Decentralized Wastewater Management for Adaptation
to Climate Change in Jordan (ACC Project)
P.O. Box 92 62 38, Amman 11190, Jordan
T: +962 6 5682915
E: jens.goetzenberger@giz.de , hesham.asalamat@giz.de

September 2019

Photo credits
BORDA

Authors
Anas Abu Khalaf/ BORDA, Sophia von Dobschütz/ BORDA

Editors
Georg Schaumberger/ BORDA, Hesham Asalamat/ GIZ

Coordinator
Jens Götzenberger/ GIZ

On behalf of the
German Federal Ministry for Economic Cooperation and Development (BMZ)
1.0 Introduction .......................................................................................................................... 3
1.1 Why an O&M Manual is required? ..................................................................................... 3
1.2 How to use this manual? ..................................................................................................... 4
2.0 DWWT/PP description ......................................................................................................... 5
2.1 Process Design ................................................................................................................... 6
3.0 Modules Flow Process ......................................................................................................... 7
3.1 Biogas Digester .................................................................................................................. 7
3.2 Anaerobic Baffled Reactor ABR ....................................................................................... 8
3.3 Floating Valve .................................................................................................................. 9
3.4 Vertical Flow Constructed Wetland (VFCW) ................................................................. 10
3.5 Solar Pump ....................................................................................................................... 11
3.6 Irrigation network system ............................................................................................... 11
4.0 System startup procedure ................................................................................................. 13
4.1 Treatment Modules Startup ............................................................................................ 13
4.2 Irrigation Network Controller programming .................................................................... 15
5.0 Tasks to be performed ...................................................................................................... 19
5.1 Biogas digester tasks ...................................................................................................... 20
  Task 1: Check for grease and scum accumulation ............................................................... 20
  Task 2: Cleaning biogas stove burner .................................................................................. 21
  Task 3: Check for biogas leakage at biogas supply pipeline ............................................. 22
  Task 4: Desludging the biogas digester dome .................................................................... 23
5.2 Anaerobic Baffled Reactor tasks ..................................................................................... 24
  Task 5: Check of free wastewater flow ............................................................................. 24
  Task 6: Stir the scum in the anaerobic reactors (Biogas digester + ABR) ......................... 25
  Task 7: Remove the scum in the ABR chambers ............................................................... 26
  Task 8: Check the sludge level of the biogas digester and ABR ........................................ 27
  Task 9: Desludging ABR chambers ................................................................................... 28
5.3 Floating valve tasks ........................................................................................................ 29
  Task 10: Cleaning the floating valve chamber and pipes .................................................. 29
  Task 11: Replacing the flexible hoses in the floating valve chamber ............................... 30
5.4 Solar pump tasks ............................................................................................................. 31
  Task 12: Cleaning the solar pump chambers ...................................................................... 31
  Task 13: Check the function of the solar pump ................................................................. 32
5.5 Vertical Flow Constructed Wetland tasks ...................................................................... 33
  Task 14: Check and adjust the pile up pipe level in the VFCW ........................................ 33
  Task 15: Check the colour of the outflow ......................................................................... 35
  Task 16: Check the surface of the reed basins (stagnant water) ....................................... 36
  Task 17: Check the colour of the reed plants (Green or yellow) ....................................... 37
  Task 18: Reeds harvesting and removal of dead leaves .................................................... 38
  Task 19: Check and clean VFCW distribution system (blockage of holes) .................... 39
  Task 20: Checking and cleaning of VFCW drainage pipes ............................................... 40
5.6 Valves adjusting tasks .................................................................................................... 41
  Task 21: Adjusting of recirculation valve (no.2) ................................................................. 41
  Task 22: Open/Close valve no.1 ....................................................................................... 42
  Task 23: Cleaning of the pipe between the Irrigation tank and the DWWT/PP .................. 43
  Task 24: Clean the existent solar panels with the treated wastewater ............................ 44
5.7 Irrigation network tasks .................................................................................................. 45
  Task 25: Flushing the Irrigation system ........................................................................... 45
  Task 26: Controller Quick Check ..................................................................................... 46
  Task 27: Setting and modifying the irrigation schedule .................................................. 47
  Task 28: Cleaning of the filtering medium ........................................................................ 48
  Task 29: Cleaning the Solenoid Valve .............................................................................. 49
  Task 30: Cleaning of the bubblers .................................................................................... 50
6.0 Emergency overflow cases .............................................................................................. 51
7.0 Troubleshooting .............................................................................................................. 53
8.0 Quality Monitoring ......................................................................................................... 59
9.0 Don’ts List ....................................................................................................................... 60
10.0 Activity and Time Checklists / Maintenance plan ...................................................... 61
  10.1 Overview of Tasks ...................................................................................................... 64
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABR</td>
<td>Anaerobic Baffled Reactor</td>
</tr>
<tr>
<td>ACC</td>
<td>Decentralized Wastewater Management for Adaptation to Climate Change in Jordan</td>
</tr>
<tr>
<td>BORDA</td>
<td>Bremen Overseas Research and Development Association</td>
</tr>
<tr>
<td>DWWM</td>
<td>Decentralized Wastewater Management</td>
</tr>
<tr>
<td>DWWTP</td>
<td>Decentralized Wastewater Treatment Plant</td>
</tr>
<tr>
<td>EMFM</td>
<td>Electro-Magnetic Flowmeter</td>
</tr>
<tr>
<td>ETO</td>
<td>Reference Evapotranspiration</td>
</tr>
<tr>
<td>GIZ</td>
<td>Deutsche Gesellschaft für Internationale Zusammenarbeit</td>
</tr>
<tr>
<td>HRT</td>
<td>Hydraulic Retention Time</td>
</tr>
<tr>
<td>ME</td>
<td>Middle East</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>Operation and Maintenance</td>
</tr>
<tr>
<td>RSCN</td>
<td>Royal Society for the Conservation of Nature</td>
</tr>
<tr>
<td>TSE</td>
<td>Treated Sewage Effluent</td>
</tr>
<tr>
<td>VFCW</td>
<td>Vertical-Flow Constructed Wetland</td>
</tr>
<tr>
<td>WW</td>
<td>Wastewater</td>
</tr>
<tr>
<td>ELCB</td>
<td>Earth-leakage circuit breaker</td>
</tr>
</tbody>
</table>
List of Figures

Figure 1: Conceptual drawing of a fixed-dome (left side) and flow principle of the digester .......... 7
Figure 2: ABR conceptual design and its flow principle ................................................................. 8
Figure 3: Float-valve chamber AutoCAD design ........................................................................... 9
Figure 4: VFCW 3D design model ................................................................................................ 10
Figure 5: Solar pump elements identification .................................................................................. 12
Figure 6: Schematic Diagram of Bubbler Irrigation System .......................................................... 12
Figure 7: Setting date and time ..................................................................................................... 15
Figure 8: Setting program starting time ........................................................................................ 15
Figure 9: Setting station run times ................................................................................................ 16
Figure 10: Setting days to water .................................................................................................. 16
Figure 11: Treatment system layout (top view) shows the valves location ...................................... 41
Figure 12: Irrigation tank drawing shows the location of valve no.1 ............................................. 42
Figure 13: Drawing shows the recirculation pipe ....................................................................... 43
Figure 14: AutoCAD drawing that shows the layout of the Ecolodge and the treatment system .... 51

List of Tables

Table 1: Illustrated daily run time at different growing seasons .................................................. 17
Table 2: Illustrate the accompanying run time of irrigation frequency at different growing seasons .... 17
Table 3: Troubleshooting activities for all treatment modules ....................................................... 53
Table 4: Sampling frequency for (small population) treatment plants as per JS 893/2006 ........... 59
Table 5: Tasks and frequency of each module ............................................................................. 61
Table 6: EMFM readings table ..................................................................................................... 62
Table 7: Biogas digester feeding list ............................................................................................ 63
Table 8: Maintenance tools list ................................................................................................... 65
The GIZ Project “Decentralised Wastewater Management for Adaptation to Climate Change in Jordan” (ACC-Project) is supporting partner organizations in decentralized wastewater management (DWWM) as a measure for adaptation to climate change. The project aims to promote robust, easy-to-build, easy-to-operate, proven, flexible and sustainable wastewater treatment technologies. Within the scope of the ACC-Project, an integrated concept for DWWM is implemented for demonstration purposes at Feynan Ecolodge located in Dana Biosphere Reserve south of Jordan.

The Operation and Maintenance (O&M) Manual was jointly developed by BORDA and GIZ and is supposed to support and facilitate day-to-day operational tasks to provide smooth functioning of the treatment system at Feynan Ecolodge.

1.0 Introduction

1.1 Why an O&M Manual is required?

- Steady functioning of the System
- Continuous high Treatment Performance
- Longer Lifetime System Expectancy
- Social Benefits: Prevent Possible Complaints on Malfunctioning Effects
1.2 How to use this manual?

This manual is intended to be used by the operator of the Decentralised Wastewater Treatment Plant (DWWTP). The tasks are simple and require only basic training. Nevertheless, regular Operation and preventative maintenance is mandatory and critical to ensure continuing high performance of the treatment system.

Each operational task is addressed in terms of where and when it will occur, why it is needed and how the task should be performed.

The given guidelines shall support the operator to keep the system working efficiently. However, changes in quantity or quality of the WW influent or drastic changes in the climate may also affect the DWWTP’s performance, mainly by extending or shortening the intervals between the operational tasks.
2.0 DWWTP description

- **Vertical Flow Constructed Wetland (VFCW)**
  A VFCW is a planted filter bed for tertiary treatment of wastewater. The water flows vertically down through the filter matrix to the bottom of the basin. The water is treated by a combination of biological and physical processes.

- **Biogas Digester**
  A small-scale biogas reactor serves as a primary treatment technology to remove settleable solids by sedimentation and to allow them to sink to the bottom, while constituents lighter than water float to the surface. The anaerobic process produces biogas that can be used for cooking.

- **Floating Valve**
  The purpose of the floating valve is to distribute the pre-treated wastewater in regular batches to the VFCW without using electricity.

- **Anaerobic Baffled Reactor (ABR)**
  ABR is an improved septic tank and a secondary treatment module composed of a series of chambers in which grey and black water is forced via down-shaft pipes through sludge layers that are accumulated at the chambers’ bottoms.
2.1 Process Design
3.0 Modules Flow Process

3.1 Biogas Digester

Biogas digesters are used as primary treatment modules instead of regular settlers in order to use the generated biogas instead of releasing it into the environment.

![Figure 1: Conceptual drawing of a fixed-dome (left side) and flow principle of the digester](image)

The following elements are to be distinguished for the infrastructure:

1. **Inlet:** Part of the system where the organic material is fed into the digester in addition to the WW influent that derives from the toilets and the kitchen.

2. **Digester:** (Underground) part of the system where the organic material (WW mixed with the organic solid waste) is exposed to methane-producing bacteria under anaerobic conditions.

