

CHALMERS



A Method for Treatment of Organotin Contaminated Marine Sediments: Degradation, Stabilisation and Leaching

Master of Science Thesis in the Master's Programme Infrastructure and Environmental Engineering

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Department of Civil and Environmental Engineering
Water Environment Technology
CHALMERS UNIVERSITY OF TECHNOLOGY
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Cover:
Filtrates obtained from developed sediment treatment processes.

Department of Civil and Environmental Engineering Göteborg, Sweden 2014

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ABSTRACT

High concentrations of tributyltin (TBT) are often found in sediment in harbors in Sweden. The chemical originates from boat paint where it has served as an antifouling-agent. Tributyltin in boat paint has been forbidden since 1993 in Sweden and since 2003 in the EU due to its toxicity and long half-life. Exposure to TBT has proven to affect hormone and immune system of marine organisms. High concentrations of TBT in sediment force the Port of Gothenburg to investigate sediment disposal options.

In this study a method was developed for treating TBT contaminated sediment. The treatment method in this master thesis has been developed based on experimental TBT remediation methods together with the stabilisation and solidification (s/s) method to meet existing regulation and limits concerning TBT in sediment set by the Swedish EPA and the Port of Gothenburg's current permission to relocate dredged material to deep sea storage at SSV Vinga.

Sediment was sampled and treated by acidic leaching of metals or a sediment shaking method. Treated sediment from both methods were then stabilised according to the s/s method.

Analyses of the TBT concentrations in the treated sediments and leachates from the stabilised sediment suggest that the vigorous shaking method is most efficient. The concentration of TBT in sediment was reduced by 600 µg/kg DS by using this method. The concentration of TBT is however still higher than the guidelines values for deposition at SSV Vinga and the Swedish EPA guideline values for inert waste

The leaching of TBT varies due to the chemical and physical character of the aquatic environment surrounding the sediment or the stabilised sediment. The leaching of TBT in fresh water corresponds to 75% of the leaching in water with high salinity. The leaching in an acidic, aerobic or anaerobic water environment is depending on whether the sediment is stabilised or not.

Key words: Organotin compounds, Contaminated sediment, Remediation, Degradation, Leaching, Stabilisation and solidification

Metod för behandling av sediment med tennorganiska förurenningar: Nedbrytning, stabilisering och lakning

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SAMMANFATTNING

Hög halt av tributyltenn (TBT) är vanligt förekommande i hamnsediment i Sverige. Tributyltenn har sitt ursprung från båtbottenfärg där den används för att förhindra påväxt av exempelvis alger och havstulpaner på båtens skrov. Båtbottenfärg med TBT har varit förbjudet sedan 1993 i Sverige och sedan 2003 i EU på grund av sin giftighet och långsamma nedbrytning. Exponering för TBT har visat sig påverka marina organismers hormoner och immunsystem. Höga koncentrationer av TBT i sediment har lett till att Göteborgs Hamn utreder alternativa möjligheter till omhändertagande av muddermassor.

I detta examensarbete har en metod för behandling av TBT-förorenade sediment utvecklats baserat på experimentella TBT-saneringsmetoder tillsammans med stabilisering och solidifiering-metoden (s/s). Sediment från hamnen behandlades genom att använda en metod för sur utlakning av metaller i jord. Sediment behandlades även med en skakmetod. Behandlat sediment från de båda metoderna stabiliseras sedan i enlighet med s/s-metoden.

Analyser av TBT-halter i det behandlade sediment samt lakvätskor från stabiliseringat sediment tyder på att skakmetoden är den mest effektiva metoden för avlägsnande av TBT. TBT-koncentrationerna i sediment minskade med 600 µg/kg TS med skakmetoden. Halterna av TBT är dock fortfarande högre i det behandlade sedimentet än vad gränsvärdena tillåter för inert avfall utfärdade av Naturvårdsverket och de gränsvärden som fastställts för Göteborgs Hamn för deponering vid SSV Vinga.

En slutsats är att lakning av TBT beror på de fysikaliska och kemiska parametrar i den akvatiska miljö som omger sedimentet eller det stabiliseringade sedimentet. Utlakningen av TBT i sötvatten motsvarar cirka 75% av utlakningen i saltvatten. Hur stor lakningen är i en sur, aerobisk eller anaerobisk miljö varierar beroende på om sedimentet är stabiliseringat eller ej.

Nyckelord: Tennorganiska ämnen, förorenat sediment, lakning, stabilisering och solidifiering

CONTENTS

ABSTRACT	I
SAMMANFATTNING	II
CONTENTS	III
PREFACE	V
1 INTRODUCTION	1
1.1 Backgroud	1
1.2 Aim and goals	1
1.3 Boundaries	2
1.4 Disposition	2
2 THEORY	3
2.1 Tributyltin	3
2.1.1 Tin and other organotin compounds	5
2.1.2 Removal and remediation techniques	5
3 DESCRIPTION OF CASE STUDY AREA	8
3.1 Water	8
3.2 Sediment	9
3.3 Dredging	9
3.4 Environmental legislations	9
4 EXPERIMENTAL	11
4.1 Sampling	11
4.1.1 Sampling of water	11
4.1.2 Sampling of sediment	12
4.1.3 Determine sediment characteristics	12
4.2 Tributyltin removal methods	12
4.2.1 Acidic leaching method	12
4.2.2 Vigorous shaking method	13
4.3 Stabilisation and solidification	13
4.3.1 Binders	14
4.3.2 Manufacture method	14
4.3.3 Bend test	14
4.4 Diffusion tests	15
4.4.1 Maximum available leaching tests	15

4.4.2	Surface leaching test	15
4.5	Laboratory process scheme	16
4.6	Chemical analysis	17
5	RESULTS AND DISCUSSION	18
5.1	Water and sediment status	18
5.1.1	Characterisation of water	18
5.1.2	Characterisation of sediment	19
5.2	Removal of TBT	19
5.2.1	Differences between treatment methods	19
5.2.2	Concentrations in sediment	22
5.2.3	Comparison to guidelines values	27
5.3	Stabilisation and solidification	29
5.3.1	Manufacture and cure of cement	29
5.3.2	Bend test	30
5.4	Diffusion tests	31
5.4.1	Maximum available leaching tests	31
5.4.2	Comparisons to guideline values	34
5.4.3	Surface diffusion tests	35
5.5	General discussion	40
6	CONCLUSIONS	42
7	SUGGESTIONS FOR FUTURE STUDIES	43
8	REFERENCES	44
APPENDICES		

Preface

This study has been conducted at the division of Water Environment Technology at Chalmers University of Gothenburg from November 2013 to June 2014.

I would like to thank my supervisors Ann-Margret Strömvall and Karin Karlfeldt Fedje at Chalmers and Anna Wilhelmsson at Cowi for their mentorship and feed-back during this time. Special thanks is given to Ida Fossenstrand at the Port of Gothenburg for sharing her experience in stabilising sediment, to Mona Pålsson for her knowledge and assistance at the Water Environmental Technology Laboratory and to Marek Machowski at the Division of Building Technology for the help at the concrete laboratory.

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Gothenburg June 2014

Anna Norén

1 Introduction

In this chapter the background of the study is described together with the aim, goals, boundaries and method.

1.1 Background

The Port of Gothenburg needs to be dredged continuously and several thousands of cubic meters sediment is to be removed every time. The sediment does however contain metals and organic pollutants, originating from for example the shipping industry and outlets in the river Göta Älv's drainage area. Measurements in the harbour basins have shown that the sediment has a high content of copper and tributyltin (TBT), both toxic for the aquatic environment. The average level of TBT in the suggested dredging area is 510 µg/kg DS (Holm, 2011). Several marine organisms are negatively affected by TBT in concentrations below 2 µg/kg DS (Magnusson et al, 2012).

TBT is degraded slowly in nature and its degradation compounds are toxic as well, thus treatment is needed in order to get a healthy seabed (Feng, 2013). There are a number of remediation techniques available today, but most of them have only been tested in laboratory or in pilot plant (Du et al., 2014). Thermal treatment has proven to be an efficient treatment method for a full scale dredging, but is expensive due to the heating costs for the large volumes of dredged material. Consequently new remediation methods are needed.

Sediments classifies as waste according to Swedish regulations. The regulation makes no exception for clean sediments.

Dredged material which classifies as clean has earlier been sent out to the disposal site outside Vinga and contaminated sediment has been relocated to the harbour basin in Lundby. After 2014/2015 the Lundby basin will be fully used, causing the Port of Gothenburg to look for other disposal measures regarding the contaminated sediment. An option is to treat the sediment and use it as a building material in the harbour according to the stabilisation and solidification methods.

The results from this study could contribute to a better aquatic environment and improve water and sediment statuses.

1.2 Aim and goals

The main aim is to develop a method to treat sediment contaminated with organotin compounds such as tributyltin (TBT). The treatment method should be applicable in large scale production in order to meet existing environmental regulations, and should also be a reasonable option for the Port of Gothenburg. By simulating environmental changes in water, leaching patterns of TBT from Göta Älv sediment will be investigated. The specific goals with the project are to:

- develop and test treatment methods, one based on sediment shaking for leaching of TBT, and the other based on acidic leaching of metals for soils. In both methods the sediment is stabilised with cement and fly ash after treatment.

- compare the developed treatment techniques for their efficiency of reducing TBT in sediment, and application in large scale dredging.
- determine if stabilised sediment passes the requirements from the deep sea disposal site SSV Vinga and to see if it could be classed as inert waste according to the Swedish Environment Protection Agency (Swedish EPA).
- investigate and compare how parameters such as pH, redox ability, aerobic and anaerobic conditions affect the leaching of organotins and TBT from untreated sediment and stabilised sediment stored in an aquatic environment.

1.3 Boundaries

This report will focus on the leaching of TBT and metals based on information from the Port of Gothenburg.

The strength of the stabilised sediment will be tested, but the focus will however be on the leaching of the stabilised sediment.

1.4 Disposition

Literature studies will be done to evaluate the existing TBT remediation methods and will serve as references when developing TBT treatment techniques, see Chapter 2. The stabilisation and solidification method will be investigated to be implemented in the treatment process. Description of the case study area is presented in Chapter 3. Designed treatment processes will be described in Chapter 4. Results and observations during the treatment will be noted and discussed in Chapter 5. In Chapter 6 the general discussion and conclusions are presented.

2 Theory

A literature study concerning TBT in sediments was done to get an overview of its environmental impact and degradation. By investigating and comparing existing TBT removal techniques, this knowledge will serve as the foundation to developing an experimental TBT removal technique. Enhanced soil washing will also be studied in order to investigate its possibility to degrade or extract TBT out of the sediment.

The stabilisation and solidification method (s/s) will be examined and current legislation concerning sediment is described.

2.1 Tributyltin

Tributyltin (TBT) is an artificial organotin compound, consisting of a tin atom and three butyl-groups. It was used in boat paints as an antifouling-agent to prevent fouling for example algae and barnacles. Tributyltin in boat paint has been forbidden since 1993 in Sweden and since 2003 in EU (Bengtsson & Wernersson, 2012) due to its toxicity.

Tributyltin is very toxic even in low concentrations and affects hormones and the immune system in organisms. Concentrations of TBT below 1 ng/L in sea water and 2 µg/kg DS in sediment are toxic for several marine organisms (Magnusson et al, 2012). The toxicity of organotins, and TBT in particular, are comparable with dioxins which is one of the most toxic substances released into the environment (Bengtsson & Wernersson, 2012). Tributyltin is classified as one of the prioritised compounds in the Swedish version of the water directive (Magnusson et al, 2012).

Exposure to TBT causes imposex in gastropods and molluscs (Castro et al. 2008). The fertility of gastropods is reduced partly or completely and leads to a premature death, having an impact of entire populations. Several other species are affected and on the west cost of Sweden high levels of TBT have been found in wrack, mussels, eelpout and cod liver. Dead marine mammals have been found with high levels of TBT in their livers. Known effects on humans are severely irritated skin and respiratory problems.

It takes several years for TBT to be degraded in nature. Some microalgae can degrade organotin compounds into tin, if the concentrations are below 25 µg/L (Feng 2013). The degradation of TBT into tin consists of numerous steps, see Figure 1. During aerobic conditions TBT is degraded into DBT (dibutyltin), and then into MBT (monobutyltin) (Cato et al, 2007), and the half-life vary between 1–3 years (Magnusson et al, 2012). If the environmental condition is anaerobic, the half-life of TBT could be years or even decades. During unfavourable conditions, the half-life could be up to 90 years (Magnusson et al, 2012). Laboratory scale experiments of wastewater treatment plants have shown that degradation of TBT generally is three times higher in an aerobic environment than in anaerobic.

In water the half-life of TBT is between 1–3 weeks (Port of Antwerp, 2003). Thus the degradation is enhanced during transfer from solid to liquid phase.

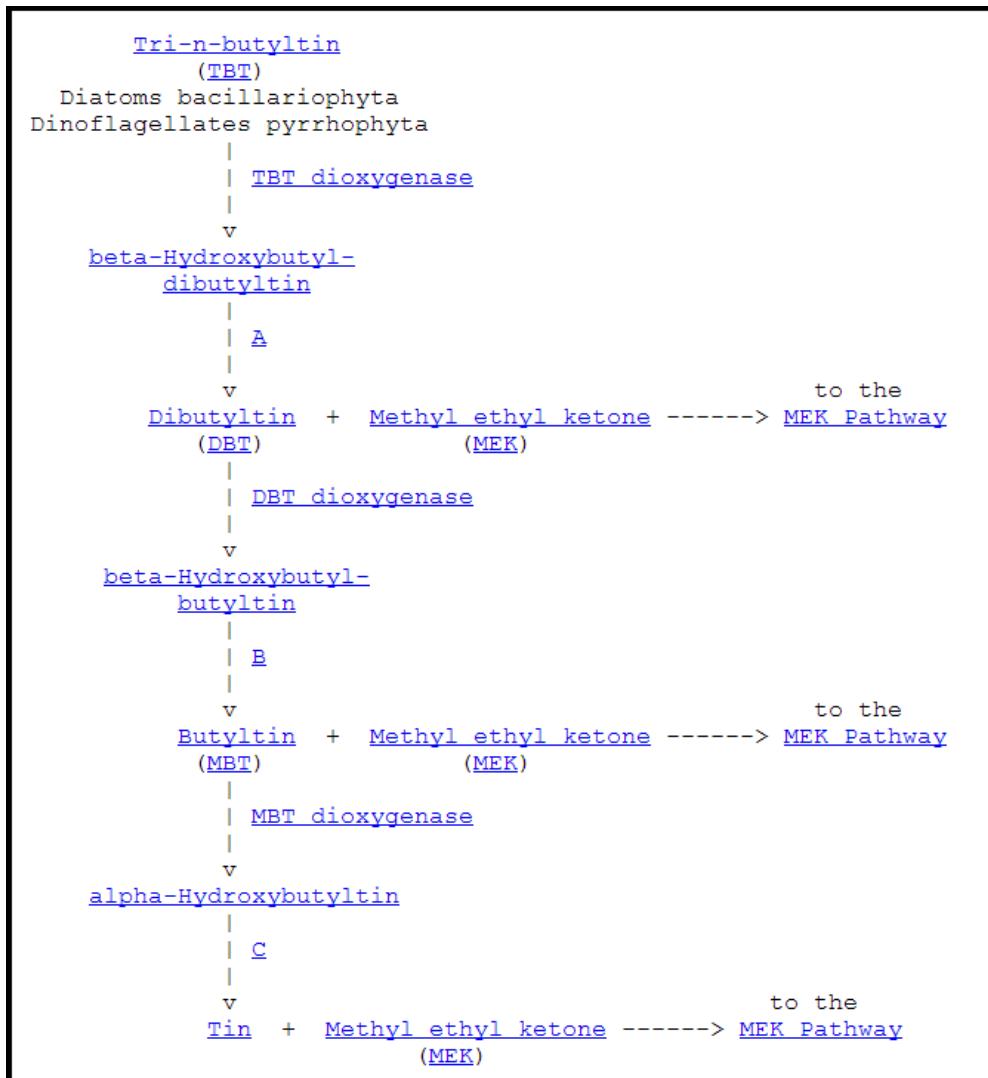


Figure 1. Degradation of tributyltin by algae (Feng, 2013)

Sunlight and UV increases the degeneration of TBT (Port of Antwerp, 2003). The temperature is also of importance for the degradation of TBT. Warmer temperatures accelerate the decomposition of TBT into DBT and MBT.

When increasing the pH the TBT half-life is decreasing. The solubility of TBT is also pH-dependent at pH 2.6 the solubility is 750 mg/L and at pH 8.1 it is 3 100 mg/L (Port of Antwerp, 2003).

Tributyltin is strongly bounded to particles in sediment and water (Castro et al, 2008). The bound to organic content is important at high concentration of salinity (Stichnothe et al. 2001). The salinity also affects the extraction rate of TBT, which is four times higher in 5 M NaCl than in 1 M NaCl.

When the quota between TBT and its degeneration compounds, DBT and MBT, is greater than one, it means that accumulation of TBT is greater than the degradation (Cato et al, 2007).

Tributyltin (TBT) is highly volatile and is easily released during a dredging (Port of Antwerp, 2003).

2.1.1 Tin and other organotin compounds

Tin is the resulting metal during the degeneration of TBT, see Figure 1. It is a natural occurring metal and is present in the earth's crust as tinstone or cassiterite. Tin compounds can be inorganic or organic (Winship, 1988).

Inorganic tin has a low toxicity. If tin is consumed, 95% of it goes straight through the intestinal system. The resulting 5% is distributed in the body and is eventually extracted by the kidneys.

Organotins consists of tin and one or more organic group. The group of organics attached to the tin are significantly related to the toxicity of the compound (Smith, 1978). Ethyl-organotins are the most toxic, followed by methyl-, propyl- and butyl-organotins (Winship, 1988). The toxicity is the highest within the triorganotin group. Di- and monoorganotin groups' toxicity is generally gradually lowered. Organotins are used in antifouling agents, biocides, plastic stabilisers and as catalytic agents (Lu et al, 2004).

Tetraorganotins have low toxicity and are stable compounds (Australian Government Department of Environment, n.d.). Tetrabutyltin (TTBT) is often used as industrial catalytic and could be metabolised into the triorganotin TBT.

Triorganotins are phytotoxic and are often used as biocides (Lu et al, 2004). They are considered the most toxic of all organotins (Winship, 1988). Triphenyltin (TPT) has proven to have the same effect on hormones for molluscs as TBT (Castro et al., 2008). It also affects the immune system negatively. Triphenyltin is a prioritised pollution in several countries (Lu et al, 2004). Animal experiments with tricyclohexyltin (TCHT) have been shown to affect the liver and metabolism of mammals and gastropods (FAO & WHO, 1970) and are the most toxic compound of all triorganotins.

Diorganotins are generally less toxic than triorganotins and have no antifungal and antibacterial activity (Australian Government Department of Environment, n.d.). Diphenyltin (DPT) and dibutyltin (DBT) has shown to be three times less toxic than TPT and TBT respectively (Committee on Minerals and Toxic Substances in Diets and Water for Animals, 2005). Dibutyltin is however believed to affect the metabolism and immune system negatively (Gumy et al, 2008). Dioctyltin (DOT) is another one of the diorganotin and has shown to be harmful to the immune system and the thymus when tested on rats (Boyer, 1989).

The monoorganotins have very low toxicity and does not have any biocide abilities (Australian Government Department of Environment, n.d.). They are used in PVC plastics. Examples of monoorganotins are monobutyltin (MBT), monophenyltin (MPT), monoocetyltin (MOT).

2.1.2 Removal and remediation techniques

A difficulty when designing remediation techniques for TBT is that organotin consists of both organic groups and a metal, which means its behaviour is somewhat complicated since it neither acts as a typical organic compound or a metal.

There are techniques available to reduce the concentration of TBT, for example adsorption, biodegradation, chemical/electrochemical oxidations, coagulation/flocculation, phytoremediation, solvent extraction and thermal treatment

(Du et al., 2014). However, most of the techniques have only been done in laboratory scale or in pilot plant. Some treatment techniques of interest are described below.

The stabilisation and solidification method (s/s) is a way to treat polluted sediment (SGI, 2011). By mixing dredged material with a binder mixture, containing binder agents such as cement, blast furnace slag and/or fly ash, a monolithic mass can be formed. Pollutants are bounded chemically in the stabilised sediment and during the production pollutants could be converted into less dangerous substances. The stabilised sediment can, if it meets environmental and building requirements, be used as a building material in a sustainable way, see Figure 2.

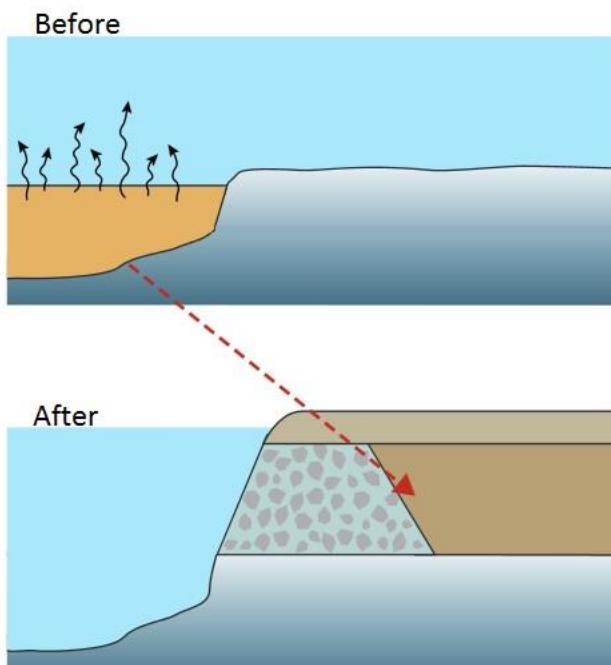


Figure 2. The stabilisation and solidification method (SGI, 2011) (with modifications). Before: Polluted sediment in contact with water. After: Stabilised sediment used in a platform, protected from water by a barrier.

