Project Name / Number:	STAPLEFIELD WTW / 752214
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Southern Water Services AMP7 Programme

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Operations & Maintenance Plan

Project Name / Number:	STAPLEFIELD WTW / 752214
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Rev	Amendments	Section
C01	Updated text	5.3.4
C02	Updated text	5.5.3
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Section 1: Introduction

This Operation and Maintenance Plan (O&M Plan) has been prepared as part of the design stage to set out procedures for the Integrated Constructed Wetland (ICW) system at the Staplefield WTW, Haywards Heath, UK. It is recommended that supervisory managers and operators responsible for the day-to-day operation and maintenance of the ICW system are aware of how ICWs function, what they were designed to treat and their expected performance.

Managers and operators should also understand the ICW's site-specific characteristics and setting including the general hydraulics of the system, its ecology and the principal factors influencing them. Any queries relating to the ICW, and this Operation and Maintenance Plan can be directed to VESI Environmental Ltd.

Table 1: Contact List

ICW Designer	VESI Environmental Ltd., Unit B, Dunhill Eco Park, Dunhill, Co. Waterford, X91 FVF9, Ireland Tel: +353 (0)87 215 1882 Email: info@vesienviro.com W: www.vesienviro.com

1.1: Key Items

Key items in this O&M Plan include:

- Appropriate water level management;
- Vegetation management;
- Wetland vegetation assessment;
- Knowing when and what actions are needed;
- Knowing when and who to contact;
- Monitoring schedule.
- Records and data logging.

Note: This O&M Plan developed for design stage, is to set out requirements for the operation stage. It will be updated and finalised prior to commissioning and will include check sheets and drawings. All records and data should be kept on file for review and inspection as required.

The ICW O&M plan will operate in conjunction with ongoing Staplefield WTW Operation and Maintenance plans. There may be some overlapping of operations and maintenance. The ICW site extends from inlet pipe to Cell 1, through a series of 4 wetland cells and connection of discharge into new manhole (MH) within the existing Final Effluent (FE) pipeline, upstream of existing FE MH3. ICW

monitoring records will include recording flows to (pump station) and from (FE MH 3) the ICW within the Staplefield WTW facility.

Section 2: General ICW Overview

The ICW system at Staplefield WTW has been designed to provide supplementary treatment of wastewaters, with focus on phosphorus reduction before discharging to receiving waters. Stormwater overflows will be directed directly to the existing Final effluent (FE) pipeline. The ICW concept is based on the natural ability of wetlands to cleanse incoming contaminated water (influent); they are free water surface-flow systems consisting of a series of shallow cells, across which influents flow. The bottoms and sides of the cells are constructed with on-site soils to provide containment.

The series of 4 cells will have an operational water depth of 100-200 mm, are densely vegetated and are sequentially arranged to maximise the distance over which influent must travel. The maintaining of this water depth is crucial for continuous, efficient water management and treatment of the pollutant loading to be managed.

Table 2: ICW Cell Areas

Cell Number	Cell Area (m^2)
Cell 1	487
Cell 2	5399
Cell 3	4418
Cell 4	2585
Total treatment area	**12889**

The final discharge from the ICW/Cell 4 is to a new manhole in the existing FE pipeline, upstream of FE MH3 and within the Staplefield WTW. (See drawing 752214-UAX-ZZ-ZZ-DR-EN-00003). Discharge from the ICW will be sampled in line with the Environment Agency (EA) licence consent conditions and with the ICW Operating Techniques Agreement (OTA).

Section 3: Treatment Processes & ICW Objectives

The ICW design endeavours to optimise natural biological, chemical and physical processes of pollutant removal in a way that is compatible with the local aquatic and terrestrial communities and in a way that does not incur negative impact on adjacent aquatic and terrestrial ecosystems.

The ICW concept effectively integrates the following main objectives:

- The containment and treatment of influents within emergent vegetated areas using, local soil-material;
- The aesthetic placement of the containing wetland structure into the local landscape towards enhancing a site's ancillary values; and
- Enhanced habitat diversity and nature management.

Further details of the ICW system are provided in ICW Design Report and drawings.