3. **Outlet:** Part of the system where the digested organic material is leaving the digester. During the digestion process methane gas is generated in the digester and due to the rising pressure in the digester the pre-treated WW is pushed out of the digester through the outlet.

4. **Expansion chamber:** Part of the system where the pre-treated WW is replaced by gas inside the digester is stored, which also maintains the pressure to push the gas out of the digester.

The following termini relate to the inputs and outputs of the digestion process:

- **Slurry:** The material fed into the digester (Wastewater mixed with organic solid waste).
- **Sludge:** The material settling at the bottom of the digester and in the expansion chamber.
- **Swimming layer:** Material forming and accumulating in the digester on top of the slurry.
- **Scum:** Floating layer at the top which contain dirt and gas bubbles.

The inflow (in the case of Feynan blackwater originating from sewer pipes and organic solid waste) is totally mixed at the inlet manhole before getting in contact with the old substrate and the sludge retaining in the digester. Organic and inorganic settleable solids sediment to the bottom forming a sludge layer that must be removed after some years.

Besides the mechanical removal of solids by sedimentation, anaerobic bacteria degrade organic pollutants and the sludge is digested anaerobically. During this process biogas is generated which accumulates in the top of the dome. The accumulating gas pushes the water from the digester into the expansion chamber. If gas is released from the dome through the gas valve, the water level raises again in the digester.
3.2 Anaerobic Baffled Reactor ABR

The ABR consists of a series of chambers, in which the WW flows upstream. In Feynan case the ABR consists of 5 equal chambers in series. As mentioned, pipes direct the WW stream between the individual chambers from top to bottom. At the bottom of each chamber, active sludge is retained. During inflow into the chamber, WW is forced to pass through sludge blanked whereby it is inoculated with the WW organisms, which decompose the contained pollutants. The increased contact time with the active biomass (sludge) results in improved treatment. In the first chamber degradable substances are broken down easily while in the following chambers, decomposition of less degradable substances takes place. The first chamber contains the most sludge height compared to the following chambers.
3.3 Floating Valve

From the outlet of the ABR, the wastewater is pumped into the floating valve chamber using a pump run by solar energy. The floating valve chamber is filled constantly with wastewater until a certain limit (2 m³). At the maximum water level, the floating valve is automatically pushed through the stop limit as well as through its own weight down. As a result, the amount of wastewater between maximum and minimum water level in the chamber is pushed in one batch into the distribution chamber. From the distribution chamber, the wastewater flows in one batch through two equal sloped pipes fixed at the bottom of the chamber into the two VFCW beds.

Figure 3: Float-valve chamber AutoCAD design
3.4 Vertical Flow Constructed Wetland (VFCW)

The VFCW is a natural treatment system or eco-technology referred to as ‘constructed wetlands’. The VFCW serves the purpose of treating and recycling wastewater in a sustainable way through utilizing natural microbial processes to transform the pollution in the water into gases, minerals and humus. Once established it is a very stable habitat which does most of the processes without any required input from the operator. Even high fluctuation in the inflow in relation to volume and concentration show only little or no influence on the process and performance of the system. The hot climate in the ME and the nutrient load in the wastewater cause a rapid growth of the reed plants, which enhances the treatment process (strong root systems, higher biological processes and greater supply of oxygen) but requires also harvesting of the accumulated biomass on the filter surface.

After the pre-treated wastewater is flushed from the floating valve to the VFCW basins, it is distributed on the VFCW basin surface through perforated distribution pipes. The wastewater percolates then vertically through the filter layer to the bottom drain pipes. This leads to a forced dewatering, drying, aeration and mineralization of the organic solids. The bottom drains are connected to the two header drains which will end in the drainage control manhole.
3.5 Solar Pump

The wastewater treatment system in Feynan runs by the automatic operation of the floating valve and on solar energy (solar pumps 1 and 2). The solar pumps operate once solar energy is available (sunlight) and enough water is in the pump chambers.

The solar pumping system includes several devices: pump, controller unit, switch box, charge controller, pressure switch and all required accessories and equipment to regulate the flow.

There are two pumps installed in the system:
Solar pump 1:
Function: the outflow of the ABR flows on gravity into solar pump 1st chamber. The solar pump is feeding continuously the effluent of the ABR into the floating valve shaft chamber while sunlight is available.
Purpose: to lift the wastewater into another treatment module which is the VFCW via the floating valve.
Solar pump 2:
Functions: the treated sewage effluent (TSE) as an outflow from the VFCWs, is collected through the drainage network of the VFCW basins and flows into an underground pumping station by gravity. From this solar pump 2nd chamber the TSE is pumped by solar pump 2 to the irrigation storage tank which is located in the mountains in the west direction of the lodge.

By opening the manual valves after the irrigation tank to the inflow of the ABR, up to 100% re-circulation can be achieved. For re-circulation purpose, the TSE flows by gravity from the irrigation storage tank through a pipe back to the mixing manhole up-flow the ABR.

Purpose:
• Re-circulate the WW from the VFCW outlet to the ABR inlet via the irrigation storage tank (pumped from solar pump 2 to the irrigation tank; then running on gravity to the inlet of the ABR) in order to achieve further nitrogen removal in the ABR.
• Pump the treated WW to the irrigation storage tank at a higher point in order to reuse the treated wastewater for the irrigation of the native trees, and for cleaning of the lodge’s solar panels in order to maintain their efficiency. The TSE is to be taken from the irrigation storage tank via a valve.

3.6 Irrigation network system

The irrigation network system is responsible to distribute the TSE from the irrigation storage tank via the network by gravity to irrigate the targeted native trees which is controlled by a programmed automatic controller. The network covers the whole area surrounding the ecolodge with an average water demand of 3 m³/day for irrigation.
Figure 5: Solar pump elements identification

<table>
<thead>
<tr>
<th>Pos.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SQF pump</td>
</tr>
<tr>
<td>2</td>
<td>Submersible drop cable</td>
</tr>
<tr>
<td>3</td>
<td>Cable clips Not Included in offer</td>
</tr>
<tr>
<td>4</td>
<td>Straining wire Not Included in offer</td>
</tr>
<tr>
<td>5</td>
<td>Wire clamps Not Included in offer</td>
</tr>
<tr>
<td>6</td>
<td>Solar panels Not Included in offer</td>
</tr>
<tr>
<td>7</td>
<td>Support structure Not Included in offer</td>
</tr>
<tr>
<td>11</td>
<td>CO 903 SQFlex control unit</td>
</tr>
<tr>
<td>12</td>
<td>IO 50 SQFlex switch box</td>
</tr>
<tr>
<td>16</td>
<td>Charge controller</td>
</tr>
<tr>
<td>17</td>
<td>Batteries Not Included in offer</td>
</tr>
<tr>
<td>18</td>
<td>Pressure switch</td>
</tr>
</tbody>
</table>

Figure 6: Schematic Diagram of Bubbler Irrigation System
4.0 System start-up procedure

This chapter explains how to run the system for the first time. This procedure is considered as one of the most critical procedures that relate to the DWWTP, due to the sensitivity of the anaerobic processes inside the treatment units (i.e. Biogas digester and ABR). In addition, construction faults, pipe leakages and gas/water tightness of the units can be explored during the commissioning phase.

4.1 Treatment Modules Startup

Biogas Digester:

The biogas digester receives blackwater from the ecolodge’s toilets, kitchen wastewater, food waste, as well as papers and cardboards after shredding. The methane gas production needs normally between 25-40 days to be generated. Hence, to reduce the time needed to initiate gas production in Feynan, sludge that is stored in the existing septic tank is pumped into the digester. This inoculation with active biomass enhances the bacterial digestion environment which will speed up the gas production.

ABR:

A newly constructed and empty ABR requires a start-up period of several months to reach its full treatment capacity since the slow growing anaerobic biomass first needs to be established in the reactor. To reduce start-up time, the ABR shall be inoculated with anaerobic bacteria, e.g., by adding sludge from the existing septic tank or adding fresh cow or animals’ dung. The added stock of active bacteria will multiply and adapt to the incoming WW. In principle, if none were possible to be added, then it is advantageous to start with a quarter of the daily flow and then slightly increase loading rates over three months, allowing the bacteria to multiply before suspended solids are washed out. Because of the delicate ecology inside the reactor, care should be taken not to discharge harsh chemicals into the ABR especially during the commissioning phase.

VFCW:

The VFCW needs enough water to avoid loss of reed plants after plantation phase. For that reason, a constant water level (5 cm below filter surface) must be maintained in the basins during the first weeks (normally 6 weeks) of plantation phase especially in the springtime or till it is needed on later stages. After that, the water level in the VFCW basin should be reduced every two weeks by drilling holes (5 cm lower) into the pile-up pipe, according to root growth of young reed plants.

Young reed plants are vulnerable to dehydration and drowning. During sowing or planting they require damp soil with water around 5 cm below the surface for the first weeks of planting. After young shoots have sprouted, water levels can be reduced, but the top ⅓ of the plants must be above the water surface. Older reeds can ‘breathe’ in deeper water, the preferable water depth is from 5 cm – 1 m.

After the reeds are grown and in good condition, then the pile-up pipe can be removed.
4.2 Irrigation Network Controller programming

The irrigation network has many characteristics that should be adjusted to work properly

A)- Setting Current Date and Time

The Set Current Date and Time dial position allows you to set the current date and time in your I-CORE controller.

1. Turn the dial to the SET CURRENT DATE/TIME position.
2. The year will be flashing in the display. Use the + / - button to change the year. Press the ► button to proceed.
3. The month will be flashing. Use the + / - button to change the month. Press the ► button to proceed.
4. The day will be flashing. Use the + / - button to change the day. Press the ► button to proceed and set the time.
5. Use the + / - button to select AM, PM, or 24 HR. Press the ► button.
6. Use the + / - button to set the hour. Press the ► to set the minutes. Use the + / - button to change the minutes until they are correct. The correct date and time have now been set. Always return the dial to the RUN position when you are finished programming the controller.

B)- Setting Program Start Times

The Set Program Start Times mode allows you to program start times for each of the four programs (A, B, C, or D) independently. Up to eight start times per day can be set for each program.

1. Turn the dial to the SET PROGRAM START TIMES position.
2. Program A and start time 1 will be displayed. If necessary, you can select Program B, C, or D by pressing the PRG button.
3. The program start time will be flashing. Use the + / - button to change the start time. The time will change in 15-minute increments. Press the ► button to select an additional start time if you would like more than one watering cycle per day to occur for that program. Programs A, B, C have eight start times per day, while program D has 16 start times. Press the PRG button to change between programs A, B, C, and D to assign a start time to the particular program.
4. To eliminate a program start time turn the dial to the SET PROGRAM START TIMES position, use the PRG button to select the program and the ► button to select the start time you would like to eliminate. Press the + / - button until you reach 12:00 AM. Press the – button once more and the display will show dashed lines --:--, indicating no start time.
C)- Setting Station Run Times  
(Length of Watering for Each Station)

The Set Station Run Times mode allows you to enter a length of run time for each station assigned to a program. Each station that has a run time associated with a program will be activated and operate one after another sequentially with each start time for that program.

