TACKLING SOURCES OF MARINE PLASTIC POLLUTION THROUGH EFFECTIVE CORPORATE ENGAGEMENT: A DANISH CASE STUDY

Background

Recent figures[1] suggest that 167,431 tonnes of plastic pellets, flakes and powders – the raw materials and building blocks of the plastic industry (hereafter collectively referred to as 'pellets') – enter the marine environment annually from across the European Union[2] as a consequence of inadequate spill prevention and containment measures at industrial facilities and during transportation. Recorded on the coastline of every European country monitored[3], pellets are known to negatively impact marine life and degrade habitats.[4,5,6]

For almost 30 years, plastic trade associations have promoted Operation Clean Sweep (OCS) as a solution to the problem of pellet loss. Created in the US by the plastic industry in 1991 and now endorsed by plastic trade associations across the world, OCS is essentially a toolkit that highlights best management practices that are designed to prevent or mitigate pellet loss during routine operations. However, the one-off sign up to OCS as opposed to annual memberships and the lack of independent auditing or transparent reporting on implementation of the OCS guidelines on implementation of the OCS guidelines means that little is known about the effectiveness of OCS across the plastic industry as a whole. It is clear that these notable limitations and the low levels of sign up to OCS to date have resulted in ongoing pellet loss becoming the second largest direct source of marine microplastic pollution.[7]

In order to fully tackle pellet loss across the plastic industry as a whole, pellet management must become a top priority for all actors handling pellets across the entire supply chain. This approach is favoured by non-governmental organisations and is being explored by regulators at national, European and wider international level.

To achieve a supply chain approach to tackling pellet loss, there needs to be a systemic shift from voluntary OCS sign up to a system that requires all actors that handle pellets to adhere to a set of recognised best practice measures based on the OCS toolkit with improvements, where needed. This stipulation must be reinforced by a governing body that manages spot inspections, annual compliance audits by an accredited third-party, and the sharing of transparent performance reports with

[1] http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-10/pdf/microplastics_final_report_v5_full.pdf

[2] Eunomia, Plastics in the Marine Environment: Where Do They Come From? Where Do They Go? (2016), available at http://www.eunomia.co.uk/reports-tools/plasticsin-the-marine-environment/

[3] https://www.nurdlehunt.org.uk/take-part/nurdle-map.html

[4] Rochman, C. M., Hoh, E., Kurobe, T., & Teh, S. J. (2013). Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress. Scientific reports, 3.

[5] Nobre, C. R., Santana, M. F. M., Maluf, A., Cortez, F. S., Cesar, A., Pereira, C. D. S., & Turra, A. (2015). Assessment of microplastic toxicity to embryonic development of the sea urchin Lytechinus variegatus (Echinodermata: Echinoidea). Marine Pollution Bulletin, 15, 99-104. [6] Mato, Y., Isobe, T., Takada, H., Kanehiro, H., Ohtake, C., & Kaminuma, T. (2001). Plastic resin pellets as a transport medium for toxic chemicals in the marine environment. Environmental science & technology, 35(2), 318-324. [7] http://www.eunomia.co.uk/reports-tools/plastics-in-the-marine-environment/

downstream customers, to enable companies to purchase plastic materials that have been made with responsibly handled pellets throughout the supply chain. This could be done either by the publication of audit reports or by establishing an administrative record flow such as a Chain of Custody model for pellets.

One way to achieve this would be to incorporate OCS-based pellet management best practices into supply chain standards and certification schemes, with clear buy-in and leadership from top management within companies, across operations and between upstream and downstream stakeholders. Forward-thinking companies have a unique opportunity to lead the charge on this issue by recognising pellet loss as a high-risk priority issue that can be mitigated against by incorporating pellet loss prevention measures outlined in the OCS toolkit into existing and new supply chain standards and certification schemes, with improvements where needed.