Figure 1: Staplefield WTW, ICW layout.

Section 4: Loss Control

4.1: Plant Failure Detection & Procedure

A regular inspection of the ICW is required to include a general walk around and check on items as listed in Section 5, below.

Should any failure of the ICW system occur or any failure upstream of the ICW, regular checks will identify any failure or problem. This will allow for the appropriate steps to be undertaken to determine whether the ICW system requires full system or section (cell) to be isolated. This can be carried out by closing pipework and stopping any flows from exiting the system. Advice must be sought in such circumstances from the ICW designer. Flows can bypass the ICW by turning the flows off to the pumpstation, directing flows to the existing FE pipeline (valve control at the pump station) should it be required for any short period of time. This change in flow must be informed and confirmed to the treatment manger and environmental process scientist.

4.2: Accidental Discharges – Emergency Response Procedure

Regular maintenance on the ICW will ensure that any accidental discharges, should they ever occur to the ICW and from the ICW, will be identified and the appropriate action taken to correct the problem. Due to the residence time within the ICW, discharges of accidental or high concentrated waters to the ICW are unlikely due to the nature and source (in the first instance) and are unlikely to continue from the first cell and accidentally discharge (within a short period of time, subject to loading rate) provided regular checks are maintained.

As the ICW is segmented into 4 No. cells, the occurrence of any spillages and discharges to the ICW will allow for any affected area/cell to be isolated. In the event of unsatisfactory discharge from the ICW, the discharge pipe can be closed off until the issue is resolved.

Section 5: Maintenance & Operations Schedule

5.1: Daily Maintenance

5.1.1: Flow Monitoring

Flows will be monitored at the new pumping station and shall record daily flows into the ICW. Discharge flows will be monitored through the existing flow meter within the existing FE line.

Flow equipment should be checked daily to ensure it is operating correctly and in line with visual observations. Any failures in flow monitoring equipment shall be logged and fixed as soon as possible.

Visual flows into the ICW and between the cells and discharge from cell 4 shall also be recorded.

5.1.2: Inspection of Discharge

The general appearance of the final effluent in Cell 4 should be noted, paying particular attention to water colour. If the final discharge from the ICW appears to be heavily discoloured or polluted, then the outlet pipe should be isolated immediately by turning up the adjustable pipe preventing unsatisfactory discharge. Any closing of the outlet should not occur for more than 24hrs. If a discharge cannot occur water is to be recirculated or removed (as a last resort) off site. Should this occur, daily sampling of the discharge may be required for a period of time.

Any closure of pipes will result in water levels rising - this will generate an adverse impact on treatment and functionality of the ICW if allowed to continue for more than 24hrs. The treatment manager should be informed of the situation to obtain advice on the next course of action.

5.1.3: Visual Monitoring of Influent

The general appearance of the influent into the ICW site should be noted. Reference should be made to weather conditions and operations on site.

Typical appearance of influent to the ICW is that of a cloudy off-white colour, with suspended material/solids within the water stream. If there are obvious differences, such as visually noticeable oils, strong opaque colour (of any kind), particularly strong and noxious odour, then a record with a date and time stamp must be made.

5.1.4: Weather Station Monitoring

Weather station monitoring, temperature, rainfall and wind direction shall record the daily data and stored on an online server. The condition of the weather station equipment and recording of data shall be checked regularly. If the weather station is not functioning, then weather data shall be recorded from the neatest available weather station.

5.2: Weekly Maintenance

Weekly inspections of the Integrated Constructed Wetland should be carried out to assess the following;

5.2.1: Assess and Log Water Levels in Cells 1-4

The operator shall undertake a visual inspection of the water levels weekly to ensure that water depths are no greater than 200 mm. Under normal operating conditions water levels should be maintained at 100-150 mm. Water levels can be managed using the adjustable pipes on the outlet points. Water levels in the first cell should be no greater than 100 mm to maximise treatment.

- Cell 1 – 100 mm
- Cell 2 – 150-200 mm
- Cell 3 – 150-200 mm
- Cell 4 – 150-200 mm

Water levels will fluctuate depending on weather conditions, with water levels increasing during prolonged wet weather and reduced water levels during dry periods.

