Site Visit Report

Under the European Union (Drinking Water) Regulations 2014 as amended, the Environmental Protection Agency is the supervisory authority in relation to Irish Water and its role in the provision of public water supplies. This Audit was carried out to assess the performance of Irish Water in providing clean and wholesome water to the visited public supply.

The audit process is a sample on a given date of the facility's operation. Where a finding against a particular issue has been reported this should not be construed to mean that this issue is fully addressed.

Water Supply Zone

Name of Installation	Carlow North Regional
Organisation	Irish Water
Scheme Code	0100PUB1142
County	Carlow
Site Visit Reference No.	SV22522

Report Detail

Issue Date	21/07/2021
Prepared By	Derval Devaney

Site Visit Detail

Date Of Inspection	23/06/2021	**Announced**	Yes
Time In	10:30	**Time Out**	12:30
EPA Inspector(s) **Additional Visitors**	Derval Devaney Aoife Loughnane		
Company Personnel	David Dunne - Carlow County Council Rory Jackman - Carlow County Council Donnacha Lynch - Carlow County Council Catherine Rice - Irish Water Pat Duggan - Irish Water		

Summary of Key Findings

1. The audit found the *Cryptosporidium* failure detected in the final water sample on 11/05/21 was most likely due to a deterioration in raw water quality on 10/05/21, combined with significant deficiencies and pressures on the treatment processes at the Rathvilly Water Treatment Plant. These include lack of online alarms and automatic plant shutdown in the event of an incident, absence of pH control on the coagulation process, filter media which had not been replaced since the 1980's, absence of a run to waste facility on the filters and the recycling of sludge supernatant to the head of the works.

2. The plant is currently at planning stage for an upgrade which Irish Water state will address the 22 high and very high risks it has identified in its Drinking Water Safety Plan (DWSP). As part of the plant upgrade, Irish Water should investigate the possibility of ceasing the recirculation of sludge supernatant to head of works because it places an added pressure on the water treatment processes. The audit found the supernatant return chamber at the sludge lagoon had a large build-up of sludge which presents a risk of sludge recirculation to the head of the works. The supernatant return chamber needs to be cleaned as a matter of priority.

3. Alarms and plant shutdowns are not appropriate to afford sufficient time for the plant operators to respond to an incident or water quality failure and are not appropriate to ensure the *Cryptosporidium* barrier is intact. In addition, online monitors while within calibration, appeared to be reading inaccurately and the scale of units for turbidity on SCADA differed between filters.

4. Based on the audit findings, the EPA is considering adding Carlow North Regional PWS to its Remedial Action List (RAL).

Introduction

The Carlow North Regional Public Water Supply serves a population of 9,783 serving parts of Counties Carlow, Kildare and Wicklow. Water abstracted from the River Slaney is treated at Rathvilly Water Treatment Plant (WTP) which was built in the 1980's. The Rathvilly WTP is designed to produce approximately 11,500 m3 per day and produces approx. 7,000 m3 treated water per day. Approximatly 330 m3/hr of raw water is abstrated from the River Slaney and there is an abstraction licence to take 9,000 m3 per day. Treatment processes at the WTP include coagulation, flocculation and clarification (CFC), rapid gravity filtration, pH correction, chlorine disinfection and fluoridation.

The audit was carried out in response to the detection of *Cryptosporidium* in final treated water at the WTP on 11/05/21.

Supply Zones Areas Inspected

A virtual audit was carried out on 22nd June 2021 and an on-site audit at the Rathvilly WTP was carried out on 23rd June 2022 where all aspects of the water treatment stages, from the intake from the River Slaney through to the final water treatment stages and sludge management processes, were inspected.

1. Incident Management

		Answer
1.1	Was the incident suitably alerted to the plant operators, escalated and managed in order to maintain water quality and protect public health?	Yes

Comment

The EPA was notified on 14/05/21 of a *Cryptosporidium* failure in the final water of Rathvilly WTP on 11/05/21. The HSE was consulted in advance of notifying the EPA to determine risk to public health. The final water was resampled for *Cryptosporidium* on 15/05/21, 03/06/21 and 18/06/21 and all samples were clear.