Stabilisation and solidification for polluted sediment has been used in a few locations in Sweden and seems to be on the rise (SGI, 2011). Similar methods have been used to improve the geotechnical properties of soil for 40 years. In other countries such as USA and England this method has been used for more than 15 years with good results.

Thermal treatment has been used in large scale dredging and has proven to be successful for removal of TBT. By heating up the dredged material to 203°C for two hours all TBT and DBT, and approximately all MBT, are disintegrated into tin (Port of Antwerp, 2003). This alternative is efficient but not cost-efficient since it consumes much energy to heat up large quantities of sediment.

Soil washing could be efficient to remove TBT (US EPA, 1993). The technique is proven to be efficient when removing metals from soil. A liquid, for example water, is used to mechanically scrub the soil (US EPA, 1996). This way pollutant is concentrated within the finer fractions of the soil which could be separated and further

treated, reducing the volume of contaminated soil. Chemical additives are sometimes added to enhance treatment efficiency. One way is to acidify the soil using hydrochloric acid. At low pH metals are released from its bounds and can thus be used to reduce and extract high levels of metals in contaminated soils. If it is carried out properly and is cost-effective, metals can be recovered.

An experiment carried out by Fent 1996 has proven that 80% of the TBT in sediment has been removed during three days by vigorously shaking it. Tributyltin is bounded to particles and by shaking the sediment with a fluid, TBT is removed mechanically from the bound and enters the liquid phase. The liquid could then be obtained and treated separately.

Electro-chemical oxidation has been proven to have an efficiency of up to 67% in laboratory scale experiments (Stichnothe et al. 2001).

Most pollution is attached to the finer sediments such as silt and clay but also humic matter; hence by sieving the sediment it could be possible to remove TBT by sorting finer particles and treat it separately (Eschenbach, 2001).

UV-treatment can be performed on TBT in liquid phase (Port of Antwerp, 2003). This treatment method has successfully removed up to 99.9% TBT in large scale water treatment. The method is considered cheap and is not so time consuming compared to most other alternatives. Activated carbon filtration, activated sludge removal and solvent extraction are other potential removal techniques for TBT in liquid form (Port of Antwerp, 2003). Since TBT is strongly bound to organic matter it is possible to gather waterborne TBT into sludge (Fent, 1996).

3 Description of case study area

There is a constant exchange of chemicals between water and sediment. By investigating both water and sediment, a greater overview of the situation in the river Göta Älv is given. Properties for sediment could vary a lot, even at different locations within the same water body. Shipment traffic, wind and the flow of the river is causing water movements at the location of the case study area. This affects the sedimentation of particles as well as the exchange of ions between water and sediment. For every location where a dredging and/or stabilisation and sedimentation is to be done, local sediment parameters must be investigated and evaluated in order to optimise cost and quality. Literature about earlier measurements of water and sediment collected at the sampling point and its surroundings are described in the sections below.

3.1 Water

The Göta Älv originates from Lake Vänern and transports freshwater into Kattegat. When the freshwater meets the heavier colder saltwater a saltwater wedge is formed in the mixing zone (Lindén & Saglamoglu, 2010). Due to parameters such as wind conditions, water flow in the river and sea level, the location of the saltwater wedge moves up and down the river constantly changing the bottom environment at its presences, see Figure 3.

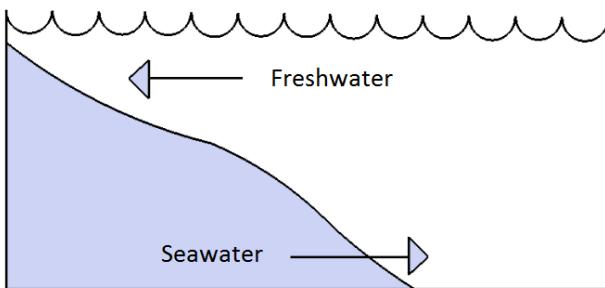


Figure 3. Saltwater wedge (Lindén & Saglamoglu, 2010) (with modifications).

Other water parameters, such as oxygen level and conductivity also changes during the months and years in Göta älv (Göta älv's vattenvårdsförbund, 2004 & 2005). The average oxygen level in Göta Älv is 10.7 between 2011 and 2012 (Göta älv's vattenvårdsförbund, 2013). An oxygen level above 7 mg/L indicates an oxygen-rich bottom (Swedish EPA, 2000).

The pH value of sea water is varying between 7.5 – 8.4 according to Bydén (2004). During the year the average pH value of Göta älv varies, but has an average of 7.3 throughout the river (Göta älv's vattenvårdsförbund 2013). Measuring conductivity is a way to measure the ion content in a fluid. About 90% of the ions present in seawater are sodium chloride (USGS, 2014). The conductivity in seawater is around 4 S/m and in freshwater it is around 10^{-3} S/m. The salinity of the water can be calculated by the simplified conversion: 1 mS/cm = 600 NaCl mg/L (Queensland Government, 2012).

3.2 Sediment

The sediment in this study originates from the harbour of Gothenburg. A high level of TBT in the sediment is well documented and is believed to be originating from the shipping and shipyard industry in the area. Surface sediment (0–5 cm) in 2011 had an average TBT concentration of 288 µg/kg DS, and deeper down in the sediment (30–35 cm) the average concentration of TBT was 734 µg/kg DS, thus creating an average TBT content of 511 µg/kg DS (Holm, 2011). Regular tests performed by the Port of Gothenburg confirm that the TBT-levels are decreasing in the sediment due to natural degradation but are still a lot higher than guideline values set by the Swedish EPA.

Sediment at the sampling location consists mainly of clay. The grain size determines the properties of the sediment. An investigation about the finer particles in the sediment in the area was made by Ramböll in 2013, and it was noted that around 50% of the particles were size distributed below 0.63 mm, see Appendix A.

3.3 Dredging

The Port of Gothenburg has a continuous need to dredge in order to maintain depth and safety. In a typical maintenance dredging campaign at the Port of Gothenburg 30 cm or more of the bottom sediment is removed. For the dredging campaign in 2014 a total volume of 200 000 m³ is to be dredged according to Fossenstrand (2013). In Sweden a total of 14 million m³ sediment is expected to be dredged within years, of which 2.5 million m³ is assumed to be polluted (SGI, 2011).

The two major ways to take care of dredged material in Sweden is to put it on deposition, either on land or to send it out into sea (SGI, 2011). Deposition on land is the most expensive way to treat the dredged material since it must be cleaned and stored in regulated ways. The price of deposition on land is >1 500 SEK/m³. Deep sea storage is when the dredged material is deposit out at sea, often without any treatment at all. This alternative is cheaper than land deposition, 25–50 SEK/m³. Cost for treating sediment with the s/s method is estimated to be around 150–300 SEK/m³ (SGI, 2011).

3.4 Environmental legislations

Regulations concerning dredged material will be investigated: SSV (south south west) Vinga's and the Swedish EPA's. Concentrations of substances in sediment and water will be analysed, assessed and compared with these values.

SSV Vinga is the name of a disposal site that has been used as storage for dredged materials from the Port of Gothenburg since 1970 (Göteborgs Hamn, 2013). Dredged materials must have lower concentration then set limit values in order to be disposed outside Vinga, see Table 1.

Table 1. Requirements for dredged material at SSV Vinga (Göteborgs hamn, 2013).

Metals	Unit: mg/kg DS
Arsenic, As	<100
Cadmium, Cd	<1
Cobalt, Cc	<150
Chromium, Cr	<200
Copper, Cu	<100
Iron, Fe	<400 000
Mercury, Hg	<1
Nickel, Ni	<150
Lead, Pb	<100
Tin, Sn	<10
Vanadium, V	<500
Zink, Zn	<750
Organotins	Unit: µg/kg DS
Tributyltin, TBT	<200

The Swedish EPA has regulations concerning dredged material. Requirements for a dredged material to be classed as an inert waste according to the Swedish EPA are posted in Table 2. If the results from both the leaching test and from analyses of concentrations within the sediment are below these limits, the sediment can be put on landfill.

Table 2. Swedish EPA's regulations concerning inert waste (Naturvårdsverket 2006).

	c0 (L/S = 0,1 l/kg) mg/L	L/S = 10 l/kg mg/kg DS
Arsenic, As	<0.06	<0.5
Barium, Ba	<4	<20
Cadmium, Cd	<0.02	<0.04
Chromium, Cr	<0.1	<0.5
Copper, Cu	<0.6	<2
Mercury, Hg	<0.002	<0.01
Molybdenum, Mo	<0.2	<0.5
Nickel, N	<0.12	<0.4
Lead, Pb	<0.15	<0.5
Antimony, Sb	<0.1	<0.06
Selenium, Se	<0.04	<0.1
Zink, Zn	<1.2	<4
Chloride, Cl	<460	<800
Fluorine, F	<2.5	<10
Sulphur, S	<1500	<1000
Phenol index	<1	
DOC	<160	<500
Dry substance for dissolved particles		<4000

4 Experimental

Based on literature studies, laboratory processes were created with the intention to develop a feasible TBT remediation technique in larger dredging scale.

4.1 Sampling

Based on results from earlier sediment sampling and chemical analysis done by the Port of Gothenburg, a location with high TBT-concentrations near the dock was chosen to be investigated. Sampling of water and sediment were carried out 27th of November 2013.

The location was accessed by boat and the sampling was done by a diver under the supervision of a marine geologist from COWI. A Van Veen grab sampler was lowered to the bottom where the two clam shaped jaws shut and captured sediment, which could be brought up to the surface and be examined to make sure the location was suitable for sampling. When arriving to a sampling point, the location and water depth was given by a GPS and sonar on the boat. To see where the sampling was made, see Figure 4.



Figure 4. Sampling point as seen on a map (left) and from air (right) (Eniro, 2013).

4.1.1 Sampling of water

Water was collected before taking the sediment samples. The water was taken a bit above the bottom to minimise the impact that the diver could have induced while swimming up and down with the plastic bottles. Six plastic bottles of five litres each were collected at the sampling site. The temperature on the bottom was measured by the diver. Parameters measured were:

- Water temperature at bottom
- pH
- Oxygen content
- Conductivity

The parameters were measured with a Multi-Liner directly after the samples were collected on the boat.

The water samples were stored in a seven degrees temperature stable room at Chalmers and were sent for, organotin compound and metal analysis including tin at an external laboratory.

4.1.2 Sampling of sediment

Samples of sediment were obtained by the diver by scooping up sediment with plastic 22 litres containers. A volume of approximately 40 litre was obtained and at depth of 0 to 35 cm in the sediment.

After the sampling the sediment was stored in containers at Chalmers in a climate room with a constant temperature of 7°C. A sediment sample was sent to external laboratory for analysis of tin, tin organic compounds and other metals.

4.1.3 Determine sediment characteristics

SS-EN 028113 is a standard which was used to determine water content and organic content in the sediment. Water content was investigated by putting sediment into a porcelain dish and incinerated it in a Muffle furnace at 105 °C for 24 hours in order for the water to vaporise.

Sediment used to determine the water content was thereafter placed in a Muffle furnace at 550 °C for 2 hours to incinerate the organic content. Soils with less than 20% organic content get a large uncertainty using this method. To determine the organic content at low concentrations, a carbon analyser is a more reliable tool in that scenario (SGI, 2008). However, the method being used gives an estimation about the sediment content and is easily performed.

4.2 Tributyltin removal methods

Two TBT removal methods were designed; the acidic leaching method (A.L), and the vigorous shaking method (V.S). Both were designed having the volume of a large scale dredging process in mind. The execution of each process is described in the following subchapters. About 8 kg of the sediment was treated by using the acidic leaching method and 7 kg sediment was treated by the vigorous shaking method. Milli-Q was used in both treatment methods and in leaching tests. It is a high purity water filtered through 0.22 µm pore size (18.2 MΩ cm at 25°C).

Treated sediments were analysed by an external laboratory and fluids extracted from the treatment processes were analysed by an external laboratory and with ICP-MS, see Chapter 4.6.

4.2.1 Acidic leaching method

The working process for the acidic leaching method was based on the master thesis “*Soil Washing: Optimization of Acid Leaching of Copper from Contaminated Soil*” by Eriksson & Johansson (2013) but with some modification due to the characteristics and amount of sediment to be washed. A sample of sediment, with a mass of 200 g, was put in a plastic 1 litre bottle together with 100 ml leaching agent. The bottle was put on a magnetic stirrer for 30 minutes in order to get a thorough mixing.

As leaching agent an acidic waste liquid i.e. process water was used. The process water is a residue and came from the wet flue gas cleaning after waste incineration at Renova's facility in Sävenäs, Gothenburg. The pH of the process fluid was determined to 0.1. See analysis of chemical content in Appendix B.

In order to separate the access acidic water the sediment mixture was put in a 4–7 µm paper filter covered funnel in a glass suction bottle. When no more fluid was obtained through filtration, the sediment was moved into another filter covered funnel. Milli-Q, with a volume of 100 ml, was poured onto the sediment and filtered to extract excess acid.

4.2.2 Vigorous shaking method

A sample of sediment, with a volume of 300 ml, was put in a 1 litre Plexiglas tube together with 700 ml 5 M sodium chloride. The tube was then placed in a shaker, which rotated the tube one turn per second, see Figure 5. After being spun in the machine for 24 hours the sediment mixture was poured into a 5 litre glass container in order for the sediment to settle, be decanted and filtered through a 4–7 µm filter. Foam formed during the settling process was removed.



Figure 5. The vigorous shaking method in action.

4.3 Stabilisation and solidification

Two recipes was chosen based on the results of the stabilisation and solidification master thesis “*Stabilisering och solidifiering av muddermassor i Gävle hamn*” by Fossenstrand which was carried out in Gävle 2009. The mixing quantity that was chosen to be used was 150 kg/m³. The difference between the two recipes was the cement/fly ash ratio, 20/80 and 30/70 respectively, to see how the strength dependent on the amount of cement used. The characteristics for the fly ash and cement are described in the sections below.

Sediment treated with the A.L method, fly ash and cement was mixed according to the recipes. The same was done for the V.S sediment, to investigate how the treatment methods affect the abilities of the stabilised sediment in terms of strength and

diffusion. Recipes can be found in Table 3. The samples stabilised for 28 days to receive a representative strength.

The stabilised sediment was manufactured and tested at the concrete lab at Chalmers.

Table 3. Stabilisation recipes.

	Cement/ fly ash	Sediment [kg]	Cement [kg]	Fly ash [kg]
C1A	80/20	3.657	0.373	0.093
C1B	70/30	3.657	0.326	0.140
C2A	80/20	3.657	0.373	0.093
C2B	70/30	3.657	0.326	0.140

4.3.1 Binders

Two kinds of binder agents have been used in order to stabilise the dredged material; fly ash and cement. The binder agents are described below. Further information about the binders used could be found in Appendix C.

Fly ash is the general term used to describe the solid residue after separating solids in the smoke produced during an incineration process. The fly ash used was from Mölndals Energi where only biomass is used as a fuel. The content of the fly ash varies, due to variations of fuels. Mölndals Energi produces between 4 500 to 5 000 tons of fly ash as a residue each year (Fors, 2014).

The cement used is construction cement CEMII/A-LL 42,5 R from Cementa made in Skövde.

4.3.2 Manufacture method

The dry binder ingredients, fly ash and cement, were weighed and mixed in a metal bowl. Sediment was then weighed and put together with the binders and mixed for 2 minutes.

Each piece of concrete was made by filling a mould to the half and vibrated it in order to get rid of gas bubbles. When no more bubbles appeared the mould was filled to the top, vibrated and the surface was smoothed with a butter knife. The vibrating and smoothing process was repeated until no bubbles were formed. This procedure was done for six moulds with dimensions 40 * 40 * 160 mm and a cylindrical mould with diameter of 100 mm and a height of 100 mm for each recipe.

4.3.3 Bend test

Strength variation for the two recipes within each treatment method was determined by bend-testing the stabilised sediment. The bend test was chosen mainly due to the reduced volume need of treated sediment, compared to other available strength tests.

A piece of stabilised sediment with dimensions 40 * 40 * 160 mm was put in the machine. In the middle of the test piece, pressure was applied by the machine until the

test piece fractured, see Figure 6. Resulting strength could then be noted. This was repeated for all test pieces of each recipe.

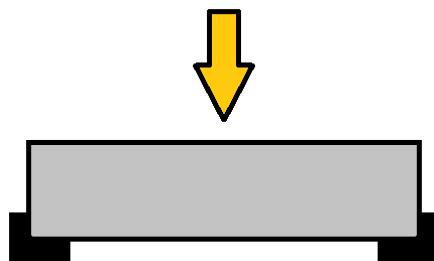


Figure 6. Bend test sketch. The arrow represents the applied pressure on the test piece.

4.4 Diffusion tests

In this study two types of diffusion tests were chosen to investigate the leaching from the sediment and stabilised sediments: The maximum available leaching test and the surface tests.

4.4.1 Maximum available leaching tests

The diffusion test used was the standardisation SS-EN-12457-3. This method is used to determine the maximum available leaching. Since the aim is to get a representative result for diffusion from sediment and stabilised sediment from Göta Älv, the tests were done in both Milli-Q and saline water. The saline water consisted of Milli-Q and sodium chloride (NaCl) diluted such that the conductivity was as high as in the river as at the time of the sampling of sediment. The formula used to calculate the salinity is presented in Chapter 3.1. A simplification, that all salts were sodium chloride, was made to facilitate the L/S10 diffusion experiment.

Sediment was put in two plastic bottles with lids in an amount corresponding to a dry weight of 200 g each. In one bottle Milli-Q was added and in the other saline water was added. The bottle was then placed on a shaking table with a speed of 100 min^{-1} to get a thorough mixing during the leaching test. After six hours the fluids were extracted by using a centrifuge at a speed of 3000 RCF for 15 minutes. Fresh Milli-Q and saline water was then added and the bottles were placed on the shaking table for additional 18 hours, and then centrifuged. The contents of the two fluids were used to calculate the maximum leachate of the sediment.

Stabilised sediment was crushed into 4 mm pieces according to the standardisation method and then the same procedure as described above was done for them as well.

4.4.2 Surface leaching test

Standard NEN 7375 tests were done, as well as altered tests with changed salinity, pH-level, oxygen level and nitrogen level to investigate how different environmental parameters affect the leaching. Saline water consisted of Milli-Q and sodium chloride diluted to such concentration as the salinity at the study area at the time of the sampling. The buffer that was used in the decreased pH value test consisted of sodium

hydroxide and citric acid and had a pH of 6. Aerobic and anaerobic conditions were created through addition of oxygen and nitrogen respectively. The tests were performed on the sediment and the stabilised sediment.

Each time the fluids were replenished, their pH and conductivity were measured. Content of metals in each leachate was analysed with ICP-MS in order to get time-dependent leaching curves. Leachate fluids were sent to external laboratory for analysis of organotin compounds, metals, sulphur and fluoride on the ninth day. The ninth day was chosen to get representative value to be compared with, and was mainly because of the cost of running the nitrogen tests.

4.5 Laboratory process scheme

This subchapter contains a summary of the experimental working process. Each step is further described in their respective chapters earlier in this thesis.

Step 1. Treatment of sediment

Two treatment techniques were carried out. Geological characteristics such as water content and organic content were determined for untreated and treated sediment. For each treatment method, the sediment was stabilised and solidified by adding fly ash and cement according to two recipes, see Figure 7. The stabilised sediment cured for 28 days.

Treatment s/s	Name
V.S	80/20 C1A
V.S	70/30 C1B
A.L	80/20 C2A
A.L	70/30 C2B

Figure 7. Treatment scheme. 80/20 and 70/30 represent the cement/fly ash ratio used for stabilising the treated sediment.

Step 2. Tests performed on untreated and stabilised sediment

After being cured for 28 days, bend tests were performed to determine the strength of the stabilised sediment. The strongest stabilised sediment within each treatment method was chosen to be used in maximum available leaching tests. Leachates were analysed, and the stabilised treatment method that resulted in the lowest emission of TBT was chosen to be used in surface leaching tests in different aquatic environments. See Figure 8.

Maximum available leaching tests and surface leaching tests were performed on untreated sediment.

