Technology analysis

When looking at our requirements, a few different solutions can be found. A few relatively large robots which only remove driftwood and check the water quality. These robots do not need to communicate with another. On the other hand we have a swarm of relatively small robots. These will be able to remove small pieces of wood but will need help with bigger pieces, these would also be able to communicate their measurements with adapt their behaviour on that. The final option would be a stationary sensor network. In order to make a choice between these, a closer look has to be taken at the requirements.

When looking at the requirements that the robot(s) need to determine the shape and size, and need to make decisions on this, it would give a more detailed image and thus better decisions if driftwood can be mapped from different angles. A single robot would need a whole different design to make it independent of this requirement. A static sensor network would not be able to solve this problem at all. Coming back to the design of the robot. A single robot would have to be made to be able to perform every task. Things like a robotic arm or net to catch wood would also need to be scalable. The robot would become quite big and need a strong engine to be able to move large pieces of wood. In a swarm de robots would be a lot more simple in their design. They would not need a robotic arm or net. Larger pieces of wood can be removed by the robots working together. The robot will need to push the pieces of wood away, and for this the shape of the wood is of importance in order to find the right places to push without the pieces spinning away. The simpler design is also better to make a more sturdy robot.

Another task the robots need to fulfil is detecting contaminations in the water using a given set of sensors. For this it is important to find the core of the pollution and seeing the contamination as one whole, instead of a set of loose points. The contaminations is made out of two situations. The first is a pollution created outside of the range of the system. In this case all three options can be used. The other situation is when a pollution inside of the environment of the robot, the area the robot has to survey. An example of this is a boat throwing waste overboard. A static sensor would be able to detect this but not be able to follow it. To solve this the network has to be expanded to where it has overlap between sensors but this would be very expensive. A single robot would have a chance to miss the contamination but will be able to follow it. This could work but result in the robot moving far from its set environment. There will also be a problem if multiple of these cases are in the system at the same time, because the robot will not be able to divide itself. A swarm would be a solution for this. They can survey the area much faster because they can communicate their individual findings with another. The chance of finding the source will then be much higher. Following a ship can then be done in steps. A new robot can take over for a previous robot because of their communication. Besides this the swarm would be able to divide itself in case multiple sources are present. They can divide their tasks without dropping another task.

The robot must not hinder other traffic in its environment. It needs to be able efficiently move through the water without bumping into the shore, boat or other obstacles. For a static sensor network this is not a problem. This will be important though for a single robot or a swarm. A singular robot has less chance of collisions than a swarm, as long as the number of singular robots is smaller than the number of drones in a swarm. A swarm however has a wider field of vison, allowing it to see objects and avoid these more easily. If a singular robot misses a boat this can be a big problem, but if

a robot in a swarm misses a boat but the rest of the swarm does see it, then the rest of the swarm will also know by their communication.

Another requirements is for the robot to be autonomous and be active through the whole day. A sensor network can be active all day and does not need to be autonomous because it does not need to move. For a robot it is more difficult to be active for the whole day, since it has to be provided with energy. In singular robots it is possible for different robots to work in shifts. If one robot runs low on energy the other takes its place. In a swarm this can also be done. For the part of the robot being autonomous, this can be quiet difficult for a single robot. It would be more efficient to let it follow a set path. A swarm can check an area more swiftly and efficiently because of the communication of their findings.

From this we conclude that a sensory network would be ideal for measuring contaminations, but this is already being done by Rijkswaterstaat. A sensory network however cannot solve the driftwood problem. It also cannot find the source of a pollution or its size in a dynamic world. A sensor network only measures for a pollution. A singular robot is deemed to be to inefficient for our environment. It has a big chance for missing contaminations by working in another area at the moment. This could be solved by using more of these robots at the same time, but if these do not communicate with each other there is a chance of them performing the same task without knowing this. With a swarm of robots this can be avoided. We also want the reaction time of the swarm being quite low. As soon as something happens to the system this has to be detected as soon as possible. This can only be done if the environment is surveyed efficiently.