Irish Water stated a review of plant performance, including CFC, filtration processes, water quality and daily records, in the period leading up to the C*ryptosporidium* detection did not indicate any significant issues however a number of risks which could affect the *Cryptosporidium* barrier were identified by Irish Water in the Drinking Water Safety Plan (DWSP) completed for this supply and by the EPA during the audit.

The DWSP's high and very high risks included the presence of floc carryover from the clarifiers, inadequate particle removal by the filter media, an inadequate backwashing regime with an absence of a run to waste facility and recycled backwash water. Such risks were also identified during the audit and are outlined in more detail in this report below.

Irish Water stated an Asset Management Improvement Plan (AMIP) is to be put in place to mitigate the 22 very high and high hazards identified in the DWSP and planning is underway to progress the upgrade works.

2. Source Protection

		Answer
2.1	Is the abstraction source(s) adequately protected against contamination?	No

Comment

The raw water is abstracted from the River Slaney under an abstraction licence, limiting the abstraction to 9 MLD. The current daily abstraction rate is approx. 7 MLD (330 m3/hour). The raw water is screened at the intake and flows through an actuated inlet valve and then flows by gravity into a raw water sump.

During the audit silvery creatures approx. 20 cm long, thought to be eels, were observed resting on top of the filter media of Filters No 2 and No 3. The presence of eels in the filters indicate that the intake screens are not effective enough in protecting the drinking water treatment processes.

There is an online ammonia monitor which is linked to an alarm on the intake. There is also a turbidity, pH and flow monitor on the intake. Irish Water could not provide the alarm settings for the raw water online monitors. The turbidity monitor located at the intake was reading 135.3 NTU on the day of the on-site audit. While the monitor was installed and calibrated in Sept. 2020 the caretaker stated that it was not reading accurately and the additional raw water turbidity monitor located in the WTP's lab which read 10 NTU during the on-site audit was the correct turbidity concentration.

The SCADA shows turbidity in the raw water can rise to concentrations as high as 100 NTU. The virtual audit found that turbidity levels in the raw water can rise steadily over time. For example, raw water turbidity readings taken by the caretaker from SCADA around the time of the *Cryptosporidium* failure was provided during the virtual audit and were as follows: 14 May 2021 10.9 NTU; 15 May 2021 12.4 NTU; 15 May 2021 29.4 NTU; 17 May 2021 42.2 NTU and 18th May 85.5NTU.

SCADA graphs show there was a turbidity spike up to 60 NTU in the raw water on 10/05/21 from approx. 12 pm – 3 pm and again from approx. 8:45 pm – 11:00 pm. Ammonia also rose steadily from 3 am on 10/05/21 from its usual concentration of 0.2 mg/l spiking at 1.3 mg/l at 9am on 10/05/21. The *Cryptosporidium* failure was detected on 11/05/21 in the final water (FW) at the water treatment plant (WTP). The deterioration in raw water quality the day before the failure could have caused the *Cryptosporidium* detection in the FW. Irish Water or Carlow County Council could not confirm the cause of the deterioration in raw water quality the day before the *Cryptosporidium* detection.

The raw water turbidity monitor is not alarmed nor does it initiate an automatic plant shutdown to prevent raw water of high turbidity concentrations entering the the plant and potentially compromising the treatment processes.

3. Coagulation Clarification Flocculation (CFC) Stage

		Answer
3.1	Is the pH within a suitable range for the coagulant used?	No

Comment

The raw water pipeline is dosed with 8% liquid alum (coagulant) by a duty and standby dosing pump with automatic switchover. There is an inline static mixer to aid mixing. Water then enters the raw water mixing tank where polyelectrolyte Cledarfloc: 501PWG is dosed to assist flocculation. Retention time here is approx. 1 minute. There is a pH monitor on the mixing tank however it is not actively used to ensure optimum pH is being maintained for coagulation and it is not alarmed.