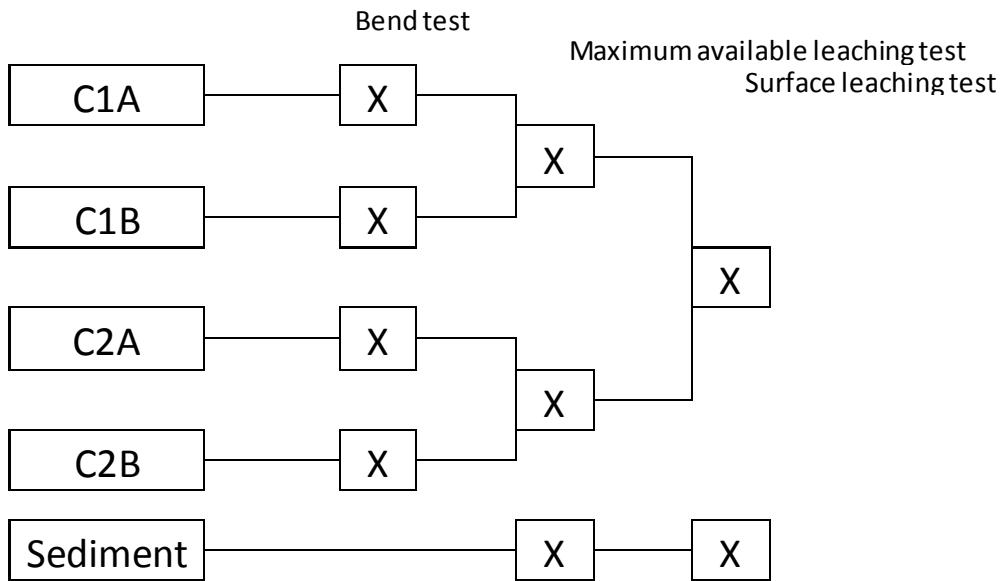


Figure 8. Test schedule.

4.6 Chemical analysis

Samples taken during this study was analysed for tin and other metals at Chalmers with ICP-MS (inductively coupled plasma mass spectrometry) and the parameters presented in Table 4 were analysed at an external certified laboratory. The liquid parameters pH, oxygen level, conductivity and temperature were measured with electrodes in a Multi-Liner instrument.

Table 4. Methods used at external laboratory.

Substance	Sediment	Water
Metals	SS 028150-2/ICP-MS SS 028150-2/ICP-AES ISO 11466/EN13346 mod. / ICP-MS	SS 028150-2/ICP-MS SS 028150-2/ICP-AES
Hg	SS 028150-2 / AFS	SS EN 1483
Organotins	DIN 19744	EN ISO 17353
Sulphur		St Meth 4500-SO4 / Kone
Fluorine	St Meth 4500-F / Kone	St Meth 4500-F / Kone
DOC		SS EN 4484
Dry matter	SS EN 12880	

Some test had a liquid volume less than the volume of the sampling containers to be sent to the external laboratory, due to test standards. In those cases the liquids were diluted to be able to meet the required volume set by the laboratory. The result of those analyses were calculated to corresponding content in the undiluted liquids, hence some results in Chapter 5 and in Appendix E may seem to vary.

5 Results and discussion

In this chapter results from the laboratory experiments are presented and discussed.

5.1 Water and sediment status

Specific results for water and sediment obtained while sampling are described in following subchapters.

5.1.1 Characterisation of water

The concentration of oxygen in the water at the bottom at the sampling site was 8.2 mg/l (see Table 5). It indicates an oxygen-rich bottom according to the Swedish EPA (2000). This would enhance the degradation of TBT compared to an anaerobic bottom. The oxygen content does however vary during the year and reaches its peak values during spring and autumn, meaning that the oxygen levels were probably higher than usual during the time of the sampling (2013-11-27). Due to differences in density between lighter freshwater and heavier seawater, the wedge makes it difficult to oxygenate the water at the bottom. It would be informative to have measured the surface water at the sampling point, thus knowing if the saltwater wedge was present at the location or if the water was throughout saline.

Table 5. Data taken when sampling. * Height above bottom.

GPS-coordinates: N 57° 42.350', E 11° 57.008	Unit
Water temperature at bottom	9.8 °C
Oxygen content	8.2 mg/L
Conductivity	44.2 mS/cm
pH	8.0 -
Water depth	10.4 m
Water collected *	9.1 m
Sediment collected *	0–35 cm
Water level	+19 cm

Conductivity in the sampled water was 44 mS/cm, which is corresponding to a salinity of 27 NaCl g/L. Based on the conductivity the water closest to the bottom is sea water according to the USGS (2014). This means, according to Stichnothe, that the bound between TBT and organic content is strong.

The water at the sampling location had a pH of 8 which could also be seen as an indicator of seawater. According to Göta älvs vattenvårdförbund 2013, the average pH in the river is 7. Since the drainage area of Göta Älv does not consist of calcareous bedrock that would increase the pH level of the river, it is a likely assumption to believe that the saltwater wedge is present at the location. A high pH does also indicate that the solubility for TBT is high, but according to analysis result all organotin compounds were in concentration below detection limit in the water sample, see Appendix E. The overall water condition seems to indicate that degradation of TBT could take place naturally.

5.1.2 Characterisation of sediment

Investigation of soil fraction in a location close to the sampling point implies that the sediment consists of silty clay (SGI, 2008). Some of the sediment characteristics were determined at Chalmers. By drying the sediment at 105 °C and crushing it, it could be determined that the sediment is well mixed and the fraction is difficult to sieve. The obtained bulk unit weight and low organic content ratio point towards a sediment consisting of clay moraine, according to SGI's *Jords Egenskaper*. The overall conclusion is that the soil consists of silty clay.

Visible oil spot in the water covering the sediment were observed in the plastic 22 litres containers. A smell of oil was also emitted from the sediment. A small gastropod and polychaetes were found in the sediment, otherwise no plants or animals were observed. The sediment was covered with an oxidised surface, and beneath this the colouring was black, see Figure 9.



Figure 9. Sampled sediment. Notice the difference in colour between oxidised surface and underlying sediment.

5.2 Removal of TBT

The differences in concentrations and characteristics between the untreated and treated sediment are presented below. Observations during the treatment are also described.

5.2.1 Differences between treatment methods

Differences in colour were observed between the untreated, A.L and V.S sediment, see Figure 10. The dark colour of the untreated and V.S sediment could imply that the sediment contains oil substances. Odours from the untreated sediment and the fact that the sampling point is located close to the dock supports this theory as well.

The colour of the A.L sediment changed from black to brown during the treatment process, which could give an indication of a high content of oil, see Figure 10. The reaction between the basic sediment and the acidic process fluid may have started a degradation of oil residues, resulting in a lighter colour. During the mixing process of sediment and the acidic process water the gas H₂S may be released, revealed by the smell of "rotten eggs". While mixing the sediment flakes of metal attached the magnet flea, indicating the presence of pure metals, see Figure 11.

Vigorous shaken sediment had an odour of decay similar to the one often present by beaches, unlike the untreated and A.L sediment. This could imply the V.S method activated the degradation of organic matter within the sediment by microorganisms.



Figure 10. Sediment: A.L (left) Untreated (middle).V.S (right).
Top: 22 °C. Middle: 105 °C. Bottom: 550 °C.



Figure 11. Flakes of metal attached to a magnet flea.

Filtrate obtained from the A.L-method had a brown amber colouration that could be caused by iron released due to the lowered pH. It is also possible that oil residue has been extracted from the sediment, giving the leachate a dark nuance. When Milli-Q was added to the sediment to remove access acid, the filtrate received a lighter nuance of the same brown amber colour. This fluid was transparent unlike the acidic leachate see Figure 12.

During the mixing process of the V.S sediment and the saline water it is likely that humic acid present in the sediment has been leached out, resulting in the light golden colour of the V.S fluid, see Figure 12.



Figure 12. Acidic filtrate (left), Acidic + Milli-Q filtrate (middle) and V.S filtrate (right).

The different sediment types had also different pH-values, see Table 6. The pH of the sediment dropped from 7.7 to 2.2 during the A.L process due to the addition of the acidic process fluid. Untreated and V.S-treated sediment had a small difference in pH, 7.7 and 7.5 respectively.

Table 6. pH value in sediments and liquids.

Sediment	pH
Untreated sediment	7.7
V.S sediment	7.5
A.L sediment	2.2
Liquid	pH
Acidic filtrate	1.1
Acidic + Milli-Q filtrate	1.8
V.S filtrate	7.4

Characteristics of the different sediments are described in Table 7. The most noticeable change was between untreated and V.S sediment where the moisture ratio was lowered and the organic content was increased. The content of salt in the V.S was very high, as salt crystals can be spotted on the surface for the dried samples in Figure 10. This result is caused by the treatment method. The structure of the sediment changed during the vigorous shaking method (V.S) from being a compact thick cohesive mass until becoming a thick fluid. When being stored in a container, a certain separation of water and sediment was observed, but the sediment did not completely return to the same structure as before the shaking process. This sedimentation process explains why the bulk densities are higher and moisture ratio is

lower for sediment treated with the V.S method compared to the untreated and A.L sediment. While examining the moisture rate and organic content it appeared that the untreated and the A.L treated sediment was most similar, see Table 7. This could also been seen in the way the sediment dried after had been put in the 105°C and 550 °C ovens, see the two lower pictures of the dried sediments in Figure 10.

Table 7. Sediment characteristics.

Sediment	Untreated	A.L	V.S	Unit
Wet bulk density	1.4	1.4	1.4	t/m ³
Dry bulk density	0.53	0.59	0.70	t/m ³
Wet unit weight	13.3	13.6	14.4	kN/m ³
Bulk unit weight	13.2	13.8	14.2	kN/m ³
Moisture content ratio	153	138	107	%
Organic content ratio	6	8	11	%
Dry matter content ratio	40	42	48	%

5.2.2 Concentrations in sediment

Concentrations of metals and organotins in the sediments are presented in Table 8 and Appendix D. Variations between the concentrations are likely due to local differences within the sediment, even though care was taken to get a homogenous mixture. Since sediment was collected 0–30 cm below sediment surface, sediment layers from different years was obtained meaning that the deeper sediment probably still have flakes of boat paint from the time when TBT still was allowed to be used, resulting in local maximums for different organotins and metals. A single flake in a sediment sample could result in a significantly higher concentration during an analysis, compared to what the average would have been.

According to Holm (2013) the concentrations of TBT in the deeper levels in the Port of Gothenburg have an average of 793 µg/kg DS, which is less than half of the concentration found in the untreated sediment which is 1 700 µg/kg DS, see Table 8.

The acidic process water affects the concentrations of certain metals, see Table 8. While comparing the cases where the removal rate is negative i.e. metal contents increase, as for molybdenum, lead, cadmium, copper and mercury, it is found that the increase of metals are originating from the process water. However, there was no data given for the concentration of tin in the process fluid, but it is likely to assume that the concentration could be high like the other metals mentioned above, since it is mainly volatile metals that are enriched in the process water, see Appendix B. Another way to explain these differences in concentration is that the concentration varied much within the sampled sediment. This encourages several more analyses of sediment specimen to get statistical variation of concentration at the sampling site. The higher levels of organotin are probably due to a local maximum value in the sampled sediment used to be treated with the acidic leaching method, since there would not be any organotins originating from the process fluid.

All examined concentrations in the V.S sediment was reduced, except for selenium, see Table 8. The higher concentration of selenium is most likely to be caused by

natural variation within the sediment as it could not originate from the Milli-Q or the added sodium chloride. All organotins are reduced by the V.S method. This is probably because of the shaking process where the organotin have moved from solid to liquid phase, where it is more easily degenerated. Another reason to why the organotin was reduced to a greater extent for the V.S sediment, compared to the A.L sediment, was probably because of the removal of the foam formed in the beaker. The foam consisted of fine grain size particles, such as silt, were most pollutants is attached to according to literature.

Table 8. Concentrations for untreated sediment and sediment treated with A.L and V.S. The removal percentage for A.L and V.S is presented in the right columns (A negative number represents an increment in components).

		Untreated	A.L	V.S	Removal A.L	Removal V.S
		Unit: mg/kg DS			Unit: %	
Antimony	Sb	9.3	5.9	<3.7	37	60
Molybdenum	Mo	9.3	9.8	5.8	-5	38
Arsenic	As	9	9	8.1	0	10
Barium	Ba	110	100	84	9	24
Lead	Pb	32	39	25	-22	22
Iron	Fe	35000	27000	26000	23	26
Cadmium	Cd	0.29	0.49	0.23	-69	21
Cobalt	Co	11	10	8.7	9	21
Copper	Cu	230	250	180	-9	22
Chromium	Cr	57	45	41	21	28
Mercury	Hg	0.2	1.6	0.18	-700	10
Nickel	Ni	22	19	17	14	23
Selenium	Se	1.9	1.7	2.6	11	-37
Tin	Sn	12	15	9.9	-25	18
Vanadin	V	53	48	43	9	19
Zink	Zn	360	280	270	22	25
Sulphur		2700	1400	670	48	75
Fluorine		4.6	<0.94	4.4	80	4
Organotins		Unit: µg/kg DS			Unit: %	
Dibutyltin	(DBT)	330	340	190	-3	42
Diphenyltin	(DPT)	15	5.9	6.9	61	54
Dioctyltin	(DOT)	9.2	6.4	6.9	30	25
Monobutyltin	(MBT)	85	89	57	-5	33
Monophenyltin	(MPT)	13	16	7.1	-23	45
Monooctyltin	(MOT)	1.5	<1	<1	33	33
Tetrabutyltin	(TTBT)	12	14	6.7	-17	44
Tributyltin	(TBT)	1700	2300	1100	-35	35
Tricyclohexyltin	(TCHT)	<1	<1	<1	0	0
Triphenyltin	(TPT)	16	7.6	5.8	53	64

As earlier mentioned, tin can be either bond to organic matter or not. Inorganic tin is the most common type of tin within the sediments, 82% for the untreated sediment, 81% for the A.L and 86% for the V.S sediments. Concerning the organotins all of the sediment types had highest amount of TBT, then DBT and MBT in decreasing order, see Figure 13. The percentage of TBT compared to total organotin for untreated, A.L and V.S sediment are 85%, 84% and 88% respectively. The rest of the organotins were in much lower concentrations, compared to the butyl-organotins.

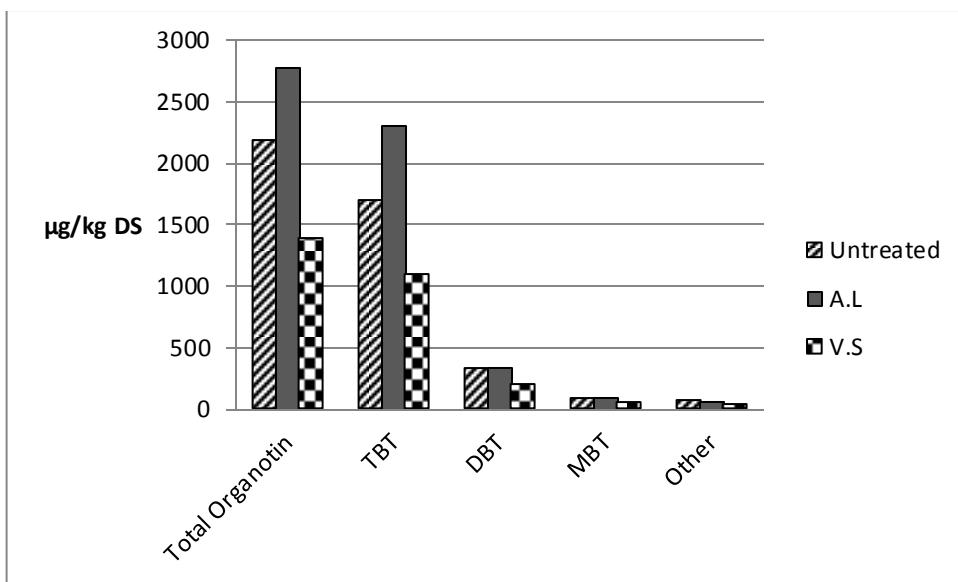


Figure 13. Organotin concentrations in untreated, A.L and V.S sediment.

For the leachates obtained during the treatment methods, as well as for the seawater, many of the concentrations are below detection limits, see Table 9. For the seawater collected while sampling the sediment almost all concentrations of metals and organotins were below detection limits, except for sulphur, fluorine and DOC, indicating that the seawater itself is not contaminated.

Degradation for TBT is higher in liquid phase compared to solid phase and that could be a reason to why the concentrations of TBT are low in all liquids. A reason why there are high concentrations of organotins in the two liquids obtained from the A.L method, the acidic filtrate and the acid + Milli-Q filtrate could be caused by the low pH.

Table 9. Concentrations in seawater and liquids from the treatment methods: V.S and Acidic leachates and Acid + Milli-Q filtrate.

		Seawater	V.S leachate	Acidic leachate	Acid + Milli-Q filtrate
Unit: mg/L					
Sulphur		2300	630	1400	340
Fluorine		0.58	0.51	17	8
DOC		2.3	8.9	140	35
Iron	Fe	<0.1	<0.4	3400	1100
Arsenic	As	<0.01	<0.04	0.044	<0.02
Antimony	Sb	<0.05	<0.2	<0.2	<0.1
Barium	Ba	<0.05	0.23	1.9	0.82
Lead	Pb	<0.0025	<0.01	3.6	1
Cadmium	Cd	<0.001	<0.004	0.15	0.045
Cobalt	Co	<0.01	<0.04	0.86	0.39
Copper	Cu	<0.01	<0.04	0.22	0.27
Chromium	Cr	<0.01	<0.04	4.1	1.3
Mercury	Hg	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	Mo	<0.025	<0.1	<0.1	<0.05
Nickel	Ni	<0.01	<0.04	1	0.51
Selenium	Se	<0.025	<0.1	0.34	0.053
Tin	Sn	<0.005	<0.02	<0.02	<0.01
Vanadin	V	<0.01	<0.04	3.8	1
Zink	Zn	<0.05	<0.2	130	24
Organotins					
Unit: mg/L					
Monobutyltin	(MBT)	<1	3.3	65	9.1
Dibutyltin	(DBT)	<1	<1	440	84
Tributyltin	(TBT)	<1	1.5	<1	<1
Tetrabutyltin	(TTBT)	<1	<1	<1	<1
Monoctyltin	(MOT)	<1	3.7	<1	<1
Diocetyltin	(DOT)	<1	1.2	<1	<1
Tricyclohexyltin	(TCHT)	<1	<1	<1	<1
Monophenyltin	(MPT)	<1	<1	<1	<1
Diphenyltin	(DPT)	<1	<1	<1	<1
Triphenyltin	(TPT)	<1	<1	<1	2.5

5.2.3 Comparison to guidelines values

Results from analyses of sediment have been compared to limit values for inert waste from the Swedish EPA and the limit for SSV Vinga, see Table 10 and Table 11. None of the sediment types, the untreated, A.L or V.S, are clean enough to be disposed as inert waste, see Table 10. Fluorine is the only substance which is below the limit value for all three types of sediment. The V.S sediment does also pass the limit for sulphur. Further treatment is needed to be able to pass the limits. Since there are high amounts of metals as copper, lead and zinc for example, additional soil washing could be a method to remove the metals. The metals could plausibly be obtained and be re-used in the society.

A comparison between the results and the guidelines from SSV Vinga are more promising, see Table 11. Other metals are used in these guidelines and those which also are present in the Swedish EPA's guidelines have a much higher limit value in SSV Vinga's. However, unfortunately too high levels of TBT are present in all three sediment types. Otherwise the V.S treated sediment passes the limits. Both untreated and A.L sediment have to high levels of tin and the A.L sediment also have too high level of mercury for being accepted at SSV Vinga.

Consequently, none of the treatment methods are efficient enough to treat such highly contaminated sediment as the sediment from the case study area. Additional treatment or optimisations of these techniques are needed in order to be able to meet the guidelines.

Table 10. Limit values for the Swedish EPA (Naturvårdsverket 2006) presented together with content of untreated and stabilised sediments. An orange cell indicates a concentration above limit.

Swedish EPA	Limits	Untreated	A.L	V.S
Unit: mg/kg DS				
Arsenic	As	0.5	9.0	9.0
Barium	Ba	20	110	100
Cadmium	Cd	0.04	0.29	0.49
Chromium	Cr	0.5	57	45
Copper	Cu	2	230	250
Mercury	Hg	0.01	0.20	1.60
Molybdenum	Mo	0.5	9.30	9.80
Nickel	Ni	0.4	22	19
Lead	Pb	0.5	32	39
Antimony	Sb	0.06	9.3	5.9
Selenium	Se	0.1	1.90	1.70
Zinc	Zn	4	360	280
Fluorine		10	4.60	<0.94
Sulphur		1 000	2 700	1 400
				670

Table 11. Limit values for the SSV Vinga (Göteborgs hamn, 2013) presented together with content of untreated and stabilised sediments. An orange cell indicates a concentration above limit.

SSV Vinga	Limits	Untreated	A.L	V.S
Unit: mg/kg DS				
Arsenic	As	100	9.00	9.00
Cadmium	Cd	1	0.29	0.49
Cobalt	Co	150	11	10
Chromium	Cr	200	57	45
Copper	Cu	100	230	250
Iron	Fe	400 000	35 000	27 000
Mercury	Hg	1	0.20	1.60
Nickel	Ni	150	22	19
Lead	Pb	100	32	39
Tin	Sn	10	12	15
Vanadium	V	500	53	48
Zinc	Zn	750	360	280
Unit: µg/kg DS				
Tributyltin	TBT	200	1 700	2 300
				1 100

5.3 Stabilisation and solidification

Since the salinity of the water in Göta Älv is changing, the salt content in bottom sediment will also change. Salt in the sediment affects the stabilised sediment's properties since salt binds liquid that otherwise would act as a binder for the stabilised sediment. The salt can also affect the stabilised sediment so that crystallization and fractures occurs, both visible on the surface but also within the cement. Before any large-scale stabilisation of sediment, extensive investigations of the sediment properties and content are required. Grain size distribution curve and water content should be investigated among other parameters.

