

Manual for the Development of a Quality Assurance Programme

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Background – Quality Assurance of Sludge

When sludge is used as fertilizer in agriculture its quality, the fact that it does not contain poisonous materials or other contaminants, is of paramount importance.

Poisonous substances accumulate on fields when sludge is used as fertilizer and it is important to work systematically to reduce the amounts of substances and to do this according to the principles set down in the form of a certification system. In Sweden this system is called Revaq.

The Revaq system is a system for self-monitoring of the practices applied at the waste water facility in order to measure the content of various substances in the sludge and to apply systematic activities with the goal of reducing these amounts.

There are numerous up-stream sources of contamination. The most important of those being:

- External sludge
- Cadmium and other heavy metals and compounds
- Storm water
- Drainage water
- Industrial discharge

Systemic failures in the quality assurance system are also possible. Possible sources of error have to be detected and controlled. These may be constituted by:

- Sampling errors
- Measurement errors
- Errors of compilation or calculation
- Oversight by people who devised the system

A certification system that in detail sets down all routines for quality assurance at the waste water treatment plant can be used in order to keep track of pollution sources and gradually improve sludge quality.

Quality assurance of sludge from a municipal waste water system requires an overall view of the system that covers all of its aspects from collection of waste-water at households, offices, industries, and other types of suppliers, to its treatment at the waste-water treatment plant and all these steps are documented in a system, such as the Swedish Revaq.

Basic Philosophy and Methodology for QA in the Sludge Area

The Swedish government has set the goal that the rate of accumulation of essential tracing elements by 2025 will not exceed 0.2%. This translates to a rate of doubling of the content of these substances on farmlands less than every 500 years. In the case of Cadmium the goal has been set at zero accumulation beyond 2025.

Essential tracing elements are defined as elements that are essential parts of the nutrition for humans, animals and plants. Prioritized elements are the ones that show a rate of accumulation

above 0.2%. Elements that are present in volumes exceeding 50% above the allowed limits are always prioritized.

The Revaq system represents a structured format for describing the work at the waste water plant. It describes how tests are taken, how equipment is calibrated, and how employees at the plant work in order to reduce the content of poisonous substances in the sludge. Through the system employees describe their work. It is therefore important to develop well-structured work practices and then describe these through the system. Focus areas of the system are:

- A structured work method.
- Systematic up-stream work in order to identify and eliminate sources of poisonous substances.
- Traceability.
- A quality of sludge that is specified based on specific requirements.

The process of certification is conducted on-site at the waste water treatment plant. At the point of certification the owner of the plant is required to be able to prove that the plant is run according to the routines that have been described in the documentation. In case there are remarks or questions regarding the routines or the documentation, the owner has to provide revised or complementary documents within the time frame specified by the person performing the certification.

There has to be a quality policy focusing on the improvement of the quality of the sludge as it is used as fertilizer. This policy has to be updated regularly as relevant experiences are made or as market demand for fertilizer of a certain quality is developed. The policy has to:

- Describe the ambitions related to up-stream quality assurance and sludge quality.
- Be formed on the basis of an ambition to constantly improve sludge quality.
- Be well known by the employees of the waste water treatment plant and be updated on a continuous basis.

The management team of the plant has to, at least once every year, discuss the process of quality assurance from a number of perspectives and protocol the decisions related to each of these topics discussed.

It is also a requirement that the owner of the plant has to do an annual revision of each of the major suppliers to the plant. The routines concerning the revision of suppliers have to be documented within the system documentation.

Quality control of sludge starts downstream with sampling and measuring the phosphorus balance at the waste-water treatment plant. Personnel involved in the quality assurance process then need to move their focus of attention upstream, step-by-step until they reach the step of adjusting influent flows from various sources. This process goes through five steps:

1. Sample and measure the phosphorus balance at the treatment plant.
2. Map and measure flows in the collection system.
3. Identify needs to improve specific parameters and identify possible sources of contamination in the collection system.
4. Collect samples from various sources in the collection system and perform analyses.