A water level gauge is located at the outlet of each ICW cell. Water levels will be recorded at these monitoring points. These gauges are to be kept clear of vegetation, so that the gauge can be clearly read.

NOTE: Any adjustments to pipes must be done gradually to avoid any large flows/flushes from one cell to the next, as this can result in complications. Guidance must be sought from VESI Environmental Ltd on water level management and adjustments, if required to be adjusted.

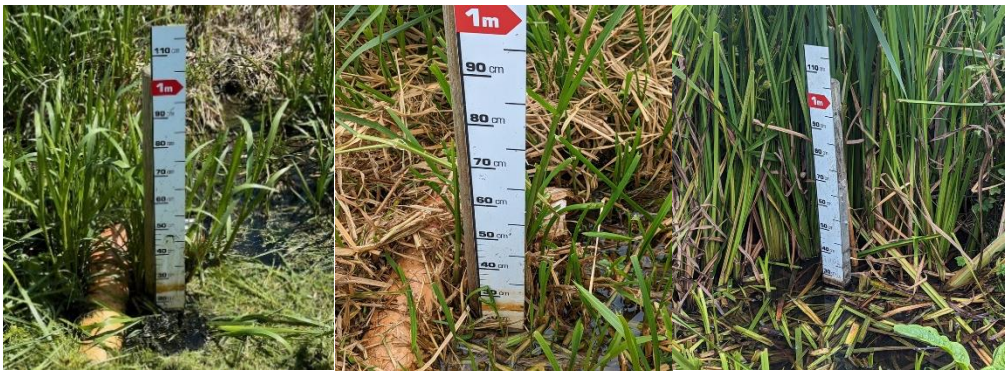

Figure 2: Example water level gauges at outlet.

5.2.2: Inspection of Inlet & Outlet Pipes

All inlet and outlet pipes within the ICW system should be visually inspected for blockages, sediment accumulation, vegetation growth or debris around/in the inlet/outlet pipes. Blockages will affect the flows through the system and weekly checks will help to reduce issues relating to flows.

The operator should maintain access to all inlet and outlet points by keeping vegetation within the cells and on the embankments clear of vegetation and ensure gravel access ramps on the embankments are clear of vegetation.

A photo of each sampling point location is to be taken as required for problem investigation and resolution. Note if flow/no-flow is observed.

Figure 3: Example of blocked and overgrown pipe and cleared pipe.

The overgrowth of vegetation will limit access to the inlet and outlet pipes for maintenance and monitoring and thus any maintenance required should be noted so that appropriate actions can be carried out. It is recommended that overgrowing vegetation be pulled aside from the inlet/outlet pipe as needed. Cutting the vegetation will encourage denser growth of vegetation and require the removal of cut material.

Any vegetation management and clearance shall not be undertaken on water sampling days or days leading up to sampling.

Figure 4: Before and after image of cleared vegetation around outlet pipe.

5.2.3: Assessment of Wetland Vegetation

The ICW cells have a dense cover of emergent/wetland plant species. The plant species planted within the cells will multiply and diversify as the ICW develops over time with additional native plant species colonising within the ICW. The main ICW plant species are included in Appendix A and the complete list of planted species are available in Drawing 752214-UAX-ZZ-ZZ-DR-EN-00007 Landscape Plan.

Figure 5: Dense vegetation cover (left summer and right winter).

General plant behaviour:

- The main growing season is May to September. New growth begins in March, with species such as Iris pseudacorus being one of the first to emerge. The exact emergence of new growth in a given season will depend on the temperature. Milder springs are associated with earlier growth and cooler springs associated with later growth (April-May).
- All plants begin to brown between September-October, with deciduous plants losing all foliage and foliage from some of the plant species falling below the water (such as *Iris*, *Alisma* and *Ranunculus*). The foliage of the main plant deciduous species, such as *Typha*, will remain above water until the spring.
- Some species are semi-evergreen (such as *Glyceria maxima*) whereby the level of die back will depend on the winter conditions. Colder winters cause more die back than milder winters while evergreen plants such as Carex and Juncus effusus will brown slightly and will reduce in height during the winter.