5.3.1 Manufacture and cure of cement

Treated sediment was mixed with cement and fly ash. Stabilised sediment treated with the V.S method was called C1 and stabilised sediment treated with the A.S method was called C2. The different mixture quantities were 80/20 and 70/30, and named A and B respectively, resulting in a total of four different recipes: C1A, C1B, C2A and C2B. While manufacturing some differences between the stabilised sediments made from the two treatment methods were observed, see Table 12 and Figure 14.

The C1 mixtures took longer time to cure and the surface was still soft after two days. It developed a dark surface with local salt marks. Rust spots appeared on the pieces, indicating the presence of iron. The C2 mixtures cured faster initially but after three days, two of six cement pieces fractured into two pieces. A flaky surface appeared and the pieces shrunk during the curing, causing fractures to appear.

Table 12. Observed differences between stabilised sediment C1 (made with V.S sediment) and C2 (made with A.L sediment).

Stabilised sediment	C1	C2
Colour	Black	Dark grey
Smell	Slightly oily	Ammonia
Texture	Moist	Dry and "grainy"
Drying ability	Low	Faster than C1, but still low



Figure 14. Stabilised sediment on the 18th day of curing; C1 (left) and C2 (right).

The stabilised sediments had longer curing time than ordinary concrete. This is probably caused by the much finer particles in sediment, which are not present in conventional concrete. The higher amount of finer particles results in more open spaces for water to be trapped in, which makes its curing process slower.

Both stabilised sediments emitted a hollow sound when knocked on, in contrast to concrete. This is most likely due to the finer fraction causing open spaces, as earlier mentioned. When crushed, the stabilised sediment C2 appears to be dustier than C1. This is most likely dependent on that the A.L. method seems to affect the structure of the sediment differently than what the V.S method seems to have done.

The recipes used were earlier performed on sediment from the harbour of Gävle. Large differences in salinity in sediment between Gävle and Gothenburg are worth mentioning since the salts have an impact on the stabilised sediment. An additional rinse of water would probably wash out at least some of the salt. The mixing recipes could be altered to cope with the higher salt level as well.

The stabilised sediment mixture was to be stabilised for 28 days since it then has approximately reached its maximum strength and could be compared with literature data. However, in this report the diffusion from the sediment has been the focus, rather than the cement strength.

5.3.2 Bend test

For both of the treated sediment types the recipe with fly ash/cement ratio of 70/30 (recipe B) was the strongest in the bend test. For the A.L treated stabilised sediment the difference between C1A and C1B were low, with average values of 12.9 MPa and 13.0 MPa. The differences in strength between the C2A and C2B recipes were noticeable. For the C2A mixture the average strength was 0.84 MPa and for C2B 1.22 MPa. The removal the foam in the V.S process has affected the strength of the stabilised sediment, since fine fraction sizes used in concrete have an impact on its curing process.

During the bend test it was observed that C1 and C2 fractured with different angles. C1 test pieces broke perpendicular and C2 test pieces received a fracture with an average angle of 64°, see Figure 15. These fracture patterns were observed for all test pieces.



Figure 15. Fracture pattern of stabilised sediment; C1 (left) and C2 (right).

5.4 Diffusion tests

The diffusion tests were performed on untreated sediment and the two types of stabilised sediments.

5.4.1 Maximum available leaching tests

The maximum available leaching test gives two leachates, L2 and L2-L10, which are used to calculate the maximum leachate of sediment and stabilised sediment. Less difference in pH between L2 and L2-10 in both NaCl and Milli-Q can be seen for the C2B than C1B, see Table 13. Once again, the treatment method has affected properties of the stabilised sediment. In C1B natural occurring humic acid has been washed out and since the addition of cement is basic it is likely that the pH value of the leachate is decreasing during time. In C2B there is the acidic A.L sediment and the basic cement counteracting each other, thus the pH is remained to a greater extent. These trends could also be observed for the surface diffusion tests, see Appendix F.

Table 13. L/S10 measurements for sediment and stabilised sediment C1B and C2B.

	NaCl		Milli-Q		Unit
	L2	L2-L10	L2	L2-10	
Sediment:	pH	7.6	7.8	7.7	7.7
	Temperature	19	19	19	19
	Conductivity	45	47	19	2.3
	Oxygen	5.7	6.4	5.6	5.5
C1B:	pH	10.6	11.3	10.5	11.2
	Temperature	21	25	21	22
	Conductivity	140	61	120	16
	Oxygen	5.1	5.3	7	6.6
C2B:	pH	10.3	10.3	10.3	10.9
	Temperature	22	25	20	22
	Conductivity	72	-	38	4.6
	Oxygen	5.2	5.3	7.7	7.1

Analyses from the second batch step according to the maximum available leaching test method for untreated and stabilised sediments are shown in Table 14. For almost every substance analysed the untreated sediment leached less than the stabilised sediment types. A reason for these results are probably that there was difficulties to get a throughout mixing of the sediment and liquid during leaching. The shaking table were not equipped to hold bottles of the size used, which meant that the speed of the shaking table was not as high as it ought to be due to the risk of bottles falling off the table, especially when left during longer time periods (16 h). The untreated sediment and the crushed stabilised sediment had different consistency and it is possible that the bound between the substances was different due to that fact. Another reason is that the external laboratory used analysis methods which also affect the result to some extent. Digested samples give a higher value than filtered samples does.

Table 14. L/S10 result for untreated sediment, C1B and C2B. The leachates of the untreated sediment were prepared by filtration and the leachates of the stabilised sediment were prepared by digestion.

	Sediment		C1B		C2B	
	NaCl	Milli-Q	NaCl	Milli-Q	NaCl	Milli-Q
Unit: mg/L						
Sulphur	180	140	1675	1625	1150	1125
Fluorine	0.36	0.74	<0.5	<0.5	<0.5	0.675
DOC	5.8	7.9	195	167.5	127.5	127.5
Iron	Fe	<0.1	0.033	0.375	1.675	0.55
Arsenic	As	<0.01	0.0011	<0.0075	0.00825	<0.0075
Antimony	Sb	<0.05	0.0038	-	-	0
Barium	Ba	0.04	0.0068	0.425	0.325	0.7
Lead	Pb	<0.0025	0.00013	<0.005	<0.005	<0.005
Cadmium	Cd	<0.001	<0.00004	<0.001	<0.001	<0.001
Cobalt	Co	<0.01	<0.0004	0.01525	0.0115	<0.01
Copper	Cu	<0.01	0.048	1.475	1.175	0.925
Chromium	Cr	<0.01	<0.0004	0.105	0.0875	0.0675
Mercury	Hg	<0.0001	<0.0001	<0.00025	<0.00025	<0.00025
Molybdenum	Mo	0.05	0.06	0.1925	0.1775	0.55
Nickel	Ni	<0.01	0.0014	0.1	0.0775	0.0275
Selenium	Se	<0.025	<0.001	<0.03	<0.03	<0.03
Tin	Sn	<0.005	<0.0002	<0.005	<0.005	<0.005
Vanadin	V	<0.01	0.0024	0.0525	0.065	0.0575
Zink	Zn	<0.05	0.007	<0.05	<0.05	0.03
Organotins						
Unit: ng/L						
Monobutyltin	(MBT)	4.6	21	210	230	235
Dibutyltin	(DBT)	11	45	155	375	400
Tributyltin	(TBT)	95	400	60	<25	75
Tetrabutyltin	(TTBT)	<1	<1	<2.5	<2.5	<2.5
Monooctyltin	(MOT)	<1	<1	<2.5	8	<2.5
Diocetyltin	(DOT)	<1	<1	<2.5	<2.5	<2.5
Tricyclohexyltin	(TCHT)	<1	<1	<2.5	<2.5	<2.5
Monophenyltin	(MPT)	<1	<1	<2.5	<2.5	<2.5
Diphenyltin	(DPT)	<1	<1	<2.5	<2.5	<2.5
Triphenyltin	(TPT)	<1	<1	<2.5	<2.5	<2.5

The concentration of TBT in both saline water and in Milli-Q was lower in the leachate of C1B, i.e. the stabilised V.S sediment with a cement/fly ash ratio of 70/30, compared to the concentrations for C2B, i.e. the A.L sediment with a cement/fly ash ratio of 70/30. This result determined that the stabilised sediment of type C1B should be used for surface diffusion tests.

Butyltins will be analysed separately since the other organotin groups are present in low concentration, see Table 15. For the cases in Table 15 when the concentrations were below the detection limit, the limit has been used as value. This gives a higher

value than what the case is in reality. The result for non-butyl groups are however still low, 0–4% of the total amount of organotins.

In leachates of untreated sediment, approximately 86% of the total concentration of organotins was TBT. For both types of stabilised sediment, C1B and C2B, TBT accounted for 3 – 13% of the leachate of organotin, meaning that TBT has degraded or been chemically locked during the manufacturing of the stabilised sediment.

Tin in treated and untreated sediments consisted of 18% organotins as a median value. In leachates obtained during the maximum available leaching tests the tin consisted of 13.8% organotins as a median value. These results points towards that organotins are less able to leach compared to non-organic tin.

Table 15. Concentrations of tin and organotins in L/S10 liquids. * For the cases when the concentrations were below the detection limit, the limit has been used as value.

		Sediment		C1		C2	
Concentrations		NaCl	Milli-Q	NaCl	Milli-Q	NaCl	Milli-Q
Unit: ng/L							
Tin	Sn	5000	200[0]	5000	5000	5000	2025
Monobutyltin	MBT	4.6	21	210	230	235	275
Dibutyltin	DBT	11	45	155	375	400	1075
Tributyltin	TBT	95	400	60	25	75	207.5
Other *		7	7	17.5	23	17.5	20
Unit: %							
Monobutyltin	MBT	0.1	1.1	4.2	4.2	4.7	13.6
Dibutyltin	DBT	0.2	2.3	3.1	7.5	7.5	53.1
Tributyltin	TBT	1.9	20	1.2	1.2	0.5	10.2
Other		0.1	0.4	1.2	0.4	0.5	1
Total		2.3	23.7	8.9	13	14.6	77.9

5.4.2 Comparisons to guideline values

Results from the ICP-MS samples for the maximum available leaching test were used to calculate an accumulated leach for the stabilised sediments. The result was then compared to the limit values from the Swedish EPA to be classified as inert waste, see Table 16. Some of the parameters could not be measured by the ICP-MS, hence some of the data is missing in the table. The instrument could neither detect some of the parameters, in these cases the concentration has been set to zero. All analysed substances in leachates, except for lead in Milli-Q for both types of stabilised sediment, are higher than accepted.

It appears as if no general trend could be spotted for the leaching patterns. Some substances have a higher leachate in Milli-Q and some in saline water. The different stabilised sediment types have different leaching patterns as well, for some substances the leachate concentration is higher in C1B than in C2B and vice versa. This is a result from the different treatment processes. For instance could the A.L process have removed more arsenic than the V.S process, resulting in a lower diffusion concentration due to the lesser amount of the matter available for leaching. Another

reason could also have been that the arsenic forms different bound to the stabilised sediment depending on the treatment. A stronger bound would mean that the arsenic is attached to the crushed particles of stabilised sediment and are not available for diffusion. These assumptions could be the case for other metals as well.

Table 16. Accumulated concentration from the maximum available leaching test compared to guideline values for inert waste (Naturvårdsverket 2006). n.d. = no data available.

		Limit	C1B Milli-Q	C1B NaCl	C2B Milli-Q	C2B NaCl
			Unit: mg/L			
Arsenic	As	<0.06	1.76	1.47	0.13	0.10
Barium	Ba	<4	0	0.39	0	0
Cadmium	Cd	<0.02	0.20	0.41	0.18	0.47
Chromium	Cr	<0.1	5.32	96.00	104.02	211.65
Copper	Cu	<0.6	7.03	21.78	29.03	85.09
Mercury	Hg	<0.002	n.d.	n.d.	n.d.	n.d.
Molybdenum	Mo	<0.2	3.88	2.91	2.76	2.52
Nickel	Ni	<0.12	8.70	188.60	203.53	1350.98
Lead	Pb	<0.15	0	0.21	0	0.37
Antimony	Sb	<0.1	n.d.	n.d.	n.d.	n.d.
Selenium	Se	<0.04	0.32	1.42	0.36	0.33
Zink	Zn	<1.2	7.86	31.61	23.25	139.80
Chloride	Cl	<460	n.d.	n.d.	n.d.	n.d.
Fluorine	F	<2.5	n.d.	n.d.	n.d.	n.d.
Sulphur	Su	<1500	n.d.	n.d.	n.d.	n.d.
Phenol index		<1	n.d.	n.d.	n.d.	n.d.
DOC		<160	n.d.	n.d.	n.d.	n.d.

5.4.3 Surface diffusion tests

Surface diffusion tests were performed on untreated sediment and stabilised sediment placed in different environments:

- Milli-Q (surface diffusion test standard)
- Saline water (NaCl)
- A pH 4 buffer
- Aerobic
- Anaerobic

Untreated sediment, C1B and C2B have the highest conductivity in the NaCl leachate, see Appendix F. In the buffer leachate the trend were a bit higher than for Milli-Q and Oxygen. This is probably due to the addition of sodium hydroxide and citric acid added to create the buffer. A general trend is that the conductivity does not vary so much between the untreated and stabilised sediment within each aquatic environment.

A clear pH trend for the untreated sediment and the two stabilised sediments within each aquatic environment are a bit more difficult to spot, see Appendix F. The stabilised sediments share more likeness, probably due to the addition of cement and fly ash. The pH seems to be lowered during time, as the buffer ability from the cement decreases. The average pH of C1 leachates at the last measured replenish time is 9.9 and the corresponding value for C2 is 8.5. The lower pH for C2 is most likely a result from the acid washing. Having an aerobic condition at the bottom seems to lower the pH rather than to put the stabilised sediment pieces in a buffer. The pH for the untreated sediment differs more throughout the test, but seems to converge at the final replenish.

In all leachates of the pH surface diffusion test, “oily” biofilms were formed. This indicates the presence of microorganisms originating from the untreated sediment which have survived the different treatment techniques.

Untreated sediment

Tributyltin-concentrations in the leachates varied due to the differences in the aquatic environment, see Figure 16. It appeared that the highest diffusion of TBT takes place in an oxidised environment considering the difference between aerobic and anaerobic diffusion tanks. When the two gases (N_2 and air) were induced during the sediment surface diffusion tests, they stirred the surface of the sediment to some extent and in a manner that does not occur in the natural waters. Therefore it is likely that these experiments provide high values. When working with the two gases it is also noted that an even flow of nitrogen and oxygen is a difficulty, especially for the addition of nitrogen which had a difficult regulator.

Another reason why the samples leached differently could also be caused by variation in concentrations within each beaker due to heterogenic sediment. Some mixing of sediment during the replenishment of water was inevitable, even though care was taken. This could most likely increase the amount of pollutants in the leachate.

The leachates had different appearances, see Figure 18. Leachate of oxidised sediment received a colour such as the Milli-Q and NaCl leachates, as time passed as the particles mixed up by the addition of air settled.

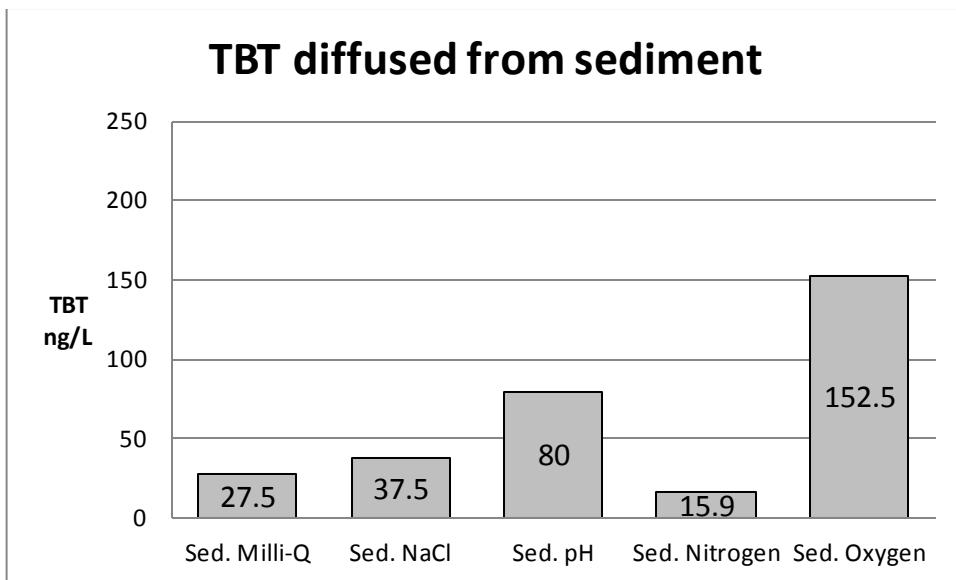


Figure 16. Concentration of TBT in untreated sediment leachate after nine days.

Stabilised sediment

Since C1B emitted the least amount of TBT in the maximum available leaching test, only the leachate from C1B was send to external lab for analysis, see Table 15. The anaerobic diffusion test was only performed on the C1B based on the same reason. When treating the sediment its structure could have changed. Based on the strength, amount of bubbles and the loss of small pieces of the surfaces of the stabilised sediment different properties could be determined. As well as for the sediment diffusion tests the addition of gases in the leachate could affect the surface of the stabilised sediments and result in a greater diffusion from these tests.

When comparing the TBT diffused from the untreated sediment and stabilised sediment some differences and similarities could be spotted. The leached concentrations of TBT in Milli-Q seem to be about three quarters of the corresponding concentrations in NaCl, see Figure 16 and Figure 17. This indicates that the guideline value for acceptable TBT leachate should be set dependent on the salinity of the water the TBT contaminated sediment is in, since the standardised test is always done in a high purity water. Since the leachate in saline water is higher, the guideline limit should be lowered if the sediment is to be put in saline water. For leachate of TBT in the buffer solution, anaerobic and aerobic beakers no trend is visible. The addition of cement and fly ash is the reason to the differences in leaching ability for the untreated sediment and stabilised sediment.

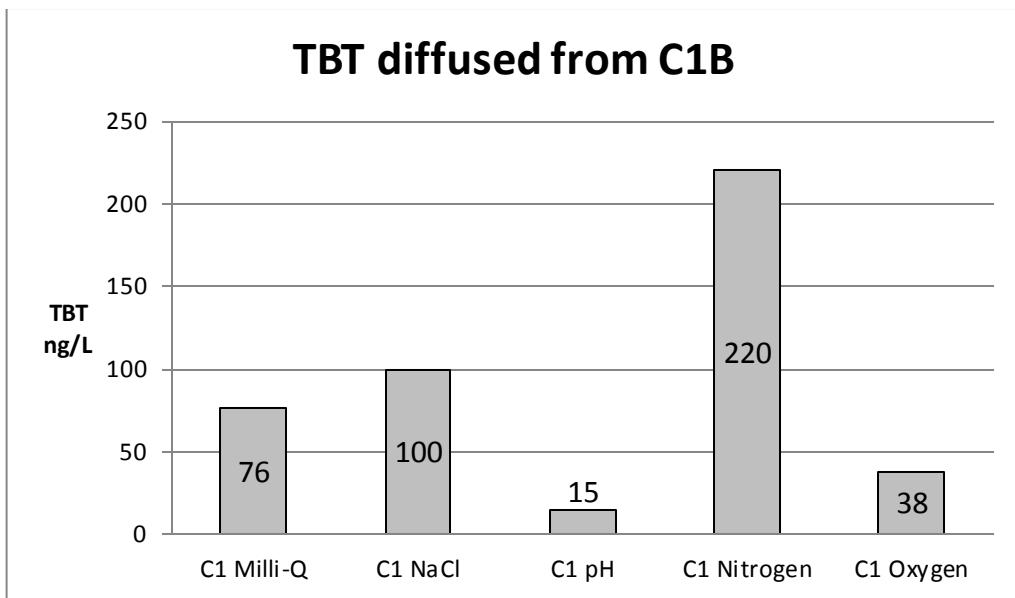


Figure 17. Concentration of TBT in stabilised sediment C1B leachate after nine days.

The leachates from C1B and C2B were similar in colour, see Figure 19 and Figure 20. Leachates from stabilised sediment treated with the A.L method had a slightly more intensive colour than the leachates from stabilised sediment treated with the V.S method.



Figure 18. Leachate from sediment surface diffusion test. From left to right: Milli-Q, NaCl, pH and Oxygen.



Figure 19. Leachate from stabilised sediment C1B. From left to right: Milli-Q, NaCl, pH and Oxygen.



Figure 20. Leachate from stabilised sediment C2B. From left to right: Milli-Q, NaCl, pH and Oxygen

5.5 General discussion

Even though remediation was achieved to some extent, the reduction of TBT is however not efficient enough to be able to pass requirements from the Swedish EPA or SSV Vinga regardless to which of remediation method used. Consequently an additional treatment step or optimisation of the methods is recommended before any implementation of the techniques should be done. It is possible that the remediation techniques developed in this study would be sufficient enough to treat TBT-polluted sediment of the area's average concentration of 510 µg/kg DS. A reduction of TBT with 600 µg/kg DS was achieved using the V.S method, which is an achievement even though it was not sufficient enough in this scenario.

There are a lot of differences in acceptable limits for the guidelines investigated. For all cases the limit is a lot higher for the storage basin. Still, the limit value for the SSV Vinga is high, 200 µg/kg DS, compared with the known toxic concentration which is 2 µg/kg DS. Based on this knowledge the author thinks that the guideline limit at SSV Vinga should be lowered.