		Answer
3.2	Is the CFC process optimised to respond to changes in raw water quality?	No

Comment

From the mixing tank, water enters one of two flat bottomed upward flow clarifiers (settlement tanks). A sludge bleed occurs every 15 minutes and lasts for 80 - 120 seconds. The sludge from the sludge bleeds discharges to a balance tank on-site and is discussed in detail in the report further below.

The clarifiers have a turbidity monitor which is alarmed, a pH monitor and a floc blanket level sensor. The turbidity monitor on the settled water is alarmed at 1.5 NTU after 900 seconds but is not linked to a plant shutdown. SCADA screenshots submitted in advance of the audit, for a period prior to the detection of *Cryptosporidium* on 11/05/21 in the final water, illustrates that there were issues with plant performance on 9th and 10th May 2021. The settled water turbidity took a sharp increase at 5 am on the 9th May (usually 0.15 NTU and rose to 0.33 NTU) and remained at 0.24 NTU – higher than normal - into the 10th May 2021. This increase in turbidity is also reflected in SCADA readouts for the three filters and in the final water during the same time period. It would appear from these trends that the CFC process is unable to respond to changes in raw water quality and this may have attributed to the detection of *Cryptosporidium* in the final water.

		Answer
3.3	Were the CFC tanks, channels and weirs observed to be clean, level and well maintained during the audit?	No

Comment

The channel carrying clarifed water from the settlement tanks to the filters was noted to have significant amounts of algae on the walls and around the overflow pipe. Carlow Co. Co. stated that this channel would not have been cleaned in at least four years due to a health and safety (H&S) issue with access for cleaning.

		Answer
3.4	Were the CFC processes visually observed to be operating appropriately during the audit?	No

Comment

Pin floc was observed in the settled water in the clarifiers.

4. Filtration

		Answer
4.1	Are the filters designed and managed in accordance with EPA guidance?	No

Comment

Clarified water is filtered in one of three Rapid Gravity Filters, filtering at a rate of 3.5 m3 / m2 / hr.

The filter media has not been replaced since the plant was built in the 1980's. Carlow County Council stated that Filters 1 and 2 have a media depth of 830 mm and Filter 3's depth ranges from 900 mm - 990 mm. The filter's concrete walls were pitted signifying erosion had occurred over time.

There is no run to waste or slow start on the filters and supernatant from the the backwash water is returned to the head of the works. Irish Water stated that this is to be addressed as part of an upgrade planned for the plant which is at an advanced planning stage. The outflow from each filter is monitored by online turbidity meters which are not alarmed or linked to an automatic plant shutdown.

		Answer
4.2	Was there visual indication that the filters were operating appropriately?	No

Comment

A backwash occurs daily (Monday - Friday) on two of the three filters. This is not based on turbidity or headloss but is triggered manually based on a visual check of the filters or if there happens to be an issue with the treatment process. A backwash was observed on Filter No 2 during the on-site audit. An air scour occurs first for 3-4 minutes and then a water scour for 5 minutes. A dead zone and boils were noted in places during the backwash. There was also uneven flow across the weir during the backwash. The entire plant is shutdown during a backwash.

		Answer
4.3	Does monitoring indicate that the filters are operating effectively?	No

Comment

SCADA screenshots showed a similar trend evident in the settled water where there was an increase in turbidity in all three filters and in the final treated water from 5 am 9th May. Turbidity is usually less than 0.1 NTU in Filter 1 and Filter 2 and it rose to 0.28 NTU. Filter 3's turbidity also rose at 5 am on 9th May from 0.0025 NTU to 0.086 NTU over the same time period. It appears the rise in turbidity, which lasted until 10th of May, didn't trigger a backwash on the 9th. It is noted that the 9th of May was a Sunday and the caretaker stated during the audit that backwash is manual and not based on head loss or turbidity and is carried out only from Monday to Friday.

