1.000 mg/l)
- suspended solids
- Bacteria – failures for Coliforms and general bacteria

The recommended treatment will be partial settlement; extensive particle filtration followed by a UF and RO unit (see emailed attachment for full RO design calculations) with remineralisation thereafter of the permeate. The treatment train will be similar to that for the Brook Hill Development, recently accepted by HDC and reported on by HDC consultant Dr. G. Pearce; and also, Lime Kiln Farm, Copsale.

We propose the following design:

- Borehole pump feeding
- 1350 litre raw water tank with level controls feeding
- Booster pump feeding
- Automatic backwashable media filter for sediment removal to 5 um or lower feeding
- Automatic regenerating meter-controlled softener to remove residual iron, some organics and any hardness
- Bespoke UF unit (to remove colloidal clay)
- Bespoke RO unit (as per attached preliminary RO design)
- Remineralisation filter
- UV Unit to disinfect prior to storage
- 5,000 litre treated water tank with level controls
- Booster pump
- 5 um sediment filter cartridge
- UV disinfection unit with UV sensor and controls
- Control panel with level indicators
- PVC rigid solvent weld pipework, MDPE pipework
- High strength chlorination of all pipework prior to use
- UKAS sampling of treated water as per PWS Regs

We are not proposing chlorine dosing currently, as the supply is limited to a handful of new build properties.

The filtration equipment is modular in nature and so upgrades are quite straight forward. The treated water will meet the PWS Regs requirements.

The Process Flow Diagram and RO projection are shown below.

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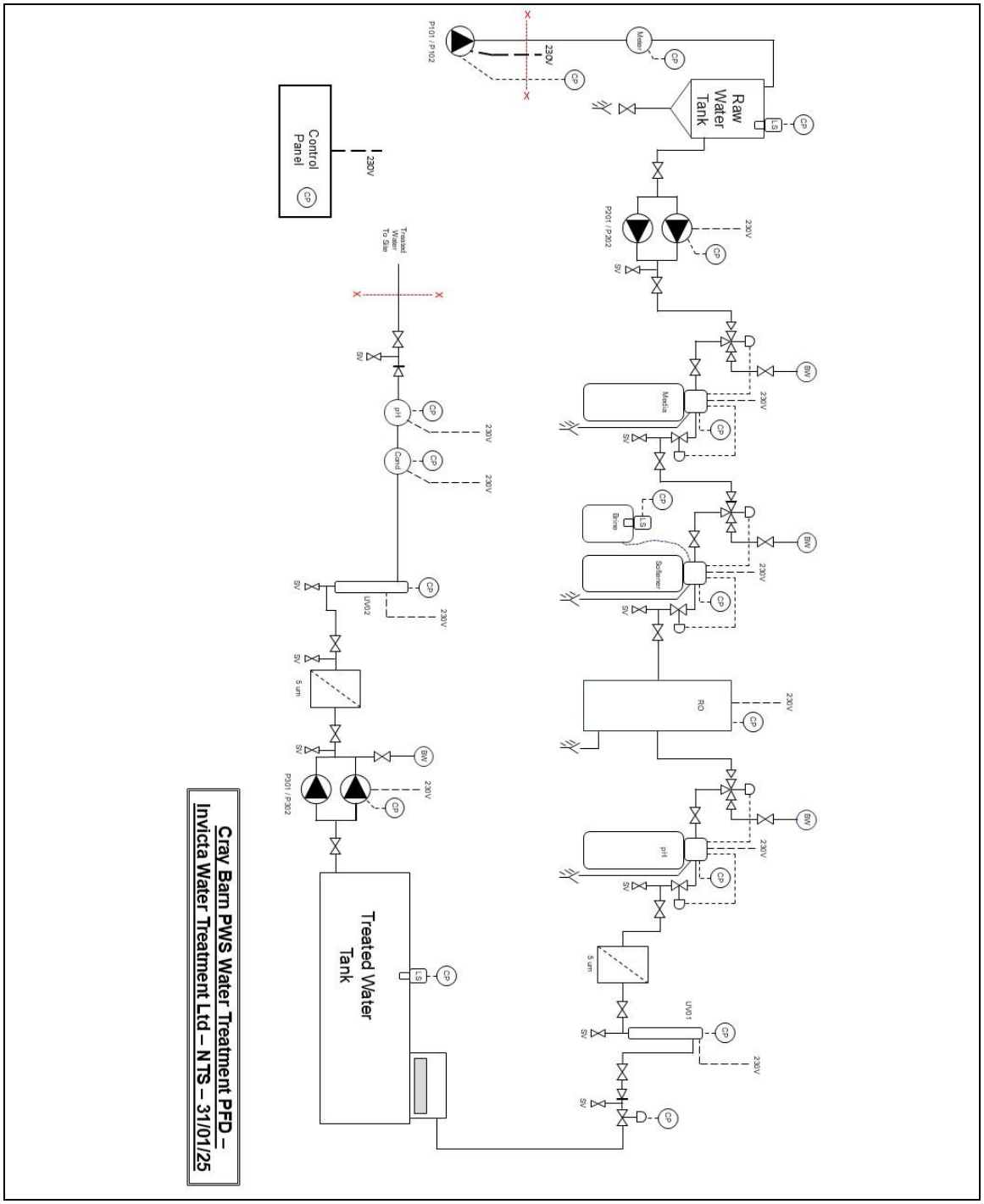
Process Flow Diagram