See appendix A for list of wetland plant species.

5.2.4: Vegetation Monitoring

Any differences in the composition or cover of the plants should be noted and recorded weekly.

Any significant/rapid changes in the colour of the vegetation or die off should be monitored. Any increased establishment of weeds/grass should be noted. The vegetation throughout the treatment area of the ICW will respond quickly to excess nutrient loading. For example, should a “path” of plant die-off be noted, the cell should be isolated, and the relevant bodies contacted immediately.

5.2.5: Algae

Any growth of algae should be monitored, which will occur in any open water areas (even small areas) generally between April-September. This is not necessarily an indication of poor water conditions, rather a condition of the open nature of the ICW system. Photos of algae growth/cover to be taken as required if issue arises.

Should algae be present, barley bales shall be positioned around the cell outlet areas to ensure a clean representative water sample is retrieved. On-site supplies shall be ensured for the initial years of operations, with local supply of bales available as needed thereafter.

5.2.6: Invasive Plant Species

The operators and maintenance personnel should be familiar on how to identify invasive species, should they occur on the site (such as Japanese Knotweed). Japanese Knotweed is highly invasive and thrives on disturbance and specific measures should be undertaken to manage such a species.

There are no recorded invasive species on site, but an inspection of the site will identify if any establish overtime.

Should works be required to remove any invasive plants it will be carried out by an experienced contractor under specific code of practice and a specific method statement prepared and agreed.

5.2.7: Litter

Litter collection forms part of the maintenance works. As the source of water to the ICW is from the existing WTW, it is expected that little to no litter and debris will be washed down into the ICW system. Additionally, while the proposed ICW system will not be open to the public, wind-blown litter and litter from maintenance activities can cause issues. This litter may cause blockages and hinder ICW performance as well as being unsightly.

5.3: Monthly Maintenance

5.3.1: Bi-monthly Monitoring of ICW Influent and Discharge Water Quality

A sample of the surface water into the ICW and discharging shall be taken by suitably qualified personnel as per the discharge consent and OTA and analysed for at least the following parameters. The ICW facilitates grab sampling at the inlet points of each of the Cells. Monitoring of additional parameters may also be considered as part of the operations and maintenance.

Table 3: Operational monitoring parameters

Parameter	Unit	Discharge consent limits
Biological Oxygen Demand (BOD)	mg/l O_2	80
Suspended Solids	mg/l	120
Iron	mg/l	4
Phosphorus	mg/l P	0.5

5.3.2: Frequency and Sampling Location

The sampling locations for the ICW include:

- Inlet point to Cell 1
- Mid ICW process: Inlet to Cell 3
- Discharge: FE point

The frequency of the OTA sampling at the above sampling points is fortnightly (24 per year) for the first 3 years.

Due to the nature of the ICW system there may be periods when there is very low or no flow. These monitoring times should be logged as undertaken, with result 'No flow/No sample'.

Surface water samples should be taken from the water flowing through the pipe and not directly from the wetland cell.

Pipes should be checked before sampling and cleaned for any accumulation of sediment or algae that might build up in the pipe.

Appropriate PPE and equipment must be used when obtaining samples.

Should the sampling location deem unsuitable when samples are to be taken, notify the site manager. Any poor conditions of the site surrounding, or equipment may cause negative impact on samples, leading to 'failures' and mis-information.

5.3.3: Inspection of Cell Embankments

The operator shall undertake a visual inspection of the sloping embankments on either side of the cell (internal and external) to check for any sign of leakage, slippage or distortion. Any defects noted should be recorded and the necessary action required should be undertaken immediately. Any leakage, slippage or distortion will require a track machine or digger to be brought in on site to amend any defects. All works must be supervised by appropriate personnel.

Notice should also be given to any slippages or overland flows from surrounding areas.

5.3.4: Safety maintenance

An assessment of the security features shall be conducted that they are in good functioning order. This included locks on access gates, manhole cover locks, and site fencing.