The final water turbidity also rose at 5 am 9th May from 0.02 NTU up to 0.072 at 5 pm that day. Chlorine concentrations also dropped in this period. During the virtual audit it was stated a drop in chorine can be due to no flow from the filters, however this drop was not as a result of a backwash or a no flow event. The rise in turbidity and drop in chlorine occured over a long time period and seems to correlate with the higher than normal turbidity concentrations coming through the plant from the clarifiers.

The audit found that Filter No 2 is incorrectly labelled in SCADA as Filter No 3 and vice versa. Also, Filter No 2 is reading turbidity on a unit scale of mNTU while Filters 1 and 3's turbidity scale is in NTU.

The online turbidity monitors were calibrated on March 2021 with the next calibration due in September 2021. The online turbidity monitors on the filters during the audit read for Filter 1: 0.096 NTU; Filter 2: 0.088 NTU and Filter 3: 0.073 NTU. The final water turbidity monitor read 0.018 NTU and the auditors questioned the reliability of the turbidity monitors readings, given that the final water was giving a much lower turbidity reading than that coming off the filters.

5. Disinfection

		Answer
5.1	Is the disinfection system verified using monitors and alarms, with trended data recorded and accessible?	Yes

Comment

The combined flow from the rapid gravity filters enters a 2,358 m3 clear water tank which has a baffled inlet and retention time of 5.6 hours. The water before entering the clear water tank is dosed with 10% Sodium Hypochlorite. Disinfection dosing control is flow proportional with a partial dose based on the free chlorine reading from the online chlorine monitor. There is a duty and standby chlorine dosing pump with automatic switchover.

The residual chlorine is monitored at the outlet of the clearwater tank to ensure the target chlorine dose is met. The chlorine target leaving the plant is 1.4 - 1.5 mg/l due to the large network and the absence of chlorine booster stations on the network.The chlorine monitor was reading 1.36 mg/l on the day of the audit.

Effective contact time (Ct) is achieved using storage in the clearwater tank, the rising main to Moate reservoir and Moate reservoir. There are no houses served from the rising main between the plant and the reservoir. The Ct is validated by a chlorine monitor on the outlet of the Moate Reservoir and the chlorine target here is 0.5 mg/l or greater. There is also a chlorine monitor on the inlet to the Moate reservoir.

There is an automatic plant shutdown on the final water for the following setpoints: maximium free chlorine (2.3 mg/l after 1800 seconds), minimum free chlorine (0.5 mg/l after 999 seconds), turbidity (0.5 NTU after 900 seconds), maximum pH (9 pH units after 300 seconds) and minimum pH (6.5 pH units after 600 seconds). The chlorine alarm and plant shutdown is based on the chlorine monitor reading from the outlet of the clearwater tank to afford sufficient time to respond to an incident and protect public health.

pH correction is via Sodium hydroxide (25%) dosing and fluoridation takes place before water is pumped to Moate Reservoir 2 km away from the treatment plant and gravity feed to distribution mains. The pH monitor on the final water read 7.25 on the day of the audit.

		Answer
5.2	Are monitors and alarms operational via dial out and being responded to with a suitable cascade system in place?	Yes

Comment

The alarm dial out from online monitors potentially goes to three people as part of a cascade system. Once the first person receives an alarm they can text back a code to prevent the alarm going to the next person on the cascade system.

6. Reservoirs and Distribution Networks

		Answer
6.1	Are reservoirs adequately inspected and maintained?	No

Comment

Treated water enters a very large distribution area which encompasses parts of Wicklow, Kildare and much of Carlow. There are are three reservoirs on the supply: the Moate reservoir, 2 km from Rathvilly water treatment plant; the Brownshill Reservoir which is located on the outskirts of Carlow and feeds by gravity to Oakpark where it is blended with production wells there; and the Ballyraggan Reservoir which serves parts of Co. Kildare. There are chlorine monitors at all reservoirs.

Carlow County Council confirmed that while an inspection of the Moate reservoir was carried out in the past, it was unknown when the reservoirs on this network were last cleaned.