1. Turn the dial to the SET STATION RUN TIMES position
2. The display will show the station number and program. Use the PRG button to select a program
3. Use the + / - button to change the station run time on the display
4. Use the ▶ button to advance to the next station for which you would like to enter a run time
5. When finished entering run times, rotate the dial to the RUN position

D)- Setting Days to Water

Set Days to Water mode allows you to select days you would like to water for each program independently.

1. Turn the dial to SET DAYS TO WATER position.
2. Program A water days will be displayed. Use the PRG button to select your desired program (A, B, C, or D).
3. Use the ◄ and ▶ button to change from 1) Specific Days of the Week; 2) Odd Day Watering; 3) Even Day Watering; or 4) Interval Day Watering. Each program can only be assigned one type of water day option at a time.

Please note that:

• The Irrigation run time and frequency must be taken from table 1 at different months and seasons.
• The irrigation run time for both solenoid valve is the same.
• The irrigation run time was calculated based on using two bubblers of 0.25GPM flow rate for each tree.
• The same irrigation requirements have been assumed for all native plants surrounding the lodge.
### Run-times

#### Table 1: Illustrated daily run time at different growing seasons

<table>
<thead>
<tr>
<th>Year</th>
<th>1st year</th>
<th>2nd year</th>
<th>3rd year</th>
<th>4th year</th>
<th>5th year</th>
<th>6th year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation requirement %</td>
<td>25.00</td>
<td>30.00</td>
<td>40.00</td>
<td>55.00</td>
<td>75.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>Eto mm/day</th>
<th>Run time (minute/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1.6</td>
<td>1 1 2 2 3 4</td>
</tr>
<tr>
<td>February</td>
<td>2.4</td>
<td>2 2 3 3 5 6</td>
</tr>
<tr>
<td>March</td>
<td>3.3</td>
<td>2 3 3 5 7 9</td>
</tr>
<tr>
<td>April</td>
<td>4.6</td>
<td>3 4 5 7 9 12</td>
</tr>
<tr>
<td>May</td>
<td>5.8</td>
<td>4 5 6 8 11 15</td>
</tr>
<tr>
<td>June</td>
<td>6.5</td>
<td>4 5 7 9 13 17</td>
</tr>
<tr>
<td>July</td>
<td>6.9</td>
<td>5 5 7 10 14 18</td>
</tr>
<tr>
<td>August</td>
<td>6.3</td>
<td>4 5 7 9 12 17</td>
</tr>
<tr>
<td>September</td>
<td>5.0</td>
<td>3 4 5 7 10 13</td>
</tr>
<tr>
<td>October</td>
<td>3.2</td>
<td>2 3 3 5 6 8</td>
</tr>
<tr>
<td>November</td>
<td>2.0</td>
<td>1 2 2 3 4 5</td>
</tr>
<tr>
<td>December</td>
<td>1.5</td>
<td>1 1 2 2 3 4</td>
</tr>
</tbody>
</table>

#### Table 2: Illustrate the accompanying run time of irrigation frequency at different growing seasons

<table>
<thead>
<tr>
<th>Year</th>
<th>1st year</th>
<th>2nd year</th>
<th>3rd year</th>
<th>4th year</th>
<th>5th year</th>
<th>6th year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run-time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF (days)</td>
<td>Run time (minute/day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January</td>
<td>9 10 11 15 21 29 38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>6 10 11 15 21 29 38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>4 9 10 14 19 26 35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>3 9 11 15 20 27 36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>2 8 9 12 17 23 31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>2 9 10 14 19 26 34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>2 9 11 15 20 27 36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>2 8 10 13 18 25 33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>3 10 12 16 22 30 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>4 8 10 14 19 25 34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>7 9 11 15 20 28 37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>9 9 11 14 20 27 36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.0 Tasks to be performed

This chapter covers all tasks that are to be performed on daily/weekly/monthly basis.
5.1 Biogas digester tasks

Task 1: Check for grease and scum accumulation

Where this task should be done?

• At the biogas digester inlet manhole, where mixing of black water and organic waste takes place
• At the expansion chamber outlet manhole

When this task should be done?

• Once every 2 weeks
• Or, in the following cases
  - There is large quantity of grease or scum observed in the biogas inlet manhole, expansion chamber or in the next treatment module (ABR)
  - There is bad odour and overflow of grease from the top of the expansion chamber or ABR

Why this task should be done?

• To allow the required free flow of WW through the treatment system (avoid cloggings)
• To avoid grease or scum entering subsequent treatment modules
• To avoid bad odour in and around treatment system (i.e. Biogas digester and ABR)

How this task should be done?

Step 1
1. Open the inlet manhole cover of the biogas digester and the expansion chamber

Step 2
1. Check for the presence of excess grease or floating solids in the biogas digester and expansion chamber
2. Check whether the WW remains its usual flow (compare the flow with earlier observations relating to the EMFM recordings)

Step 3
1. Remove the grease and the scum from the biogas digester inlet manhole, expansion chamber using an appropriate tool (e.g. perforated shovel)
2. Remove all grease from the mentioned chambers and pipes (using flexible stick) prior the ABR chamber
3. Dispose the grease and other waste safely.
4. If an unusual flow is observed, contact a qualified and specialized service company.
Task 2: Cleaning biogas stove burner

Where this task should be done?
- At the biogas stove burner(s) in the kitchen

When this task should be done?
- Once every month
- In the following cases
  - There is an inconsistent gas flame
  - There is corrosion observed on the stove burner
  - There are signs of corrosion
  - There are blockages in the stove holes

Why this task should be done?
- To keep the stove efficient by eliminating depositions
- To use the biogas efficiently

How this task should be done?

Step 1
1. Close the biogas supply valve near the biogas stove

Step 2
1. Dismantle the burner(s) of the stove or other biogas appliances as per appliance manual
2. Clean the burner(s) ring and its holes using a brush and if required a needle
3. Clean the jet hole with a needle
4. Sometimes you may also have to dismantle and clean the gas flame regulator valve if it does not turn easily
5. If corrosion is found, remove it with a brush
6. After completion of all the above steps, make sure that every part is properly put together again
7. Open the biogas supply valve near the biogas stove and check the flame

Step 3
1. If you are not satisfied with the performance of the stove, then contact the stove provider
Task 3: Check for biogas leakage at biogas supply pipeline

Where this task should be done?

- At the on-ground biogas pipelines, from the biogas digester to the appliances.

When this task should be done?

- Once every 4 months as a routine
- Or, in the following cases
  - There is no steady pressure and flame in the biogas appliances
  - There is little or no biogas supply
  - There is gas odour near the biogas pipeline

Why this task should be done?

- To ensure optimum use of biogas
- To avoid leakage of biogas
- To avoid odour of biogas
- To avoid outburst of fire

How this task should be done?

Step 1
1. Prepare a soap solution by mixing water and liquid soap (3:1 mixture) or water and detergent powder (1 cup water: 1 tea spoon detergent powder)
2. Check the following:
   - Availability of gas by lighting the appliance (stove etc.)
   - Whether the main valve at biogas unit is open
   - The gas pressure by observing the gas meter which is hanged on the kitchen wall
3. Apply this solution on exposed pipes and pipe joints using a paint brush at the place where the gas leakage is suspected

Step 2
1. Check for the bubbles or foam formation during the application of the soap, which indicates the location of gas leakage

Step 3
1. If bubbles or foam formation is observed, contact a plumber for rectification work immediately
2. If biogas leakage continues after rectification, contact a qualified and specialized service company
Task 4: Desludging the biogas digester

Where this task should be done?
- At the biogas digester

When this task should be done?
- Once every 3 – 4 years, or when desludging is needed; hence when the sludge level exceeds 85 cm above the bottom of the inlet chamber (Refer to Task 8)

Why this task should be done?
- To keep the efficiency of the sludge settling in the biogas chamber
- To maintain the desired effluent characteristics taking into consideration the required hydraulic retention time inside the digester. When the biogas digester is full, then the sludge will move to the next treatment module (ABR) which will affect the expected efficiency of the DWWTP
- To ensure that about 5 cm layer of sludge remains; hence, it gets enough time to be stabilised and to produce the methane gas efficiently for cooking in the kitchen
- To allow required free flow of wastewater through the entire system (treatment modules) and prevent clogging

How this task should be done?

Step 1:
1. Use the external gas supply for cooking
2. Open the stopper at the gas outlet to avoid damaging the dome, see the picture above

Step 2:
1. Open all manholes covers of the biogas digester
2. Insert the desludging vacuum pipe in the inlet manhole chamber
3. De-sludge the digester by using a vacuum truck (recommended) or any other way that is suitable on-site
4. Leave about 10% (about 5 cm) of the sludge at the bottom to maintain the biological process in the digester
5. Make sure to close the manhole tightly
6. Close the stopper at the gas outlet

Step 3:
1. Discharge the sludge at a safe disposal facility
5.2 Anaerobic Baffled Reactor tasks

Task 5: Check of free wastewater flow

Where this task should be done?

- Inlets and outlets of all treatment modules at the distribution channels

When this task should be done?

- Once every month, during the peak period (normally in the morning)
- Or, in the following cases
  - There is overflow in the inspection chamber
  - There is overflow in the inlet or outlet chambers of any treatment module
  - There is no wastewater flow in the inspection chambers or treatment modules

Why this task should be done?

- To identify possible blockages in pipes or in any treatment module
- To allow required free flow of wastewater through the entire system (all treatment modules)
- To identify possible damages or leakages
- To prevent mosquito from breeding in the system

How this task should be done?

Step 1
1. Open the manhole cover of the inspection chamber
2. Open the manhole cover at inlet and outlet of each treatment module (biogas digester, ABR, solar pump chambers and floating valve chamber)

Step 2
1. Check for obstructions like solid materials, floating materials and deposition at all manholes
2. Check whether the wastewater has its usual flow (compare with what was observed in earlier inspections through flow meter recordings) (see table 6)

Step 3
1. Remove obstructions, if any, using an appropriate tool like shovel/ broom and ensure that all lids are closed properly to avoid odour
2. If no flow is observed, check whether the system is in use or weather leakages can be observed in and around the treatment system and if so, contact a qualified and specialized service company
3. If an unusual flow (extremely low, high or much dirtier than usual) is observed, repeat Step 1 and Step 2 for 3 days. If unusual flow continues during observation for 3 days, then contact a qualified and specialized service company
Task 6: Stir the scum in the anaerobic reactors (Biogas digester + ABR)

Where this task should be done?

- At the biogas digester inlet and outlet chamber
- At ABR chambers

When this task should be done?