Deep sea storage is an alternative that is cheaper than land deposition, but is however not a sustainable solution since many of the pollutions is attached to minor particles which gets dispersed and hurts ecosystems in the sea. Even though it is deep out at sea the matter could be spread, by waves and streams but also with animals. Bioaccumulation of TBT is known and means that the chemical could be spread long distances from the deep sea storage. There could be a risk for TBT to be spread on land as well by sea birds or humans by eating fish, crayfish and clams. By stabilising the sediment the substances are locked, lowering the leaching of sediment and reduces the movement of potentially contaminated particles. Stabilisation could hence be performed on dredged material which is to be put on sea storage, as well for dredged material to be used as a building material or when it is to be put on landfill.

The treatment method for remediating the sediment has an impact on the properties of the stabilised sediment. Not only is an examination of the removal efficiency of importance. Whether or not the treated sediment is to be used as stabilised sediment or not, it is of interest to see how the characteristics of the sediment are changed due to the treatment method. For instance, a changed pH in the sediment could have a great impact on the aquatic life if the sediment is treated and put back. If the treated sediment is to be used as stabilised sediment, pH and grain size should be investigated among other parameters, to see how the strength and leachate changes.

Having the stabilisation of dredged material in mind, a conclusion is drawn that no sediment is the same, and that each individual dredging must be investigated separately in the current situation. More analysis on the sediment characteristics could perhaps facilitate the treatment, the stabilisation of sediments recipe and the stabilised sediment's behaviour in the future. The content of TBT seems to vary a lot in the sediment due to natural sedimentation. If it is possible, it would be good to create a standardised approach for producing stabilised sediments, for example a standardised recipe that could be altered to fit local variations of sediment properties.

If the fly ash would be useful as stabiliser in the production of stabilised sediment it would be of interest to gain a large quantity of fly ash that has an even quality. Since the fly ash is a residue after the incineration process it is likely that the production of fly ash varies a lot during one year, depending on the use of energy which is higher

during the winter due to heating of buildings. Mölndals Energi is a district heating facility and their main focus for them is to give the customers price worthy heat the quality of fuels might vary, resulting in differences in fly ash. This would affect the leaching and the properties of the stabilised sediment.

The results from the surface diffusion tests could serve as a base for decision making. If the dredged material is to be put in an oxygen rich environment with a low pH it would be better to stabilise it first. If the dredged should be sent to a deep sea storage where the aquatic environment probably would be oxygen deficient and have a high pH, it is probably better not to stabilise the sediment. Dependent on where the dredged material is to be put, a choice could be made whether or not to stabilise the sediment. These results could also be used when setting guideline limits. A lower guideline value for acceptable concentration of TBT in sediment should be set if the contaminated sediment is to be put in saline water since the leaching rate is higher in saline water than in freshwater, which the standardised tests is performed in.

Since the TBT is kept at anaerobic conditions within the sediment, the degradation of TBT is really low. That means, the TBT on the bottom could be seen as a diffuse source of TBT today, and could be considered as a potential risk when high concentrations of TBT could be released to the marine environment during an activity such as dredging, shipping activities or an accident. Oxidising the sediment in-situ could be a potential technique to lower the concentration of TBT. Treating polluted sediment before a dredging will lower the dispersion of TBT-polluted particles that could be released.

6 Conclusions

Two methods were developed with the intention of treating TBT contaminated sediments, the vigorous shaking (V.S) method and the acidic leaching (A.L) method. Both methods were combined with stabilisation and solidification. The reduction of TBT were analysed through sediment content analyses, maximum available leaching tests and surface diffusion tests, which were performed on untreated sediment and the two stabilised sediments. Results from these tests points toward a more efficient removal of TBT by using the V.S method which decreased the TBT concentration by 35%, compared to the A.L method where the TBT concentration increased by 35%. None of the treatment methods were however efficient enough to reduce the concentrations of TBT in order to be lower than the guideline values set by the Swedish EPA or SSV Vinga.

It appears that the sediment in the study area is heterogeneous so further analyses of geotechnical properties and organotin concentrations within the sediment are recommended in future remediation examination. Further analyses of how different treatment techniques are affecting the properties of the sediment are of importance when stabilising the sediment since it is affecting the abilities of the stabilised sediment, for example strength.

The amount of TBT diffusing from sediment and stabilised sediment varies due to different aquatic environments. There is also a difference between leaching patterns between untreated sediment and stabilised sediment. Based on this knowledge, decision on where and how to store TBT-polluted sediments could be done to lower the leaching. In standardised tests and guidelines only freshwater is examined. The leaching of TBT is however approximately 25 percentage points lower in freshwater than in saline water, so a suggestion is to have stricter guidelines for TBT-polluted dredged material, which is to be put in sea storage.

7 Suggestions for future studies

If a large scale treatment would be of interest, it is important to scale up the treatment processes and optimise each treatment step. More analyses of sediment properties and concentration of compounds, both on untreated and treated sediment, are recommended. Parameter such as salinity and pH of the sediment are of importance in order to make strong stabilised sediment with a low TBT diffusion rate.

Suggested changes in laboratory procedure A.L:

- Make sure acid and sediment are properly mixed from the start. A magnet flea is not sufficient to start with. Stir initially by hand or use a more throughout mixer.
- Pre-treat the process water by removing those metals that are noted to be accumulated in the sediment, e.g. Hg.

Suggested changes in laboratory procedure V.S:

- A secondary rinse of water should be able to extract excess salt. The high concentration of salt in the sediment is likely to affect the abilities of the stabilised sediment in an unfavourable way.

It would be of interest to let the stabilised sediment cure for 56 days, since then all of the fly ash components have become reactive and would perhaps be noticeable in the leaching liquids. By continually testing the strength of the stabilised sediment it would show how the curing process differs between different sediment types and treatment techniques. Untreated sediment should also be stabilised to serve as a reference value for the treated and stabilised sediment.

It would also be interesting to perform maximum available leaching tests on treated sediment before stabilising it, this in order to find out if there is any change in leaching patterns between untreated and treated sediment but also between treated and stabilised sediment. An investigation of how the leaching pattern of TBT is dependent on the pH would be of interest. This could be done in both acidic and alkaline solution.

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Appendices

Appendix A - Grain size distribution

Appendix B - Process water

Appendix C - Binders

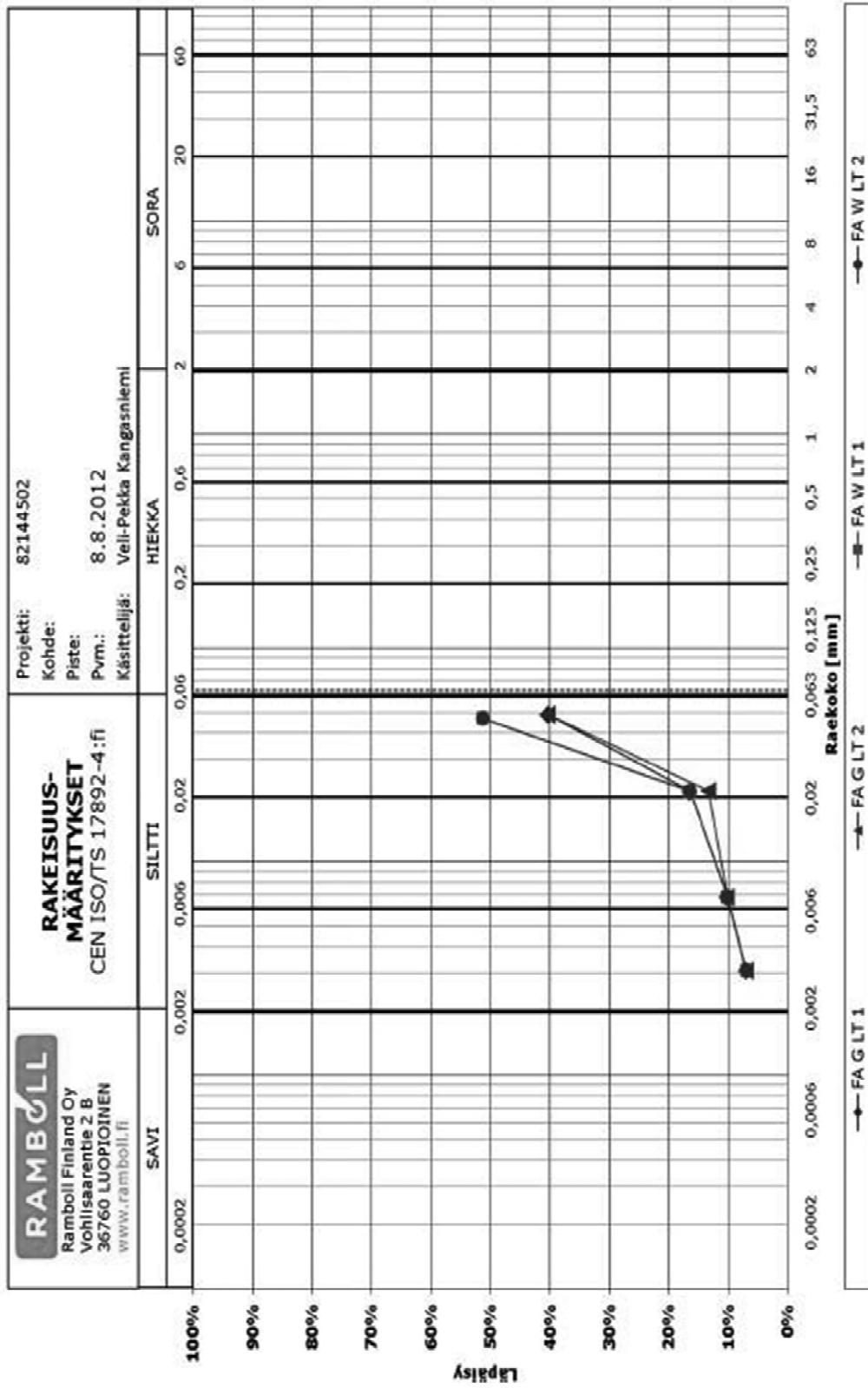
Appendix D - Analyses of sediments

Appendix E - Analyses of liquids

Appendix F – Surface diffusion tests

GRAIN SIZE DISTRIBUTION

Appendix A - Grain size distribution



SWEDECO
LUTED
ALSTROM
KONTAKT
E D I T O R I A L
200
08/02/1995

L1333259

2G8FN3JTRAA



Appendix B - Process water

Er beteckning	D						
Labnummer	U10924891						
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign	
Filtrerad med 0,45 μm före mettanalys*	NEJ			1	I	MKA	
Ca	10.8	1.4	mg/l	1	R	EL	
Fe	34.5	4.2	mg/l	1	R	EL	
K	94.1	11.6	mg/l	1	R	EL	
Mg	2.14	0.26	mg/l	1	R	EL	
Na	273	33	mg/l	1	R	EL	
Si	31.7	3.7	mg/l	1	R	EL	
Al	7170	1110	$\mu\text{g/l}$	1	R	EL	
As	551	95	$\mu\text{g/l}$	1	H	DKA	
B	17400	2050	$\mu\text{g/l}$	1	R	EL	
Ba	612	95	$\mu\text{g/l}$	1	R	EL	
Cd	358	44	$\mu\text{g/l}$	1	R	EL	
Co	<20		$\mu\text{g/l}$	1	R	EL	
Cr	118	14	$\mu\text{g/l}$	1	R	EL	
Cu	2830	337	$\mu\text{g/l}$	1	R	EL	
Hg	1110	86	$\mu\text{g/l}$	1	F	TALA	
Li	67.5	8.1	$\mu\text{g/l}$	1	R	EL	
Mn	216	25	$\mu\text{g/l}$	1	R	EL	
Mo	34.2	6.2	$\mu\text{g/l}$	1	R	EL	
Ni	<40		$\mu\text{g/l}$	1	R	EL	
P	3370	443	$\mu\text{g/l}$	1	R	EL	
Pb	11200	1760	$\mu\text{g/l}$	1	R	EL	
Sb	2990	723	$\mu\text{g/l}$	1	H	IDJO	
Se	6.49	1.72	$\mu\text{g/l}$	1	H	DKA	
Sr	97.0	13.7	$\mu\text{g/l}$	1	R	EL	
V	18.9	4.4	$\mu\text{g/l}$	1	R	EL	
Zn	62000	7530	$\mu\text{g/l}$	1	R	EL	



L1333259

2G8FN3JTRAA



Metod	
1	Analys av vattenprov utan föregående uppslutning. Provet har surgjorts med 1 ml salpetersyra(suprapur) per 100 ml. Detta gäller dock ej prov som varit surgjort vid ankomsten till laboratoriet.. Analys har skett enligt EPA-metoder 200.7 (ICP-AES).

	Godkännare
DKA	Dan Krekula
EL	Erik Lidman
IDJO	Ida Jonsson
MKA	Martina Krekula
TALA	Tanja Larsson

	Utf¹
F	AFS
H	ICP-SFMS
I	Man.lm.
R	ICP-AES

* efter parameternamn indikerar icke ackrediterad analys.

Mätsäkerheten anges som en utvidgad osäkerhet (enligt definitionen i "Guide to the Expression of Uncertainty in Measurement", ISO, Geneva, Switzerland 1993) beräknad med täckningsfaktor lika med 2 vilket ger en konfidensnivå på ungefärligt 95%.

Mätsäkerhet från underleverantör anges oftast som en utvidgad osäkerhet beräknad med täckningsfaktor 2. För ytterligare information kontakta laboratoriet.

Denna rapport får endast återges i sin helhet, om inte utfärdande laboratorium i förväg skriftligen godkänt annat.

Resultaten gäller endast det identifierade, mottagna och provade materialet.

Beträffande laboratoriets ansvar i samband med uppdrag, se aktuell produktkatalog eller vår webbplats www.alsglobal.se

Den digitalt signerade PDF filen representerar orginalrapporten. Alla utskrifter från denna är att betrakta som kopior.

¹ Utförande teknisk enhet (inom ALS Scandinavia) eller anlitat laboratorium (underleverantör).

Appendix C – Binders

- Fly ash
- Cement

Mölndal Energi AB
 Göran Lundström
 Box 34
 431 21 MÖLNDAL

AR-13-SL-122089-01



EUSELI2-00135440

Kundnummer: SL8432089

Analysrapport

Provnummer:	177-2013-11060917			
Provbeskrivning:				
Matris:	Aska			
Provet ankom:	2013-11-06			
Utskriftsdatum:	2013-11-19			
Provmarkning:	Flygaska 10-15% torv 15-20% rt. KVV:2013-11-05 Prov silo 1			
Analys	Resultat	Enhet	Mäto.	Metod/ref
Fukthalt	0.3	%	10%	EN 14774 / 15414 a)
Kalkverkan som CaO	15	% Ts	20%	Lantbruksstyrelsen Kungörelse 1950 nr 7 4:59-60 a)
pH	12.6			Skogsstyrelsen 2-2001 a)*
Oförbränt	5.9	% Ts	10%	SS 187187 a)
Aluminium Al	44000	mg/kg Ts	25%	EN 13656 mod. / ICP-AES a)
Fosfor P	7800	mg/kg Ts	20%	EN 13656 mod. / ICP-AES a)
Järn Fe	24000	mg/kg Ts	25%	EN 13656 mod. / ICP-AES a)
Kadmium Cd	6.2	mg/kg Ts	30%	EN 13656 mod. / ICP-MS a)
Kalcium Ca	110000	mg/kg Ts	30%	EN 13656 mod. / ICP-AES a)
Kalium K	53000	mg/kg Ts	25%	EN 13656 mod. / ICP-AES a)
Kisel Si	190000	mg/kg Ts	20%	EN 14385 / ICP-AES a)*
Magnesium Mg	18000	mg/kg Ts	25%	EN 13656 mod. / ICP-AES a)
Mangan Mn	7200	mg/kg Ts	20%	EN 13656 mod. / ICP-AES a)
Natrium Na	18000	mg/kg Ts	20%	EN 13656 mod. / ICP-AES a)
Titan Ti	3400	mg/kg Ts	20%	EN 13656 mod. / ICP-AES a)
Arsenik As	65	mg/kg Ts	25%	EN 13656 mod. / ICP-MS a)
Antimon Sb	16	mg/kg Ts	15%	EN 13656 mod. / ICP-MS a)
Barium Ba	1600	mg/kg Ts	30%	EN 13656 mod. / ICP-AES a)
Beryllium Be	< 2.6	mg/kg Ts	30%	EN 13656 mod. / ICP-MS a)
Bly Pb	240	mg/kg Ts	20%	EN 13656 mod. / ICP-MS a)
Kobolt Co	12	mg/kg Ts	30%	EN 13656 mod. / ICP-MS a)
Koppar Cu	200	mg/kg Ts	20%	EN 13656 mod. / ICP-AES a)
Krom Cr	130	mg/kg Ts	25%	EN 13656 mod. / ICP-MS a)
Molybden Mo	< 21	mg/kg Ts	25%	EN 13656 mod. / ICP-AES a)
Nickel Ni	35	mg/kg Ts	35%	EN 13656 mod. / ICP-MS a)
Svavel S	12000	mg/kg Ts	25%	EN 13656 mod. / ICP-AES a)*

Förklaringar

AR-003v34

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätsäkerheten, om inget annat anges, redovisas som utvidgad mätsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.



Tenn Sn	10	mg/kg Ts	20%	EN 13656 mod. / ICP-MS	a)
Vanadin	50	mg/kg Ts	25%	EN 13656 mod. / ICP-MS	a)
Zink Zn	2200	mg/kg Ts	25%	EN 13656 mod. / ICP-AES	a)
Bor B	160	mg/kg Ts	15%	SS 028150-2 / ICP-AES	a)*
Kvicksilver Hg	0.64	mg/kg Ts	25%	SS 028150-2 / AFS	a)*

Utförande laboratorium/underleverantör:

a) Eurofins Environment Sweden AB (Lidköping), SWEDEN

Kopia till:

Annika Malmberg (annika.malmberg@molndalenergi.se)

Lars Rosengren, Rapportansvarig

Denna rapport är elektroniskt signerad.

Byggcement

CEM II/A-LL 42,5 R



Cement type and cement class

Byggcement is a CEM II Portland-limestone cement manufactured in Skövde and Slite. It has normal compressive strength development and is used in standard concrete work, e.g. in house building. Technical data is on page 2 of this technical data sheet.

Standards and control

Byggcement satisfies the requirements of SS-EN 197-1 Cement-Part 1: Composition, specifications and conformity criteria for common cements.

Byggcement Skövde is P-marked with certificate number 10 13 14 and CE-marked with certificate number 10 13 24.

Byggcement Slite is P-marked with certificate number 10 13 15 and CE-marked with certificate number 10 13 23.

Packaging, distribution and storage

Delivery takes place in bulk, in 1,000 kg big bags or in 25 kg bags by Saint-Gobain Byggprodukter AB. Delivery terminals are listed in our price list. Storage in an environment that has an element of moist air or direct contact with ground moisture or water damages the cement very quickly (days, weeks). Byggcement must be stored in a dry, sealed silo for a maximum of six months after delivery, as the chromate reduction process gradually loses its effect.

Cement in bags must be stored on plastic-coated storage pallets for a maximum of six months after the packing date. It is always the buyer's responsibility to make sure and be able to show that the storage location is dry and sealed, and that the storage time is observed.

General terms of delivery

The delivery of Byggcement is subject to ABM 92 and Cementa's Special Terms and Conditions.

Safety during handling

All cement must be stored out of the reach of children and is dangerous to consume. Cement in the eyes creates a risk of serious eye damage. Moist cement forms calcium hydroxide, which irritates the skin and the respiratory organs. For complete information and instructions on protection, see the Material Safety Data Sheet.

Product information

For the latest updates to the Technical Data Sheet and Material Safety Data Sheet, see our website www.cementa.se.

Technical data

Byggcement CEM II/A-LL 42,5 R

Byggcement Skövde and Slite complies with the data below.
On rare occasions the values may deviate from the specified ranges or limits.