5.3.5: Flood Mitigation area

Visual checks will be carried out on the Flood mitigation area (FMA) and any maintenance works carried out as required. These checks include:

- Visual sediment/silt level assessment. Levels are to be recorded and logged for review. Any maintenance works required for sediment/silt removal will be undertaken following review and method statement.
- Log and record water levels in FMA (water level gauge).
- Inspect water level gauge to ensure that it is clearly visible for water level monitoring.
- Visual check on vegetation within the FMA for differences in the composition or cover of the plants should be noted and recorded. Any significant/rapid changes in the colour of the vegetation or die off should be monitored. Any increased establishment of weeds/grass should be noted.
- Check outlet pipes to ensure there are no blockages or obstruction hindering flows from the FMA to the river.
- Check concrete headwall at the outfalls to the river shall be checked for any damage and debris.
- Note any further observations in the area including presence of wildlife.

5.4: Quarterly Maintenance

5.4.1: Quarterly Review of Maintenance and Monitoring Records

A site visit should be conducted by design personnel to give a visual inspection of the conditions and performance of the ICW and a review of the results from the maintenance and monitoring carried out on the ICW. The review of monitoring results will assess the general performance and health of the wetland and provide recommendations on actions for improvement as required.

The operation and maintenance manual must be updated should there be any changes in the number of samples taken or the frequency of sampling.

Data and information shall be shared in advance of site visits for review prior to scheduled visits.

5.4.2: Grass Verges

The grass verges on site should be maintained to a reasonable manner. The main growing season for these areas will depend on weather and should be assessed quarterly. Optimal growing seasons will be from early May to late September where assessment of these areas should be increased to a monthly basis and maintained accordingly. Exercise extreme care when working in close proximity to

trees to prevent damage to stems/trunks. Grass verges shall be cut/mowed and mulched and left in situ.

Figure 6: Road and grass verge maintenance.

5.4.3: Access Road Maintenance

All access roads are finished with gravel. Over time, these roads will have vegetation establish. Gravel paths should be monitored for any grass growth and if necessary, cut/mowed. The verge of the roadways should be cut at least twice annually 0.3-0.5m from the edge of the road. Care should be given where trees /shrubs are located so that they are not accidentally cut.

Any disturbance or alteration to the path/roads must be reviewed and any works undertaken as required.

NOTE: Over time, some of the above-mentioned quarterly maintenance procedures may be moved to bi-annual checks if it is deemed appropriate to do so. This will be checked as part of the quarterly/annual review.

5.5: Bi-annual Maintenance (Every 6 Months)

5.5.1: Visual Assessment and Maintenance of Trees, shrubs and Hedging

Trees, shrubs and hedging should be checked (seasonally), and any maintenance works should be undertaken by a landscaping contractor. Please refer to the Landscape Management Plan.

5.5.2: Willow and unwanted plant species

The presence of willow and other unwanted plant species that will naturally self-establish within the treatment cells and cell embankments should be noted and maintenance carried out to remove them as required, under good horticultural practice. Willow roots can cause damage of the cell base seal and thus may cause exfiltration. Willows and trees if establishing adjacent to the treatment cell area will cause shading over the wetland plants and reduce the efficiency of the ICW. Works should be carried out by licenced contractor and checked by operations personnel. Any works carried out will follow agreed specific method statement ahead of works.

Figure 7: Example of Willow to be removed from cell embankment.

5.5.3: Access gates and fencing

A new access gate is located to the east of the site off the public road (B2114) and new fencing along the eastern site boundary. Access gates and fencing are to be inspected for integrity and damage by operations personnel. Any maintenance works required should be carried out by a landscape contractor.

Figure 8: Example fencing and gates.

5.5.4: Signage

Any signage throughout the ICW site (e.g. Cell 1 inlet) are to be kept in clear visual condition for operational assistance.

5.5.5: Manhole covers.

Manhole covers should be checked for visibility and functionality. This is to be carried out to ensure they are functioning correctly if access is required.

5.5.6: Outlet pipe adjustable elbows

Each treatment cell outlet pipe is fitted with an adjustable elbow for water level management.

The functionality of these elbows will be checked biannually to ensure that they can be adjusted if required. This will require manually moving the elbow bends on the outlet pipe. It is important to ensure that once checked the position of the elbow is returned to the required angle to maintain required water level depth.