5. Initiate a dialogue with suppliers of contaminated waste-water in order to reduce contamination in flows.

Preparations for Certification

Before certification the owner of the plant has to analyze the content with regard to 60 different tracing elements during three consecutive months. Tracing elements that show a rate of accumulation exceeding 0.2% per annum have to be identified. All analyses are to be performed at the same laboratory. There are differences between tracing elements that are essential and non-essential elements. There are also examples of elements that are deemed, based on the current state of knowledge, not to be harmful. Excessive amounts of these elements do not lead to a need to prioritize them. One such element is gold.

The methods that have to be used in order to calculate and depict the rate of improvement of the sludge content is specified in detail in the requirements for the Revaq system. These requirements are briefly described below.

Up-stream QA Routines

Continuous Sampling and Analysis

After certification the owner of the waste water treatment plant has to analyze and record the overall load of flow, phosphorous and of prioritized tracing elements, as well as the loads emanating from households, A- and B-activities, additional waters, and other activities. The sources of the prioritized tracing elements are to be documented. Material emitted into the network may, for example, be fat from grease traps, waste from food processing industries, or sludge from closed containers. The owner of a certificate should not receive material that may adversely affect sludge quality.

The owner may not receive additional batches of material until previous batches have been sampled and tested for each of the tracing elements. Exceptions can be made for single batches that are not deemed to influence sludge quality. If material may contain prohibited substances the owner should not accept the batch. Disposal at waste disposal facilities is prohibited.

The owner of the certificate shall demand accounts of chemicals used by each depositor of sludge into the system. The account has to contain all chemicals that may affect the quality of sludge in the system. Production plants that produce pharmaceuticals shall provide lists of chemicals that may reach the waste water treatment plant and the amount used of each chemical has to be reported. Households often contribute a substantial share of the load on the treatment plant. For this reason, the owner has to make efforts to help households improve the quality of incoming water.

Developing a Methodology for Upstream Identification of Sources of Tracing Elements

There is a need to develop a stepwise process of identifying sources of tracing elements. This process will then be a central part of the methods that are certified within the quality assurance system.

1. Measuring Phosphorus Balance

Phosphorous is an important nutrient for the soil and when sludge is used as a fertilizer it is important to monitor the phosphorous balance. Most of the phosphorous content in sewage water in Sweden is contributed by humans and domestic animals. A grown person urinates and excretes two to three grammes of phosphorous per day. Additional amounts are contributed by agriculture and industrial sources

As a first step it is important to develop a method for measuring and analyzing the phosphorous content of the sewage. Numerous possible sources of sampling errors exist. The method used should provide consistent and correct results.

2. Mapping of Flows in the Collection System

In order to get a picture of the various sources of nutrients, chemicals and pollutants, inflows need to be mapped. In doing this it is particularly important to map sources of larger volumes of storm or drainage water and identify the chemical composition of these waters. It is also important to map large inflows from different parts of a municipality that may exceed expected levels.

3. Select Parameters to Focus on

Depending on the metal contents of the water it is now time to select focus areas for improvement. It is advisable to choose a maximum of two heavy metals at a time in order not to spread resources too thin. Which one is the most important to reduce? Could it be cadmium, zinc, or another heavy metal?

4. Analyze Samples from Collection System

Start to systematically take samples from different parts of the collection system in order to identify the sources of the heavy metals chosen. As this work progresses it is important to also monitor the diurnal variations in the collection system. If contents of heavy metals increase at a particular time of the day or the week, this may provide important clues as to their sources.

5. Initiate Dialogue with Suppliers of Contaminated Sewage

Once sources of contamination have been identified a dialogue needs to be initiated regarding how to reduce volumes of heavy metals.

A similar method can then be used for the sampling and measurement of the contents of the various tracing elements in order to identify the sources of these among the suppliers of sludge into the system.