A Danish Case Study

Denmark has potential to become a role-model that other nations could follow by taking the lead in implementing a robust, transparent, industry-wide set of best management practices to reduce loss of plastic pellets to the environment. In Denmark, 26,000 people are employed in the plastic industry (equivalent to 1% of the total Danish workforce) which has an annual turnover in excess of billion DKK.[6]

The federation for the Danish plastic industry, Plastindustrien, represents 70-80 % of the Danish plastic production by turnover and about 50 % of the number of companies involved in plastic product production in Denmark. Total number of members are ca. 240[7] and the goal is to increase this to 300 members by 2020. Plastindustrien represents most of the big companies like Coloplast and LEGO and the tendency is that small companies with low turnover and few employees are not members of the federation.[8]

In May 2017, Plastindustrien presented its board's ambition for promoting pellet loss prevention. By 2020, Plastindustrien aim to have 80% of all of its members voluntarily signed up to Operation Clean Sweep – an international pellet loss prevention scheme managed in Europe by the pan-European plastics trade association Plastics Europe of which PlastIndustrien is a member. Denmark does not have any pellet producers but imports pellets for conversion by around 600 companies. Additionally, a handful of recyclers produce recycled pellets.

In Denmark an industrial production company including plastic converters must have an environmental approval by the municipality in which the production is located. Environmental approvals of industrial production sites follow the Environmental Protection Act (Miljøbeskyttelsesloven) and should be approved by an auditing authority before production on the site can commence. If the company wish to change production or increase production an additional approval must be attained.

An environmental approval contains the following elements:

[6] Analysis of the Danish plastic industry on growth and employment 2016

[7] As reported in July 2018

[8] Personal communications with Asbjørn Lindsø, Head of Communications Plastindustrien

- An introduction and verdict of the approval to give a quick overview of what the company have applied for, the character of the company and the auditing authority's decision on the application.
- Terms of environmental approval concern the statutory provisions that the company must live up to in order to comply with the stated pollutant threshold limits, and so the company's operation is without significant hazard/nuisance for neighbors, surroundings and the environment.
- There must be a technical description and evaluation of the auditing authority's reasoning and evaluation of why the authority can approve the company's application. A description and evaluation of the environmental circumstances, including the authority's reasoning for granting approval, of why the company must be assumed to be able to live up to the demands is also part of the environmental approval document.
- There must be a description of other statutory provisions from previous approvals that will be affected and may be over-ruled, statements from other authorities in relation to the new environmental approval including the legal circumstances (legal protection, publication of the approval, laws about complaining and notification duties), which relates to the approval.

The environmental approval for a D208 company[9] includes specifications on the physical setup of the factory including operational procedures. Impacts on air pollution is covered both as particle emissions and odors. There are requirements of waste handling including recycling of material. Prevention of pollution of soil, groundwater and surface water relates to liquid raw materials and hazardous waste. Plastic raw material is not as a standard regarded in this section.

The environmental approval states requirements for the company's self-monitoring including requirements of an operational logbook to be updated and available always. Noise is regarded as pollution and included in the environmental approval as is waste water handling.

Furthermore the environmental approval includes a verdict from the approving authority of whether the company's practices pose a risk according to the Risk Announcement (Risikobekendtgørelsen) and whether the authority deems the company to uphold best available practices (BAT) of prevention and limitation of the environmental impact of the company's procedures.

Industry Action

In May 2017 the board of Plastindustrien agreed a 3-year strategy for the future of the plastic industry which included initiatives on OCS. The two strongest KPIs are the strategic targets of 300 members and 80% sign up to OCS by 2020.

It is the goal for Plastindustrien to have 80% of its members signed up to OCS by 2020 which it sees as an ambitious goal however, it should be noted that members include companies who are not involved in plastic production (e.g. like producers of machinery for the plastic industry) as well as the fact that Plastindustrien does not represent all plastic converters in Denmark.[10]

[9] D208 is a category of companies producing plastic products by injection molding, extrusion including calendering and thermoforming and turning over 5 tons or more of plastic raw material a day.
[10] Plastic Change were not able to obtain confirmation from PlastIndustrien about how many of its members included in this 80% were relevant to the pellet loss issue – i.e. it is not understood how many of the companies directly handle pellets.

The total number of companies signed up according to the home page as of July 2018 is 23, where at least one, Wiba Tech, is a producer of machinery. To obtain the goal of 80 % of members signed up to OCS, PlastIndustrien have launched a recruiting campaign which includes:

- Informing members about OCS and urging them to sign up via newsletters, its homepage and by demonstrating a company case[11] at the annual trade day Plastdagen in May 2018 which was presented by Primo A/S CEO Claus Lykke[12];
- Inviting members to a workshop to educate them on the content of the initiative and the relatively low-tech improvements needed during production procedures to obtain the goals of OCS; and
- Hiring an environmental advisor to carry the boards vision to fulfilment. The position is planned to commence mid 2018 but at the time of writing (August 2018) no formal announcement have been made.