Physical data

Property	Guideline value Skövde	Guideline value Slite	Range	Unit	Requirement	Current standard
Blaine fineness	430	460	± 30	m ² /kg		
Setting time	140	160	± 30	min	≥ 60.0	EN 197-1
Compressive strength 1 d*	23	21	± 3	MPa		
Compressive strength 2 d*	35	33	± 3	MPa	≥ 20.0	EN 197-1
Compressive strength 7 d*		44	± 4	MPa		
Compressive strength 28 d*	55	56	± 4	MPa	≥ 42.5 and ≤ 62.5	EN 197-1
Compact density	3 080	3 080	± 20	kg/m ³		
Bulk density	1 250	1 250	± 250	kg/m ³		
Brightness	26	30	± 1	%		

* Measured on standard mortar

Chemical data

Property	Limits Skövde	Limits Slite	Unit	Requirement	Current standard
Magnesium oxide, MgO	1.1–1.3	2.3–2.7	%	≤ 5.0	EN 197-1
Sulfates, SO ₃	3.4–4.0	3.1–3.7	%	≤ 4.0	EN 197-1
Chloride, Cl ⁻	0.02–0.04	0.03–0.07	%	≤ 0.10	EN 197-1
Water-soluble, Cr ⁶⁺	0–2	0–2	ppm	≤ 2 (In accordance with EG 2003/53 and KIFS 2004:6)	

CEMENTA
HEIDELBERGCEMENT Group

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www.cementa.se

Appendix D – Analyses of sediments

- Untreated sediment
- A.L sediment
- V.S sediment

Göteborgs Hamn AB
Ida Fossenstrand
Hamnmyndigheten, Kusten
403 38 GÖTEBORG

AR-14-SL-023284-01
EUSELI2-00152420

Kundnummer: SL2002335

Uppdragsmärkn.
Göteborgs Hamn

Analysrapport

Provnummer:	177-2014-02190391	Provtagare	Anna Noren
Provbeskrivning:		Provtagningsdatum	2014-02-17
Matris:	Sediment		
Provet ankom:	2014-02-18		
Utskriftsdatum:	2014-03-07		
Provmarkering:	Original		
Provtagningsplats:	Göteborgs Hamn		
Analys	Resultat	Enhet	Mäto.
Torrsubstans	37.4	%	10%
Antimon Sb (Kungsv.)	< 9.3	mg/kg Ts	15%
Molybden Mo (Kungsv.)	< 9.3	mg/kg Ts	15%
Arsenik As	9.0	mg/kg Ts	20%
Barium Ba	110	mg/kg Ts	20%
Bly Pb	32	mg/kg Ts	25%
Järn Fe	35000	mg/kg Ts	15%
Kadmium Cd	0.29	mg/kg Ts	15%
Kobolt Co	11	mg/kg Ts	20%
Koppar Cu	230	mg/kg Ts	15%
Krom Cr	57	mg/kg Ts	15%
Kvicksilver Hg	0.20	mg/kg Ts	25%
Nickel Ni	22	mg/kg Ts	15%
Selen Se	1.9	mg/kg Ts	20%
Tenn Sn	12	mg/kg Ts	20%
Vanadin V	53	mg/kg Ts	15%
Zink Zn	360	mg/kg Ts	15%
Sulfat (vattenlöslig)	2700	mg/kg Ts	
Fluorid (vattenlöslig)	4.6	mg/kg Ts	St Meth 4500-F / Kone
Dibutyltenn (DBT)	330	µg/kg Ts	DIN 19744
Difenyltenn (DPhT)	15	µg/kg Ts	DIN 19744
Dioktyltenn (DOT)	9.2	µg/kg Ts	DIN 19744
Monobutyltenn (MBT)	85	µg/kg Ts	DIN 19744
Monofenyltenn (MPhT)	13	µg/kg Ts	DIN 19744
Monooktyltenn (MOT)	1.5	µg/kg Ts	DIN 19744

EUSELI2-00152420

Tetrabutyltenn (TTBT)	12	µg/kg Ts	10%	DIN 19744	b)
Tributyltenn (TBT)	1700	µg/kg Ts	10%	DIN 19744	b)
Tricyklohexyltenn (TCHT)	<1.0	µg/kg Ts	10%	DIN 19744	b)
Trifenytlenn (TPhT)	16	µg/kg Ts	10%	DIN 19744	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

noanna@student.chalmers.se (noanna@student.chalmers.se)

Marcus Dovberg, Rapportansvarig

Denna rapport är elektroniskt signerad.

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Måtosäkerheten, om inget annat anges, redovisas som utvidgad måtosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Göteborgs Hamn AB
Ida Fossenstrand
Hamnmyndigheten, Kusten
403 38 GÖTEBORG

AR-14-SL-023283-01
EUSELI2-00152420

Kundnummer: SL2002335

Uppdragsmärkn.
Göteborgs Hamn

Analysrapport

Provnummer:	177-2014-02190392	Provtagare	Anna Noren
Provbeskrivning:		Provtagningsdatum	2014-02-17
Matris:	Sediment		
Provet ankom:	2014-02-18		
Utskriftsdatum:	2014-03-07		
Provmarkning:	Tvätt		
Provtagningsplats:	Göteborgs Hamn		
Analys	Resultat	Enhet	Mäto.
Torrsubstans	42.6	%	10%
Antimon Sb (Kungsv.)	5.9	mg/kg Ts	15%
Molybden Mo (Kungsv.)	9.8	mg/kg Ts	15%
Arsenik As	9.0	mg/kg Ts	20%
Barium Ba	100	mg/kg Ts	20%
Bly Pb	39	mg/kg Ts	25%
Järn Fe	27000	mg/kg Ts	15%
Kadmium Cd	0.49	mg/kg Ts	15%
Kobolt Co	10	mg/kg Ts	20%
Koppar Cu	250	mg/kg Ts	15%
Krom Cr	45	mg/kg Ts	15%
Kvicksilver Hg	1.6	mg/kg Ts	25%
Nickel Ni	19	mg/kg Ts	15%
Selen Se	1.7	mg/kg Ts	20%
Tenn Sn	15	mg/kg Ts	20%
Vanadin V	48	mg/kg Ts	15%
Zink Zn	280	mg/kg Ts	15%
Sulfat (vattenlöslig)	1400	mg/kg Ts	
Fluorid (vattenlöslig)	<0.94	mg/kg Ts	St Meth 4500-F / Kone
Dibutyltenn (DBT)	340	µg/kg Ts	10% DIN 19744
Difenyltenn (DPhT)	5.9	µg/kg Ts	10% DIN 19744
Dioktyltenn (DOT)	6.4	µg/kg Ts	10% DIN 19744
Monobutyltenn (MBT)	89	µg/kg Ts	10% DIN 19744
Monofenyltenn (MPhT)	16	µg/kg Ts	10% DIN 19744
Monooktyltenn (MOT)	<1.0	µg/kg Ts	10% DIN 19744

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätsäkerheten, om inget annat anges, redovisas som utvidgad mätsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Tetrabutyltenn (TTBT)	14	µg/kg Ts	10%	DIN 19744	b)
Tributyltenn (TBT)	2300	µg/kg Ts	10%	DIN 19744	b)
Tricyklohexyltenn (TCHT)	<1.0	µg/kg Ts	10%	DIN 19744	b)
Trifenytlenn (TPhT)	7.6	µg/kg Ts	10%	DIN 19744	b)

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

noanna@student.chalmers.se (noanna@student.chalmers.se)

Marcus Dovberg, Rapportansvarig

Denna rapport är elektroniskt signerad.

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AR-14-SL-023282-01
EUSELI2-00152420

Kundnummer: SL2002335

Uppdragsmärkn.
Göteborgs Hamn

Analysrapport

Provnummer:	177-2014-02190393	Provtagare	Anna Noren
Provbeskrivning:		Provtagningsdatum	2014-02-17
Matris:	Sediment		
Provet ankom:	2014-02-18		
Utskriftsdatum:	2014-03-07		
Provmarkning:	Skak		
Provtagningsplats:	Göteborgs Hamn		
Analys	Resultat	Enhet	Mäto.
Torrsubstans	46.2	%	10%
Antimon Sb (Kungsv.)	< 3.7	mg/kg Ts	15%
Molybden Mo (Kungsv.)	5.8	mg/kg Ts	15%
Arsenik As	8.1	mg/kg Ts	20%
Barium Ba	84	mg/kg Ts	20%
Bly Pb	25	mg/kg Ts	25%
Järn Fe	26000	mg/kg Ts	15%
Kadmium Cd	0.23	mg/kg Ts	15%
Kobolt Co	8.7	mg/kg Ts	20%
Koppar Cu	180	mg/kg Ts	15%
Krom Cr	41	mg/kg Ts	15%
Kvicksilver Hg	0.18	mg/kg Ts	25%
Nickel Ni	17	mg/kg Ts	15%
Selen Se	2.6	mg/kg Ts	20%
Tenn Sn	9.9	mg/kg Ts	20%
Vanadin V	43	mg/kg Ts	15%
Zink Zn	270	mg/kg Ts	15%
Sulfat (vattenlöslig)	670	mg/kg Ts	
Fluorid (vattenlöslig)	4.4	mg/kg Ts	St Meth 4500-F / Kone
Dibutyltenn (DBT)	190	µg/kg Ts	10% DIN 19744
Difenyltenn (DPhT)	6.9	µg/kg Ts	10% DIN 19744
Dioktyltenn (DOT)	6.9	µg/kg Ts	10% DIN 19744
Monobutyltenn (MBT)	57	µg/kg Ts	10% DIN 19744
Monofenyltenn (MPhT)	7.1	µg/kg Ts	10% DIN 19744
Monooktyltenn (MOT)	<1.0	µg/kg Ts	10% DIN 19744

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätsäkerheten, om inget annat anges, redovisas som utvidgad mätsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

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EUSELI2-00152420

Tetrabutyltenn (TTBT)	6.7	µg/kg Ts	10%	DIN 19744	b)
Tributyltenn (TBT)	1100	µg/kg Ts	10%	DIN 19744	b)
Tricyklohexyltenn (TCHT)	<1.0	µg/kg Ts	10%	DIN 19744	b)
Trifenytlenn (TPhT)	5.8	µg/kg Ts	10%	DIN 19744	b)

Utförande laboratorium/underleverantör:

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 b) GALAB Laboratories GmbH, GERMANY

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Marcus Dovberg, Rapportansvarig

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Förklaringar

AR-003v35

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Mätsäkerheten, om inget annat anges, redovisas som utvidgad mätsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

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Appendix E – Analyses of liquids

- Seawater
- V.S filtrate
- Acidic filtrate
- Acidic + Milli-Q filtrate
- Maximum available leaching test: Sediment NaCl
- Maximum available leaching test: Sediment Milli-Q
- Surface diffusion test: Sediment Milli-Q
- Surface diffusion test: Sediment NaCl
- Surface diffusion test: Sediment pH
- Surface diffusion test: Sediment Nitrogen
- Surface diffusion test: Sediment Oxygen
- Maximum available leaching test: C1B NaCl
- Maximum available leaching test: C1B Milli-Q
- Maximum available leaching test: C2B NaCl
- Maximum available leaching test: C2B Milli-Q
- Surface diffusion test: C1B Milli-Q
- Surface diffusion test: C1B NaCl
- Surface diffusion test: C1B pH
- Surface diffusion test: C1B Nitrogen
- Surface diffusion test: C1B Oxygen

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AR-14-SL-037177-01
EUSELI2-00158866

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-03240481	Ankomsttemp °C	13,1
Provbeskrivning:		Provtagningsdatum	2014-03-21
Matris:	Övrigt förorenat vatten		
Provet ankom:	2014-03-24		
Utskriftsdatum:	2014-04-04		
Provmarkering:	1 Havsvatten		
Analys	Resultat	Enhet	Mäto.
Sulfat	2300	mg/l	15%
Fluorid	0.58	mg/l	25%
DOC	2.3	mg/l	15%
Järn Fe (filtrerat)	< 0.10	mg/l	20%
Arsenik As (filtrerat)	< 0.010	mg/l	15%
Antimon, Sb (filtrerat)	< 0.050	mg/l	20%
Barium Ba (filtrerat)	< 0.050	mg/l	25%
Bly Pb (filtrerat)	< 0.0025	mg/l	15%
Kadmium Cd (filtrerat)	< 0.0010	mg/l	15%
Kobolt Co (filtrerat)	< 0.010	mg/l	15%
Koppar Cu (filtrerat)	< 0.010	mg/l	25%
Krom Cr (filtrerat)	< 0.010	mg/l	15%
Kvicksilver Hg (filtrerat)	< 0.00010	mg/l	20%
Molybden, Mo (filtrerat)	< 0.025	mg/l	25%
Nickel Ni (filtrerat)	< 0.010	mg/l	15%
Selen, Se (filtrerat)	< 0.025	mg/l	30%
Tenn Sn (filtrerat)	< 0.0050	mg/l	15%
Vanadin V (filtrerat)	< 0.010	mg/l	20%
Zink Zn (filtrerat)	< 0.050	mg/l	25%
Monobutyltenn (MBT)	<1.0	ng/l	10%
Dibutyltenn (DBT)	<1.0	ng/l	10%
Tributyltenn (TBT)	<1.0	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monookytyletten (MOT)	<1.0	ng/l	10%
Dioktyltenn (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Måtsäkerheten, om inget annat anges, redovisas som utvidgad måtsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

Förklaringar

AR-003v35

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Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

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AR-14-SL-037178-01
EUSELI2-00158866

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-03240482	Ankomsttemp °C	13,1
Provbeskrivning:		Provtagningsdatum	2014-03-21
Matris:	Övrigt förorenat vatten		
Provet ankom:	2014-03-24		
Utskriftsdatum:	2014-04-04		
Provmarkering:	2 Skaklavätska		
Analys	Resultat	Enhet	Mäto.
Sulfat	630	mg/l	15%
Fluorid	0.51	mg/l	25%
DOC	8.9	mg/l	15%
Järn Fe (filtrerat)	< 0.40	mg/l	20%
Arsenik As (filtrerat)	< 0.040	mg/l	15%
Antimon, Sb (filtrerat)	< 0.20	mg/l	20%
Barium Ba (filtrerat)	0.23	mg/l	25%
Bly Pb (filtrerat)	< 0.010	mg/l	15%
Kadmium Cd (filtrerat)	< 0.0040	mg/l	15%
Kobolt Co (filtrerat)	< 0.040	mg/l	15%
Koppar Cu (filtrerat)	< 0.040	mg/l	25%
Krom Cr (filtrerat)	< 0.040	mg/l	15%
Kvicksilver Hg (filtrerat)	< 0.00010	mg/l	20%
Molybden, Mo (filtrerat)	< 0.10	mg/l	25%
Nickel Ni (filtrerat)	< 0.040	mg/l	15%
Selen, Se (filtrerat)	< 0.10	mg/l	30%
Tenn Sn (filtrerat)	< 0.020	mg/l	15%
Vanadin V (filtrerat)	< 0.040	mg/l	20%
Zink Zn (filtrerat)	< 0.20	mg/l	25%
Monobutyltenn (MBT)	3.3	ng/l	10%
Dibutyltenn (DBT)	< 1.0	ng/l	10%
Tributyltenn (TBT)	1.5	ng/l	10%
Tetrabutyltenn (TTBT)	< 1.0	ng/l	10%
Monookytlytten (MOT)	3.7	ng/l	10%
Dioktyltytten (DOT)	1.2	ng/l	10%
Tricyklohexyltenn (TCHT)	< 1.0	ng/l	10%
Monofenyltenn (MPhT)	< 1.0	ng/l	10%

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Måtosäkerheten, om inget annat anges, redovisas som utvidgad måtosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitro (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

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AR-14-SL-037179-01
EUSELI2-00158866

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-03240483	Ankomsttemp °C	13,1
Provbeskrivning:		Provtagningsdatum	2014-03-21
Matris:	Övrigt förorenat vatten		
Provet ankom:	2014-03-24		
Utskriftsdatum:	2014-04-04		
Provmarkering:	3 Lakvätska 1		
Analys	Resultat	Enhet	Mäto.
Sulfat	1400	mg/l	15%
Fluorid	17	mg/l	15%
DOC	140	mg/l	15%
Järn Fe (filtrerat)	3400	mg/l	10%
Arsenik As (filtrerat)	0.044	mg/l	15%
Antimon, Sb (filtrerat)	< 0.20	mg/l	20%
Barium Ba (filtrerat)	1.9	mg/l	15%
Bly Pb (filtrerat)	3.6	mg/l	15%
Kadmium Cd (filtrerat)	0.15	mg/l	15%
Kobolt Co (filtrerat)	0.86	mg/l	10%
Koppar Cu (filtrerat)	0.22	mg/l	10%
Krom Cr (filtrerat)	4.1	mg/l	15%
Kvicksilver Hg (filtrerat)	< 0.00010	mg/l	20%
Molybden, Mo (filtrerat)	< 0.10	mg/l	25%
Nickel Ni (filtrerat)	1.0	mg/l	15%
Selen, Se (filtrerat)	0.34	mg/l	30%
Tenn Sn (filtrerat)	< 0.020	mg/l	15%
Vanadin V (filtrerat)	3.8	mg/l	20%
Zink Zn (filtrerat)	130	mg/l	30%
Monobutyltenn (MBT)	65	ng/l	10%
Dibutyltenn (DBT)	440	ng/l	10%
Tributyltenn (TBT)	<1.0	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monooktyltenn (MOT)	<1.0	ng/l	10%
Dioktyltenn (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

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Måtosäkerheten, om inget annat anges, redovisas som utvidgad måtosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

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AR-14-SL-037180-01
EUSELI2-00158866

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-03240484	Ankomsttemp °C	13,1
Provbeskrivning:		Provtagningsdatum	2014-03-21
Matris:	Övrigt förorenat vatten		
Provet ankom:	2014-03-24		
Utskriftsdatum:	2014-04-04		
Provmarkering:	4 Lakvätska 2		
Analys	Resultat	Enhet	Mäto.
Sulfat	340	mg/l	15%
Fluorid	8.0	mg/l	15%
DOC	35	mg/l	15%
Järn Fe (filtrerat)	1100	mg/l	10%
Arsenik As (filtrerat)	< 0.020	mg/l	15%
Antimon, Sb (filtrerat)	< 0.10	mg/l	20%
Barium Ba (filtrerat)	0.82	mg/l	15%
Bly Pb (filtrerat)	1.0	mg/l	15%
Kadmium Cd (filtrerat)	0.045	mg/l	15%
Kobolt Co (filtrerat)	0.39	mg/l	15%
Koppar Cu (filtrerat)	0.27	mg/l	10%
Krom Cr (filtrerat)	1.3	mg/l	15%
Kvicksilver Hg (filtrerat)	< 0.00010	mg/l	20%
Molybden, Mo (filtrerat)	< 0.050	mg/l	25%
Nickel Ni (filtrerat)	0.51	mg/l	15%
Selen, Se (filtrerat)	0.053	mg/l	30%
Tenn Sn (filtrerat)	< 0.010	mg/l	15%
Vanadin V (filtrerat)	1.0	mg/l	20%
Zink Zn (filtrerat)	24	mg/l	30%
Monobutyltenn (MBT)	9.1	ng/l	10%
Dibutyltenn (DBT)	84	ng/l	10%
Tributyltenn (TBT)	<1.0	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monooktyltenn (MOT)	<1.0	ng/l	10%
Dioktyltenn (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

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Måtsäkerheten, om inget annat anges, redovisas som utvidgad måtsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	2.5	ng/l	10%	EN ISO 17353	b)

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

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AR-14-SL-037181-01
EUSELI2-00158866

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-03240485	Ankomsttemp °C	13,1
Provbeskrivning:		Provtagningsdatum	2014-03-21
Matris:	Övrigt förorenat vatten		
Provet ankom:	2014-03-24		
Utskriftsdatum:	2014-04-04		
Provmarkering:	5 L/S10 Salt		
Analys	Resultat	Enhet	Mäto.
Sulfat	180	mg/l	15%
Fluorid	0.36	mg/l	25%
DOC	5.8	mg/l	15%
Järn Fe (filtrerat)	< 0.10	mg/l	20%
Arsenik As (filtrerat)	< 0.010	mg/l	15%
Antimon, Sb (filtrerat)	< 0.050	mg/l	20%
Barium Ba (filtrerat)	0.040	mg/l	15%
Bly Pb (filtrerat)	< 0.0025	mg/l	15%
Kadmium Cd (filtrerat)	< 0.0010	mg/l	15%
Kobolt Co (filtrerat)	< 0.010	mg/l	15%
Koppar Cu (filtrerat)	< 0.010	mg/l	25%
Krom Cr (filtrerat)	< 0.010	mg/l	15%
Kvicksilver Hg (filtrerat)	< 0.00010	mg/l	20%
Molybden, Mo (filtrerat)	0.050	mg/l	10%
Nickel Ni (filtrerat)	< 0.010	mg/l	15%
Selen, Se (filtrerat)	< 0.025	mg/l	30%
Tenn Sn (filtrerat)	< 0.0050	mg/l	15%
Vanadin V (filtrerat)	< 0.010	mg/l	20%
Zink Zn (filtrerat)	< 0.050	mg/l	25%
Monobutyltenn (MBT)	4.6	ng/l	10%
Dibutyltenn (DBT)	11	ng/l	10%
Tributyltenn (TBT)	95	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monookytlytten (MOT)	<1.0	ng/l	10%
Dioktyltytten (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

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Måtosäkerheten, om inget annat anges, redovisas som utvidgad måtosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

EUSELI2-00158866

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
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Kopia till:

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätsäkerheten, om inget annat anges, redovisas som utvidgad mätsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Göteborgs Hamn AB
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 403 38 GÖTEBORG

AR-14-SL-037182-01
EUSELI2-00158866

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-03240486	Ankomsttemp °C	13,1
Provbeskrivning:		Provtagningsdatum	2014-03-21
Matris:	Övrigt förorenat vatten		
Provet ankom:	2014-03-24		
Utskriftsdatum:	2014-04-04		
Provmarkering:	6 L/S Milli-Q		
Analys	Resultat	Enhet	Mäto.
Sulfat	140	mg/l	15%
Fluorid	0.74	mg/l	10%
DOC	7.9	mg/l	15%
Järn Fe (filtrerat)	0.033	mg/l	20%
Arsenik As (filtrerat)	0.0011	mg/l	15%
Antimon, Sb (filtrerat)	0.0038	mg/l	20%
Barium Ba (filtrerat)	0.0068	mg/l	25%
Bly Pb (filtrerat)	0.00013	mg/l	20%
Kadmium Cd (filtrerat)	< 0.000040	mg/l	15%
Kobolt Co (filtrerat)	< 0.000040	mg/l	15%
Koppar Cu (filtrerat)	0.048	mg/l	25%
Krom Cr (filtrerat)	< 0.00040	mg/l	15%
Kvicksilver Hg (filtrerat)	< 0.00010	mg/l	20%
Molybden, Mo (filtrerat)	0.060	mg/l	25%
Nickel Ni (filtrerat)	0.0014	mg/l	15%
Selen, Se (filtrerat)	< 0.0010	mg/l	30%
Tenn Sn (filtrerat)	< 0.00020	mg/l	15%
Vanadin V (filtrerat)	0.0024	mg/l	20%
Zink Zn (filtrerat)	0.0070	mg/l	25%
Monobutyltenn (MBT)	21	ng/l	10%
Dibutyltenn (DBT)	45	ng/l	10%
Tributyltenn (TBT)	400	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monookytlytten (MOT)	<1.0	ng/l	10%
Dioktyltytten (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Måtsäkerheten, om inget annat anges, redovisas som utvidgad måtsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