- Once every month

Why this task should be done?

- To press down the floating scum and heavy particles
- To maintain the efficiency of the modules and avoid transferring heavy particles to the next modules

How this task should be done?

Step 1
1. Open the manholes covers
2. Insert the stick into the biogas digester and into the ABR chambers
3. Stir the water until the heavy particles sink down
4. Close the manhole covers

Step 2
1. If few solids were not able to sink down, then remove them using (shove, picking tool)
Task 7: Remove the scum in the ABR chambers

Where this task should be done?

- At ABR chambers

When this task should be done?

- Once every 6 months

Why this task should be done?

- To maintain the efficiency of the module and to avoid scum accumulation

How this task should be done?

Step 1:
1. Open the manhole covers
2. Insert the perforated shovel or the steel sieving tool in the chambers of the ABR
3. Remove any accumulated grey foam, scum or fat
4. Dispose the accumulated scum, foam or fat into a bucket before final safe disposal
5. Close the manhole covers
Task 8: Check the sludge level of the biogas digester and ABR

Where this task should be done?
- At the first chamber of the ABR.
- At the inlet manhole of the biogas digester

When this task should be done?
- Once every year

Why this task should be done?
- To identify the sludge level (not more than 50 cm from the bottom) in the first ABR chamber.
- To identify the sludge level (not more than 85 cm from the bottom) in the biogas digester at the inlet chamber

How this task should be done?

Step 1
1. Take a stick and wrap it with cotton material
2. Open the manhole of the first chamber of the ABR or the inlet chamber of the biogas digester
3. Hold the stick vertically in the chamber and all the way down until it reaches the bottom

Step 2
1. Take it out and measure how high the accumulated sludge reaches
2. If the sludge level reaches more than 85 cm from the bottom of the biogas digester inlet manhole, then biogas digester desludging is needed (refer to task 4)
3. If the sludge level reaches more than 50 cm on the stick in the first ABR chamber, then ABR desludging is needed (refer to task 9)
Task 9: Desludging ABR chambers.

Where this task should be done?
- At the ABR

When this task should be done?
- Once every 5 - 7 years, or when desludging is needed (Refer to Task 8)

Why this task should be done?
- To avoid solidification of sludge
- To maintain the desired effluent characteristics. A minimum hydraulic retention time is required, which depends in the volume of the chambers. If the ABR chambers are full, the sludge will move to the next treatment module which will affect the expected efficiency of the treatment system
- To allow required free flow of wastewater through the entire system (all treatment modules), and to maintain the required retention time for the flow of the wastewater through other modules
- To prevent clogging in the down shaft pipes

How this task should be done?

Step 1:
1. Open the manhole covers of the ABR chambers
2. De-sludge the first chamber and the other chambers if required (exceeds 50 cm) using vacuum truck (recommended) or any other way that is suitable on-site and leave 20% of sludge quantity (about 10 cm)
3. Close the manholes covers and make sure that they are tightly closed

Step 2:
1. Discharge the sludge at safe disposal facility
5.3 Floating valve tasks

Task 10: Cleaning the floating valve chamber and pipes

Where this task should be done?

- Floating valve chamber, chamber walls and inner pipes

When this task should be done?

- Once every year

Why this task should be done?

- To identify and remove the possible accumulated sludge in the chamber
- To identify and remove the accumulating bio-film solids (dirt) in pipes
- To allow required free flow of wastewater through the entire system

How this task should be done?

Step 1:
1. Pick the time when the chamber is almost empty (after a flush, preferably not in the peak time)
2. Open the floating valve chamber manhole cover
3. Insert a high-pressure water hose and start cleaning the pipes
4. Check where solids are accumulated and start cleaning the chamber manually.

Step 2:
1. Remove the pile up pipe to drain out the water to the VFCW
2. Remove the high-pressure water hose
3. Install the pile-up pipe again and close the manhole cover
Task 11: Replacing the flexible hoses in the floating valve chamber

Where this task should be done?

- Floating valve pipes

When this task should be done?

- Once every 5-10 years (recommended time when there are no visitors or when the tank is empty)
- If there is clogging / no free flow of wastewater through the floating valve to the VFCW

Why this task should be done?

- Preventive maintenance task to avoid a sudden breakdown of the floating valve
- Preventive maintenance to guarantee effluent is delivered to the VFCW in batches

How this task should be done?

Step 1:
1. Use a hydraulic car-lift, heavy duty planks and timber to take off flexible hoses from floating valve pipes and wall ducting pipes
2. Use the hammer and the hard wood edge to remove all flexible hoses by hand force from floating valve pipes and wall ducting

Step 2:
1. Install new flexible hoses (4 pieces, 160mm internal diameter) by connecting to all 4 joints with stainless steel bolts and nuts towards pre-installed wall ducting
2. Apply a dish washing liquid inside the new flexible hoses to become slippery
3. Hydraulic car-lift, heavy duty planks and timber will create a permanent pressure of flexible hoses against the pre-installed wall ducting pipes
4. Push all flexible hoses by hand over the wall ducting using a heavy-duty hard wood wedge and a hammer
5. Squeeze all flexible hoses tightly to the wall ducting pipes using two stainless steel hose clamps (all stainless steel within sewage should have only A4 quality)

Step 3:
1. Adjust the floatation of the floating valve (reduce partly) by sewage resistant concrete blocks which rested in a box at head of the floating valve
2. If the new installed flexible hoses did not work well, then contact a qualified and specialized service company
5.4 Solar pump tasks

Task 12: Cleaning the solar pump chambers

Where this task should be done?
- At the solar pump 1st and 2nd chamber

When this task should be done?
- Once every year

Why this task should be done?
- To identify the accumulated solids and sludge
- To keep the solar pump working in an efficient way
- Preventive maintenance: preventing damages to the pump (affected through solids) guarantees a longer running time of the pump

How this task should be done?

Step 1:
1. Pick the time when there are no visitors or when the chamber is empty
2. Switch off the solar pumps
3. Open the manhole cover of the solar pump chamber
4. Clean the accumulated waste, if exists, manually using the suitable tool (shovel, picking stick tool)
5. Close the manhole
6. Switch on the solar pumps

Step 2:
1. In case of sludge accumulation inside the chamber, a vacuum truck is needed to de-sludge the chamber, knowing that the pump should be adjusted to pump not more than 30 cm from the water level in the chamber
2. Discharge the sludge at safe disposal facility
**Task 13: Check the functionality of the solar pump**

![Solar pump (Grundfos) phone application]

**Where this task should be done?**
- At the solar pump 1st and 2nd chamber

**When this task should be done?**
- Once every day.

**Why this task should be done?**
- To ensure that the solar pump is working in an efficient way and pumps the required flow within a specified time
- The readings are considered as a reference point for flow rate analysis

**How this task should be done?**

**Step 1:**
1. Open the manhole of the solar pump chamber
2. Check if the solar pump is working by taking readings from the EMFM and compare it with the previous readings (previous day)
3. Check the cleanliness of the chamber and remove any obstacles in the chamber if existed
4. Close the manhole

**Step 2:**
1. Make sure that the solar pump is switched on
2. If any problem occurs regarding the pump functionality, refer to the troubleshooting table
5.5 Vertical Flow Constructed Wetland tasks

Task 14: Check and adjust the pile-up pipe level in the VFCW

Where this task should be done?

- Pile up pipe inside the control manhole of the VFCW

When this task should be done?

- Once every 2 weeks (in the commissioning phase)
- Or, in the following cases
  - Stagnant water body in the VFCW basins: the water level is observed above the upper surface of the filter material (coarse aggregates)
  - Dampness on the filter material
  - No plant growth
  - Excess mosquito growth
  - In the low season with low inflow, this pile-up pipe can be used to pile-up water in the basins to support the plants with enough water, especially in summer time

Why this task should be done?

- To ensure efficient usage of filter media for wastewater treatment
- To avoid water accumulation above the upper surface of the filter material
- To enhance healthy plant growth after plantation
- To avoid death of plants through constant water table
- To avoid mosquito breeding due to water accumulation
- To avoid clogging of the filter material and to maintain the dryness feature in the filter

How this task should be done?

Step 1
1. Open the cover slab of the outlet chamber
2. Check if the level of the pile-up pipe from the bottom of the control manhole is at the desired level

Step 2
1. If the top hole of the pile up pipe is not at the desired level, remove it and install a new pile up pipe by drilling a boring a hole through the pipe at the desired height level (determines the water level inside the VFCW basins)
2. If there is no water flowing through the pile-up pipe, check for possible leakage at the pile up pipe joint at the bottom. If any leakage is found, inform the specialized service company
How to know the desired water level of the VFCW?
In a very hot weather with a minor WW inflow, fresh water should be discharged to the VFCW basins to keep the reeds in a healthy condition or to pile up the water again with the desired level. Normally the reeds length above the filter surface is double the roots length (2:1), after measuring the reeds length above the surface, the drilling level of the pile up pipe could be measured.

Rare case:
If a small amount of sand is observed at the control manhole outlet or at the next module, this means that sand is coming out from the drainage network. In this case the pile up pipe (after the commissioning phase) should be installed at a level 3 cm to block the sand from flowing out of the VFCW and will settle at the bottom of the control manhole. Therefore, the operator should check and clean the control manhole regularly (once every 3 months)
Task 15: Check the colour of the outflow

Where this task should be done?

• At the inspection chamber/ VFCW control manhole or at the recirculation pipe

When this task should be done?

• Once every 7 days

Why this task should be done?

• To inspect/ maintain the efficiency of the treatment process.
• For preventive maintenance: if something is not working properly within the system, the colour of the effluent could be considered as an alarm for the operator

How this task should be done?

Step 1:
1. Visually check for the water colour
2. If unexpected water colour (brown) is recognized, then bring transparent bottles
3. Fill the flask with the VFCW effluent and check whether the colour if it is normal or not

Step 2:
1. If the water colour is not normal, check the sludge level in the biogas chamber and ABR chambers. (refer to Task 8)
2. If the sludge level is high inside the modules, de-sludging should take a place (Task 4 & Task 9)

Step 3:
1. If the sludge level is not too high, check whether the filter material in the VFCW is clogged (refer to task 16)
2. Insert the stop pipe in the outflow pipe (Distribution chamber) of the targeted VFCW basin
3. A drying phase (7-14 days) on one basin should take place to dry up the filter surface
4. The inflow by default is redirected to the second basin until the drying phase ends
5. Remove the stop pipe from the outflow pipe that goes to the basin
6. If the water colour stays unsatisfactory, refer to a qualified and specialized service company
Task 16: Check the surface of the reed basins (stagnant water)

Where this task should be done?
• At the VFCW

When this task should be done?
• Once every 7 days
• Or, in the following cases:
  - If stagnant water was observed by eye
  - If a lot of mosquitos are observed above the filter material

Why this task should be done?
• Preventive maintenance to guarantee the proper operation of the system
• To ensure efficient usage of filter media for wastewater treatment
• To avoid water accumulation above the upper surface of the filter material
• To avoid death of plants because of having constant water table
• To avoid mosquito breeding due to water ponding

How this task should be done?