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Integrated Membranes Solutions Design Software

Created on: 30/07/2024 04:47:09

Nitto HYDRANAUTICS Nitto Group Company

Permeate Throttling (Variable), Concentrate Recirculation

Project name	Cray Barn		
Calculated by	Stefan Massingham		
HP Pump flow	3.07	m3/h	
Feed pressure	5.5	bar	
Feed temperature	25.0	°C(77.0°F)	
Concentrate recirculation	2.50	m3/h	
Feed water pH	8.40		
Chem dose, mg/l, -	H2SO4		
Specific energy	1.47	kwh/m3	
Pass NDP	2.3	bar	
Average flux rate	17.9	lmh	

Permeate flow/train	0.40	m3/h
Raw water flow/train	0.57	m3/h
Permeate recovery	13.03	%
Total system recovery	70.00	%
Element age	0.0	years
Flux decline %, per year	5.0	
Fouling factor	1.00	
SP increase, per year	7.0	%

Feed type: Brackish Well Non-Fouling

Pass - Stage	Perm. Flow m3/h	Flow / Vessel Feed m3/h	Flow / Vessel Conc m3/h	Flux lmh	DP bar	Flux Max lmh	Beta	Stagewise Pressure Perm. bar	Stagewise Pressure Boost bar	Stagewise Pressure Conc bar	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	0.4	1	0.9	18	0.1	18	1.13	1	0	5.4	120.1	ESPA4-LD-4040	3	3 x 1M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1
Hardness, as CaCO3	0.00	0.00	0.000	0.0
Ca	0.00	0.00	0.000	0.0
Mg	0.00	0.00	0.000	0.0
Na	380.00	1018.82	46.386	1164.5
K	0.00	0.00	0.000	0.0
NH4	0.70	1.08	0.079	1.2
Ba	0.000	0.000	0.000	0.0
Sr	0.000	0.000	0.000	0.0
H	0.00	0.00	0.000	0.0
CO3	0.00	0.02	0.000	0.0
HCO3	0.10	0.26	0.012	0.3
SO4	2.00	5.78	0.026	6.6
Cl	585.45	1571.37	71.619	1796.1
F	0.00	0.00	0.000	0.0
NO3	0.00	0.00	0.000	0.0
PO4	0.00	0.00	0.000	0.0
OH	0.04	0.10	0.005	0.1
SiO2	6.70	18.69	0.444	21.4
B	1.58	1.58	1.581	1.6
CO2	0.00	0.00	0.00	0.00
NH3	0.10	0.36	0.36	0.36
TDS	976.53	2617.59	120.15	2991.78
pH	8.40	8.78	7.50	8.83

Saturations	Raw Water	Feed Water	Concentrate	Limits
CaSO4 / ksp * 100, %	0	0	0	400
SrSO4 / ksp * 100, %	0	0	0	1200
BaSO4 / ksp * 100, %	0	0	0	10000
SiO2 saturation, %	4	10	11	140
CaF2 / ksp * 100, %	0	0	0	50000
Ca3(PO4)2 saturation index	0.0	0.0	0.0	2.4
CCPP, mg/l	0.00	0.00	0.00	850
Langelier saturation index	0.00	0.00	0.00	2.8
Ionic strength	0.02	0.04	0.05	
Osmotic pressure, bar	0.8	2.1	2.3	

RO Design Calculations (see email attachment for full set)

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Compliance
With reference to the PWS Regs 2016 and amended 2018, this supply will be classified as Reg 9. We have allowed for a DWI risk assessment on the completed system by David Clapham (RIAMS independent consultant) along with the required sampling by a UKAS accredited sampler. We understand, under PWS Regs section 6 & 7, the duties of the council. We look for the council to provide clarity on this.