Göteborgs Hamn AB
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AR-14-SL-037173-01
EUSELI2-00158818

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-03240346	Ankomsttemp °C	14,4
Provbeskrivning:		Provtagningsdatum	2014-03-21
Matris:	Övrigt förorenat vatten		
Provet ankom:	2014-03-24		
Utskriftsdatum:	2014-04-04		
Provmarkering:	Sed. Milli-Q		
Analys	Resultat	Enhet	Mäto.
Sulfat	57	mg/l	15%
Fluorid	< 0.20	mg/l	25%
DOC	< 2.0	mg/l	15%
Järn Fe (filtrerat)	0.0055	mg/l	20%
Arsenik As (filtrerat)	0.0025	mg/l	15%
Antimon, Sb (filtrerat)	< 0.0020	mg/l	20%
Barium Ba (filtrerat)	0.0038	mg/l	25%
Bly Pb (filtrerat)	< 0.00010	mg/l	20%
Kadmium Cd (filtrerat)	< 0.000040	mg/l	15%
Kobolt Co (filtrerat)	< 0.000040	mg/l	15%
Koppar Cu (filtrerat)	0.0010	mg/l	25%
Krom Cr (filtrerat)	< 0.000040	mg/l	15%
Kvicksilver Hg (filtrerat)	< 0.000010	mg/l	20%
Molybden, Mo (filtrerat)	0.0073	mg/l	25%
Nickel Ni (filtrerat)	< 0.000040	mg/l	25%
Selen, Se (filtrerat)	< 0.0010	mg/l	30%
Tenn Sn (filtrerat)	< 0.000020	mg/l	15%
Vanadin V (filtrerat)	0.0018	mg/l	20%
Zink Zn (filtrerat)	< 0.0020	mg/l	25%
Monobutyltenn (MBT)	2.3	ng/l	10%
Dibutyltenn (DBT)	3.2	ng/l	10%
Tributyltenn (TBT)	11	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monookytlytten (MOT)	<1.0	ng/l	10%
Dioktyltytten (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Måtosäkerheten, om inget annat anges, redovisas som utvidgad måtosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

EUSELI2-00158818

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenyttenn (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätsäkerheten, om inget annat anges, redovisas som utvidgad mätsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

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AR-14-SL-037174-01
EUSELI2-00158818

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-03240347	Ankomsttemp °C	14,4
Provbeskrivning:		Provtagningsdatum	2014-03-21
Matris:	Övrigt förorenat vatten		
Provet ankom:	2014-03-24		
Utskriftsdatum:	2014-04-04		
Provmarkering:	Sed. NaCl		
Analys	Resultat	Enhet	Mäto.
Sulfat	100	mg/l	15%
Fluorid	< 0.20	mg/l	25%
DOC	< 2.0	mg/l	15%
Järn Fe (filtrerat)	< 0.040	mg/l	20%
Arsenik As (filtrerat)	< 0.0040	mg/l	15%
Antimon, Sb (filtrerat)	< 0.020	mg/l	20%
Barium Ba (filtrerat)	< 0.020	mg/l	25%
Bly Pb (filtrerat)	< 0.0010	mg/l	15%
Kadmium Cd (filtrerat)	< 0.00040	mg/l	15%
Kobolt Co (filtrerat)	< 0.0040	mg/l	15%
Koppar Cu (filtrerat)	< 0.0040	mg/l	25%
Krom Cr (filtrerat)	< 0.0040	mg/l	15%
Kvicksilver Hg (filtrerat)	< 0.00010	mg/l	20%
Molybden, Mo (filtrerat)	0.011	mg/l	25%
Nickel Ni (filtrerat)	< 0.0040	mg/l	15%
Selen, Se (filtrerat)	< 0.010	mg/l	30%
Tenn Sn (filtrerat)	< 0.0020	mg/l	15%
Vanadin V (filtrerat)	< 0.0040	mg/l	20%
Zink Zn (filtrerat)	< 0.020	mg/l	25%
Monobutyltenn (MBT)	2.7	ng/l	10%
Dibutyltenn (DBT)	<1.0	ng/l	10%
Tributyltenn (TBT)	15	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monooktyltenn (MOT)	<1.0	ng/l	10%
Dioktyltenn (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Måtsäkerheten, om inget annat anges, redovisas som utvidgad måtsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

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AR-14-SL-037175-01
EUSELI2-00158818

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-03240348	Ankomsttemp °C	14,4
Provbeskrivning:		Provtagningsdatum	2014-03-21
Matris:	Övrigt förenat vatten		
Provet ankom:	2014-03-24		
Utskriftsdatum:	2014-04-04		
Provmarkering:	Sed. pH		
Analys	Resultat	Enhet	Mäto.
Sulfat	71	mg/l	15%
Fluorid	0.77	mg/l	10%
DOC	130	mg/l	15%
Järn Fe (filtrerat)	1.9	mg/l	10%
Arsenik As (filtrerat)	0.00042	mg/l	15%
Antimon, Sb (filtrerat)	< 0.0020	mg/l	20%
Barium Ba (filtrerat)	0.014	mg/l	25%
Bly Pb (filtrerat)	< 0.00010	mg/l	20%
Kadmium Cd (filtrerat)	< 0.000040	mg/l	15%
Kobolt Co (filtrerat)	0.00049	mg/l	15%
Koppar Cu (filtrerat)	0.00052	mg/l	25%
Krom Cr (filtrerat)	0.0060	mg/l	15%
Kvicksilver Hg (filtrerat)	< 0.00010	mg/l	20%
Molybden, Mo (filtrerat)	0.0011	mg/l	35%
Nickel Ni (filtrerat)	0.00087	mg/l	15%
Selen, Se (filtrerat)	< 0.0010	mg/l	30%
Tenn Sn (filtrerat)	< 0.00020	mg/l	15%
Vanadin V (filtrerat)	0.00074	mg/l	20%
Zink Zn (filtrerat)	0.0075	mg/l	25%
Monobutyltenn (MBT)	7.0	ng/l	10%
Dibutyltenn (DBT)	6.4	ng/l	10%
Tributyltenn (TBT)	32	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monookyltenn (MOT)	<1.0	ng/l	10%
Diokyltenn (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

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Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

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 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

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AR-14-SL-051231-01
EUSELI2-00163045

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-04101025	Ankomsttemp °C	4
Provbeskrivning:		Provtagare	Anna Norén
Matris:	Övrigt förorenat vatten	Provtagningsdatum	2014-04-09
Provet ankom:	2014-04-10		
Utskriftsdatum:	2014-05-05		
Provmarkering:	Sed. Nitrogen		
Analys	Resultat	Enhet	Mäto.
Järn Fe (uppslutet)	0.13	mg/l	20%
Arsenik As (uppslutet)	< 0.00050	mg/l	35%
Antimon, Sb (uppslutet)	< 0.10	mg/l	30%
Barium Ba (uppslutet)	< 0.020	mg/l	35%
Bly Pb (uppslutet)	0.0012	mg/l	35%
Kadmium Cd (uppslutet)	< 0.00010	mg/l	50%
Kobolt Co (uppslutet)	< 0.0010	mg/l	25%
Koppar Cu (uppslutet)	0.0074	mg/l	15%
Krom Cr (uppslutet)	0.0011	mg/l	25%
Kvicksilver Hg (uppslutet)	< 0.00010	mg/l	20%
Molybden, Mo (uppslutet)	0.011	mg/l	30%
Nickel Ni (uppslutet)	0.0012	mg/l	40%
Selen, Se (syrauppslutet)	< 0.0030	mg/l	35%
Tenn Sn (uppslutet)	< 0.00050	mg/l	30%
Vanadin V (uppslutet)	0.00077	mg/l	30%
Zink Zn (uppslutet)	0.0051	mg/l	20%
Monobutyltenn (MBT)	1.3	ng/l	10%
Dibutyltenn (DBT)	2.4	ng/l	10%
Tributyltenn (TBT)	5.3	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monooktyltenn (MOT)	<1.0	ng/l	10%
Dioktyltenn (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%
Difenyltenn (DPhT)	<1.0	ng/l	10%
Trifenyltenn (TPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

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Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
- b) GALAB Laboratories GmbH, GERMANY

Kopia till:

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

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403 38 GÖTEBORG

AR-14-SL-037176-01
EUSELI2-00158818

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-03240349	Ankomsttemp °C	14,4
Provbeskrivning:		Provtagningsdatum	2014-03-21
Matris:	Övrigt förorenat vatten		
Provet ankom:	2014-03-24		
Utskriftsdatum:	2014-04-04		
Provmarkering:	Sed. Oxygen		
Analys	Resultat	Enhet	Mäto.
Sulfat	160	mg/l	15%
Fluorid	< 0.20	mg/l	25%
DOC	3.6	mg/l	15%
Järn Fe (filtrerat)	< 0.0040	mg/l	20%
Arsenik As (filtrerat)	< 0.00040	mg/l	15%
Antimon, Sb (filtrerat)	< 0.0020	mg/l	20%
Barium Ba (filtrerat)	0.0072	mg/l	25%
Bly Pb (filtrerat)	< 0.00010	mg/l	20%
Kadmium Cd (filtrerat)	< 0.000040	mg/l	15%
Kobolt Co (filtrerat)	< 0.000040	mg/l	15%
Koppar Cu (filtrerat)	0.0032	mg/l	25%
Krom Cr (filtrerat)	< 0.000040	mg/l	15%
Kvicksilver Hg (filtrerat)	< 0.000010	mg/l	20%
Molybden, Mo (filtrerat)	0.013	mg/l	25%
Nickel Ni (filtrerat)	< 0.000040	mg/l	25%
Selen, Se (filtrerat)	< 0.0010	mg/l	30%
Tenn Sn (filtrerat)	< 0.000020	mg/l	15%
Vanadin V (filtrerat)	0.000052	mg/l	20%
Zink Zn (filtrerat)	0.0061	mg/l	25%
Monobutyltenn (MBT)	6.9	ng/l	10%
Dibutyltenn (DBT)	11	ng/l	10%
Tributyltenn (TBT)	61	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monookytlytten (MOT)	<1.0	ng/l	10%
Dioktyltytten (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Måtosäkerheten, om inget annat anges, redovisas som utvidgad måtosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

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AR-14-SL-051227-01
EUSELI2-00162991

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-04100790	Ankomsttemp °C	12,5	
Provbeskrivning:		Provtagare	Anna Norén	
Matris:	Övrigt förorenat vatten	Provtagningsdatum	2014-04-07	
Provet ankom:	2014-04-10			
Utskriftsdatum:	2014-05-05			
Provmarkering:	12 L/S10 NaCl C1			
Analys	Resultat	Enhet	Mäto.	Metod/ref
Sulfat	670	mg/l	15%	StMeth 4500-SO4 / Kone a)
Fluorid	< 0.20	mg/l	25%	St Meth 4500-F / Kone a)
DOC	78	mg/l	15%	SS EN 1484 a)
Järn Fe (uppslutet)	0.15	mg/l	25%	SS 028150-2 / ICP-MS a)
Arsenik As (uppslutet)	< 0.0030	mg/l	30%	SS 028150-2 / ICP-MS a)
Barium Ba (uppslutet)	0.17	mg/l	30%	SS 028150-2 / ICP-MS a)
Bly Pb (uppslutet)	< 0.0020	mg/l	25%	SS 028150-2 / ICP-MS a)
Kadmium Cd (uppslutet)	< 0.00040	mg/l	30%	SS 028150-2 / ICP-MS a)
Kobolt Co (uppslutet)	0.0061	mg/l	25%	SS 028150-2 / ICP-MS a)
Koppar Cu (uppslutet)	0.59	mg/l	20%	SS 028150-2 / ICP-AES a)
Krom Cr (uppslutet)	0.042	mg/l	25%	SS 028150-2 / ICP-MS a)
Kvicksilver Hg (uppslutet)	< 0.00010	mg/l	20%	SS EN 1483 a)
Molybden, Mo (uppslutet)	0.077	mg/l	30%	SS 028150-2 / ICP-MS a)
Nickel Ni (uppslutet)	0.040	mg/l	15%	SS 028150-2 / ICP-MS a)
Selen, Se (syrauppslutet)	< 0.012	mg/l	35%	SS 028150-2 / ICP-MS a)
Tenn Sn (uppslutet)	< 0.0020	mg/l	20%	SS 028150-2 / ICP-MS a)
Vanadin V (uppslutet)	0.021	mg/l	30%	SS 028150-2 / ICP-MS a)
Zink Zn (uppslutet)	< 0.020	mg/l	15%	SS 028150-2 / ICP-MS a)
Monobutyltenn (MBT)	84	ng/l	10%	EN ISO 17353 b)
Dibutyltenn (DBT)	52	ng/l	10%	EN ISO 17353 b)
Tributyltenn (TBT)	24	ng/l	10%	EN ISO 17353 b)
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monooketyltenn (MOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Dioketyltenn (DOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monofenyltenn (MPhT)	<1.0	ng/l	10%	EN ISO 17353 b)
Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353 b)

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Måtosäkerheten, om inget annat anges, redovisas som utvidgad måtosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Trifenyltenn (TPhT)	<1.0 ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.				

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
- b) GALAB Laboratories GmbH, GERMANY

Kopia till:

Noanna Chalmers (noanna@student.chalmers.se)

Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

Göteborgs Hamn AB
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 403 38 GÖTEBORG

AR-14-SL-051228-01
EUSELI2-00162991

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-04100791	Ankomsttemp °C	12,5
Provbeskrivning:		Provtagare	Anna Norén
Matris:	Övrigt förorenat vatten	Provtagningsdatum	2014-04-07
Provet ankom:	2014-04-10		
Utskriftsdatum:	2014-05-05		
Provmarkering:	13 L/S10 Milli-Q C1		
Analys	Resultat	Enhet	Mäto.
Sulfat	650	mg/l	15%
Fluorid	< 0.20	mg/l	25%
DOC	67	mg/l	15%
Järn Fe (uppslutet)	0.67	mg/l	20%
Arsenik As (uppslutet)	0.0033	mg/l	30%
Barium Ba (uppslutet)	0.13	mg/l	30%
Bly Pb (uppslutet)	< 0.0020	mg/l	25%
Kadmium Cd (uppslutet)	< 0.00040	mg/l	30%
Kobolt Co (uppslutet)	0.0046	mg/l	25%
Koppar Cu (uppslutet)	0.47	mg/l	20%
Krom Cr (uppslutet)	0.035	mg/l	25%
Kvicksilver Hg (uppslutet)	< 0.00010	mg/l	20%
Molybden, Mo (uppslutet)	0.071	mg/l	30%
Nickel Ni (uppslutet)	0.031	mg/l	15%
Selen, Se (syrauppslutet)	< 0.012	mg/l	35%
Tenn Sn (uppslutet)	< 0.0020	mg/l	20%
Vanadin V (uppslutet)	0.026	mg/l	30%
Zink Zn (uppslutet)	< 0.020	mg/l	15%
Monobutyltenn (MBT)	92	ng/l	10%
Dibutyltenn (DBT)	150	ng/l	10%
Tributyltenn (TBT)	<10.	ng/l	10%
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%
Monooktyltenn (MOT)	3.2	ng/l	10%
Dioktyltenn (DOT)	<1.0	ng/l	10%
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%
Monofenyltenn (MPhT)	<1.0	ng/l	10%
Difenyltenn (DPhT)	<1.0	ng/l	10%

Förklaringar

AR-003v35

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Måtsäkerheten, om inget annat anges, redovisas som utvidgad måtsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Trifenyltenn (TPhT)	<1.0 ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.				

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
- b) GALAB Laboratories GmbH, GERMANY

Kopia till:

Noanna Chalmers (noanna@student.chalmers.se)

Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

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AR-14-SL-051229-01
EUSELI2-00162991

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-04100792	Ankomsttemp °C	12,5	
Provbeskrivning:		Provtagare	Anna Norén	
Matris:	Övrigt förorenat vatten	Provtagningsdatum	2014-04-07	
Provet ankom:	2014-04-10			
Utskriftsdatum:	2014-05-05			
Provmarkering:	14 L/S10 NaCl C2			
Analys	Resultat	Enhet	Mäto.	Metod/ref
Sulfat	460	mg/l	15%	StMeth 4500-SO4 / Kone a)
Fluorid	< 0.20	mg/l	25%	St Meth 4500-F / Kone a)
DOC	51	mg/l	15%	SS EN 1484 a)
Järn Fe (uppslutet)	0.22	mg/l	20%	SS 028150-2 / ICP-AES a)
Arsenik As (uppslutet)	<0.0030	mg/l	30%	SS 028150-2 / ICP-MS a)
Barium Ba (uppslutet)	0.28	mg/l	20%	SS 028150-2 / ICP-AES a)
Bly Pb (uppslutet)	< 0.0020	mg/l	25%	SS 028150-2 / ICP-MS a)
Kadmium Cd (uppslutet)	< 0.00040	mg/l	30%	SS 028150-2 / ICP-MS a)
Kobolt Co (uppslutet)	< 0.0040	mg/l	25%	SS 028150-2 / ICP-MS a)
Koppar Cu (uppslutet)	0.37	mg/l	20%	SS 028150-2 / ICP-AES a)
Krom Cr (uppslutet)	0.027	mg/l	25%	SS 028150-2 / ICP-MS a)
Kvicksilver Hg (uppslutet)	< 0.00010	mg/l	20%	SS EN 1483 a)
Molybden, Mo (uppslutet)	0.22	mg/l	30%	SS 028150-2 / ICP-MS a)
Nickel Ni (uppslutet)	0.011	mg/l	15%	SS 028150-2 / ICP-MS a)
Selen, Se (syrauppslutet)	< 0.012	mg/l	35%	SS 028150-2 / ICP-MS a)
Tenn Sn (uppslutet)	< 0.0020	mg/l	20%	SS 028150-2 / ICP-MS a)
Vanadin V (uppslutet)	0.023	mg/l	30%	SS 028150-2 / ICP-MS a)
Zink Zn (uppslutet)	< 0.020	mg/l	15%	SS 028150-2 / ICP-MS a)
Monobutyltenn (MBT)	94	ng/l	10%	EN ISO 17353 b)
Dibutyltenn (DBT)	160	ng/l	10%	EN ISO 17353 b)
Tributyltenn (TBT)	30	ng/l	10%	EN ISO 17353 b)
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monooktyltenn (MOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Dioktyltenn (DOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monofenyltenn (MPhT)	<10	ng/l	10%	EN ISO 17353 b)
Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353 b)

Förklaringar

AR-003v35

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Måtosäkerheten, om inget annat anges, redovisas som utvidgad måtosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

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Trifenyltenn (TPhT)	<1.0 ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.				