5.6: Annual Maintenance

5.6.1: Sediment Assessment

Over time there will be an accumulation of sediments in the wetland, this however will be confined initially to Cell 1. The sediment build-up in this cell will be comprised of the settlement of solids from the influent and the accumulation of dead plant matter.

The depth of the sediment should be investigated in all cells on an annual basis and recorded. The depth of the sediment should be investigated prior to removal to ensure that the compacted subsoil layer/clay liner beneath the sediment is not disturbed, ideally the material that lies 0.1 m above this layer should be undisturbed.

To undertake any desludging a cell will need to be bypassed. This will be undertaken by over pumping or by connecting the inlet to the outlet (with temporary pipe) and feeding this to the next cell. The management and disposal of the sediment will need to be confirmed in advance of desludging to ensure this is managed and disposed of under best practice and limit the volume of material by undertaking works in summer and dewatering the sludge as much as possible. A site-specific method statement will be submitted by contractor carrying out the sediment removal but may consist of a long reach excavator within the cell and dumper along the access path.

Once the sediment is removed, the requirement of topsoil for the re-planting and sealing of the cell should be assessed. Once the first cell has been cleaned out, subsequent cells are cleaned by diverting the effluent away from the cell to the next one.

Figure 9: Wetland cell after de-sludging, addition of new topsoil and replanting.

The sediment will have an accumulation of nutrients due to the nature of the wastewater being treated through the ICW. An assessment of the nutrient content will determine the appropriate application/management of the material. The removed sediment may need to be removed by a licensed contractor to a licensed facility or ideally can be used as a fertiliser/compost as land application under nutrient management plans. The removed material (removed sediment) will be high in phosphorus, nitrogen and carbon, as well as other nutrients. This material can be stockpiled in a bunded area and left dewater for a short period of time. Subject to appropriate testing and granting of statutory consents the organic material can be spread on farmland, acting as a sustainably sourced fertilizer.

5.6.2: Grassed and Wildlife Areas

The upper section areas along the inner cell embankment are to be mowed on an annual basis. This should ideally be carried out between September-November. Areas should be cut to a minimum height of 100mm. Remove all litter, rubbish and other debris from the area before cutting. Removal of all cuttings can be stacked in outer embankment areas, so that it can be used as habitat piles and increase the diversity of the wildflowers.

Section 6: Annual Reporting

There should be an annual report on the performance and of the operations and maintenance to assess performance and identify if any works are required. A copy to be issued to the designer to allow for a detailed assessment and provision of recommendations, if required.

The annual assessment shall include details such as:

- List and details of operations carried out during the year;
- All logs such as those included in the operation and maintenance manual;
- Any changes or upgrades that have occurred during the year;
- Data collected during the year and any comments; and
- Recommendations

Appendix A: Staplefield ICW Plant Species

Treatment and Marginal Plants Commonly Used in an ICW	
Common Name: Reed Sweet Grass	**Botanical Name: *Glyceria maxima***
 Winter	 Summer
Common Name: Lesser Pond-sedge	**Botanical Name: *Carex acutiformis***
 Spring	 Summer

Common Name: Yellow Flag Iris	Botanical Name: *Iris pseudacorus*
Note: No visable winter growth as this species dies back completely during winter months.	 Summer
Common Name: Lesser Reed-mace	**Botanical Name: *Typha angustafolia***
 Winter	 Summer
Common Name: Purple Loosestrife	**Botanical Name: *Lythrum salicaria***
Note: This species dies back during the winter, with only the woody brown vertical stems remaining.	 Summer

Common Name: Water Mint	Botanical Name: *Mentha aquatica*
Note: No visable winter growth as this species dies back completely during winter months.	 Summer

Invasive Species
Common Name: Himalayan Balsam **Botanical Name: *Impatiens glandulifera***

Common Name: Japanese Knotweed **Botanical Name: *Fallopia japonica***

Common Name: Giant Hogweed **Botanical Name: *Heracleum mantegazzianum***


Common Name: Parrot's Feather **Botanical Name: *Myriophyllum aquaticum***

Common Name: New Zealand Pigmyweed **Botanical Name: *Crassula helmsii***