Step 1
1. Visual check of the VFCW surface

Step 2
1. If there is stagnant water at the surface of the VFCW, check the water level in the pile-up chamber and perform the respective task (Task 14)

Step 3
1. If the pile-up pipe is not the problem, then the filter material surface should be checked. If it is clogged, it indicates a reduced percolation rate of the wastewater through the filter material.
2. Insert the stop pipe at the outflow pipe (Distribution chamber) of the targeted VFCW basin.
3. A drying phase (7-14 days) on one basin should take a place to dry up the filter surface.
4. The inflow by default is redirected to the second basin until the drying phase ends.
5. Remove the stop pipe from the inflow pipe to the basin

Step 4:
1. If there is no leakage, and the water level was at the desired level, then the system might get overloaded. In this case refer to task 22
Task 17: Check the colour of the reed plants (Green or yellow)

Where this task should be done?

- At the VFCW

When this task should be done?

- Once every month

Why this task should be done?

- To ensure that the reed plants are in a good condition (green and not getting dry)
- To guarantee quality of treated wastewater

How this task should be done?

Step 1
1. Check the colour of the reeds, it should be green

Step 2
1. If the reeds are not green, then perform Task 18
Task 18: Reeds harvesting and removal of dead leaves

Where this task should be done?

- At the VFCW

When this task should be done?

- Once every 2-3 years, or when the reeds look too yellow and the outflow efficiency is getting lower

Why this task should be done?

- To check the condition of the reeds to ensure the efficient use of the reeds in treating the WW
- To avoid death of plants
- To avoid rotting of dead leaf litter in the VFCW
- To avoid clogging of filter material in the VFCW
- To maintain the cleanliness and to increase aesthetics near the treatment modules
- To maintain the green view of the reeds and outer appearance of the system

How this task should be done?

Step 1:
1. Use the cutter for reed harvesting
2. Shred the harvested reeds
3. Dispose them in the biogas digester

Step 2:
1. Check for presence of dead leaf litter or/and weed inside the VFCW
2. Check for trees, bushes and other litter around all the treatment modules

Step 3:
1. If the dead leaf litter or other litter is present, remove it manually or by using an appropriate tool (garden rake, fish net and sieve)
2. Trees and bushes should be removed by extracting the roots
3. Dispose them in the biogas digester after shredding
Task 19: Check and clean VFCW distribution system (blockage of holes)

Where this task should be done?

- At VFCW distribution pipes.

When this task should be done?

- Once every 3 months
- Or if the distribution pipes opening holes are observed to be clogged

Why this task should be done?

- To allow required free flow of wastewater through the entire system (all treatment modules)
- To maintain the amount of wastewater flow that is needed for the reeds to survive

How this task should be done?

Step 1
1. Close the outflow of the floating valve chamber using the stop pipe
2. Fill the floating valve chamber with water to the top
3. Open the end caps of the distribution pipe

Step 2
1. Open the outflow of the floating valve to distribute the stored water in one flush through the distribution pipes to remove all accumulated dirt
2. Check the distribution pipe holes and clean them using a stick if they are still blocked
3. Close the end caps of the distribution pipes
Task 20: Checking and cleaning of VFCW drainage pipes.

Where this task should be done?
- At VFCW drainage pipes

When this task should be done?
- Once every 3 years
- Or, in the following cases:
  - No water is coming out from the VFCW to the control manhole
  - Water is overflowing from the VFCW; hence the water level is observed above the upper surface of the filter material

Why this task should be done?
- To allow required free flow of wastewater through the entire system (all treatment modules)
- To avoid any negative site conditions, e.g. mosquitoes

How this task should be done?

Step 1
1. Open the control manhole cover
2. Install the pile-up pipe in the control manhole in case the pile-up pipe was removed before. The pile-up pipe needs to be drilled with holes at 50 cm from the basin bottom
3. Open the ventilation caps of the drainage pipes
4. Wait until the water level reaches 50 cm (in the control manhole and basin) from the basin bottom

Step 2
1. Make sure that the solar pump chamber 2 is emptied before, and the sun is at its peak
2. Make sure that the water level inside the VFCW is at 50 cm from the bottom through the pile-up pipe
3. Switch off solar pump 2
4. Remove the pile-up pipe and release the water for 2 minutes and then reinstall the pile-up pipe
5. Wait for 15 minutes until the sand at the solar pump chamber is settled if there is any
6. Empty the solar pump chamber using another pump
7. Check if there is any sand or debris accumulated at the chamber bottom
8. Clean the solar pump chamber & close the manhole cover

Step 3:
1. Bring the pile-up pipe back to its original position (if the pile up pipe was removed before, don’t install the pipe. If not, install the pile up pipe inside the control manhole at the desired level)
2. Close the ventilation caps of the drainage pipes & close the control manhole cover
3. Switch on solar pump 2
5.6 Valves adjusting tasks

Task 21: Adjusting of recirculation valve (no.2)

Where this task should be done?

- At the recirculation valve “valve no.2” (after the irrigation tank and directly before ABR)

When this task should be done?

- This valve is adjusted normally to insert maximum 5 m³/day (it is marked), and it should be always like that under normal conditions, it should only be adjusted whenever more denitrification is needed to be achieved based on the test results (NO₃ ≤ 100 mg/l) at the peak (high season)

Why this task should be done?

- To maintain the treatment efficiency to ensure proper outflow characteristics

How this task should be done?

Step 1
1. Test the treated wastewater parameters (especially the nitrate) at the peak time

Step 2
1. If the test result for the nitrate was less than required, then no adjustment is required
2. If the test result for nitrate was more than required, then the valve opening should be increased to insert more water for recirculation to lower the nitrate concentration in the treated wastewater

Step 3
1. Re-test the nitrate concentration after one month, if the result was:
   - Exceeding 100 mg/l, then increase the recirculation valve opening to insert more water to the system.
   - Lower than 100 mg/l, then re-adjust the valve back to 5 m³/day
Task 22: Open/Close valve no.1

Where this task should be done?
- At the Irrigation storage tank outlet valve towards the system “valve No.1”

When this task should be done?
- This valve is fully open under normal conditions, but it should be adjusted in the following cases:
  - When stagnant water appears at the VFCW surface
  - When the overflow towards the cesspit is more than 5 m³/day

Why this task should be done?
- To avoid overloading the system during days with high flow rates (peak)
- To maintain the treatment efficiency to ensure proper outflow characteristics

How this task should be done?

Step 1
1. Take the readings of the black and grey water EMFM
2. If combined total number exceeds 10 m³/day and stagnant water appears at the VFCW surface then close the valve (No.1) to stop the recirculation
3. Perform task 16 step 3 to dry one basin of the VFCW
4. Check whether the stagnant water has disappeared, if yes then re-open the valve fully

Step 2
1. If odour is observed at the solar pump 1st chamber while closing the valve (no.1) between the irrigation tank and the ABR, make sure that the recirculation valve (no.2) before the ABR is closed.
2. Open the valve (no.1) fully between the irrigation storage tank towards the system.
3. Open the valve (no.3) which is located before the 1st solar pump chamber for wastewater dilution for 5 hours to insert about 1 m³ to the chamber
4. Close the valve (no.3) before the 1st solar pump chamber
5. Re-adjust the valve (no.2) between the irrigation tank and the ABR at 5 m³/day
Task 23: Cleaning of the pipe between the Irrigation tank and the DWWTP

Where this task should be done?
• At the irrigation tank outlet valve (No.1) to the ABR

When this task should be done?
• Once every 3 months

Why this task should be done?
• To remove the sediments in the connection pipe

How this task should be done?

Step 1
1. Close valve No.1 for one day
2. Open valve No.1 fully
3. Flushing water for two minutes is enough
4. Keep the valve open for normal operations
Task 24: Clean the existent solar panels with the treated wastewater

Where this task should be done?

• At the existing solar panels that serve the Ecolodge

When this task should be done?

• Once every 8 – 10 days
• Or, in the following cases:
  - A lot of dust is accumulated on the solar panels’ surface due to windy weather or sand storm

Why this task should be done?

• To maintain the efficiency of the solar panels
• To reuse the existing treated wastewater in an efficient way

How this task should be done?

Step 1
1. The responsible person for cleaning the solar panels should wear the personal protection equipment (gloves, mouth guard, etc)
2. Open the ball valve to get the water from the irrigation tank through a connected flexible hose.
3. Clean the solar panels using a squeegee stick (not to harm the solar panel surface), it is better to add little soap
4. Dry the solar panel with a soft piece cloth
5. Close the ball valve
5.7 Irrigation network tasks

Task 25: Flushing the Irrigation system

Where this task should be done?

- Main manifolds and bubbler irrigation lines

When this task should be done?

- Once every year
- Or, in the following cases:
  - When operating the irrigation system for the first time
  - When the lateral flow rate is too low

Why this task should be done?

- To reduce the accumulation of organic and mineral materials in the pipes (or avoid bubbler clogging)

How this task should be done?

Step 1:
1. The pipes in the system should be flushed in sequence. Each one of them should be flushed for at least two minutes, or until flush water runs clear.
Task 26: Controller Quick Check

Where this task should be done?

- At the irrigation controller

When this task should be done?

- Once every year
- Or in the following cases:
  - When operating the irrigation system for the first time
  - If the solenoid valve failed to open

Why this task should be done?

- To quick identify “shorts” commonly caused by faulty solenoids

How this task should be done?

Step 1:
1. With the dial in the RUN position, press and hold the +, -, <, >, buttons for approximately two seconds and then release
2. After a few seconds, the display will show a number 1
3. Press the + button. The screen will initially show a number 20
4. within one second, the Hunter Quick check will begin
5. If a field wiring short is detected on a station, the controller will display a fault message for each faulty station
Task 27: Setting and modifying the irrigation schedule

Where this task should be done?

• At the irrigation controller

When this task should be done?

• Once every month

Why this task should be done?

• To cover the irrigation demand

How this task should be done?

Step 1:
1. Refer to chapter 4.2 in this manual
2. Please refer to irrigation O&M manual, section 2.1 in Appendix A and follow the procedure
Task 28: Cleaning of the filtering medium

Where this task should be done?

- At the irrigation filter

When this task should be done?

- Once every week
- When the pressure difference between the filter inlet and its outlet is more than 0.3 bar (readings can be checked at the pressure gauge)

Why this task should be done?

- To keep the irrigation system, working properly

How this task should be done?

Step 1:
1. Release the metal band and remove the cover of the filter and remove the disk medium
2. Unscrew the screw in the upper part of the filtering medium being careful with the spring tensioned inside the system. Do not compress the propeller
3. Take the screw out of the pressure plate, disengaging the guard, the spring and the spacer.
4. Take the pressure plate and the disks out of the support.
5. Wash all components with plenty of clean water.
6. Reassemble the medium and make sure that the initial configuration of the whole unit is restored.
Task 29: Cleaning the Solenoid Valve

Where this task should be done?