7. Management and Control

		Answer
7.1	Is the water treatment plant resilient enough to cope with significant variations in raw water quality or demand?	No

Comment

SCADA screenshots showed an increase in turbidity in the raw water and throughout the plant from the settled water to the filters and on to the final water from 5 am 9 th May. Chlorine concentrations at the plant also decreased below the target level from 3 am on 9 th May and didn't rise to usual levels (1.3 mg/l) until 11 am 10 th May. While still above the required 0.5 mg/l for adequate Ct, there is no explanation for this drop in chlorine over such an extended period in time.

Such trends occurring throughout the plant at the same time would indicate that the plant is unable to cope with significant variations in raw water quality (be it that from the River Slaney or the blend of sludge supernatant return and raw water at the head of works). In addition, the lack of a run to waste post backwashing the filters and the significant age of the filter media (approx. 40 years) would also place added pressure on the treatment capabilities of the Rathvilly WTP.

		Answer
7.2	Has the protozoal compliance log treatment requirement been identified for the water treatment plant?	Yes

Comment

Irish Water stated that using their new *Cryptosporidium*-Source risk assessment methodology, the risk score for the Rathvilly WTP has been calculated to be 3 Log. This includes a 0.4 Log penalty to take account of the fact that the sludge supernatant is recirculated back to the head of the works.

Irish Water stated that the final water is monitored for *Cryptosporidium* at a frequency of nine times per year; however during 2020 there were only six samples taken. All results were clear. Eight samples for *Cryptosporidium* were taken to date for 2021; one sample per month from January to April which were clear, the sample on the 11th May which detected *Cryptosporidium* prompted additional samples to be taken on 15/05/21, 03/06/21 and 18/06/21 all of which were clear.

		Answer
7.3	Is the plant suitably managed and controlled to maintain the designed log credit on each treatment stage?	No

Comment

In order for a 3 Log Credit to be achieved at the plant, certain alarm and plant shutdown criteria are required to be adhered to in accordance with the EPA's Filtration Manual and Irish Water's Protozoa Log Credit Compliance Criteria for the operation of CFC and RGF processes. Irish Water recognised during the audit that there is a need to review the alarms settings and plant shutdown criteria to ensure the required Log credit is in place at all times.

8. Sludge Management

		Answer
8.1	Is sludge arising from the treatment processes adequately managed?	No

Comment

Discharges arising from sludge bleeds and filter backwashing (210m3) go to a sludge balancing /settlement tank. Supernatant from this tank is directed by gravity from a pipe (which can be lowered to just below the water's surface) to the head of the works for recirculation back through the water treatment plant.

The sludge settling at the bottom of the sludge balance tank is pumped to a sludge lagoon on-site. A significant about of algae was noted to be floating on the surface of the water in the lagoon. Supernatant from the sludge lagoon flows over a weir into a supernatant return chamber. There is a vertical pipe in this chamber and once the water reaches a certain height, it flows into the pipe and flows by gravity to the head of the works for recirculation through the water treatment plant. There was a significant amount of dried solids, which appeared to comprise of algae and sludge, in the supernatant return chamber. These solids were at risk of returning to the head of works with the supernatant and placing added pressure on thE treatment processes. Carlow County Council stated that the lagoon and supernatant return chamber was due to be cleaned out in six weeks.

There are no flow meters on the two supernatant streams being returned to the head of the works; Carlow County Council estimate that it is 2 - 3 % of the total volume of water being treated at the plant.

Irish Water stated that there are upgrade works planned for the site which are at planning stage and would include a balancing tank, thickening tank and sludge treatment on-site and would cater for just one supernatant return stream to the head of works. The auditors advised that the practice of recycling of supernatant be reviewed as part of the upgrade, with a view to ceasing this activity; as such practice can result in concentration of viruses, cysts and other undesirable particles which in turn increases the potential breakthrough into the water supply.

Sludge thickening is outsourced and a mobile dewatering unit is brought to site to carry out this process. On average, about 120 tonnes of sludge is produced per month. Sludge from the site is sent to Mortarstown WWTP (22 km away).