Calibration and Maintenance of Equipment

Routines for calibration, control, and adjustment of analysis equipment have to be documented and these activities have to be performed according to these routines. This regards equipment that is used for sampling and analysis of incoming and emitted waters and of sludge. When equipment does not meet requirements it has to be repaired. After repair the owner has to assess the validity of earlier analyses.

Contents of Chemicals Used

Owners are required to maintain a list of the content of tracing elements in chemicals used at the plant. Routines for the purchasing of chemicals need to be documented and it has to be clear from these routines how the impact on sludge quality is taken into account in purchasing decisions. The content of chemicals needs to be assessed at least once every year.

Down-Stream QA Routines

The owner of the certificate is not allowed to mix different batches of sludge in order to improve the quality. The quality of each batch has to be analyzed according to a sampling plan and analyses have to be made with respect to the 60 tracing elements and the result has to be documented and stored for later reference. In case of deviations from the required quality standards the owner is obliged to take steps to improve the quality.

After dispatch from the premises of the treatment plant the sludge is to be handled in a conscientious manner, inspiring confidence in customers. In case a subcontractor is responsible for the transportation and delivery of sludge to customers, a contract needs to be drawn up that makes explicit the respective responsibilities of the owner and the contractor. Sludge from waste water treatment plants that have been certified according to the Revaq system can only be sold to professional farmers. Storage of sludge has to follow documented routines and each batch has to be signposted with its origin and period of production.

The owner is required to make sure that each batch has been stabilized, hygienized, and that it has not been infected with salmonella.

Sludge that does not meet specifications is called divergent product. Any signage that indicates an approval of the product has to be removed. A divergent product cannot be delivered or used as a certified product. It is up to the owner of the certificate to demonstrate how batches of divergent product are handled.

Requirements for the Use of Sludge as Fertilizer on Farmland

According to the Revaq certification system treatment plants are allowed to apply the rules for use of sludge as fertilizer that were current the year when the sludge was produced. Rules older than three years cannot be applied, even if the sludge happens to be older than this.

In Revaq the maximum content of different tracing elements is specified. Particular restrictions apply to cadmium. The method for measuring the content of the various elements in the sludge is set down in the system specifications. The owner of the certificate has to calculate the amount of reduction of the content of each tracing element that has to be achieved each year in order for the plant to meet the Revaq requirements.

It is the responsibility of the owner to make sure that each batch of sludge can be traced to the farmland where it has been used. This is to be done using digital maps that have to be made publically available on the Internet. The data has to contain information regarding where each batch has been used, the delivery date, and the date when it has been spread on the land.

The owner has to use the tool for calculating the balance of cadmium that is available on the site of the association Svenskt Vatten and make sure that the balance of calcium is calculated for each field where sludge has been used. They should also maintain a dialogue with organizations, such as the association of farmers, in order to collect requirements and views from various groups in society that have an interest in sludge and in how it is used.

Withdrawal of Certificate

The Revaq certificate can be withdrawn on the following grounds:

- Delivery of sludge that does not meet requirements.
- The use of the brand name in connection with products that are not covered by the certificate.
- Inaccuracies in the certificate.
- Infringement of the certificate terms.
- Unpaid dues.
- Bankruptcy, liquidation, or sale of waste water treatment plant.
- Termination of the certificate on the part of the owner.

Unlawful use of the Revaq name or the certificate may also have legal implications that have to be settled in court.

In case of the withdrawal of the certificate, the owner has to immediately stop using the Revaq name in advertising or other forms of communication with customers.

The application for a renewed certificate, after withdrawal, will be subject to the same certification process as a new application.

Annual Audit

Activities at the plant are audited once every year, based on the documentation that has been approved through the certification process. At this audit all discrepancies compared to the certified processes will be noted and measures have to be taken in order to make sure that all activities are compliant with the certified routines.

References

Rules for the Revaq certification system – Issue valid until 1st of January 2015.