According to personal communications with Political Advisor for Plastindustrien, Lars Friis Farsoe, new signups are trickling in and the list on the homepage of Plastindustrien may not be up to date. It has not been possible to get an updated list from Plastindustrien.

In September 2017[13], CEO Thomas Drustrup wrote an article in Magasinet Plast called *"We must become even better at preventing loss of plastic to the sea*" where he points to OCS as the industry's tool for prevention, but first and foremost he calls for consumer behaviour and for a unified national waste collection and recycling program. He recommends installing filters in drains, prioritising cleaning and adjustment of a few work procedures as effective ways to overcome loss of pellets to the environment. Further he states that *"Operation Clean Sweep is suitable for supporting companies' different environmental certifications[16], so for many there will be several benefits associated with an implementation."*

PlastIndustrien's set of best management practices to reduce loss of plastic pellets to the environment as presented in their OCS workshops for new members.

A Danish pellet loss hotspot assessment

The Port of Aalborg and the Port of Aarhus were identified as major transport hubs for import of virgin plastic pellets to the Danish industry (based in Jutland). The pellets are transported in containers by truck from the harbours to the plastic converters production sites.

After being in dialog (by phone) with the Ports of Aalborg and Aarhus it was acknowledged that no plastic pellets are handled in bulk in these harbours. The harbour masters stated that all pellets going through the harbours are loaded by containers. As no containers are opened and no pellets reloaded in any of the harbours, it is more likely that loss of pellets take place when the containers are opened and bulk pellets (big bags) are handled at redistributors or at production sites.

[11] Plastic Change have included a copy of this (in Danish) in annexes

[12] Primo A/S presentation can be streamed from this address in Danish http://live.industrienshus.dk/indspark-fra-primoderfor-er-vi-med-i-operation

[13] https://plast.dk/2017/09/plastindustrien-vi-skal-endnu-bedre-forebygge-tab-plast-havet/ [16] Like ISO 14001

Attempts were made to identify redistributing hubs by contacting trucking companies around Kolding with no conclusive outcome.

To look into the loss of pellets from industrial facilities, 7 production sites were randomly chosen as samples. The companies were randomly chosen based on what could reasonably be reached in the field time available for the project. The companies included 4 companies reportedly signed up to "Operation clean sweep". In addition, the Port of Aalborg was visited and 3 "natural" locations downstream from production sites were searched.

The Port of Aalborg has an environmental profile and in 2012-2013 focused on enhancing recycling of waste and in 2014-2015 reduction of waste generation including plastic. Since 2014-2016 waste has been reduced by 50%.

Summary of field study results:

In May 2018, Plastic Change completed fieldwork at or near 7 industrial facilities in Denmark to ascertain whether or not there was evidence of pellets escaping into the environment (see Figure 1).

Figure 1: Map of field sites visited as part of an initial investigation into pellet loss from industrial facilities in Denmark.

Table 1 shows the results of the research at each location and photographic evidence is included in Annex 1 of this report.

In summary, the following was recorded during the field work in Denmark:

- Pellets were found in the environment at 6 out of 7 production sites. This finding confirms that pellet loss is occurring;
- Most pellets were found at the production sites where bulk pellets are moved into silos, thus indicating limited use of mechanisms such as catch traps to prevent spillage of pellets;

- At 4 production sites, pellets were found in (public) sewage drains for rainwater. This could be indicative of a possible pathway for pellets to enter the wider aquatic environment.
- There was no pellet spillage detected in or around the port investigated.

The simple analysis undertaken as part of this study suggests that there is no discernible difference in pellet retention and pellet loss prevention at companies that have or have not signed up to OCS. Further information is required from each of the companies included in this study to fully understand the reason for this finding.