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
- b) GALAB Laboratories GmbH, GERMANY

Kopia till:

Noanna Chalmers (noanna@student.chalmers.se)

Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

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AR-14-SL-051230-01
EUSELI2-00162991

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-04100793	Ankomsttemp °C	12,5	
Provbeskrivning:		Provtagare	Anna Norén	
Matris:	Övrigt förorenat vatten	Provtagningsdatum	2014-04-07	
Provet ankom:	2014-04-10			
Utskriftsdatum:	2014-05-05			
Provmarkering:	15 L/S10 Milli-Q C2			
Analys	Resultat	Enhet	Mäto.	Metod/ref
Sulfat	450	mg/l	15%	StMeth 4500-SO4 / Kone a)
Fluorid	0.27	mg/l	25%	St Meth 4500-F / Kone a)
DOC	51	mg/l	15%	SS EN 1484 a)
Järn Fe (uppslutet)	0.49	mg/l	20%	SS 028150-2 / ICP-AES a)
Arsenik As (uppslutet)	0.0036	mg/l	30%	SS 028150-2 / ICP-MS a)
Barium Ba (uppslutet)	0.17	mg/l	30%	SS 028150-2 / ICP-MS a)
Bly Pb (uppslutet)	0.0013	mg/l	35%	SS 028150-2 / ICP-MS a)
Kadmium Cd (uppslutet)	< 0.00010	mg/l	50%	SS 028150-2 / ICP-MS a)
Kobolt Co (uppslutet)	0.0026	mg/l	25%	SS 028150-2 / ICP-MS a)
Koppar Cu (uppslutet)	0.32	mg/l	20%	SS 028150-2 / ICP-AES a)
Krom Cr (uppslutet)	0.024	mg/l	25%	SS 028150-2 / ICP-MS a)
Kvicksilver Hg (uppslutet)	< 0.00010	mg/l	20%	SS EN 1483 a)
Molybden, Mo (uppslutet)	0.21	mg/l	30%	SS 028150-2 / ICP-MS a)
Nickel Ni (uppslutet)	0.011	mg/l	15%	SS 028150-2 / ICP-MS a)
Selen, Se (syrauppslutet)	< 0.0030	mg/l	35%	SS 028150-2 / ICP-MS a)
Tenn Sn (uppslutet)	0.00081	mg/l	30%	SS 028150-2 / ICP-MS a)
Vanadin V (uppslutet)	0.019	mg/l	30%	SS 028150-2 / ICP-MS a)
Zink Zn (uppslutet)	0.012	mg/l	15%	SS 028150-2 / ICP-MS a)
Monobutyltenn (MBT)	110	ng/l	10%	EN ISO 17353 b)
Dibutyltenn (DBT)	430	ng/l	10%	EN ISO 17353 b)
Tributyltenn (TBT)	83	ng/l	10%	EN ISO 17353 b)
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monooketyltenn (MOT)	2.0	ng/l	10%	EN ISO 17353 b)
Dioktyltenn (DOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monofenyltenn (MPhT)	<1.0	ng/l	10%	EN ISO 17353 b)
Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353 b)

Förklaringar

AR-003v35

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Måtosäkerheten, om inget annat anges, redovisas som utvidgad måtosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

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Trifenyltenn (TPhT)	<1.0 ng/l	10%	EN ISO 17353	b)
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Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
- b) GALAB Laboratories GmbH, GERMANY

Kopia till:

Noanna Chalmers (noanna@student.chalmers.se)

Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

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403 38 GÖTEBORG

AR-14-SL-067831-01
EUSELI2-00170345

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-05161037	Ankomsttemp °C	18,0	
Provbeskrivning:		Provtagare	Anna Norén	
Matris:	Övrigt förorenat vatten	Provtagningsdatum	2014-05-15	
Provet ankom:	2014-05-16			
Utskriftsdatum:	2014-06-02			
Provmarkering:	16. C1. Milli-Q			
Analys	Resultat	Enhet	Mäto.	Metod/ref
Sulfat	38	mg/l	15%	StMeth 4500-SO4 / Kone a)
Fluorid	< 0.20	mg/l	25%	St Meth 4500-F / Kone a)
DOC	5.6	mg/l	15%	SS EN 1484 a)
Järn Fe (uppslutet)	< 0.010	mg/l	25%	SS 028150-2 / ICP-MS a)
Arsenik As (uppslutet)	0.0015	mg/l	35%	SS 028150-2 / ICP-MS a)
Antimon, Sb (uppslutet)	< 0.0010	mg/l	25%	SS 028150-2 / ICP-MS a)
Barium Ba (uppslutet)	< 0.020	mg/l	35%	SS 028150-2 / ICP-MS a)
Bly Pb (uppslutet)	< 0.00050	mg/l	35%	SS 028150-2 / ICP-MS a)
Kadmium Cd (uppslutet)	< 0.00010	mg/l	50%	SS 028150-2 / ICP-MS a)
Kobolt Co (uppslutet)	0.0011	mg/l	25%	SS 028150-2 / ICP-MS a)
Koppar Cu (uppslutet)	0.085	mg/l	20%	SS 028150-2 / ICP-AES a)
Krom Cr (uppslutet)	0.0069	mg/l	25%	SS 028150-2 / ICP-MS a)
Kvicksilver Hg (uppslutet)	< 0.00010	mg/l	20%	SS EN 1483 a)
Molybden, Mo (uppslutet)	0.017	mg/l	30%	SS 028150-2 / ICP-MS a)
Nickel Ni (uppslutet)	0.0070	mg/l	15%	SS 028150-2 / ICP-MS a)
Selen, Se (syrauppslutet)	< 0.0030	mg/l	35%	SS 028150-2 / ICP-MS a)
Tenn Sn (uppslutet)	< 0.00050	mg/l	30%	SS 028150-2 / ICP-MS a)
Vanadin V (uppslutet)	0.022	mg/l	30%	SS 028150-2 / ICP-MS a)
Zink Zn (uppslutet)	< 0.0050	mg/l	20%	SS 028150-2 / ICP-MS a)
Monobutyltenn (MBT)	4.8	ng/l	10%	EN ISO 17353 b)
Dibutyltenn (DBT)	4.4	ng/l	10%	EN ISO 17353 b)
Tributyltenn (TBT)	38	ng/l	10%	EN ISO 17353 b)
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monooketyltenn (MOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Dioketyltenn (DOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monofenyltenn (MPhT)	<1.0	ng/l	10%	EN ISO 17353 b)

Förklaringar

AR-003v35

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Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

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403 38 GÖTEBORG

AR-14-SL-068734-01
EUSELI2-00170345

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-05161038			Ankomsttemp °C	18,0
Provbeskrivning:				Provtagare	Anna Norén
Matris:	Övrigt förorenat vatten			Provtagningsdatum	2014-05-15
Provet ankom:	2014-05-16				
Utskriftsdatum:	2014-06-03				
Provmarkering:	17 C1. NaCl				
Analys	Resultat	Enhet	Mäto.	Metod/ref	
Sulfat	56	mg/l	15%	StMeth 4500-SO4 / Kone	a)
Fluorid	< 0.20	mg/l	25%	St Meth 4500-F / Kone	a)
DOC	9.1	mg/l	15%	SS EN 1484	a)
Järn Fe (uppslutet)	0.056	mg/l	20%	SS 028150-2 / ICP-AES	a)
Arsenik As (uppslutet)	< 0.0040	mg/l	30%	SS 028150-2 / ICP-MS	a)
Antimon, Sb (uppslutet)	< 0.0040	mg/l	25%	SS 028150-2 / ICP-MS	a)
Barium Ba (uppslutet)	0.034	mg/l	20%	SS 028150-2 / ICP-AES	a)
Bly Pb (uppslutet)	< 0.0020	mg/l	25%	SS 028150-2 / ICP-MS	a)
Kadmium Cd (uppslutet)	< 0.00040	mg/l	30%	SS 028150-2 / ICP-MS	a)
Kobolt Co (uppslutet)	< 0.0040	mg/l	25%	SS 028150-2 / ICP-MS	a)
Koppar Cu (uppslutet)	0.095	mg/l	20%	SS 028150-2 / ICP-AES	a)
Krom Cr (uppslutet)	0.010	mg/l	25%	SS 028150-2 / ICP-MS	a)
Kvicksilver Hg (uppslutet)	< 0.00010	mg/l	20%	SS EN 1483	a)
Molybden, Mo (uppslutet)	0.020	mg/l	30%	SS 028150-2 / ICP-MS	a)
Nickel Ni (uppslutet)	0.0076	mg/l	15%	SS 028150-2 / ICP-MS	a)
Selen, Se (syrauppslutet)	< 0.012	mg/l	35%	SS 028150-2 / ICP-MS	a)
Tenn Sn (uppslutet)	< 0.0020	mg/l	20%	SS 028150-2 / ICP-MS	a)
Vanadin V (uppslutet)	0.022	mg/l	30%	SS 028150-2 / ICP-MS	a)
Zink Zn (uppslutet)	< 0.020	mg/l	15%	SS 028150-2 / ICP-MS	a)
Monobutyltenn (MBT)	16	ng/l	10%	EN ISO 17353	b)
Dibutyltenn (DBT)	10	ng/l	10%	EN ISO 17353	b)
Tributyltenn (TBT)	50	ng/l	10%	EN ISO 17353	b)
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%	EN ISO 17353	b)
Monooketyltenn (MOT)	<1.0	ng/l	10%	EN ISO 17353	b)
Dioktyltenn (DOT)	<1.0	ng/l	10%	EN ISO 17353	b)
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%	EN ISO 17353	b)
Monofenyltenn (MPhT)	<1.0	ng/l	10%	EN ISO 17353	b)

Förklaringar

AR-003v35

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Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

noanna@student.chalmers.se (noanna@student.chalmers.se)

Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

Göteborgs Hamn AB
Ida Fossenstrand
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403 38 GÖTEBORG

AR-14-SL-067832-01
EUSELI2-00170345

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-05161039	Ankomsttemp °C	18,0	
Provbeskrivning:		Provtagare	Anna Norén	
Matris:	Övrigt förorenat vatten	Provtagningsdatum	2014-05-15	
Provet ankom:	2014-05-16			
Utskriftsdatum:	2014-06-02			
Provmarkering:	18 C1. pH			
Analys	Resultat	Enhet	Mäto.	Metod/ref
Sulfat	48	mg/l	15%	StMeth 4500-SO4 / Kone a)
Fluorid	< 0.10	mg/l	25%	EN ISO 10304 a)
DOC	230	mg/l	15%	SS EN 1484 a)
Järn Fe (uppslutet)	0.64	mg/l	20%	SS 028150-2 / ICP-AES a)
Arsenik As (uppslutet)	0.0043	mg/l	30%	SS 028150-2 / ICP-MS a)
Antimon, Sb (uppslutet)	0.0013	mg/l	25%	SS 028150-2 / ICP-MS a)
Barium Ba (uppslutet)	0.021	mg/l	20%	SS 028150-2 / ICP-AES a)
Bly Pb (uppslutet)	0.0029	mg/l	25%	SS 028150-2 / ICP-MS a)
Kadmium Cd (uppslutet)	0.00017	mg/l	50%	SS 028150-2 / ICP-MS a)
Kobolt Co (uppslutet)	0.0015	mg/l	25%	SS 028150-2 / ICP-MS a)
Koppar Cu (uppslutet)	0.11	mg/l	20%	SS 028150-2 / ICP-AES a)
Krom Cr (uppslutet)	0.010	mg/l	25%	SS 028150-2 / ICP-MS a)
Kvicksilver Hg (uppslutet)	< 0.00010	mg/l	20%	SS EN 1483 a)
Molybden, Mo (uppslutet)	0.016	mg/l	30%	SS 028150-2 / ICP-MS a)
Nickel Ni (uppslutet)	0.0086	mg/l	15%	SS 028150-2 / ICP-MS a)
Selen, Se (syrauppslutet)	< 0.0030	mg/l	35%	SS 028150-2 / ICP-MS a)
Tenn Sn (uppslutet)	< 0.00050	mg/l	30%	SS 028150-2 / ICP-MS a)
Vanadin V (uppslutet)	0.035	mg/l	30%	SS 028150-2 / ICP-MS a)
Zink Zn (uppslutet)	0.011	mg/l	15%	SS 028150-2 / ICP-MS a)
Monobutyltenn (MBT)	190	ng/l	10%	EN ISO 17353 b)
Dibutyltenn (DBT)	2.2	ng/l	10%	EN ISO 17353 b)
Tributyltenn (TBT)	7.5	ng/l	10%	EN ISO 17353 b)
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monooketyltenn (MOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Dioketyltenn (DOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monofenyltenn (MPhT)	2.7	ng/l	10%	EN ISO 17353 b)

Förklaringar

AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Måtosäkerheten, om inget annat anges, redovisas som utvidgad måtosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt måtosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)

Utförande laboratorium/underleverantör:

- a) Eurofins Environment Sweden AB (Lidköping), SWEDEN
 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

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Paola Nilson, Rapportansvarig

Denna rapport är elektroniskt signerad.

Göteborgs Hamn AB
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403 38 GÖTEBORG

AR-14-SL-067833-01
EUSELI2-00170360

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-05161126	Ankomsttemp °C	17,5	
Provbeskrivning:		Provtagare	Anna Norén	
Matris:	Övrigt förorenat vatten	Provtagningsdatum	2014-05-15	
Provet ankom:	2014-05-16			
Utskriftsdatum:	2014-06-02			
Provmarkering:	19. C1 Nitrogen			
Analys	Resultat	Enhet	Mäto.	Metod/ref
Sulfat	110	mg/l	15%	StMeth 4500-SO4 / Kone a)
Fluorid	< 0.20	mg/l	25%	St Meth 4500-F / Kone a)
DOC	5.2	mg/l	15%	SS EN 1484 a)
Järn Fe (uppslutet)	0.29	mg/l	20%	SS 028150-2 / ICP-AES a)
Arsenik As (uppslutet)	0.0018	mg/l	35%	SS 028150-2 / ICP-MS a)
Antimon, Sb (uppslutet)	< 0.0010	mg/l	25%	SS 028150-2 / ICP-MS a)
Barium Ba (uppslutet)	< 0.020	mg/l	35%	SS 028150-2 / ICP-MS a)
Bly Pb (uppslutet)	0.00061	mg/l	35%	SS 028150-2 / ICP-MS a)
Kadmium Cd (uppslutet)	< 0.00010	mg/l	50%	SS 028150-2 / ICP-MS a)
Kobolt Co (uppslutet)	0.0011	mg/l	25%	SS 028150-2 / ICP-MS a)
Koppar Cu (uppslutet)	0.072	mg/l	20%	SS 028150-2 / ICP-AES a)
Krom Cr (uppslutet)	0.0093	mg/l	25%	SS 028150-2 / ICP-MS a)
Kvicksilver Hg (uppslutet)	< 0.00010	mg/l	20%	SS EN 1483 a)
Molybden, Mo (uppslutet)	0.016	mg/l	30%	SS 028150-2 / ICP-MS a)
Nickel Ni (uppslutet)	0.0053	mg/l	15%	SS 028150-2 / ICP-MS a)
Selen, Se (syrauppslutet)	< 0.0030	mg/l	35%	SS 028150-2 / ICP-MS a)
Tenn Sn (uppslutet)	< 0.00050	mg/l	30%	SS 028150-2 / ICP-MS a)
Vanadin V (uppslutet)	0.027	mg/l	30%	SS 028150-2 / ICP-MS a)
Zink Zn (uppslutet)	< 0.0050	mg/l	20%	SS 028150-2 / ICP-MS a)
Monobutyltenn (MBT)	4.1	ng/l	10%	EN ISO 17353 b)
Dibutyltenn (DBT)	12	ng/l	10%	EN ISO 17353 b)
Tributyltenn (TBT)	110	ng/l	10%	EN ISO 17353 b)
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monooketyltenn (MOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Dioketyltenn (DOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monofenyltenn (MPhT)	<1.0	ng/l	10%	EN ISO 17353 b)

Förklaringar

AR-003v35

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Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)

Utförande laboratorium/underleverantör:

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 b) GALAB Laboratories GmbH, GERMANY

Kopia till:

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Paola Nilson, Rapportansvarig

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403 38 GÖTEBORG

AR-14-SL-067834-01
EUSELI2-00170360

Kundnummer: SL2002335

Analysrapport

Provnummer:	177-2014-05161127		Ankomsttemp °C	17,5
Provbeskrivning:			Provtagare	Anna Norén
Matris:	Övrigt förorenat vatten		Provtagningsdatum	2014-05-15
Provet ankom:	2014-05-16			
Utskriftsdatum:	2014-06-02			
Provmarkning:	20 C1. Oxygen			
Analys	Resultat	Enhet	Mäto.	Metod/ref
Sulfat	37	mg/l	15%	StMeth 4500-SO4 / Kone a)
Fluorid	< 0.20	mg/l	25%	St Meth 4500-F / Kone a)
DOC	3.5	mg/l	15%	SS EN 1484 a)
Järn Fe (uppslutet)	< 0.040	mg/l	25%	SS 028150-2 / ICP-MS a)
Arsenik As (uppslutet)	<0.0020	mg/l	30%	SS 028150-2 / ICP-MS a)
Antimon, Sb (uppslutet)	< 0.0040	mg/l	25%	SS 028150-2 / ICP-MS a)
Barium Ba (uppslutet)	< 0.080	mg/l	30%	SS 028150-2 / ICP-MS a)
Bly Pb (uppslutet)	< 0.0020	mg/l	25%	SS 028150-2 / ICP-MS a)
Kadmium Cd (uppslutet)	< 0.00040	mg/l	30%	SS 028150-2 / ICP-MS a)
Kobolt Co (uppslutet)	< 0.0040	mg/l	25%	SS 028150-2 / ICP-MS a)
Koppar Cu (uppslutet)	0.080	mg/l	20%	SS 028150-2 / ICP-AES a)
Krom Cr (uppslutet)	0.0072	mg/l	25%	SS 028150-2 / ICP-MS a)
Kvicksilver Hg (uppslutet)	< 0.00010	mg/l	20%	SS EN 1483 a)
Molybden, Mo (uppslutet)	0.016	mg/l	30%	SS 028150-2 / ICP-MS a)
Nickel Ni (uppslutet)	0.0056	mg/l	15%	SS 028150-2 / ICP-MS a)
Selen, Se (syrauppslutet)	< 0.012	mg/l	35%	SS 028150-2 / ICP-MS a)
Tenn Sn (uppslutet)	< 0.0020	mg/l	20%	SS 028150-2 / ICP-MS a)
Vanadin V (uppslutet)	0.022	mg/l	30%	SS 028150-2 / ICP-MS a)
Zink Zn (uppslutet)	< 0.020	mg/l	15%	SS 028150-2 / ICP-MS a)
Monobutyltenn (MBT)	<1.0	ng/l	10%	EN ISO 17353 b)
Dibutyltenn (DBT)	1.6	ng/l	10%	EN ISO 17353 b)
Tributyltenn (TBT)	19	ng/l	10%	EN ISO 17353 b)
Tetrabutyltenn (TTBT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monooketyltenn (MOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Dioktyltenn (DOT)	<1.0	ng/l	10%	EN ISO 17353 b)
Tricyklohexyltenn (TCHT)	<1.0	ng/l	10%	EN ISO 17353 b)
Monofenyltenn (MPhT)	<1.0	ng/l	10%	EN ISO 17353 b)

Förklaringar

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Difenyltenn (DPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Trifenylnitrobenzen (TPhT)	<1.0	ng/l	10%	EN ISO 17353	b)
Kemisk kommentar Höjd rapporteringsgräns för metaller på grund av svår matris.					

Utförande laboratorium/underleverantör:

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Förklaringar

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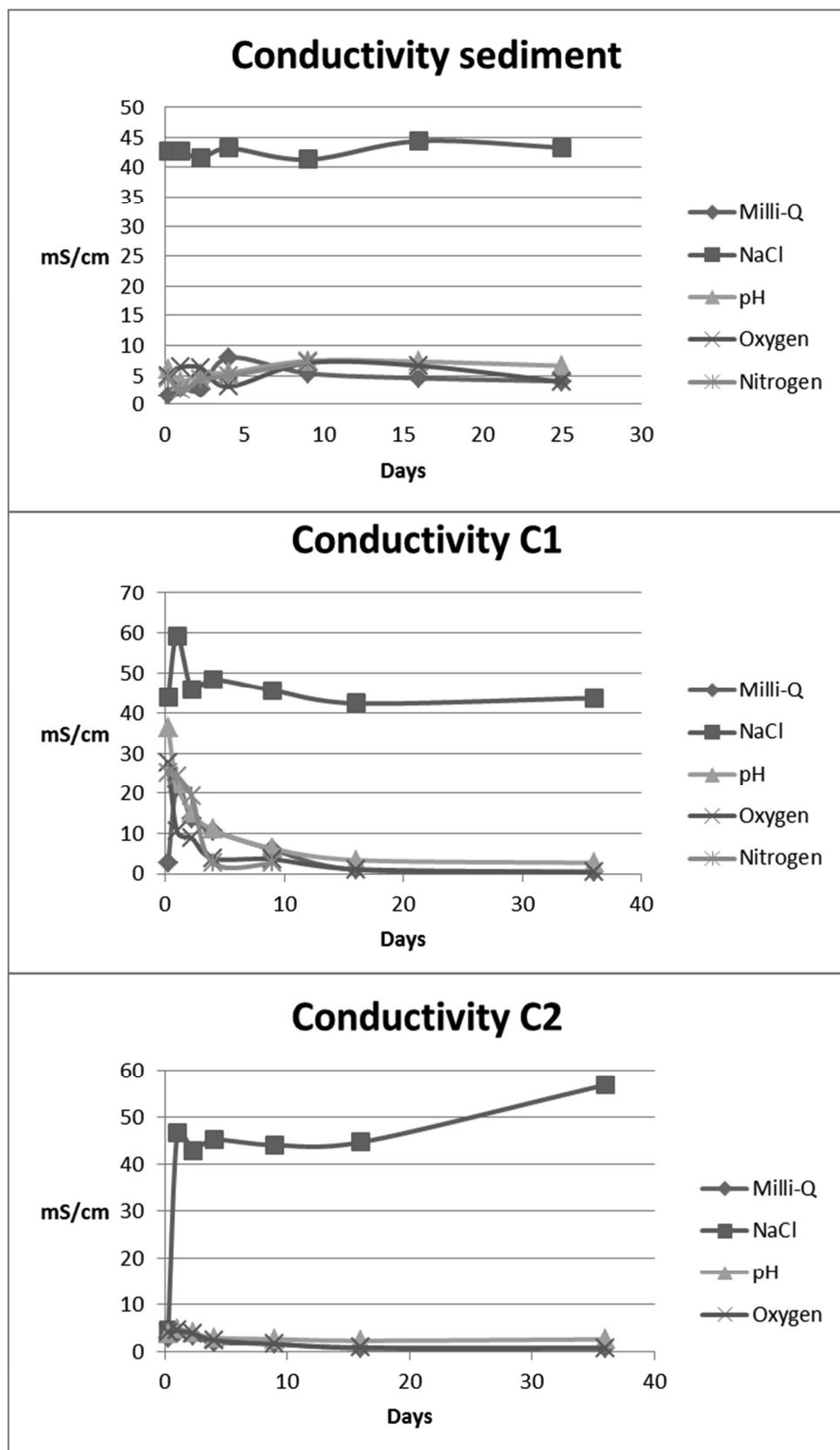
Mätsäkerheten, om inget annat anges, redovisas som utvidgad mätsäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätsäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

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Appendix F – Surface diffusion tests

- Conductivity
- pH

Result from surface leaching test for conductivity.



Result from surface leaching test for pH.