- At the solenoid valve

When this task should be done?

- When the valve is not closing and there is dirt inside the valve

Why this task should be done?

- To keep the solenoid valve work properly

How this task should be done?

Step 1:
1. Loosen the screws
2. Remove the diaphragm
3. Clean the diaphragm well and clean the inside of the valve bod
4. Reassemble the solenoid valve and make sure that the initial configuration of the whole unit is restored
Task 30: Cleaning of the bubblers

Where this task should be done?
• At the bubbler

When this task should be done?
• When the bubbler flow rate is lower than normal flow

Why this task should be done?
• To keep the bubbler, work properly

How this task should be done?

Step 1:
1. Pull up the riser.
2. Remove the bubbler head from the sprinkler.
3. Clean the inside filter.
4. Reassemble the bubbler.
6.0 Emergency overflow cases

The design of the system includes several emergency overflows for different scenarios as following:

Figure 14: AutoCAD drawing that shows the layout of the Ecolodge and the treatment system
1. Irrigation tank is full

The irrigation tank contains a mechanical floating valve. Whenever the irrigation tank is full, the inflow to the tank will be stopped and the pipe from the treatment system to the irrigation storage tank gets pressurized. At the same time the 2nd solar pump will get a signal from the pressure switch to stop pumping to the tank. As a result, the water will accumulate and stored in the 2nd solar pump chamber until it reaches the overflow pipe. Then the fully treated water will overflow to the cesspit and will infiltrate into the soil. No environmental damage or harm will occur.

Once the water level in the irrigation storage tank decreases due to use of the treated wastewater, the mechanical floating valve will open again, and the pressure in the mentioned pipe is reduced. Hence; the solar pump (2) will get a signal from the pressure switch to continue pumping.

2. Absence of sun

In case of absence of sun for few days, which can be expected mostly during winter time, solar pumps will not be functional and hence, no wastewater will be pumped into the irrigation tank or re-circulated back to the system. However, the treated wastewater from the VFCW will be stored in the solar pump 2 chamber, and from there it will be discharged to the soak pit through the overflow pipe as illustrated in the drawings.

For the first solar pump chamber, the wastewater coming from the lodge will enter the biogas, ABR and solar pump 1st chamber. After that the wastewater will be discharged to the cesspit through the overflow pipe and will infiltrate through soil knowing that this wastewater is not fully treated. This scenario is calculated to happen very rarely as there is enough storage capacity designed in the solar pump 1 chamber. In this case, the effluent is not treated to the requested standard but will not harm the environment or humans.

3. Increased WW flow during peak events

During peak events, which may be lasting only for few days, no adjustments in the system are required. Up to an occupancy rate in the hotel of 70 guests producing an inflow volume of average 10 m³ (resulting in a hydraulic load of the filter, incl. recirculation, of 15 m³/day).

The system can handle up to 20 m³/day incl. recirculation for one week maximum. After that the VFCW basins should be dried (task 16/ step 3). To avoid any changes on the hydraulic load for the system, it is recommended to close the valve at the irrigation storage tank outlet (valve no.1) towards the system completely during this period. However, the TSE characteristics will be affected slightly. See Task 22

Closing the main valve is therefore only required during very high occupancy rates.

- When the peak flow is over 10 m³/day (full hotel occupancy of 70 guests, 15 m³/day to the VFCW as recirculation is considered).

- When there is stagnant water at the VFCW surface.
# 7.0 Troubleshooting

Table 3: Troubleshooting activities for all treatment modules

<table>
<thead>
<tr>
<th>No</th>
<th>MALFUNCTION</th>
<th>CAUSES</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas Digester</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1 | Biogas is not produced even after 10-15 days | 1. No bacterial activity in the digester 2. Leakages in dome (gas storage), or in pipes and appliances | - Make sure that there is no chemicals or disinfectants are entering the digester  
- If there is a leakage in the gas outlet pipe, then search for the source of odour and repair it to maintain the tightness of the digester  
- Refer to Task 3 |
| 2 | Less gas production than forecasted | 1. Improper feeding (less quantity, irregular, more water, low temperature in digester) 2. Leakage of gas from the convergence system 3. Using chemicals in cleaning toilets 4. The temperature inside the dome is less than the desired | - Make sure that no chemicals or disinfectants are entering the digester  
- Feed as per recommendation  
- If there is a leakage in the gas outlet pipe, then search for the source of odour and repair it to maintain the tightness of the digester  
- Refer to Task 3 |
| 3 | The flame is not strong and blue, it is pale and yellow | 1. Clogging of gas tap and burner holes with dirt or accumulation of cooked items 2. No sufficient gas 3. Primary air intake in the gas stove is blocked or not operated properly | - Refer to Task 2 |
| 4 | The flame lifts off or flame is too big | 1. Excessive flow of gas, high gas pressure | 1. Reduce the gas flow 2. Reduce air supply |
| 5 | The stove does not burn even after gas production | 1. CO2 high concentration in gas 2. Defect fitting of pipes and appliances 3. Clogging of gas pipe, gas tap or gas jet due to dirt 4. Clogging of pipeline due to water or slurry from digester | - Refer to Task 2 |
| 6 | The flame extinguishes, or flame is too small | 1. Less flow of gas, not enough pressure | - Refer to Task 2  
- Refer to Task 3 |
| 7 | Slurry often enters the gas pipeline | 1. Not enough feeding to the digester 2. Not enough time left for accumulation of gas 3. Gas escape through dome pipe | 1.1. Feed as per recommendation.  
2.1. Ensure that the digester gets free time to accumulate gas  
2.2. Stop continuous use of gas for longer duration  
3.1. Check the blockages (Task 2)  
3.2. Check gas escape (Task 3). If the problem persists, call a technician  
4. Wait for some time until enough gas is produced  
5. check the sludge level and desludge if needed (Task 8) |
| 8 | Gas escape from gas pipe | 1. Expired gas rubber of the gas pipe 2. Presence of crack on the hose 3. Diameter inflation of the tip of the hose inside the kitchen that is connected to the gas pipe | - Check the pipes and the gas rubber  
- Refer to Task 3 |
<table>
<thead>
<tr>
<th>No</th>
<th>MALFUNCTION</th>
<th>CAUSES</th>
<th>SOLUTION</th>
</tr>
</thead>
</table>
| 9  | The digested slurry has a strong dirty smell in the kitchen or around the biogas digester | 1. Expired gas rubber gas pipe  
2. Presence of crack on the hose  
3. Inflation of the diameter of the tip of the hose  
4. Digester manholes are left open  
5. Biogas digester is filled with sludge | - Check the pipes and the gas rubber  
- Refer to Task 3  
- Check the pressure meter and release/use gas if the gas is above the capacity (more than 100 cm at the pressure meter)  
- Make sure that the manholes are closed  
- Check the level sludge in the digester (Refer to Task 8) and desludge if needed (refer to Task 4) |
| 10 | Stagnant water in biogas digester and overflow in manholes | 1. Treatment modules /pipes are clogged due to accumulated solids or sludge  
2. Hydraulic load is too high | - Check all modules of the DWWTP and specify where the clogged part is  
- Remove the solids or desludge the clogged module (refer to Task 1 & 4 & 7 & 9) |
| 11 | Lots of mosquitoes above the biogas digester | 1. Manholes of the biogas digester are open.  
2. Stagnant water above and around the biogas digester | - Close the manholes directly after checking the digester.  
- In case of stagnant water existence, then refer to Task 4 & 7 & 9 |
| 12 | More time is needed to cook food | 1. Efficiency of flame is not as anticipated due to heat lost or defective stove | 1. Ensure that the primary air intake is adjusted properly to produce strong blue flame that concentrates in the bottom of cooking pot  
2. Ensure that the stove is properly used and maintained  
3. Ensure that the area of cooking is not windy and open  
4. Locate stove in closed space to avoid heat lost |

**Anaerobic Baffled Reactor (ABR)**

<table>
<thead>
<tr>
<th>No</th>
<th>MALFUNCTION</th>
<th>CAUSES</th>
<th>SOLUTION</th>
</tr>
</thead>
</table>
| 1  | Back Flow from ABR to expansion chamber | 1. Clogging of the joint pipe between ABR and biogas digester | - Remove the solids from pipes by flushing.  
- Check the ABR if there is a need of desludging (Refer to Task 8 & 9) |

**Solar Pump**

<table>
<thead>
<tr>
<th>No</th>
<th>MALFUNCTION</th>
<th>CAUSES</th>
<th>SOLUTION</th>
</tr>
</thead>
</table>
| 1  | The pump does not run | 1. The fuses in the electric installation are blown  
2. The ELCB or the voltage-operated ELCB has tripped  
3. No power-supply  
4. The motor protection has cut off the power supply due to overload  
5. The pump or submersible drop cable is defective  
6. Overvoltage or undervoltage has occurred | 1. Replace the blown fuses. If the new ones blow too, check the electric installation and the submersible drop cable  
2. Cut in the circuit breaker  
3. Contact the power supply authorities  
4. Check whether the motor or pump is blocked  
5. Repair or replace the pump or the cable  
6. Check the power supply |
<table>
<thead>
<tr>
<th>No</th>
<th>MALFUNCTION</th>
<th>CAUSES</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>The pump runs but gives no water</td>
<td>1. The outlet valve is closed</td>
<td>1. Open the valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. No water or too low water level on borehole (large drawdown)</td>
<td>2. Increase the installation depth of the pump, throttle the pump or replace it by a smaller model to obtain a smaller capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. The non-return valve is stuck in its closed position</td>
<td>3. Pull out the pump and clean or replace the valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. The inlet strainer is choked up</td>
<td>4. Pull out the pump and clean the strainer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. The pump is defective</td>
<td>5. Repair or replace the pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. The outlet valve is closed</td>
<td>1. Increase the installation depth of the pump, throttle the pump or replace it by a smaller model to obtain a smaller capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. No water or too low water level on borehole (large drawdown)</td>
<td>2. Check and clean or replace the valves, if necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. The non-return valve is stuck in its closed position</td>
<td>3. Clean or replace the outlet pipe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. The non-return valve of the pump is partly blocked</td>
<td>4. Pull out the pump and check/replace the valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. The pump and the riser pipe are partly choked by impurities (ochre)</td>
<td>5. Pull out the pump. Check and clean or replace the pump, if necessary. Clean the pipes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Leakage in the pipes</td>
<td>6. Check and repair the pipes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. The riser pipe is defective</td>
<td>7. Replace the riser pipe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Undervoltage has occurred</td>
<td>8. Check the power supply</td>
</tr>
<tr>
<td>3</td>
<td>The pump runs at a reduced capacity</td>
<td>1. The drawdown is larger than anticipated</td>
<td>1. Increase the installation depth of the pump, throttle the pump or replace it by a smaller model to obtain a smaller capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. The valves in the outlet pipe are partly closed or blocked</td>
<td>2. Check and clean or replace the valves, if necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. The outlet pipe is partly choked by impurities (ochre)</td>
<td>3. Clean or replace the outlet pipe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. The non-return valve of the pump is partly blocked</td>
<td>4. Pull out the pump and check/replace the valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. The pump and the riser pipe are partly choked by impurities (ochre)</td>
<td>5. Pull out the pump. Check and clean or replace the pump, if necessary. Clean the pipes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Leakage in the pipes</td>
<td>6. Check and repair the pipes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. The riser pipe is defective</td>
<td>7. Replace the riser pipe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Undervoltage has occurred</td>
<td>8. Check the power supply</td>
</tr>
<tr>
<td>4</td>
<td>Frequent starts and stops</td>
<td>1. The differential of the pressure switch between the start and stop pressures is too small</td>
<td>1. Increase the differential. However, the stop pressure must not exceed the operating pressure of the pressure tank and the start pressure must be high enough to ensure enough water supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. The water level electrodes or level switches in the reservoir have not been installed correctly</td>
<td>2. Adjust the intervals of the electrodes or level switches to ensure suitable time between the cutting-in and cutting-out of the pump. See installation and operating instructions for the automatic devices used. If the intervals between stop and start cannot be changed via the automatics, the pump capacity may be reduced by throttling the outlet valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. The non-return valve is leaking or stuck half-open</td>
<td>3. Pull out the pump and clean or replace the non-return valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. The supply voltage is unstable</td>
<td>4. Check the power supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. The motor temperature gets too high</td>
<td>5. Check water temperature</td>
</tr>
<tr>
<td>5</td>
<td>Odour at the 1st solar pump chamber</td>
<td>Anaerobic conditions</td>
<td>- Refer to task 22/ step 2</td>
</tr>
</tbody>
</table>