Ongoing Maintenance & Sampling
The water treatment system will require maintenance. We will provide a bespoke O&M manual, with specific procedures for your system along with the manufacturer's documentation. We will issue a line drawing of the water treatment process and provide hands-on training during the commissioning phase. Critical spares will be left on site and these are: spare UV lamp, quartz sleeve and sediment filters.

Regarding headings 3,4,5 in HDC Water Neutrality Compliance requirements. Please note 3 and 4 will be detailed at contract phase in the O&M manual. The manual will also cover recording. We have other applications/systems passed based on the same wording as in this report. With regard to recording: the designated maintenance contractor/owner/agent looking after the system will take necessary samples and record in the site log book, which forms part of the O&M manual. Until the system is commissioned, we cannot say which determinands need to be tracked but it is highly likely it is those which have failed and highlighted below. Specific SOPs, contained in the O&M, will be written once the system has been commissioned and will cover inspection, cleaning and maintenance. We will comply with PWS Regs 2016 amended 2018.

Sampling the raw borehole as well as the treated water is important to understand how the ground water is changing over time and how it reacts to weather events. We will only test pertinent process determinands and those required under the Schedules (see PWS Regs). If the council requires regulatory samples, we assume we will be instructed accordingly.

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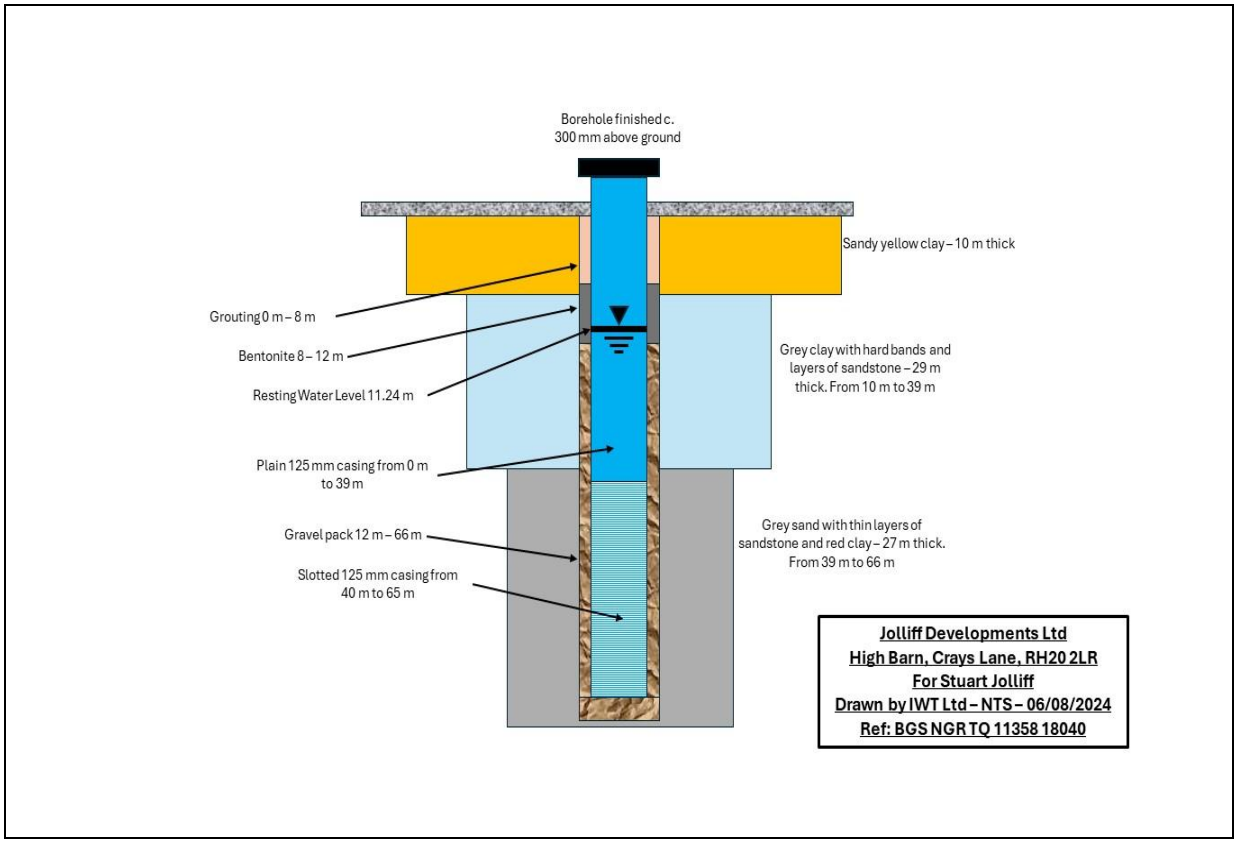
Borehole Design As Drilled On Site