Site:	Name/Location:	Description location:	Method:	Point source - Findings	OCS Certified?
1	Letbæk Plast, Hornevej 18, Tistrup.	1.a: Vegetated area around production site/the storing site of big bags with pellets. 1.b Rainwater basin at site surrounded by lawn (approx. 30m^2)	2 persons searched the area around location for 15min. 1.a: It was not possible to get close to the production site/fence do to densely vegetation. At site 1.b and 1.c the area was searched within 1 meter radius from lake shore/water.	Point source: Storing/handling of big bags with pellets: 0 pellets found	
2	Tistrup pond	Pond near city centre - down-stream from production site. (300m2).	2 persons/20 minutes searched the shore around the pond.	Production sites up-stream from pond: 0 pellets found	
3	Vitasheet Group (C/o Esbjerg Thermoplast), Thyrasvej 12, Tistrup.	3.a: Paved driveway at Odinsvej. 3.b: Silos containing pellets (close to the driveway) 3.c Silos containing pellets (middle)	2 pers. searched along the drive-way for 10 minutes. 2 drain grates were also searched. At 2.b and 2.c a radius of 1m around the silos were searched by 2 pers/5 minutes	Point source: waste or leak from silos and/or loss when filling the silos. Findings: 3.a. > 100 pellets scattered 0-200 meters from the silos. Mainly black and whites pellets + a few coloured. Around 100 pellets were found in each drain grates. 3.b Significant amounts of black and whites pellets found >1000. 3.c significant amounts of transparent pellets >1000.	Yes
4	Emtelle, Vardevej 140, Sønder Felding.	4.a. Green area around/along Production site (fenced). Mixed low-growing grassvegetation. Sloping east away from site.	2 persons search 100mx2m along the fence/ 15min.	4.a. The Production site/tent! Production/handling of pellets was done in a large tent with no solid flooring!! Findings: small amounts of pellets (50-100) were scattered along the searched area.	Yes

5	Emtelle, Vardevej 140, Sønder Felding.	A drain pipe - pouring out into a pile of stones.	2 persons searched the stone pile for 5 minutes.	Runoff from the production site/tent!	Yes

				20-50 small pieces of black granulate was found.	
6	Svanholm sø. East of Emtelle production site.	Lake shore. "Hilly" vegetated terrain.	1 person searched 50meter shore/20 min.	Emtelle production site 40 pellets found – black, white and blue.	
7	Rainwater drain east from Emtelle production site	Rainwater basin 500meter down-stream from the Emtelle production site. upstream from Svanholm sø. Drainpipe from production site is pouring into the basin. Water has overflow drains that seems to lead to the lake area3 meter steep sloping sides around basin – containing aprox. 50cm of water at the time of inspection.	2 pers/ 5 minutes.	Emtelle production site >10.000 pellets and granulates both in the water and at the banks. All colours.	
8	HN Group, Kløvermarken 310, Billund.	Parking lot/goods delivery – paved. Area around building – grass and gravel.	2 pers/ 10 minutes.	50-100 pellets	Yes
9	Kløvermarken, Billund.	Paved area in front of driveway/gate.	2 pers/ 5 minutes.	>500 pellets	Yes
10	Aalborg Habour, Langerak 19, Aalborg.	Grass area along paved road outside the fence of the habour	2 x 1 pers/ 5 minutes.	0	
11	Holm & Holm A/S, Tyveldalsgade 21, Nibe.	Paved area behind building/production site. The area is used for parking lot/goods delivery. Paved + some grass and gravel + a drain pipe.	1 pers/ 5 minutes.	Point source: warehouse/production site. Approx. 50 pieces of granulates (blue coloured)	
12	Fast Plast A/S, Vilhelmsborgvej 2, Thisted	Paved public road behind building in front of 7 silos (separated by area with grass)	1 pers/ 5 minutes.	Point source: 7 Silos with pellets. Finding: Around 100 pellets + 2 pieces of blue extruded string.	

Table 1: Locations and results of Danish field work and hot spot assessment.

Conclusions of this study

The Danish Plastic Trades Association, Plastindustrien has taken the pellet loss prevention agenda to heart by committing to Operation Clean Sweep and rolling it out amongst its members. It is a concern that Plastindustrien does not include all plastic converting businesses in Denmark and though they aim to increase the number of members it must be noted that companies engaged in other parts of the plastic industry besides plastic production are members of the trades association, e.g. producers of machines for manufacturing of plastics. These companies can still sign up for OCS but it has been beyond the scope of this project to investigate what role if any OCS plays for these companies. It also raises the question how do we reach non-members with best practices for pellet loss prevention?

The research into environmental approvals and audit reports carried out during this study reveals that plastic pellets as raw materials falls in between the standard terms for D208 category companies. It is neither liquid raw material which would be oil or chemicals like solvents typically, nor is it a hazardous material. Also, the environmental effect of plastic pollution has not been established in a way as to be categorised as soil, water or air pollution. These are points to be considered for further political work on the Danish side – exploring whether or not plastic could be categorized under one of these hazards and if that would subsequently mean that it would be included in the standard terms for environmental approval. From conversations with auditing authorities it is our understanding that the employees doing the audit keep an active eye out for pellet loss and will make remarks in the audit report under mismanaged waste if there is a visible spill.