**Vertical Flow Constructed Wetland (VFCW)**

<table>
<thead>
<tr>
<th>No</th>
<th>Blockage of holes/distribution pipe:</th>
<th>1. Sand/Solids clogging</th>
<th>- Refer to Task 19</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Ponding of water on the surface:</td>
<td>1. Drainage pipes clogging</td>
<td>- Refer to Task 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Pile up pipe level</td>
<td>- Refer to Task 14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Sand clogging</td>
<td>- Refer to Task 16</td>
</tr>
<tr>
<td>3</td>
<td>Blockage of drainage pipes:</td>
<td>1. Sand clogging</td>
<td>- Refer to Task 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Reeds roots blocks the pipe through the slots</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>MALFUNCTION</td>
<td>CAUSES</td>
<td>SOLUTION</td>
</tr>
<tr>
<td>----</td>
<td>-----------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| 4  | Low inflow of sewage:                   | 1. Low occupancy at the lodge                                           | - Take one of the reed bed lines out of operation using the pipe stop for 2 weeks  
- If water flow remains low for long period of time, then re-install the pile-up pipe to maintain the desired water level to support the plants with water to survive. (Refer to Task 14) |
|    |                                         | 2. Lack of sunlight (solar pump efficiency is reduced)                 |                                                                                                                                                                                                           |
| 5  | TSE with brown colour with/without smell: Anaerobic conditions in the VFCW | 1. Some module has a high amount of accumulated sludge.                 | - Reduce hydraulic load by closing the recirculation valve.  
- Stop the flow on one basin for drying (Refer to Task 16 step 3)  
- Desludge the selected module if it is needed. |
|    |                                         | 2. Sludge is accumulated above the filter material (surface).          |                                                                                                                                                                                                           |
| 6  | Low performance during operation:       | 1. High hydraulic and organic load                                      | - Check the incoming wastewater to the VFCW  
- If the design flow and concentrations are exceeded, then the inflow should be reduced by stopping the recirculation  
- Check for clogged distribution, drainage pipes and blocked holes, refer to (Task 19 & 20) |
|    |                                         | 2. Clogging of filter material                                          |                                                                                                                                                                                                           |
|    |                                         | 3. Absence of sun                                                      |                                                                                                                                                                                                           |
| 7  | Odor at VFCW                            | 1. Anaerobic conditions                                                | - Reduction of hydraulic and organic load back to the design limits  
- Check drainage and discharge system for blockage. refer to (Task 19 & 20)  
- After hydraulic and organic overload, basins require drying phase (3 – 6 weeks) to recover. (Refer to Task 16 step 3)  
- Check the distribution network for stagnant water |
|    |                                         | 2. Higher hydraulic and organic loads as per design.                   |                                                                                                                                                                                                           |
|    |                                         | 3. Discharge of fouling /septic sludge and wastewater onto the reed beds |                                                                                                                                                                                                           |
|    |                                         | 4. Stagnant water                                                      |                                                                                                                                                                                                           |
| 8  | Mosquito                                | 1. Stagnant water in VFCW basins                                      | - Make sure that the VFCW manholes are closed  
- The load must be reduced to the design figures by stopping the re-circulation  
- Check the drainage pipes. Refer to Task 20  
- Outlet flow must be checked at the control manhole joint bottom  
- Pile-up pipe level must be reduced if needed |
|    |                                         | 2. The filter material surface is wet                                 |                                                                                                                                                                                                           |

**Irrigation network**

**Controller malfunction**

<table>
<thead>
<tr>
<th>No</th>
<th>MALFUNCTION</th>
<th>CAUSES</th>
<th>SOLUTION</th>
</tr>
</thead>
</table>
| 1  | No Display                  | - Check AC power-supply to controller                                  | - Fix power supply  
- Connect ribbon cable on back on face pack door  
- Slide the module locking bar into the Power-on position |
<p>|    |                             | - 14 pin connectors are not fully connected                            |                                                                                                                                                                                                           |
|    |                             | - Module locking bar is not in the Power-on position                   |                                                                                                                                                                                                           |</p>
<table>
<thead>
<tr>
<th>No</th>
<th>MALFUNCTION</th>
<th>CAUSES</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>The display reads no AC Power</td>
<td>- No AC power-supply present to operate controller/valves</td>
<td>- Check the AC current entering to the transformer and DC current coming out of the transformer to see if it is installed or power is coming out of it</td>
</tr>
<tr>
<td>3</td>
<td>Display reads fault</td>
<td>- Overflow/Underflow alarm has occurred</td>
<td>- Check System for problems</td>
</tr>
<tr>
<td>4</td>
<td>Possible station short</td>
<td></td>
<td>- Check solenoid and field wiring</td>
</tr>
<tr>
<td>5</td>
<td>Display reads sensor is active</td>
<td>- The rain sensor is interrupting irrigation or not installed</td>
<td>- Slide the rain sensor switch on front panel to the bypass</td>
</tr>
<tr>
<td>6</td>
<td>Station does not irrigate</td>
<td>- Field wiring or solenoid problem</td>
<td>- Perform manual Signal-Station start and observe display and Station Status light</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- If Station Status light is red, then check solenoid and field wiring including COM (neutral) wires, Station outputs must not exceed 0.56A max.</td>
</tr>
<tr>
<td>7</td>
<td>The controller does not irrigate automatically</td>
<td>- Possible programming errors</td>
<td>- Verify all programs Days to water, start times and station run times</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Sensor shutdown</td>
<td>- Check display for fault indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Programmable Off in effect</td>
<td>- Check display for off-days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Time/Date errors</td>
<td>- Verify controller time and date, including Am/Pm/24 settings</td>
</tr>
<tr>
<td>8</td>
<td>Rain or other Click sensors do not shut down</td>
<td>- Incorrect sensor type or connection (Jumper installed)</td>
<td>- Use one normally closed Click type sensor per sensor ports. Verify the one wire from each sensor is to each SEN1 or SEN2 terminals. Remove jumper wire</td>
</tr>
<tr>
<td></td>
<td>systems</td>
<td>- Incorrect sensor settings for stations</td>
<td>- Turn dial to SET SENSOR OPERATION and verify correct response for each station of the sensor</td>
</tr>
<tr>
<td>9</td>
<td>The controller repeats a program or continuously</td>
<td>- Too many start times (user programming error)</td>
<td>Use only one-star time per active program</td>
</tr>
<tr>
<td></td>
<td>waters even when it should not be on</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Controller does not recognize output module</td>
<td>- Module seated incorrectly</td>
<td>- Verify that modules are seated all the way back in the wiring compartment and module lock is on</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Module slot skipped</td>
<td>- Verify that no module slots have been skipped from left to right</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Station output module overloaded</td>
<td>- Swap with known good module in the same position. If now module works in the position, replace the old module. If new known good module also fails to be recognized, check gold contacts for dirt, corrosion or pests.</td>
</tr>
<tr>
<td>No.</td>
<td>MALFUNCTION</td>
<td>CAUSES</td>
<td>SOLUTION</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td><strong>Hunter ICV Solenoid Valve</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Slow closing valve</td>
<td>- Debris clogs the port</td>
<td>- Replace the diaphragm assembly</td>
</tr>
<tr>
<td>12</td>
<td>Irrigation system continues to run after the controller in off-position</td>
<td>- Valve has been opened manually - Debris in the valve</td>
<td>- Locate your valve box and turn the solenoid clockwise until snug - If debris occurred in the valve:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Disassemble the valve - Rinse all parts with clean water - Reassemble the valve</td>
</tr>
<tr>
<td></td>
<td><strong>Hunter PROS Sprinkler</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Head stays up after the system shuts down</td>
<td>- Debris in the pop-up body - The riser is damaged - The riser seal is worn</td>
<td>- Unscrew the body cap - Pull out the sprinkler assembly - Examine the parts - Clean out debris - Replace parts if required</td>
</tr>
<tr>
<td>14</td>
<td>Excessive leaking around the riser seal while the bubbler is in operation</td>
<td>- Overtime general usage can cause riser seals to wear out</td>
<td>- Replace the wiper seal</td>
</tr>
<tr>
<td></td>
<td><strong>Hunter Bubbler</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>The flow rate is low</td>
<td>- Debris in the bubbler's filter</td>
<td>- Unscrew the bubbler - Pull out the filter - Clean out the debris - Replace parts if required</td>
</tr>
<tr>
<td></td>
<td><strong>EMFM</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>EMFM doesn't work</td>
<td>- High temperature with no water flow for few days - Low battery storage</td>
<td>- Call the supplier</td>
</tr>
<tr>
<td></td>
<td><strong>All Treatment Modules</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Odor at the treatment modules</td>
<td>1. Manholes are open - Anaerobic conditions - Sludge accumulation - High hydraulic and organic loads - Pipe clogging - Stagnant wastewater</td>
<td>- Identify the odour source by checking the ventilation pipe and manholes at every module - Check the sludge level (Task 8) and desludge if needed at the chosen module - In case of high occupancy rate at the lodge the ABR might smell, then refer to (Task 22 step 2) - Reduction of hydraulic and organic load back to the design limits by stopping the recirculation (Refer to Task 22 step 1)</td>
</tr>
<tr>
<td>2</td>
<td>Damage of pressure pipe line or valve</td>
<td>- Hydraulic load is too high</td>
<td>- Identify the damaged item - Shut off the line to prevent water leakage - Repair/Replace the damaged item</td>
</tr>
</tbody>
</table>
8.0 Quality Monitoring

In this chapter, few tests are considered to check and to maintain the quality of the treated effluent of the DWWTP.