Recommendations

Subject	Carlow North Regional Audit Report 23/06/21	Due Date	23/08/2021

Action Text

Recommendations

1. Irish Water should progress the planned upgrade of Rathvilly water treatment plant as soon as possible, and address the high and very high risks identified in the Drinking Water Safety Plan (DWSP) to provide both a physical and inactivation barrier for protozoa and ensure the provision of safe and secure water for the Carlow North Regional Public Water Supply. Irish Water should update the EPA on the works proposed for the upgrade and also submit details on the output from the DWSP AMIP and associated corrective actions with timelines.

2. Irish Water should provide the full details of the *Cryptosporidium* Source risk assessment methodology for Rathvilly WTP, to support Irish Water's classification of the River Slaney source as a 3 log treatment requirement which incorporates a 0.4 log penalty to take account of the recirculation of sludge supernatant to the head of the works.

3. Irish Water should monitor for *Cryptosporidium* in the final water on a monthly basis, until such time as the updgrade of Rathvilly WTP is completed, and notify the EPA and HSE immediately if any oocysts are detected.

4. Irish Water should ensure the following works are completed on plant alarms, shutdown and telemetry without delay: (a) Review critical alarm setpoints and shutdown throughout the plant to ensure such controls afford sufficient time to respond to an incident. Turbidity alarm settings and shutdown criteria should be in accordance with the EPA Water Treatment Manual: Filtration. Submit details of such amendments made to alarms and plant shutdown criteria to include any time delays; (b) Install turbidity alarm and plant shutdown on the raw water abstraction point; (c) Ensure online monitors and the SCADA system are displaying accurate readings of water quality, in particular turbidity readings, and ensure SCADA refers to the relevant filter on the system.

5. Irish Water should upgrade the inlet screens to prevent, in so afar as possible, aquatic creatures from entering the water treatment plant at the raw water inlet.

6. Irish Water should ensure the following action is undertaken regarding the coagulation, flocculation and clarification stage: (a) Clean the clarified water channel to ensure it is is free from algae and other solid material; (b) Ensure sludge bleeds are efficient and optimised so that the clarifier can respond to changes in raw water quality; (c) Ensure there is no pin floc carryover from the clarifiers to the filters; (d) Carry out jar tests to determine the target optimum pH for coagulation; (e) Ensure the pH online monitor on the mixing tank is alarmed and used as a control to ensure optimum pH for effective coagulation is achieved.

7. Irish Water should upgrade the filtration treatment process to include:(a) Replacement of filter media to a minimum sand media depth of 1000-1200 mm as per the requirements of the EPA filtration manual; (b) Provision of run-to-waste facilities on the rapid gravity filters to prevent out of specification water from entering supply; (c) Backwash is triggered automatically by elevated turbidity concentrations and head loss in addition to time; (d) Air and water nozzles are inspected to ensure there are no dead zones or boils and ensure there is even flow over the weir during a backwash; (e) Repairs are made to the concrete walls of the filters to ensure they are not eroded and are fit for purpose.

8. Irish Water, as part of the planned upgrade works, should investigate the possibility of ceasing the return of sludge supernatant to the head of the works as such practice can result in concentration of viruses, cysts and other undesirable particles which in turn increases the potential breakthrough into the water supply. In the interim, Irish Water should install flow meters on the supernatant being returned to the head of works.

9. Irish Water should ensure reservoirs are inspected and cleaned at an appropriate frequency.

Follow-Up Actions required by Irish Water

	During the audit, Irish Water representatives were advised of the audit findings and that action must be taken as a priority by Irish Water to address the issues raised. This report has been reviewed and approved by Aoife Loughnane, Drinking Water Team Leader. Irish Water should submit a report to the Agency on or before **23rd August 2021** detailing how it has dealt with the issues of concern identified during this audit. The report should include details on the action taken and planned to address the various recommendations, including time frame for commencement and completion of any planned work. The EPA also advises that the findings and recommendations from this audit report should, where relevant, be addressed at all other treatment plants operated and managed by Irish Water. Please quote the Action Reference Number in any future correspondence in relation to this Report.