It can be taken from the Danish cases that compulsory audit by a third-party authority has a value in pointing out and correcting procedures that lead to pellet loss.

More work on the interpretation of the Danish Environmental Protection Act could be valuable to understand how rainwater runoff is handled in separated sewage systems when rainwater bypasses waste water treatment plants and is directly lead into waterways like presented in the case of LEGO. Further work on the interpretation is regarding the notion that the environmental approval is given on the grounds that the auditing authority deems it likely that the company is following Best Available Practices (BAT) to minimize environmental risks. It would be valuable to have pellet loss directly mentioned as an environmental hazard and state best available practices on pellet loss prevention in the environmental approval as is the case with oil spills.

To implement OCS and BAT the interviews with OCS companies showed that good support from the trade association in the form of recruitment campaigns and knowledge sharing as well as including the workers on the grounds in the process were instrumental for successful outcomes. Another point was to make signage and procedures available in multiple languages considering that truck drivers might not be familiar with the exact facilities and may be non-Danish speakers.

The field work carried out in this project revealed significant pellet loss on a large majority of production sites, including trade association members and non-members and including OCS certified as well as noncertified production sites. Investigations of industrial ports did not show any sign of pellet loss and telephone interviews with the port authorities confirmed that pellets are only handled by closed container loads at the port sites. This study did not include land transport and distribution hubs and reloading areas

but a good place to start is at Plastcom A/S[14] which is supplying half of plastic raw material to Danish converters.

It can be concluded that pellet loss from plastic producing industrial sites in Denmark is occurring on a regular basis even though the National Environmental Protection Act has compulsory environmental audit by the municipalities and the trade association has one of the most ambitious targets for voluntary management of pellet loss. This project highlights the need for a specific mention of solid plastic raw material to be included in the focus for environmental auditing of plastic producing companies, in Denmark and abroad.

Adopting a supply chain approach to tackling plastic pellet loss

To solve this problem, all companies involved in making, using or transporting these pellets should commit to following specific guidelines that prevent pellet loss throughout all stages of making plastic products (i.e. throughout the plastic 'supply chain'). This approach is favoured overseas (e.g. in the United Kingdom) and is being explored further under the auspices of the EU Plastic Strategy. To demonstrate that OCS guidelines are being respected, companies must report and be audited on how successfully they are implementing pellet loss prevention measures.

This 'supply chain approach' would require regular assessments to check that pellet loss prevention measures are implemented properly at all sites; that all staff are trained to exceptionally high standards to prevent and mitigate pellet loss; and that companies are working together across the supply chain to communicate and demonstrate best practices with regard to the handling of pellets. Only then will people and companies be able to buy plastic products with confidence that their plastic supply chain is pellet loss free.

To achieve this goal, any voluntary or regulatory commitments to eliminate pellet loss from the supply chain, must:

- Apply to all companies handling plastic pellets regardless of company size or location, including but not limited to raw material providers (e.g. polymer producers), suppliers (e.g. haulage and distribution companies), converters (e.g. plastic manufacturers), buyers (e.g. retailers and brand owners) and the recycling industry alike;
- Stipulate that all sites, facilities and operations handling pellets are regularly audited by an accredited third party on implementation of pellet management best practices based on the Operation Clean Sweep (OCS) toolkit;
- Require all sites, facilities and operations handling pellets to regularly and transparently report on implementation of pellet management best practices based on the OCS toolkit;
- Take into account the international nature of the pellet loss problem to be able to form part of a coordinated solution that adequately captures all stages of the plastic supply chain and works effectively on a local, national, regional and international scale;
- Include provisions to facilitate the sharing of information on origin, quantities and types of pellets at point of sale or transfer of all pellet batches to ensure maintained record keeping and communication between all actors in any given supply chain.

[14] Plastcom A/S, Møllevej 9T, 1. tv. DK-2990 Nivå Danmark, CEO Lars Kaufman, kaufmann@plastcom.dk

ANNEX 1: PHOTOGRAPHIC EVIDENCE COLLATED AS PART OF DANISH HOT SPOT ASSESSMENT

Location 1 - Letbæk Plast production, inaccessible:

Location 2 - Letbæk Plast rainwater basin:

Location 3 Tistrup Anlæg:

Location 4 Esbjerg Termoplast, Odinsvej, Tistrup, part of VitaSheet Group, OCS certified

Location 4 (Left and above) - Esbjerg Termoplast, Odinsvej, Tistrup, part of VitaSheet Group From road leading up to loading area/silos at VitaSheet/Esbjerg Termo Plasts factory. Private driveway.