Section 7 of the Jordanian standards JS 893/2006 (Water-Reclaimed domestic wastewater) clarifies the water tests that should be performed on a regular basis to ensure that the quality of the treated wastewater complies with the aforementioned standards.

**Section 7 – JS 893/2006**

7.1 The owner of the domestic WWTP project shall ensure that the quality of the reclaimed water conforms to the standards and according to its final use and it must carry out the necessary laboratory tests, with the need to open official records to document the laboratory results and highlight them to the governmental regulators at their request.

7.2 The operator shall collect composite samples every two hours for a period of 24 hours according to the frequency shown in Table 4, while the regulatory authorities shall collect samples in the manner they deem appropriate.

<table>
<thead>
<tr>
<th>Treatment Plants type</th>
<th>Sampling frequency</th>
<th>Evaluation Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>For small populations</td>
<td>Routine sampling: 4 composite samples/month</td>
<td>6 months*</td>
</tr>
<tr>
<td></td>
<td>Chemical and physical properties: 3 single samples/day</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intestinal worms’ eggs: 2 composite samples/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-Coli: 4 single samples/ month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Routine Sampling: 1 sample/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical and physical properties: 1 sample/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intestinal helminth eggs: 1 sample/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-Coli: 1 sample/ month</td>
<td></td>
</tr>
</tbody>
</table>

*6 months period means summer and winter (summer from May till October and winter from November till April)

**Note:** Routine Sampling include NO3, BOD5, COD, TSS, NH4, T-N  
**Chemical and physical properties:** Turbidity, Temperature, pH, DO, RCl2
9.0 Don’ts List

1. NO chemicals (chemical detergents, or any kind of chemicals), NO condoms, NO plastics or metal, NO sanitary pads, tampons or nappies should be disposed into toilets or any basin. NO colouring toilet liquid to be put into the toilet cistern. Those items might clog the system or kill bacteria which are needed for the biological processes and might harm the system, as the system works purely based on biological processes.

2. Do not drink and wash your hands with treated wastewater!

3. Do not deal with the treated wastewater without wearing the personal protection equipment!

4. Do not leave any manhole open after doing any operational task!

5. Do not insert the paper, cardboards or the food waste without shredding to the biogas digester organic material inlet chamber

6. Smoking is prohibited near the system or when the manholes are open while practicing O&M activities, specially near the biogas digester.

7. Do not clean the flexible hoses at the floating-valve module!
10.0 Activity and Time Checklists / Maintenance plan

This chapter includes the checklist templates that should be filled by the operator while performing the requested operation and maintenance tasks.

10.1 Overview of Tasks

The next pages should be used as templates for copies

<table>
<thead>
<tr>
<th>Module</th>
<th>Task</th>
<th>Frequency</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>![icon]</td>
<td>1. Check for grease and scum formation</td>
<td>Once every 14 days</td>
<td>20</td>
</tr>
<tr>
<td>![icon]</td>
<td>2. Cleaning biogas stove burner</td>
<td>Once every month</td>
<td>21</td>
</tr>
<tr>
<td>![icon]</td>
<td>3. Check for biogas leakage at biogas supply pipeline</td>
<td>Once every 4 months</td>
<td>22</td>
</tr>
<tr>
<td>![icon]</td>
<td>4. Desludging the biogas digester dome</td>
<td>Once every 3 years</td>
<td>23</td>
</tr>
<tr>
<td>![icon]</td>
<td>5. Check of free wastewater flow</td>
<td>Once every month</td>
<td>24</td>
</tr>
<tr>
<td>![icon]</td>
<td>6. Stir the scum in the ABR chambers</td>
<td>Once every month</td>
<td>25</td>
</tr>
<tr>
<td>![icon]</td>
<td>7. Remove the scum in the ABR chambers</td>
<td>Once every 6 months</td>
<td>26</td>
</tr>
<tr>
<td>![icon]</td>
<td>8. Check the sludge level of the biogas digester and ABR</td>
<td>Once every year</td>
<td>27</td>
</tr>
<tr>
<td>![icon]</td>
<td>9. Desludging ABR chambers</td>
<td>Once every 6 years</td>
<td>28</td>
</tr>
<tr>
<td>![icon]</td>
<td>10. Cleaning the floating valve chamber and pipes</td>
<td>Once every year</td>
<td>29</td>
</tr>
<tr>
<td>![icon]</td>
<td>11. Replacing the flexible hoses in the floating valve chamber</td>
<td>Once every 5-10 years</td>
<td>30</td>
</tr>
<tr>
<td>![icon]</td>
<td>12. Cleaning the solar pump chambers</td>
<td>Once every year</td>
<td>31</td>
</tr>
<tr>
<td>![icon]</td>
<td>13. Check the function of the solar pump</td>
<td>Once every day</td>
<td>32</td>
</tr>
<tr>
<td>![icon]</td>
<td>14. Check and adjust the pile-up pipe level in VFCW</td>
<td>Once every 14 days</td>
<td>33</td>
</tr>
<tr>
<td>![icon]</td>
<td>15. Check the colour of the outflow</td>
<td>Once every 7 days</td>
<td>35</td>
</tr>
<tr>
<td>![icon]</td>
<td>16. Check the surface of the reed basins</td>
<td>Once every 7 days</td>
<td>36</td>
</tr>
<tr>
<td>![icon]</td>
<td>17. Check the colour of the reed plants</td>
<td>Once every month</td>
<td>37</td>
</tr>
<tr>
<td>![icon]</td>
<td>18. Reeds harvesting and removal of dead leaves</td>
<td>Once every 2 – 3 years</td>
<td>38</td>
</tr>
<tr>
<td>![icon]</td>
<td>19. Check and clean VFCW distribution system (blockage of holes)</td>
<td>Once every 3 months</td>
<td>39</td>
</tr>
<tr>
<td>![icon]</td>
<td>20. Checking and cleaning of VFCW drainage pipes</td>
<td>Once every 3 months</td>
<td>40</td>
</tr>
<tr>
<td>![icon]</td>
<td>21. Adjusting of recirculation valve No.2</td>
<td>When needed</td>
<td>41</td>
</tr>
<tr>
<td>![icon]</td>
<td>22. Open/close valve No.1</td>
<td>When needed</td>
<td>42</td>
</tr>
<tr>
<td>![icon]</td>
<td>23. Cleaning the pipe between the irrigation tank and the DWWTP</td>
<td>Once every 3 months</td>
<td>43</td>
</tr>
<tr>
<td>![icon]</td>
<td>24. Clean the existent solar panels with the treated wastewater</td>
<td>Once every 10 days</td>
<td>44</td>
</tr>
<tr>
<td>![icon]</td>
<td>25. Flushing the irrigation tank</td>
<td>Once every year</td>
<td>45</td>
</tr>
<tr>
<td>![icon]</td>
<td>26. Controller quick check</td>
<td>Once every year</td>
<td>46</td>
</tr>
<tr>
<td>![icon]</td>
<td>27. Setting and modifying the irrigation tank</td>
<td>Once every month</td>
<td>47</td>
</tr>
<tr>
<td>![icon]</td>
<td>28. Cleaning of the filtering medium</td>
<td>Once every 7 days</td>
<td>48</td>
</tr>
<tr>
<td>![icon]</td>
<td>29. Cleaning the solenoid valve</td>
<td>When needed</td>
<td>49</td>
</tr>
<tr>
<td>![icon]</td>
<td>30. Cleaning of the bubblers</td>
<td>When needed</td>
<td>50</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Operator name</th>
<th>Date</th>
<th>EMFM in m³ for Black water</th>
<th>EMFM in m³ grey water</th>
<th>EMFM in m³ for the irrigation network</th>
<th>EMFM for solar pumps overflow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average / week</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average / week</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average / week</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average / week</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average / month</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 7: Biogas digester feeding list

<table>
<thead>
<tr>
<th>Allowed materials</th>
<th>Prohibited materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food waste from Kitchen</td>
<td>All types of plastic</td>
</tr>
<tr>
<td>Food oil and cooked food oil</td>
<td>Nylon bags</td>
</tr>
<tr>
<td>Vegetables and fruit rotten</td>
<td>All types of wood</td>
</tr>
<tr>
<td>All kinds of paper</td>
<td>Leather and rubber</td>
</tr>
<tr>
<td>Paper napkins</td>
<td>Metals</td>
</tr>
<tr>
<td>Plants’ leaves</td>
<td>Cigarette butts</td>
</tr>
<tr>
<td>All types of cartons</td>
<td>Soil and sand</td>
</tr>
<tr>
<td>Bones of sheep and chicken (if exists)</td>
<td>All kinds of cloth</td>
</tr>
<tr>
<td></td>
<td>Chemicals, detergents and cleaning material</td>
</tr>
</tbody>
</table>

**Instructions:**

- The leaves, cartons and anything that will be inserted in the biogas digestion system should be shredded in order to facilitate its smooth flow without causing any obstruction in the tube.

- The allowed materials should be inserted only in the designated manhole.

- The use of chemicals, disinfectants and detergents should be minimized significantly which in turn it kills the bacteria that produce biogas.
<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment</th>
<th>Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shovel</td>
<td>![Shovel Image]</td>
</tr>
<tr>
<td>2</td>
<td>Perforated shovel</td>
<td>![Perforated Shovel Image]</td>
</tr>
<tr>
<td>3</td>
<td>Rake</td>
<td>![Rake Image]</td>
</tr>
<tr>
<td>4</td>
<td>Steel wire connected with a brush</td>
<td>![Steel Wire Image]</td>
</tr>
<tr>
<td>5</td>
<td>L-brush</td>
<td>![L-brush Image]</td>
</tr>
<tr>
<td>6</td>
<td>Broom stick</td>
<td>![Broom Stick Image]</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Picking tool</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Hose pipe</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Bucket</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Wheelbarrow</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Wooden stick</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>L-steel sieve</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tool Name</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---------------------------</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Sludge level indicator</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Agricultural Sickle</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Crowbar</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Meter tool</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Torch</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Ladder</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>First aid kit</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Pile-up pipe</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Transparent glass bottle</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>PPE (Overall: gloves, waterproof clothes, mask, goggles, etc.)</td>
<td></td>
</tr>
</tbody>
</table>