The borehole has been drilled as per the drill log attached to the email and as below (page 1 of log). The borehole produces water from the grey sands/sandstone and red clay. The borehole has been finished above ground. There are no known sewage systems or ground contamination sources nearby.

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WR38: Borehole record form

Borehole record form

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Environment Agency

Water Resources Act 1991 (as amended by the Water Act 2003)

A Site details

Borehole drilled for: Jolliff Developments Ltd

Location: High Barn Crays Lane Goose Green Pulborough RH20 2LR

NGR (ten digits): TQ 11358 18040 Please attach site plan

Ground level (if known): 30 metres Above Ordnance Datum

Drilling company: SussexBoreholes

Date drilling commenced: 15/03/2024 (DD/MM/YYYY) Completed: 22/03/2024 (DD/MM/YYYY)

B Construction details

Borehole datum (if not ground level) _____ metres (m). Please tick if this is above ☐ or below ☐ ground level.
(point from which all measurements of depth are taken, for example, flange, edge of chamber)

Borehole drilled diameter: 225 mm from 0 to 66 m/depth
_____ mm from _____ to _____ m/depth
_____ mm from _____ to _____ m/depth
_____ mm from _____ to _____ m/depth

Casing material: upvc diameter: 125 mm from 0 to 65 m/depth
and type (for example, if plain steel, plastic slotted). Please record permanent casing details, not temporary casing.
Casing material: plain diameter: 125 mm from 0 to 39 m/depth
Casing material: slotted diameter: 125 mm from 40 to 65 m/depth
Casing material: _____ diameter: _____ mm from _____ to _____ m/depth

Grouting details: gravel pack, bentonite pellets at 12-8 meters and cement groute to surface

Water struck at 1. _____ m (depth below datum – mbd) 2. _____ m (mbd)
3. _____ m (mbd) 4. _____ m (mbd)

C Test pumping summary (Please supply full details on form WR39)

Test pumping datum _____ m. Please tick if this is above ☐ or below ☐ ground level.
(if different from borehole datum)

Pump suction depth: 40 mbd

Water level (start of test): 11.24 mbd

Water level (end of test): _____ mbd

Type of test (for example, bailer, step, constant rate)
_____

Pumping rate: 4 m³/hour ☑ or litres/second ☐. Please tick as appropriate.
for _____ days, 2 hours, _____ mins

Recovery to _____ mbd in _____ days, _____ hours, _____ mins
(from end of pumping)

Date(s) of measurements Pump started: 27/03/2024 (DD/MM/YYYY)
Pump stopped: _____ (DD/MM/YYYY)

Please supply chemical analysis if available. If you have included this please tick this box ☐

WR38 Version 2, February 2011 page 1 of 3

Page 1 of 3 – see email attachments for full document

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Summary
We trust that there is enough information herein for HDC. Please keep us informed of your progress. HDC can contact me directly if they wish.

Please feel free to call on 07970 154529 if you need any parts of the report clarifying.

Regards

Stefan Massingham BSc (Hons Chem.) MSc (Cran) MWMSoc
Director - Invicta Water Treatment Limited
Qualified UKAS Private Water Supply Sampler