Location 4 (Left) - Esbjerg Termoplast, Odinsvej, Tistrup, part of VitaSheet Group. From rainwater drain on driveway outside production facility.

Location 5 production site – Emtelle Scandianvia, Sønder Felding, Herning Municipality:

Location 5 Accumulation of pellets outside Emtelle premises

Location 6 Drain pipe - Emtelle:

Location 7 Svanholm Sø, Herning Municipality – vicinity Emtelle:

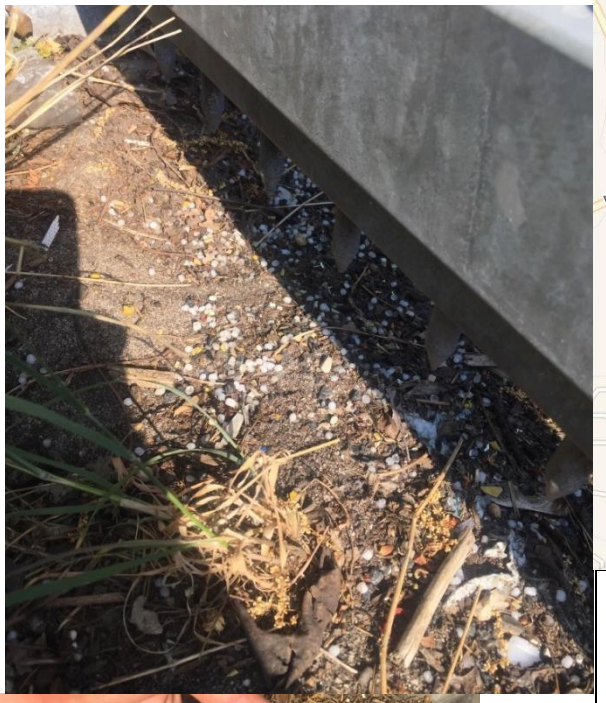
Location 8 Rainwater overflow and reservoir – between Emtelle production site and Svanholm Sø:

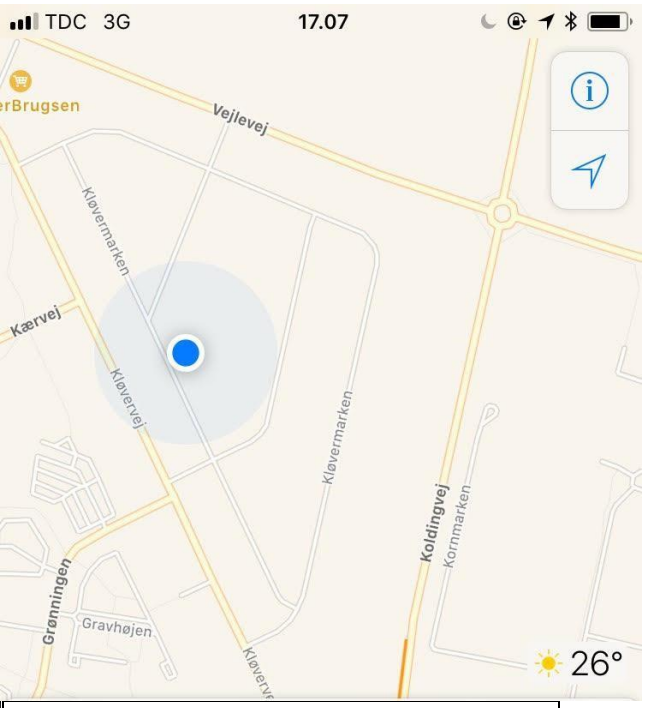
Location 8. The distance to Emtelle production site from the rainwater reservoir.

Location 8. Three pictures of the banks of the water reservoir

Location 9. HN Group, Kløvermarken 310, Billund, OCS certified:

Location 10, Kløvermarken, Billund:





Location 10, Kløvermarken, Billund. Exact GPS location of where on the premises the pellet spill was found

Location 11 Locations in the vicinity of the Port of Aalborg:

Location 12 Holm & Holm A/S:

Location 13 Fast Plast A/S: