How does a WADI work?

Supervisor: Ir. Ing. R.G.A. Bults

Critical Observer: Dr. K. Zalewska

Client: H.J. Teekens, Municipality of Enschede

Faculty of Electrical Engineering, Mathematics, and Computer Science (EEMCS)

Matthijs Mondria | 17-7-2020 | Creative Technology | University of Twente

Abstract

Because of climate change there are less rain showers, but when it rains it is probably heavy rainfall. Because of the lack of green and thus soil sealing, mostly in cities, the water is not absorbed anymore by the ground and will all end up in the sewer system. Because the sewer system cannot handle all the water at the same time, flooding is likely to occur. A solution to this, is the WADI.

WADI's are being built in more and more neighbourhoods in the Netherlands, but the information provision is limited. The municipality of Enschede gets many questions about WADI's and can only refer to webpages with a lot of text and a few images. The municipality suggested to develop an animation that explains how a WADI works. Apart from informing the resident, the challenge is also to involve them and make them look after the WADI's. The main research question then is: *How to develop an animation that communicates the relevance of a WADI to a neighbourhood?* The sub research questions are: *Why are WADI's installed in the neighbourhood?*, *How does a WADI work?* and *How to make the neighbourhood look after the WADI's?*

The development process of the animation is explained in different phases, starting with the introduction. This is followed by the state of the art in which interviews are conducted, background research is done to find more information about WADI's and literature is reviewed. Then, the methods and techniques to be used in the project are explored. After this, the ideation is done, in which the first requirements, ideas and concepts are developed. The interactive animation concept was chosen to be worked out further, which was executed in the specification phase. Here, the storyboard and first prototypes are made. In the realisation phase, the interactive animation was produced. This is evaluated by the client in the evaluation phase.

Commissioned by and together with the Municipality of Enschede, the interactive animation was developed. With this design, the inhabitants are informed about the function of the WADI, the reason of installation of WADI's and motivated to look after the WADI's. The client was very happy with the animation. The Municipality would like to continue to make the final prototype into a product that can be used for their information provision about WADI's. This still needs testing, which is future work.

Acknowledgement

Firstly, I would like to thank my supervisor Richard Bults and critical observer Kasia Zalewska for their amazing accompaniment and extremely helpful feedback during the weekly (online) meetings or whenever I had a question. I also want to thank them for the uplifting comments on my work and the genuine care for my mental wellbeing during the process, which helped me to get going again in this weird COVID-19 time. Secondly, I want to thank the client, Hendrik Jan Teekens, for the opportunity to do this interesting graduation project for the Municipality of Enschede. I really appreciated the involvement, especially in the last part of the development which made things a lot easier. I am looking forward to continuing with the development of the animation to make a final product that the municipality can actively use for their information provision. Thirdly, I want to thank the people that were open to be interviewed, when this was still possible. A special thanks goes to visual communication expert Chris Vermaas for taking time to talk to me and making me visually think in the right direction.

Table of Contents

List of Figures

1. Introduction

This introduction will explain the context of the graduation project, the challenge and will state the research question including sub questions.

1.1 Context

Coping with large amounts of rainwater can be a challenge, especially in urban areas. Due to climate change, the patterns in rainfall also change; there will be longer dry spells, but when it is raining, it will me more intense. Due to the lack of uncovered ground in urban areas, the rainwater cannot be absorbed by the soil and will end up in the sewerage. However, when there is very heavy rainfall, the sewer cannot handle all the rainwater. At a certain point, the ground water levels are also too high to accommodate even more water, and the streets will flood.

In Enschede, there is another factor that influences the amount of rainfall that the ground can cope with. Formerly, the textile industry prevented the city from floods by detracting water from the ground. Now these are gone, the groundwater level has risen again [1].

A solution for these problems that already has been widely applied in Enschede, and was also invented in Enschede, is the WADI. Wadi stands for 'Water Afvoer Drainage Infiltratie' and is also Arabic for a (dry) riverbed that only contains water after heavy rainfall. This describes the idea of a WADI already quite well. A WADI is a ditch filled with gravel and sand that can both retain and infiltrate water (see figure 1). In such a system, the water from the roofs and roads will flow to the wadi via above-ground gutters and/or ditches where it otherwise would just flow into the sewer. The main functions of a WADI are to buffer and infiltrate the water, which minimalizes the overflow of the sewer system, improves the quality of the surface water and reduces drought [2].

Figure 1. WADI in Ruwenbos. ©Amar Sjauw En Wa – Windhorst [2]

A WADI is preferably placed in a public area, so residents must be informed and involved. Doing this properly promotes the acceptation of the WADI and makes residents more aware of the use of cleaning products and other environmentally polluting substances which can harm the proper functioning of the WADI [2]. When the WADI is not used in the right way, it can even cause more damage to the environment because of the way the WADI works. At the moment, the only information available about the functioning of a WADI and the reasons of installing it is in the form

of text and imagery (see State-of-the-art, 2.4). This form might not be attractive or informative enough to all residents.

1.2 Challenge

The municipality of Enschede suggested to develop an animation that explains how a WADI works. An animation does not necessarily have to be in the form of a video but can be. Looking at the effect of videos, the advantages are very clear. Firstly, video is a popular format for content delivery. Almost half of the American population spends more than an hour watching YouTube and Facebook videos every week [3]. Looking at other social media, it turns out videos are six times more likely to be retweeted than photos [3]. Our brains are also very much visually set up: 90% of the information that is transmitted to the brain is visual and it can process images sixty thousand times faster than text [4].

As mentioned above, WADI's are preferably placed in public areas and residents must be informed and involved. Informing residents about the function of the WADI's and how they exactly work should not be presented too difficult and be quite straight forward. However, involving residents and making them care and look after the WADI's is more of a challenge. With the animation that will be developed, the biggest challenge is to make residents care about the wadi. This way, the residents will look after the WADI. Consequently, the WADI will be less polluted as the residents might take out the trash and will not e.g. pour frying fat into it litter it in other ways. They might also tell others not to do certain things or call the municipality when maintenance is needed. This way, the WADI will not need as much maintenance and there will also be less nuisance that might annoy residents. Still, as mentioned before, there will be regular maintenance needed, but when the relevance is clear the residents might understand it better.

1.3 Research Question

Based on the context and the challenge, the main research question is:

How to develop an animation that communicates the relevance of a WADI to a neighbourhood?

To help answer the main research question, these are the sub questions:

- *Why are WADI's installed in the neighbourhood?*
- *How does a WADI work?*
- *How to make the neighbourhood look after the WADI's?*

1.4 Report structure

The report is structured in different chapters to explain the development process of the animation. It starts with the introduction, which is followed by the state of the art. This chapter includes interviews, more information about WADI's, literature review and current available information about WADI's. The third chapters focuses on the methods and techniques that are used in the project. The following four chapters follow the steps of the chosen design process, which is discussed in chapter 3. In chapter 4 the ideation is conducted, which describes the first requirements, ideas and concepts. At the end of this chapter, one idea is chosen to be worked out further in the fifth chapter: specification. Here the storyboard en first prototypes are presented. The final design of the animation is presented in chapter 6: realization. This design is then evaluated by the stakeholders in chapter 7: evaluation. In chapter 8, conclusions are be drawn and answers are given to the research questions. Future work that can be done after this project is discussed in chapter 9.

2. State of the Art

In this chapter an overview will be given on the state of the art. Firstly, the conclusions of the interviews that were done. Four interviews were conducted with various relevant people: the client, neighbourhood representative, housing corporation and communication department of the municipality of Enschede. Secondly, some more information about the WADI. Thirdly, the literature review that was done. Fourthly, the current available information in both text and imagery and video is explored.

2.1 Interviews

To get a good view of the situation and information already available about WADI's, a few interviews were conducted. Firstly, the client was interviewed. He is a water designer at the Municipality of Enschede and the client of the assignment. Secondly, an interview was conducted with a neighbourhood representative. He is an active resident of 'Het Bijvank' and secretary of the neighbourhoods residents' committee. He was selected to be interviewed to gain more knowledge from the residents' perspective on the information that was supplied about the WADI and on living near a WADI. Thirdly, a representative of a housing corporation was interviewed. As developer and project manager at Domijn he, amongst other things, worked on the renovation of the neighbourhood 'Het Bijvank'. He was selected to have an interview with to find out what the housing corporation does concerning the information about WADI's and what its role could be in the future. Fourthly, it seemed interesting to talk to someone from the communication department of the Municipality of Enschede. This way, a good overview of the activities the Municipality is already doing can be obtained and how the department could be of help later on in the process.

2.1.1 Client

Water Designer Municipality of Enschede

The main reason for the client to assign the development of an animation about WADI's is to have quick and easy way to explain the functionality and workings of a WADI. He would like to be able to show it to residents that have had a different education and background than him. They must be able to understand the function and the goal of the WADI. The importance and drain function are unknown. He would like to see the residents to call him or the municipality when there is a problem with the WADI. With the animation, he would like to show how rainwater enters from the top and infiltrates into the ground. It's also important to show the fluctuation of the groundwater;

in the summer the level is lower than in the winter. Because of this, in the winter, the water will flow from the WADI to the ponds. This function is very unknown, also because it is all happening underground, so it's not visible. What cannot be found on the Internet, is the drain function of the WADI; what happens underground to make sure the homes of residents in the proximity of a WADI stay dry and waterlogging is tackled.

2.1.2 Neighbourhood representative

Secretary Residents' Committee Het Bijvank

The representative lives in the neighbourhood 'Het Bijvank' in the south of Enschede. When this neighbourhood was built in the 1960s, public housing was mostly built. With the renovation starting in 2018, the residents were involved in the design of the homes and the facilities in the neighbourhood. This was more about the placement and design of playgrounds than the greenery. At the centre of the neighbourhood a green strip was realised. Originally, this was just planned as a green area with some grass and trees. Later, however, a WADI was developed here. According to him, not many residents were aware of what it exactly is and its functions. They might see it as another ordinary 'ditch' in the backyard.

2.1.3 Housing corporation

Developer/Project Manager Domijn

Domijn is the housing corporation behind, among others, 'Het Bijvank'. In this neighbourhood there is a special sewer system. The north has a separated sewer system, for clean and dirty water. In the south there is no clean water sewerage, because of the WADI to which the houses are connected. With the delivery of a house, a living guide is supplied. He would like to see a page in this guide dedicated to water, including tips to not wash your car on the street and not to pour frying fat in the blue wells. On this page there can be a brief explanation about WADI's, but also a link or QR-code to the animation. Unfortunately, this guide is only offered with the first delivery of a new home. The next residents will not get this information, although it is quite important. A solution for this can be a digital version of this information which can be sent to the new residents, where an animation about the WADI can be embedded too. Domijn does have direct contact with the tenants, but because the WADI is part of the public area in the neighbourhood, the primary responsibility lies at the municipality of Enschede. According to him, another important aspect is the visibility of the water. He says that the water used to just go into the ground. "When you can't see it, it's not there!", was the line of thought. He finds it important to make the water more visible,

to see water as an opportunity; to prevent drought. The water is already more visible by the design of the WADI itself but can be even made more visible through the animation.

2.1.4 Communication department

Communication Officer Municipality of Enschede

The representative of the communication department agreed with the plan to try to involve people with the WADI. Nowadays, the municipality also is active on social media like Facebook and Instagram where sometimes they already post some animations or infographics about relevant subjects in Enschede. Apart from the website of the municipality, the animation could also be posted on these social media channels, whether or not in an adapted shape. She also still mentioned the importance of text with the animation when people want more information about the subject, which she could help with.

2.2 Functioning of a WADI

A WADI is a ditch filled with gravel and sand that can both retain and infiltrate water (see figure 3). In this system, the water from the roofs and roads will flow to the WADI via above-ground gutters and/or ditches where it otherwise would just flow into the sewer. Some neighbourhoods have special wells around the WADI where the water from the roofs comes out and flows into the WADI, see figure 2.

Figure 2. Well where water comes out of in Het Bijvank, Enschede.

The WADI consists of multiple layers. The top layer is planted and has permeable soil. Below, there is a box which can contain gravel, scoria or baked clay pellets. Because there is space in these materials it can buffer and infiltrate the water. Geotextile is used around the box to prevent clogging by sludge or roots.

At the bottom of the box an infiltration pipe/drainpipe is situated. In winter this pipe also acts like drainage. The function of the drainage system is to transport the water from an area with a lower infiltration capacity to an area which has a better capacity to infiltrate the water.

The WADI can be equipped with a glutton/spillway to prevent the WADI from overflowing in heavy rainfall. This provision is directly connected to the infiltration/drainpipe. When the water

level in the WADI is too high, it will flow to this pipe via the spillway. If both the drain and spillway are filled, the WADI functions as an above-ground drain and the water is directly discharged to the surface water or storm sewer.

For a proper functioning of the WADI, it must be well maintained. At least twice a year leaves and litter must be removed and spillways (see figure 3) emptied to prevent silting up and pollution of the WADI. In addition, once a year the drainage has to be hosed. When a WADI has grass on top of it, which is common, it also has to be mowed every other week when it's growing. When a WADI does not have grass but all other kinds of plants and vegetation, mowing has to be done twice a year [2].

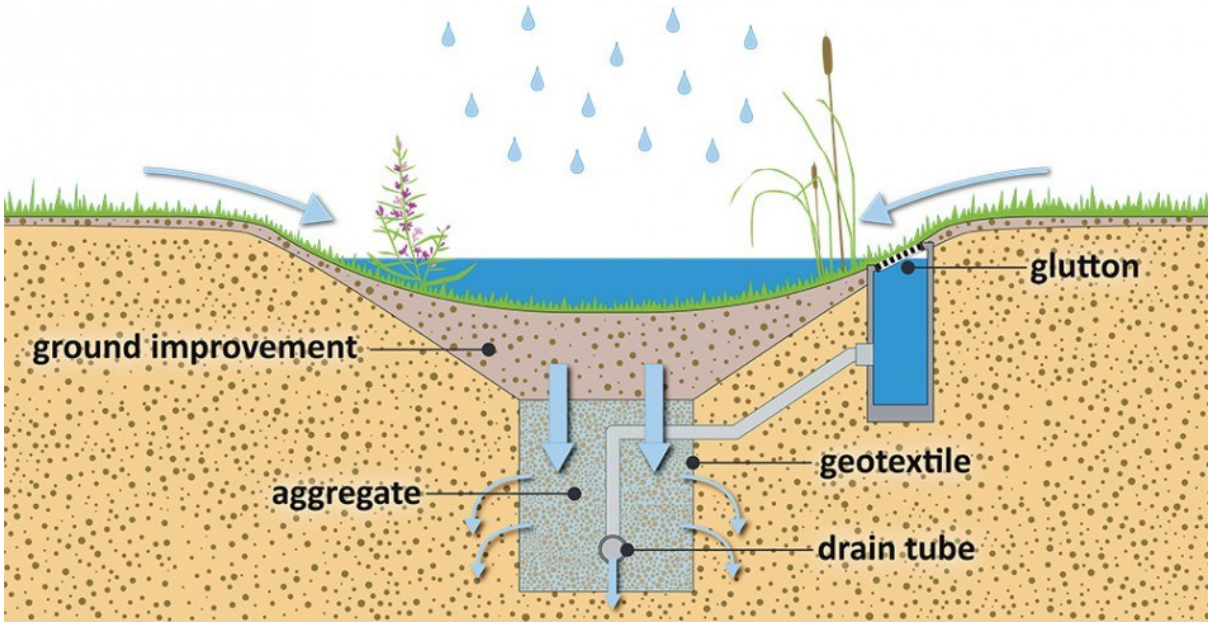

Figure 3. Section scheme of a bioswale during rainfall © atelier GROENBLAUW, Marlies van der Linden (based on: Boogaard et al, 2006) (https://www.urbangreenbluegrids.com/measures/bioswales/)

2.3 Literature review

This chapter consists of three parts. Firstly, it will explore the possibilities of evoking environmentally responsible behaviour (ERB). This part will give an overview of different ways to improve ERB. Secondly, it will focus on how to make people knowledgeable about the environment. This part will explain the different ways of education. Thirdly, it will focus on how to visually explain the message that needs to be conveyed. In the conclusion, a summary will be given of the most promising methods to be used.

2.3.1 Environmentally responsible behaviour

As the target group of the animation that will be developed considers all residents that live in a neighbourhood where a WADI is situated, this group is rather diverse in terms of age and education. The age of this group can span from 0 up to 90 years old. It is important that the animation speaks to all of these people, so all residents get the same sense of relevance. In respect to the WADI, it is important to make the residents look after it and feel responsible for it. The extent to which the residents already show environmentally responsible behaviour (ERB) can have an impact on this. Some examples of this ERB are energy saving, buying energy efficient electric appliances and using renewable energy. Štreimikienė [5] states that "Age, gender, education, and income of Lithuanian residents do not have impact on environmentally responsible behaviour in Lithuanian households". So, initially all residents should have the same sense of ERB. The only thing that has impact on ERB is environmental awareness [5].

This environmentally responsible behaviour can also be associated with tourism. Firstly, the relation between environmental knowledge, sensitivity and place attachment is explored. Cheng & Wu [6] found that people have a higher level of environmental sensitivity when they have a high level of environmental knowledge and when they have a higher environmental sensitivity their place attachment will also be at a higher level. The definition of place attachment is one's positive affection toward a specific place [6]. They also found that a stronger environmentally responsible behaviour is connected to a stronger environmental sensitivity and that ERB is also enhanced by higher place attachment [6]. So, place attachment and ERB can be enhanced by environmental knowledge and sensitivity. Thus, promotion of knowledge of the environment and the sensitivity towards the environment to make people act more responsible towards the environment. Here, the research was done among island tourists, but this may also be applicable to the home situation of people.

Apart from environmental knowledge, sensitivity and place attachment, one can also take the destination attractiveness into account in relation to ERB. When one feels a stronger attractiveness to a place, they also have a higher degree of place attachment and people also have a stronger ERB when they find the place more attractive [7]. So, place attachment and ERB can be enhanced by the attractiveness of the destination. This research was done among island tourists but can also be relevant to people's hometowns. When the residents, or the municipality, make the place more attractive, people might show more ERB and act like it.

Another way to developing one's place attachment and ERB can be to let them do activities in a natural environment. Research was done with students who had been working on trial building and maintenance activities in local natural resource areas. Vaske & Kobrin [8] found that "encouraging an individual's connection to a natural setting facilitates the development of general ERB". So, it might be a good idea to let residents experience nature more, so they will develop more environmentally responsible behaviour, which can have a positive influence on their attitude towards a WADI.

Apart from these activities, it is also interesting to explore the relation between environmental attitudes (EA) and ERB. In contrast to the lack of relation of age, gender and education to ERB, the activities one practices can have influence. Barker & Dawson [9] point out that people who participate in environmental community organizations have a better EA and ERB. So, people who are more active in these organisations behave more responsibly towards the environment. Another conclusion was that participation in organizations for motorized vehicle activities, also had a positive effect on EA and ERB. In contrast to the research of students working in the natural environment, here the participants were already active in these organizations. Nonetheless, outdoor activities can enhance ERB.

2.3.2 Environmental knowledge

As stated above, it is important to give people more knowledge about the environment to improve ERB. Consequently, ways must be found to get the knowledge to the people. A powerful tool in order to generate green behaviour is environmental education [10]. The internal human factors and environmental education were the main predictors of green behaviour. Social human factors and motivation had less effect on development of green behaviour [10]. In other words, the focus should be on good education that concentrates on the intrapersonal factors.

Now the target is clear, it is important to find out how to reach the residents. Varela-Candamio et al [10] state that "Policymakers can influence longer-term transformations of culture

and practice in green behavior by influence attitudes, awareness, intention, motivation, social norms, and especially environmental education through regulation, information (media), and marketbased instruments". To put it differently, among others, awareness and information in the form of media can do a good job in influencing the practice of environmentally friendly behaviour.

So, information supply can help to influence green behaviour. Mostly, there is a problem to act on in the environment, like pollution. Hines, Hungerford & Tomera [11] state that one must be conscious of the problem before he/she is able to act on it: "knowledge of the problem appears to be a prerequisite to action". Having the knowledge is important, but one needs to know what to do with it to make the knowledge useful. The courses of action and which one will be the most effective one for a certain position should also be known [11]. Again, it is evident that the information supply is of great importance. Both about the problem and about the best approach to tackle the problem.

2.3.3 Visuals

Now it is clear that information is very important to make people aware, a way must be found to convey this information in the best possible way. One of the advantages of visuals over textual material, is that "visuals are thought to send people along emotive pathways where textual/verbal material leaves them in a more rational, logical and linear pathway of thought" [12]. This can help to engage people more and keep their attention when trying to get a message across.

Fear is not often used to persuade audiences, but material that involves threat are more frequently used [12]. One example of fear used in campaigns was the seatbelt usage promotion in the 1970s. This effort, however, made no difference in the usage of seatbelts [13]. Later, in the 1980s, when there where campaigns about Aids, fear was again used, with little evidence for success [12]. The swiss, however, had a different approach. They did not use fear but focused on the quality of life through condom use [12]. This campaign is widely seen as the most effective one [14]. Thus, it is wise to avoid fear in the message and instead focus on the positive effects.

Comparing information in video and text, it's clear that one of the advantages of video over text is the fact that video grabs people's attention, because our eyes are attracted to movement [15].

2.3.4 Conclusions on literature review

Considering the three topics discussed (Environmentally Responsible behaviour (ERB), Environmental Knowledge, and Visuals), there are a few things that are important to note and

consider in the making of the animation. Looking at ERB, it can be said that environmental knowledge, environmental sensitivity and attractiveness are important factors to enhance ERB. Also making people connect more to the local natural sources by letting them execute activities enhances ERB. Focusing on the environmental knowledge, environmental education is key, and the focus should be on intrapersonal factors. Next to this, awareness and information in the form of visual media can do a good job in influencing the practice of environmentally friendly behaviour. Next to having the knowledge, it is of great importance to know what to do and translate this knowledge to action. Lastly, when looking at visuals, one should avoid using fear and rather focus on the positive effect of the intervention.

2.4 State-of-the-art

In the Netherlands, and especially Enschede, the term WADI is used. However, in English, the term Bioswale is often used. With both search terms, some information can be found. However, no clear animation that shows the function of a WADI or Bioswale is available. An overview of the information that is available will be given.

2.4.1 Text and imagery

There is quite some information available about WADI's. When searching for Bioswales, one can see that many cities have their own information page about them. Most of them only feature text, some have undetailed images of bioswales, and a few have detailed images that explain how it works.

Urban Street Design Guide - National Association of City Transportation Officials

This website [16] shows a guide on how to install a Bioswale. It features drawings that show the components bioswales consist of, see figure 3. On the website, there are clickable dots on several components which bring up more information. These are not visible in figure 4.

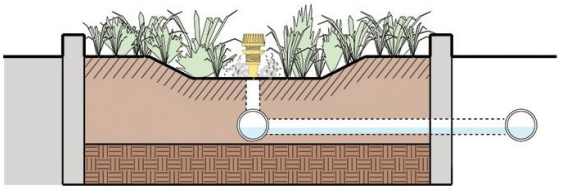

Figure 4. Urban Street Design Guide Bioswale overview

Bioswales – GrowNYC

As mentioned before, there are many cities who have their own information page on bioswales. This one is from New York City [17] and features a clear drawing (see figure 5) of the bioswale including explanatory text. Apart from this, the page even has a video embedded. This video shows some photos of bioswales and someone briefly explains how the bioswale works. In the video there is no technical imagery that helps to explain the functions.

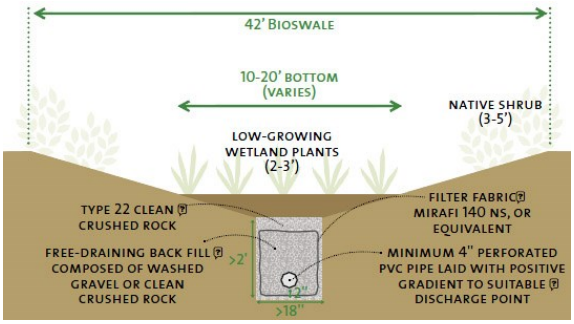

Figure 5. Bioswales – GrowNYC

Rain Gardens & Bioswales – The Watershed Project

The Watershed Project [18] is another website from a specific city or area. The watershed project focuses on the San Francisco Bay area. On this page, a brief explanation on the wadi is readable. Apart from that, a quite extensive overview of a bioswale is given in the form of a drawing with text, see figure 6. The amount of text, however, makes the image a little cluttered.

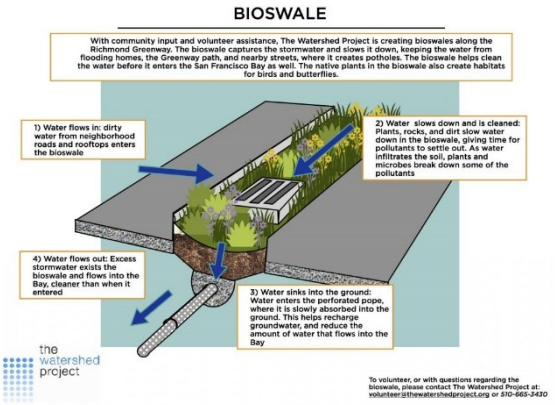

Figure 6. Bioswale overview

Bioswales – Urban Green-Blue Grids

This website [19] is both available in English and Dutch and shows really clearly how a wadi works, both in text and imagery. The available information is very elaborate, and the images are really clear, see figure 3 and 7.

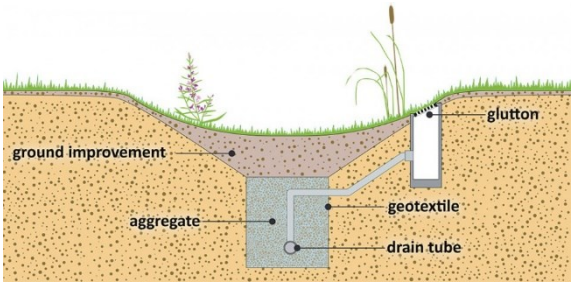

Figure 7. Section scheme of a bioswale when it is dry © [image by atelier GROENBLAUW, Marlies van der Linden (based on: Boogaard et al, 2006)

WADI's – Groenblauw Enschede

Here [20], almost the same images are used as on the Urban Green-Blue Grids website, but now with Dutch text (see figure 8). The amount of information available is less than on the other page, but still very complete.

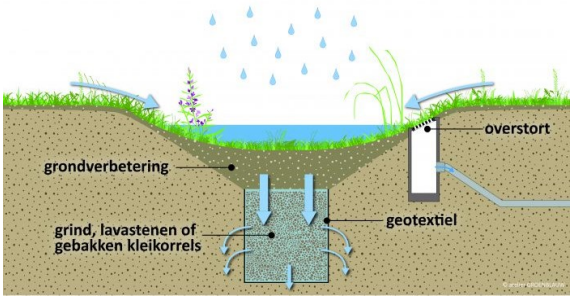

Figure 8. WADI with rain, Dutch

2.4.2 Video

There are videos available that give some background information about WADI's. Here, an overview will be given of video's from Enschede and the rest of the world.

Het Bijvank in Enschede: Ready for the future – 1Twente Enschede

Figure 9. Het Bijvank in Enschede: Ready for the future

This video is part of a series by 1Twente [21], a local medium for news, video and radio, called 'Enschede aan Zee (Enschede by the Sea). This series covers all kinds of subjects that have to do with the water management in Enschede. In this particular video, the neighbourhood 'Het Bijvank' is covered, see figure 9. They talk about the WADI that is installed there and other connected affairs. The three people that are present in the video were also interviewed, see chapter 2.1. Apart from the interesting explanation by the experts and some footage of the wadi, there is no schematic drawing present.

First WADI ever in Ruwenbos, Enschede – 1Twente Enschede

Figure 10. First WADI ever in Ruwenbos, Enschede

Another video in the 'Enschede aan Zee' series of 1Twente [22] is an interview with Mr. WADI, Gerdrik Bruins, see figure 10. He is the inventor of the WADI and tells about the basic concept of the WADI. The story is supported by some footage of the WADI and the neighbourhood. Again, there is no schematic drawing that explains the functions in a visual way.

Waterklaar wadi – Waterklaar

Figure 11. Waterklaar Wadi animation

In the southern province Limburg, a campaign called 'waterklaar' (water ready) [23] was launched. Like Groenblauw Enschede, many options are explained on how to handle the water. One of these options is a WADI. On the website of waterklaar a short video is available

which very briefly shows the concept of a WADI in an animation, see figure 11. The video is not very profound but does look good and is easy to follow for a large audience.

Hoe werkt de Maeslantkering? - Rijkswaterstaat

Figure 12. How does the Maeslantkering work?

In the southwest of the country, some storm surge barriers are installed to cope with high water levels and to prevent events such as the North Sea flood of 1953. They are called the Deltawerken. The most famous one is the Maeslantkering in Hook of Holland. Rijkswaterstaat [24] made a video about the working of this barrier. It starts with a bit of history and the reason of its existence. After that, its function is explained. Then, the working of the barrier is explained with video footage and names of each part (see figure 12). The video footage is of good quality, and the names are clearly projected. However, the function is not well visualized because of the use of general footage of the barrier and no clear visualisation of the working, only aural. The audio also is not very convincing: the information of the voice over is interesting, but the audio quality and pace of speech are poor. There is also no background music, which gives the video a serious and boring character.

O, zit dat zo! – Maeslantkering – Rijkswaterstaat

Figure 13. Oh, that's how it works! - Maeslantkering

Like the video "Hoe werkt de Maeslantkering?" above, this video also is about the Maeslantkering [25]. The style, however, is very different. Where the other video uses video footage with some text, this video is completely animated (see figure 13). It tells a story rather than plain information provision, including some emotion. The technical level is low as the information is very simple and limited. The target audience for this video probably is children. The video looks very nice and the audio is of good quality with relevant sound effects and background music.

The Art of Safety Card Safety Video – Delta

Figure 14. The Art of Safety Card Safety Video

Airline security videos usually are quite boring. They have the goal to get the safety measures across and with this, they can scare some people. Most airlines try to comfort people by saying the events talked about are very unlikely to occur. Still, the messages in these videos are really serious. Delta Air Lines, however, takes a whole different approach. This American airline also uses a safety (card) video [26] in its planes to explain all safety measures and features of the aircraft, but uses a video with humour and joy. The video starts with footage of an airline employee (figure 14) who introduces the video and opens the safety card he is holding. Then the viewer gets sucked into the world of the figures in this safety card, into the world of 2D characters in an animation. The animation takes the physical safety card as a basis, but makes the characters come to life, out of their 'frames'. Some elements are not realistic, like the woman with the 9 arms (at 0:19), but this makes the ambiance of the video which still has a serious message a lot less severe. Little amusing elements like the sign that says "You're A 2-D Character in a safety video" (at 1:15) and the monster after a line of people demonstrating the life vests (at 3:15) also help to create this ambiance. Because of these funny elements, people also probably will keep watching the video, as it is amusing. At least, that was my personal experience last summer. The transitions between scenes are very fluent, relevant and also often funny, like the girl shaking the safety card simulating turbulence (at 1:04) and the boy playing with the toy plane showing the emergency exits (at 1:31). The audio of the video is of good quality: the music is cheerful, which adds to the comforting ambience and the voice over has a soothing and happy voice that suits the rest of the video. A large variety of characters is used, so everyone can identify themselves with someone in the video. All these elements make this video pleasant to watch, while still getting the important safety information across. The video ends the same way it starts, with a man holding the safety card. This time, it is the pilot closing the card and wishing everyone a wonderful flight. Now the circle is complete, and the video ends.

2.5 Conclusion

Firstly, looking at the literature research and considering the three topics discussed, there are a few things that are important to note and consider in the making of the animation. As one of the goals of the animation is to make people look after the WADI, it might be a good idea to improve the Environmentally Responsible Behaviour (ERB). Important factors to enhance ERB are environmental knowledge, environmental sensitivity and attractiveness. So, it is important to provide the viewers the knowledge. This can be done in the first part of the animation, the explanation of the functioning of the WADI. As environmental attractiveness also is an enhancing factor for ERB, it is important that the environment of the WADI is attractive to the residents. Not only the attractiveness of the physical environment is important, it might also be a good idea to make the WADI look as attractive as possible in the animation. Apart from the knowledge, sensitivity and environmental attractiveness, making people connect more to the local natural sources by letting them execute activities enhances ERB as well. This can also be encouraged in the animation and can maybe be shown as an example. Environmental education is key when focusing on environmental knowledge, and the focus should be on intrapersonal factors. So, people personally have to see the importance and should have the knowledge. Next to this, awareness and information in the form of media can help in influencing the practice of environmentally friendly behaviour, which should be done using the animation. Next to people having the knowledge, it is of great importance for them to know what to do and translate this knowledge to action. Applied to the animation, it is important to show the situation to provide the viewers knowledge, but the way to handle this information and which actions can or should be taken are of equal importance. This should be made really clear in the animation. When looking at visuals, one should avoid using fear and rather focus on the positive effect of the intervention. So, although some actions are not allowed in relation to the WADI, the emphasis should be on the actions that should be done and are beneficial to the WADI and its environment.

Looking at the state-of-the art, it is interesting to see how everyone explains the function of the WADI. However, with these explanations not much use of imagery or animation has been made. The ones that do, are doing quite a good job and show that already a simple image of the side profile of the WADI can already improve the understanding. It also helps to attract one's attention and is more engaging. The videos that are available about the subject are sparse, and those that explain the function of the WADI well are non-existent.

3. Methods and Techniques

In this chapter, the methods and techniques will be discussed that are used in the process of developing the animation. Firstly, the used design process is explained. Secondly, the method used for the stakeholder identification and analysis is discussed. Thirdly, the way the requirements are identified and categorized is explained.

3.1 Design process

As a starting point, the design process developed by Mader and Eggink [27] is used in this project. The goal of this project is to develop an animation to show the function of a WADI and makes people look after the WADI. As the result of the project will be a visual product, this design process is chosen to be used.

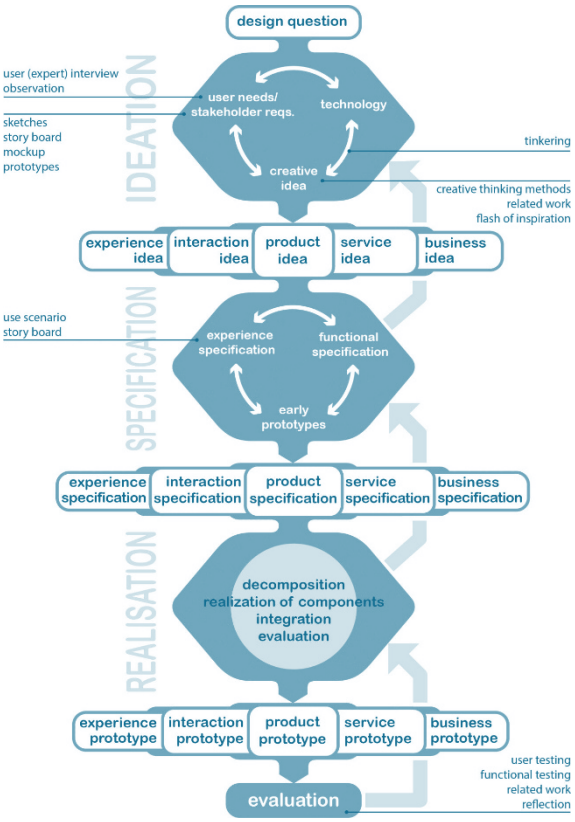

Figure 15. A Creative Technology Design Process [27]

This design process consists of four phases: Ideation, Specification, Realisation and Evaluation. In the Ideation phase, there are 3 starting points available: user needs/stakeholder requirements, technology and creative idea. One of these points can be chosen wherefrom the other points are investigated. Ideas are created that are based on the requirements of the stakeholders, like the first storyboards and storylines. In the next phase, the specification, the design space is explored by using prototypes [27]. The second versions of the storyboard and storylines are created, and the design will be improved. The requirements will also be more specified. What is also important in this phase, is the application of a short evaluation and feedback loop [27]. The third phase, the Realisation, can be started when the specification of the product requirements is given. The product will be realised using the requirements set up earlier in the specification phase. Finally, after the realisation phase, the product is evaluated by functional and/or user testing. When the result of the evaluation is not satisfactory, one should return to the previous. As visible in figure 15, not only at the evaluation phase there is an arrow pointing backwards to the preceding phase, but at all phases in the

process. This means that from every phase, there is an option to return to the preceding phase if necessary.

3.2 Stakeholder identification and analysis method

Stakeholders are people who have interest in the product/project. This can range from the people who have interest because of their function, like municipality officers, to the users the product is designed for. Investors are also examples of stakeholders. Before the stakeholders can be analysed, they need to be identified. To do this, a table is created. In the first column the names of the stakeholders are presented. The second column explains the interest of each stakeholder. In the third column the role of each stakeholder in the project is named. This way, it is easy to analyse the stakeholders and what to expect from them. See figure 16 for the template.

Stakeholder	Power	Interest	Role
X	X	X	X

Figure 16. Stakeholder identification method

The power versus interest grid by Mendolow [28] has been used to analyse the stakeholders, see figure 17. On the X-axis, the rate of interest is plotted against the rate of power on the Y-axis. Every stakeholder can be rated on interest and power. Some stakeholders, like clients have lots of power, but maybe not so much interest. Other stakeholders may not have that much power but do have a high interest, like users. With Based on the power and interest rate, in this model there is a discrimination between four groups. People to: Keep Satisfied, Manage Closely, Monitor and Keep Informed. The different stakeholders are placed in this grid. It is essential to analyse the different stakeholders in this grid to understand their importance to the project and to find out how to incorporate them into the process.

Figure 17. Power/Interest Grid for Stakeholder Prioritization [37]

3.3 Requirements identification and categorization

Before the requirements can be categorized, they need to be identified. The requirements are partially identified by interviews with the stakeholders, see section 2.1. Another part of the requirements is identified in the meetings with the supervisors and the client. These meetings were in the form of semi-structured interviews. To have good overview of the requirements and their importance, the MoSCoW method [29] can be used. The requirements are ranked using on priority using four groups: Must have, Should have, Could have and Won't have [29]. The template can be found in figure 18. On the left the requirements that have to be thought of are listed. Then, to the left of this the four categories mentioned above are stated. Each requirement is then ranked from 'Must have' to 'Won't have' by adding a cross to the cell in the table. When all requirements are ranked, a good overview is gained, and this result can be used for ideation.

Requirement	Must	Should	Could	Won't
X			X	

Figure 18. Template MoSCoW method.

3.4 Evaluation method

During the development of the animation in the ideation and specification phase, the stakeholders will already have given their opinion on several concepts. After the animation has been realized, it still needs to be evaluated. This is done to see whether the requirements set during the specification phase are met. Due to COVID-19 this evaluation will be digital and contactless. The evaluation consists of two phases. Firstly, the stakeholders will share their experiences and opinions about the realised animation. Secondly, based on the set specification requirements, the designer will evaluate if these are met with the realized animation.

3.4.1 Stakeholder evaluation

During a video meeting with the stakeholders, the animation will be shown. The general feedback and opinions of these stakeholders is then asked. This will be done in the form of a semi-structured interview. The questions that will be asked are based on the final requirements.

3.4.2 Functional evaluation

Based on the set requirements in the specification phase, the designer will evaluate if these requirements have been met in the realization. The requirements will be ranked on whether they have been met, partially met or not met. For the sake of clearness, the requirements will be colour coded: GREEN for ‘requirement fully met’, YELLOW for ‘requirement partially met’ and RED for ‘requirement not met’.

4. Ideation

In this chapter all knowledge gained before is put into practice. Firstly, the stakeholders are identified and analysed, to know what to expect from each stakeholder. Secondly, the preliminary requirements are formulated and rated. Thirdly, the conclusions of an interview with a visual communication expert are drawn. Fourthly, the developed concepts are shown and discussed in a few rounds. Lastly, the project focus is explained.

4.1 Stakeholder Identification and Analysis

4.1.1 Stakeholder identification

In figure 19 the four different stakeholders, their interests and role in the project are presented.

Stakeholder	Power	Interest	Role
Municipality of Enschede	Very High. As the client in this project, they want a good product.	Easy to send/link information for inhabitants of neighbourhoods with a WADI or where a WADI will be installed in the future to cover questions and to learn about the functioning. Might decrease maintenance (costs).	Decision-Maker. Sharing the knowledge and experience about WADI's and the currently available information. Giving advice during the process.
Inhabitants of Enschede	Low.	Easy way to get more information about what the WADI is installed and how it works.	Users. Will watch the interactive video to get informed about the WADI.
Housing Corporation	Medium.	More information for the living guide provided with the first delivery of a new home.	Decision-Maker. Sharing the current information provision and experience from their residents.
University of Twente	High. As the supervisor and assessor in this project, they want a good product.	Want the project to be successful, to keep the good name of the study and university. Also, to keep a steady relationship with the municipality for future projects.	Decision-Maker, Supportive. Sharing the experience from similar projects in the past and giving advice during the process. Assessing the work.

Figure 19. Stakeholder interests and roles

4.1.2 Stakeholder analysis

In the grid in figure 20, the different stakeholders are placed in the Power/Interest grid.

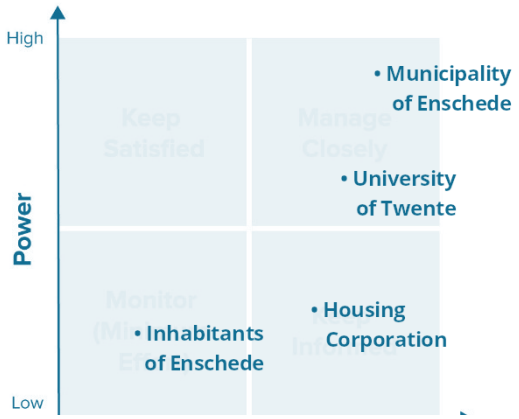

Figure 20. Filled in Power/Interest Grid for Stakeholder Prioritization [37]

4.2 Preliminary Requirements

The client's wish is to have a clear animation on how a WADI works that is understandable to everyone and is easily distributable. This way, the animation can be placed online and when there are questions from the neighbourhood, the receiver of this question can refer to the animation where the question, most likely, will be answered. The following preliminary requirements list is derived from the interviews and background research, which can be read in chapter 2. These requirements can be viewed in figure 21.

Requirement	Must	Should	Could	Won't
Animation	X			
Easily viewable by residents	X			
Easily showable on information evenings	X			
Inform residents about the buffer function of WADI's	X			
Teach residents how to look after WADI's	X			
Voice over in Dutch	X			
Show what the effects are of a contaminated WADI	X			
Show that the municipality is responsible for the clean-up of natural contamination (leaves, etc.)	X			
Show that the residents are responsible for the clean-up of human contamination (litter, etc.)	X			
Inform residents about the drain function of WADI's		X		
Interactive video		X		
Show the benefits of a WADI to residents		X		
Use sound effects for immersion		X		
Avoid discrimination		X		
Use suiting music			X	
Entertain			X	
Use realistic animations			X	
Explain the function to employees of housing corporations, municipalities, etc.			X	

Figure 21. Preliminary requirements in MoSCoW format

4.3 Visual Communication Expert Interview

To be able to efficiently come up with ideas and get some inspiration, the decision was made to have an interview with a communication expert. He had some useful tips that can be used further on in the ideation phase.

The first thing he mentioned, was to be sure where the animation has to be used. This is important to know because, based on this, the characteristics of the animation need to be determined. An animation can work great to explain to explain the technical aspects, but it might also be a good idea to catch some situations in still images. This helps to remember things. He also mentioned that still images that are clickable work great. This can be applied in interactive videos. To prevent the loss of focus on the message of the animation, it is important to not have too many impressions at the same moment. Elements should enter the scene one by one; the grass and rain should be brought in in a controlled way. To focus on something, moving images and stills can be combined; only let something move when the rest is frozen to draw attention to it. In the video frame, the area where something happens should be in the centre. Also, instead of changing the scene abruptly, the camera should be move and zoom in or out.

When talking about the message, he mentioned the tone of the visualisation is also of great importance, especially in situations where the message is serious. When the tone of the media is also very serious, the ambiance gets very negative and even frightening. However, a video can also be positive while still communicating the serious message. A great example of this, is the on-board safety card in airplanes. These have a serious message of instructions in case of an emergency, but by use of figures and colours it does not cause anxiety. A video version of this safety card is discussed in Chapter 2.

A whole different, but also interesting style is the one used by IKEA. Their manuals use technical construction drawings to make the builder feel like a real carpenter. They use drawings without perspective to make things as clear as possible. When this kind of drawings are used in the animation, naturally there is a possibility to add colour.

A new problem that has to be tackled when making the video, is distraction. Nowadays, everyone has a phone that beeps with every notification. When this happens during the watching of the animation, the attention should be kept at the video; it should be interesting enough to overrule the distractions. The rise of mobile phones causes something else to think about: screen size and orientation. Mobile phones normally used in portrait mode, while computer screens and televisions are in landscape. Maybe use a hybrid between these two, the square video?

Certain movies have so many details that every time it is watched again, something new can be spotted. Examples of these are Pixar movies like Toy Story. Another thing these movies often include are jokes for several age groups. Usually, visual jokes are used for the younger audience, while the parents are entertained with written jokes.

Some useful practical tips for the ideation phase were to just sketch an idea before putting too much time into it and getting attached to it. When a sketch only cost 3 minutes of your time, it does not really matter if it's not good.

4.4 Preliminary Concepts

Below, the first four concepts that were developed are presented. From these, the best are chosen to be worked out further.

4.4.1 Interactive Video

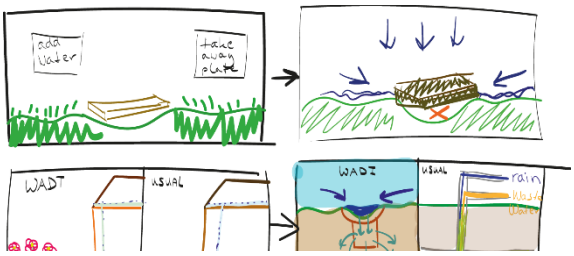

Figure 22. Interactive Video concept boards

The interactive video explains the functions of a WADI in a video where choices can be made by the user, see figure 22. In the top left frame two possible choices that can be made are visible: 'add water' or 'take away the plate'. When the choice is made to add water, the plate will still be there when the water is trying to flow to the WADI. Because of this plate, the water cannot reach the WADI and it cannot function properly. This is seen in the top right frame: the water cannot enter the WADI. However, when the choice is made to remove the plate first and then to add the water, the flow is not blocked, and the WADI is able to function like intended. The two bottom frames don't show buttons for interactivity, but rather show the difference between a WADI system and a regular sewer system.

4.4.2 Augmented Reality

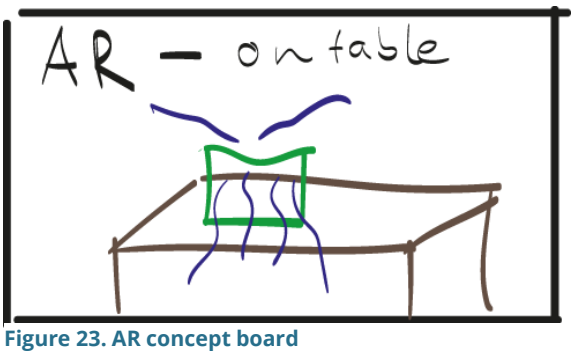

Figure 23. AR concept board

This concept uses Augmented Reality (AR) technology to display the function of the wadi, see figure 23. When pointing a smartphone at the table, a model of the WADI can be projected on the table using some anchor that is applied to the table. This can be a piece of paper with a certain sign on it that is recognised by the smartphone. Because the model is now set in a solid position

on the table, the user with the smartphone can move around the table and thus the WADI model. The user can also come closer to the table to have a more detailed look at the system. The model projected is 3D and shows an animation of the water flowing into the WADI and the way it is infiltrated into the ground.

4.4.3 WADI App

Figure 24. WADI app

This concept uses an app to make the residents knowledgeable about the WADI. The app uses services that forecast rainfall to notify the residents of a neighbourhood with a WADI when there will be rainfall, see figure 24. This is done to give the residents the opportunity to have a look at the WADI when 'in action' coping with the rain. Another function of this app is to make the residents check if the WADI is ready to process the rainwater in a good way. There could be litter in the WADI that can obstruct the flow of water to the WADI. This litter can then be removed before the rain will fall so there will be less chance of flooding.

4.4.4 WADI kids

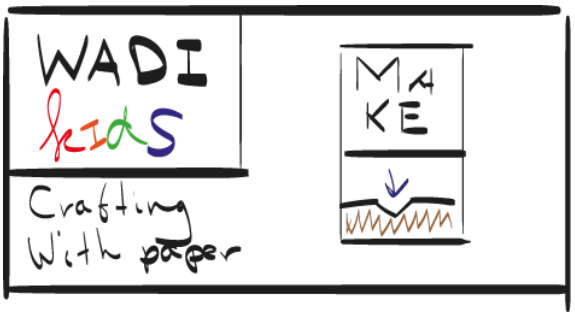

Figure 25. WADI kids

WADI kids wants to introduce children to the WADI. This is done by providing information and templates to craft a paper model of the WADI, see figure 25. This way, the children have fun messing around with the paper while learning about the water management of a WADI. While crafting, the parents might also get involved to help build the model. Even if the children manage to finish the model by themselves, they will show it to the parents when it's done. This way, the parents also get involved with the concept of the WADI which might raise interest in the function of the WADI.

4.5 Second concept phase

In consultation with the supervisors all concepts were presented. Two were chosen to be specified further, which results are shown below.

4.5.1 Interactive Video

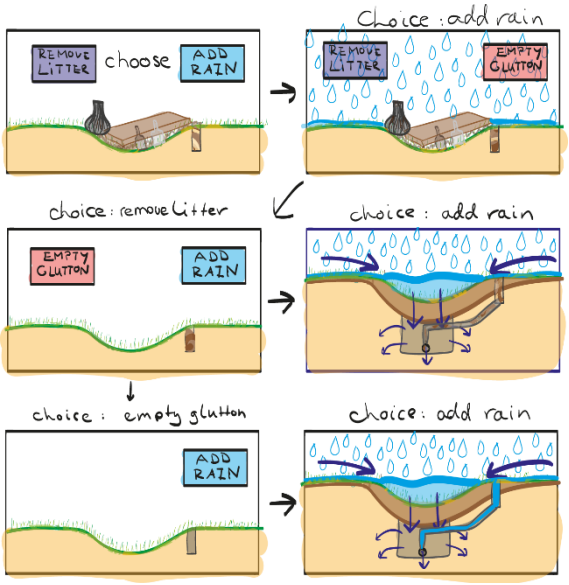

Figure 26. Interactive video storyboard

This is the second iteration of the interactive video. Like the first concept, the idea still is to let the users make choices and thus determine the course of the video. In making these choices, they can immediately see what the consequences of their choices are and find out if this was the best choice they could have made. By having to make these choices, the usually short attention span of users is coped with. This concept starts with the littered WADI on the top left of figure 26, with a filled and constipated spillway, to the right of the WADI. In this situation, two choices can be made: 'remove litter' or 'add rain'. By choosing to remove the litter, the WADI will be cleaned so no litter will be present in it anymore. The video proceeds to the middle left picture. Note that the spillway still is filled with dirt. However, when the other choice is made to add rain, there is a different situation as visible in the top right frame. Now the water will try to enter the WADI, but it is blocked by all the waste and dirt in the WADI. The result is that the water will not enter the WADI, which can cause flooding. This flooding is also shown in the video, together with the direct consequences it can have for the surrounding residents. From this situation the litter can also be removed which will allow the water to enter the wadi, see the middle right frame. The choice can also be made to instead empty the spillway. When proceeding, the WADI gets cleaner and the water can reach the WADI and use the spillway. This way, the users can see what effect litter and dirt has on the functioning of the WADI. In the end, the fully functioning WADI is shown including all parts that are very important, but not visible from the outside. By showing the functioning of the WADI and the effect of litter and dirt on the functioning, the idea is to make the residents look after the WADI more and to make them more understanding when necessary maintenance is carried out by others.

4.5.2 Augmented Reality (AR)

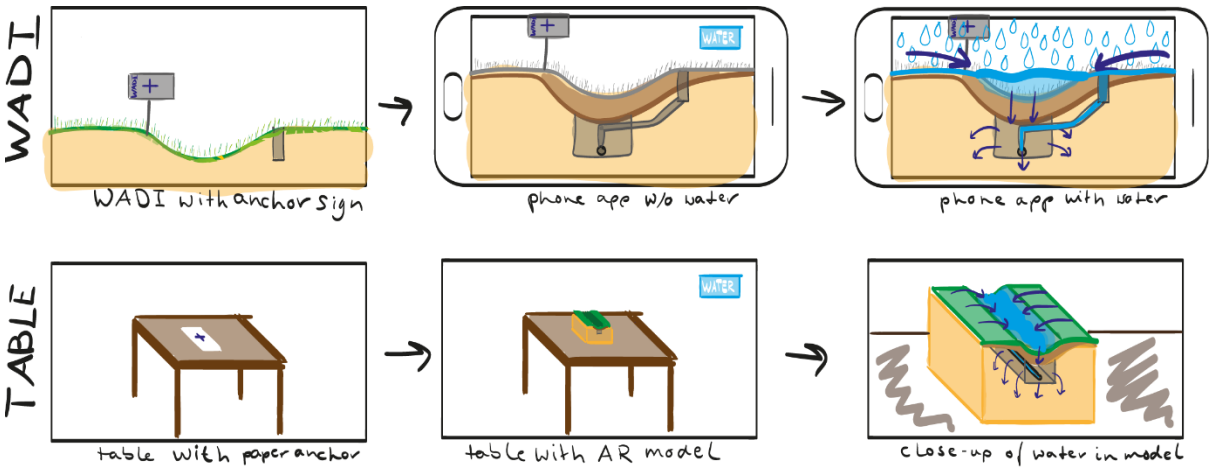

Figure 27. Augmented Reality (AR) application at location (top row) and on table (bottom row)

This is the second iteration of the Augmented Reality (AR) application. Here, it is worked out in two different versions: at location and on table. The two versions are quite similar but do have some important differences. Starting with the AR app at location, AR at the WADI. As visible in the top left frame in figure 27, there is a sign placed near the WADI that is used as an anchor. This is a reference point for the projection of the AR layer. In this situation, the WADI will be used as environment for the AR projection. When pointing the mobile device at the WADI, the reference point will be recognised and the underground components will be visible, see top middle frame. This way, the parts of the WADI installation that normally would be invisible are now viewable on the device. Now water can be added to see how the WADI works when coping with rain, see top right frame. This version of the AR app is very realistic because the projection shows only the components of the WADI that are invisible in real life because they are below the surface. Because this version only works at the location of the WADI, this solution is less versatile. When the weather is bad, nobody will go outside and learn about the WADI this way.

The second version of the AR application uses a table or other surface in or outside to project a 3D model of the WADI instead of a real WADI. In figure 27, a table is used as an example. In the bottom left frame, the table is visualised. On this table, a piece of paper with a figure is present. This figure is (like the first version) used as an anchor use a reference point for the projection. Using a mobile device, this anchor is recognised and projects a 3D model of the WADI on the table, see bottom middle frame. This 3D model is an intersection of the WADI which shows all components underneath the surface. Now water can be added, which result can be seen in the bottom right frame. This view can be achieved by simply moving closer to the table. The angle can also be changed by in a similar way, by approaching the table from a different point. By moving

around the table this way, different views of the WADI can be obtained. This can help with the better understanding of the function of the WADI. As said before, unlike the first version of the WADI, this concept can be used on most surfaces, inside and outside. This a large advantage over the AR app at location, although that version can be more realistic and immersive.

4.6 Project Focus

After the two concepts of last week were discussed with the supervisors and client, a choice was made for one concept that would suit the assignment best: the interactive video. After the first concept of this interactive video (see 4.4.1), a worked-out version of the storyboard was created. This is visible in figure 28. The story starts with a clean WADI, in the state it was constructed. Then a quick explanation of the function of the WADI is given while comparing it to a regular rainwater system. After this, the focus will shift to the clean WADI again, which will start to be polluted by both nature (leaves, dirt) and human (garbage, litter). When the WADI is polluted there are two choices: 'remove litter' or 'add rain'. When the first option is chosen, the litter is removed by an employee of the municipality and a clean WADI is shown. The second option add the rainwater, but because of the litter in the WADI, it cannot enter the WADI. The camera will pan to the right to show a house which might flood because of this. Returning to the littered WADI, two choices can be made: 'remove litter' and 'empty glutton'. The glutton also needs to be emptied for a properly functioning WADI. When water is added before the glutton is emptied, in heavy rainfall the WADI will still overflow and flooding might occur. When the option is chosen to empty the glutton, the municipality worker appears to vacuum the glutton. Eventually, when both the WADI and the glutton are emptied, the whole underlying structure of the WADI is shown in action with water flowing through it. Because the WADI has a different function in the winter than in summer, this is also visualized. In winter, the groundwater is higher and the WADI will transfer this water via the drainpipe to dryer areas or ponds nearby. This is shown by a rising groundwater level which shows that the level of the water will not get any higher than the drainpipe. When this pipe is not there, the consequences can also be visualized, with the groundwater level getting very high. To show the transport of the water, a 3D intersection of the WADI is used that shows the water in the drainpipe. The camera will then pan to the right showing the water in the drainpipe while there is no WADI above, and eventually debouch into a lake or pond. The focus will shift to the WADI again, zoom out and show the conclusions of the video on screen. After that, a combination of the residents and the municipality workers are shown in frame which communicates that together it is possible to get a clean WADI, when everyone does what he or she is supposed to do.

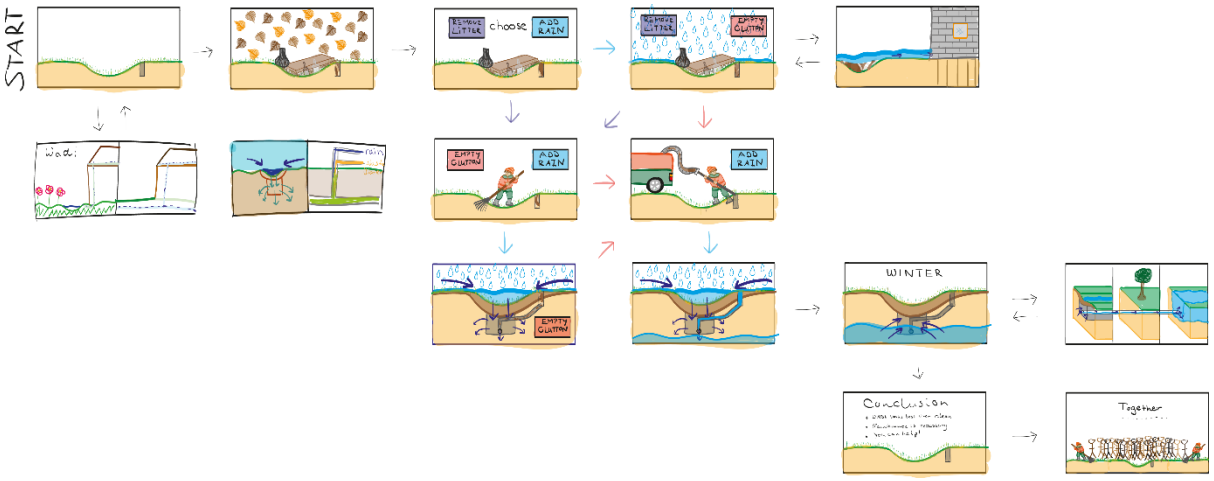

Figure 28. Worked out storyboard of interactive video

5. Specification

In the specification phase, the final concept that came out of the ideation phase is specified. This is done in several steps. Firstly, a scenario that describes the cognitive walkthrough of a possible user. Secondly, the storyline is presented per scene. Thirdly, the final storyboard is shown. Fourthly, the outcome of the lo-fi prototyping is visible. Fifthly, the script of the voice over in the animation is presented. Lastly, the final requirements are set, that are used in the realization phase.

5.1 Scenario

Imagine my client or one of his colleagues from the municipality gets a question from a resident about a WADI. A man named 'Ben' has a WADI in his neighbourhood and walks past it every day, but one day it is raining, and he sees the WADI is filling with water. Sometime later, when the weather has cleared again, the water is all gone. Ben wonders how it works and if there is some more information available. He likes talking to people, so he goes to the neighbours to ask if they know more about this WADI. They know the function but cannot tell how it works in detail. Ben decides to call the municipality with his question. The municipality will ask for Ben's email to send him a link or tell him to go to the website of the municipality or Groenblauw Enschede for more information. Here, a new video is also available which interactively shows people why the WADI's are there and how they work. Ben turns on his computer and opens his mail with the link or proceeds directly to the website. He finds the video and clicks on it to start it.

The video starts playing and opens with the helicopter view of a neighbourhood with a WADI. Ben might even recognise this neighbourhood as Ruwenbos. The video zooms in and shows the intersection view of the WADI. Ben recognizes the shape of the WADI, because he has seen some WADI's before. The camera pans downwards and the underground components of the WADI become visible. The voice over says that the WADI is a different rainwater management system than a regular system. Ben actually did not know how a regular rainwater system works, so this helps him to understand it. Now the video shows how a regular rainwater system works in comparison to the WADI. Then the WADI is shown again, and rainwater is added. It's clearly visible how the water runs from the roofs into the WADI, and infiltrates into the ground. The video tells that this is the ideal situation, but that in real life this is never the case. The intersection view of the WADI without its underground components is shown again, with two choices that can be made: 'Natural contamination' or 'Human contamination'. Ben clicks on Human contamination. He sees one of the residents mowing his own back yard and throwing the cut off grass in the WADI. He

also sees litter flying into the WADI by the wind. The WADI now is contaminated, caused by humans. Another choice has to be made now: 'Remove litter' or 'Add rain'. Ben thinks that a little rain won't be much of a problem and chooses to add the rain. The rain falls and flows towards the WADI. However, because of the litter in the WADI, the water cannot reach the bottom of the WADI. The WADI is sealed off by the litter, and the rainwater cannot penetrate it and will stay on top of it. Some more rain is falling, and the water is flowing out of the WADI towards the houses. Ben now realises what effect litter has on the WADI. He now has the choice to remove the litter. This is done by one of the residents, the person who earlier throwed his grass into the WADI. Ben realises that this is the responsibility of the him and his neighbours. The rain is falling again, and now the WADI is working properly because it is clean.

Now the video proceeds to the other choice that could have been made at the start: 'Nature contamination'. Here, Ben sees that the trees around the WADI will drop their leaves in Autumn, which end up in the WADI. Now he can choose to 'Remove leaves' or 'Add rain'. Ben has learned from the 'Human contamination' but is still curious if leaves maybe have a different effect on the functioning of the WADI than litter. Thus, again, he chooses 'Add rain'. The rain falls in the WADI that is filled with leaves, which also don't allow the water to reach the ground. Some more rain falls, and the WADI overflows water into the houses. Ben realises that leaves also have a negative effect on the proper functioning of the WADI. He now chooses to 'Remove leaves', which shows a municipality worker removing the leaves and cleaning the WADI. Ben realises that this is the responsibility of the municipality. Now 'Add rain' is chosen again, which shows the rainwater flowing into the WADI: the WADI works properly again, because of the removed leaves.

Now another function of the WADI is shown, the drain function. The intersection view of the WADI with its underground components is shown. It is winter, and the groundwater level is rising. At first, the drainpipe is not there, and the groundwater rises to a very high level. Now the drainpipe is placed, and the water will not go above this pipe. The view changes to a 3D view, which shows the drainpipe transporting the water to dryer areas and ponds. To explain the difference between the winter and summer situation, a graph is shown. On this graph the normal groundwater level is shown first: high in winter, low in summer. Now the graph of the situation with a WADI is shown. Ben now sees that the peaks in the graph are reduced: in winter the water will not get too high, and in summer it will not get too low.

The video returns to the intersection view of the WADI, now with some conclusions above it: that the WADI works best when clean, maintenance is necessary and that you can help! Ben realises he can contribute to a proper function of the WADI and will get dry feet in return. The final scene in the video shows a group of residents and municipality workers. All together, they can

make the WADI work as best as possible. As the group of people is very varied, Ben associates with them.

After watching the video, Ben knows why the WADI's are installed in his neighbourhood and how they work. He knows that the WADI needs to be maintained well to function properly. The next time the municipality workers are cleaning the WADI and might cause some nuisance, he knows it's for a good cause. Ben feels involved with the WADI and realizes he can do something and make a difference. Next time he sees some litter in the WADI, he will take it out and throw it in the bin. Next time the neighbour throws his garden litter into the WADI, Ben will kindly confront the neighbour and tell about how this action harms the functioning of the WADI. Ben might even refer to the video, so the neighbour can find out how the WADI works and what consequences his actions have himself.

5.2 Storyline

The video treats different aspects of the WADI. These are divided into 5 scenes, which are explained below.

5.2.1 Scene 1: Helicopter view of neighbourhood with WADI

In the first scene a map of a neighbourhood with a WADI in it is shown. Now the camera will zoom in, and eventually show the intersection view of the WADI in that neighbourhood.

5.2.2 Scene 2: WADI explanation

Where in the first scene the intersection of the WADI was visualised, now also the components that are not visible from the outside are shown. One by one, the underground components are shown. First, the working of a regular rainwater drainage is shown. Then, the alternative to this system is shown: the WADI. Rain will fall and flow from the roofs through the pipes and streets to the WADI. The WADI will then be filled with rain and slowly the water will infiltrate into the ground. Also, the groundwater level is shown, which rises with the rain infiltrating.

5.2.3 Scene 3: WADI contamination

The focus will return to the clean WADI that was shown before. The voice over will tell that the WADI works best when clean and well maintained, but that a clean WADI is not self-evident. Now a choice can be made what to view: Human contamination or Nature contamination.

5.2.3.1 Scene 3a: Human contamination

The camera will zoom out and show residents. One is mowing the grass in his backyard, and thinks the WADI is a great place to dump his cut off grass. On the other side of the frame, the wind carries rubbish and litter like aluminium cans, plastics bags and plastic bottles. Now the choice can be made to remove the litter from the WADI or add rain to the WADI. When the option to remove the litter is chosen, the same resident is shown removing the litter. When the option to add rain is chosen, the water is flowing towards the WADI, but is stopped by the litter that is present in the WADI. Now the WADI does not function properly, and the camera pans to the side to view houses that will flood. When first the option is chosen to remove the litter, now the rain can be added which will have no problem reaching the WADI now. When first the option is chosen to add rain, now the litter can be removed, and the water will be able to flow into the wadi properly. Now the fully working wadi is shown, and the situation with nature contamination will be shown.

5.2.3.2 Scene 3b: Nature contamination

The camera will zoom out to show trees around the WADI. These will first be fresh and green but will then turn brown as autumn starts. The leaves will start falling and will end up in the WADI. Now the choice can be made to remove the leaves from the WADI or add rain to the WADI. When the option to remove the leaves is chosen, a municipality worker is shown removing the leaves; performing maintenance. When the option to add rain is chosen, the water is flowing towards the WADI, but is stopped by the leaves that are present in the WADI. Now the WADI does not function properly, and the camera pans to the side to view houses that will flood. When first the option is chosen to remove the leaves, now the rain can be added which will have no problem reaching the WADI. When first the option is chosen to add rain, now the leaves can be removed, and the water will be able to flow into the wadi properly. Now the fully working wadi is shown, and the situation with human contamination will be shown.

5.2.4 Scene 4: Summer vs. Winter

As the function of a WADI is different in summer than in winter, this is visualised. It starts with a scene where the groundwater level rises, which happens in winter. Now the drainpipe is visualised, which stops the groundwater from rising. The view then changes to a 3D model, where first a view of the WADI is visible with the groundwater in the drainpipe. Now the camera pans to the right to show that the drainpipe will run underground towards other areas with a lower groundwater level, and to ponds nearby. To visualise both the summer and winter functions of the WADI, briefly a graph is shown. Firstly, this will show the normal fluctuation of the groundwater level in summer and winter. Now the graph of the situation with a WADI is shown, which cuts off the extreme groundwater levels. The camera returns to the view of the drainpipe.

5.2.5 Scene 5: Conclusion

Now a conclusion is drawn. The intersection view of the WADI is shown again, with some concluding statements above it like: WADI works best when clean, maintenance is necessary, and you can help! The camera now zooms out and a group of residents and municipality workers is shown. The text will be shown and said that together we can make it work.

5.3 Storyboard

After several iterations of the concept, a final storyboard was made. This version of the storyboard is used as the basis for the realization of the animation. The frames pictured in the storyboard will not directly be copied to the final animation, but the artwork in the final animation will be heavily based on these images. See figure 29 for the storyboard. A larger version of this storyboard can be found in appendix A.

Figure 29. Final storyboard

5.4 Visual communication expert interview

Earlier on, in the ideation phase, the interview with the visual communication expert was extremely helpful, so the decision was made to talk to him again. As the process developed further, now the focus was on the storyboard, see figure 29.

In the storyboard, characters were used to represent the resident and the municipality worker. These characters, however, are not drawn in the same style. This harms the consistency of the animation and should be altered in the final video. Naturally, the different characters should be looking differently to be able to tell them apart, but this can be done using clothing or accessories like caps.

The use of colours is also something to think about thoroughly. In the case of the municipality workers, the colours of the clothing should look like the colours of the real workers to make the character recognisable. The clothing colours of the resident are not predetermined and should be casual. However, one should still be careful with the colours of particular clothing items. In the storyboard the resident is wearing a red cap; e.g. in the Netherlands this might not be associated to anything or anyone. In the United States, however, a red cap is associated with the red 'Make America Great Again' caps that are worn by Trump supporters. The same goes for skin colour. One should be really careful with the skin colour choice of the residents and the workers. The user should in no possible way be able to mark certain aspects as racist. This can be avoided by using a wide variety of characters, and not make the worker have a certain different skin colour than the residents. A whole different, but still colour related aspect, is the use of desaturated or bluish colours to show depth. These colours can do a good job in showing that objects are further away than others, when used on purpose. However, when this is not done on purpose, it might still trigger this effect and the image might become unclear.

When talking about the style of the video, the sketchy drawing style that is used in the storyboard was discussed. There was some doubt about this style from my side, but the expert had some interesting things to say about this. He said that human is not perfect, so the style of the video also does not have to be. When using such a style, it may evoke sympathy. When a very conventional and formal drawing style is used, people might not feel the same way.

Lastly, the focus is on the different views used in the video. In the storyboard, 3 different views are used: helicopter, ¾ and intersection. The helicopter view is used at the start, the ¾ view is used to visualise the water transport and the intersection view is used in all scenes where the WADI is visualised. The view used should really add to the clarity of the scene. The transitions between the different scenes and views should also be fluent, to prevent confusion.

5.5 Lo-fi prototype

Based on the storyboard, a first lo-fi prototype was developed, see figure 30. This is a moving animation of the second scene of the animation. Firstly, an empty WADI is shown, see left frame. Then the camera will move downwards, and the underground components become visible one by one, see middle frame. Now the rain starts to fall and flows into the WADI. After the WADI is filled, the rainwater infiltrates into the ground. When the rainwater level is very high, the spillway will also be filled. This is visible in the right frame of figure 30.

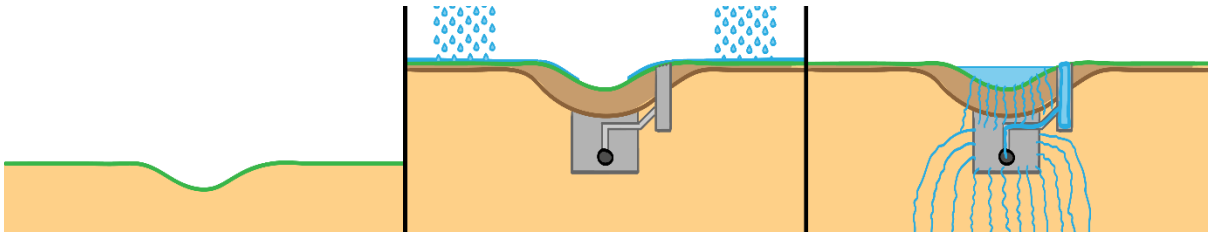

Figure 30. Low fidelity prototype snapshots

5.6 Animation Script

The script for the animation can be found below, per scene. The arrows at the end of each part of the script indicate the possible choices that can be made in the (interactive) video. As the video will have a Dutch voice over, the script also is in Dutch. The English version of the script is available in Appendix A.

Scene	Choice	Script
1		In steeds meer wijken in Nederland worden WADI's aangelegd. Maar wat is een WADI eigenlijk, en hoe werkt het?
2		Op het eerste oog lijkt een WADI een verlaging in het gras, waar verder niks bijzonders mee aan de hand is. Maar niets is minder waar. Als we onder de grond kijken zien we dat een WADI een heel uitgekiend systeem heeft. Een WADI bestaat namelijk uit verschillende onderdelen. Gelijk onder het gras ligt een speciale zandlaag. Hieronder zit een bak die is gevuld met korrels van klei. In deze bak ligt een drainagebuis. Aan de rechterkant van de WADI zit een overloop. Deze is met buizen verbonden met de drainagebuis. Normaal gesproken loopt het water vanaf de straten en daken in de riolering. Hier komt ook het afvalwater erbij, terwijl regenwater eigenlijk heel schoon

		water is! In een wijk met een WADI loopt het water vanaf de straten en daken niet in het riool, maar in de WADI. Deze wordt gevuld met regenwater en fungeert als een buffer. Vanaf hier loopt het water de grond in. Als er nog meer regen valt stijgt het waterniveau in de WADI en komt de overloop in actie. De overloop brengt het water direct naar de drainage buis onder de WADI. Hierdoor wordt de infiltratie in de bodem versnelt. Als de overloop het ook niet aankan, is er nog een noodoverloop. Zo werkt een WADI in de ideale wereld. Helaas is de wereld niet ideaal, en heeft de WADI soms last van vervuiling. Maak nu een keuze om te zien hoe vervuiling door toedoen van de mens of natuur werkt. → **3a** (menselijk) → **3b** (natuurlijk)
3a		Zoals eerder gezegd, werkt een WADI prima in de ideale wereld, maar een WADI ligt meestal in een wijk ligt waar gewoon wordt geleefd. Bijvoorbeeld door Henk. Hij heeft net zijn tuin gemaaid, en die container staat net iets te ver weg. Henk ontdekt een verlaging in het gras en besluit z'n vers gemaaide gras daar maar in te gooien. Kan geen kwaad, toch? Zwerfafval komt helaas ook veel voor. Dit wordt door de wind meegenomen en belandt in de WADI. In de loop van de tijd vult de WADI zich met vuil. Maak nu een keuze om het vuil te verwijderen, of om regen te laten vallen. → LITTER → RAIN
	LITTER	Het zwerfafval wordt verwijderd uit de WADI. Laten we nu het water toevoegen aan de WADI. → CLEAN
	RAIN	Doordat het vuil een laag vormt in de WADI blokkeert het de regen en kan het water niet goed de grond in stromen. Bij hevige regen kan het water zo niet goed weglopen, en kan het zelfs de huizen inlopen. Misschien moeten we toch eerst maar het vuil verwijderen? Laten we dat nu doen. → LITTER
	CLEAN	Nu de WADI weer schoon is, kan het water weer goed de grond in lopen. Laten we nu kijken hoe vervuiling door toedoen van de natuur werkt. Of ga door naar het volgende deel van de video.

		→ **3b** → **4**
3b		Vaak staan er bomen rondom een WADI. In de herfst laten de bomen hun blad vallen, wat in de WADI terecht kan komen. Op den duur kan er zich in de WADI een flinke laag bladeren ophopen. Maak nu een keuze om het blad te verwijderen, of om regen te laten vallen. → LEAVES → RAIN
	LEAVES	De gemeente komt om de bladeren uit de WADI te halen, maar ook om het gras te maaien, de overlopen leeg te zuigen en de drainage schoon te spuiten. Laten we nu het water toevoegen aan de WADI. → CLEAN
	RAIN	Doordat het blad een laag vormt in de WADI blokkeert het de regen en kan het water niet goed de grond in stromen. Bij hevige regen kan het water zo niet goed weglopen, en kan het zelfs de huizen inlopen. Misschien moeten we toch eerst het blad verwijderen? Laten we dat nu doen. → LEAVES
	CLEAN	Nu de WADI weer schoon is, kan het water weer goed de grond in lopen. Laten we nu kijken hoe vervuiling door toedoen van de mens werkt. Of ga door naar het volgende deel van de video. → **3a** → **4**
4		Naast de bufferfunctie, heeft de WADI ook een drainage functie. In de winter is het grondwater heel hoog. Zonder WADI zou het grondwater zodanig hoog kunnen komen, dat mensen natte voeten krijgen of muren gaan beschimmelen. Gelukkig zorgt de WADI ervoor dat het grondwaterniveau niet hoger wordt dan de drainage buis. Deze brengt het water dan naar drogere gebieden of vijvers in de buurt. Dit is een grafiek van het niveau van het grondwater in een normale situatie. In de winter is het hoog en in de zomer juist laag. Een WADI zorgt ervoor dat het niveau in de winter niet te hoog wordt, maar in de zomer ook niet te laag wordt. Hierdoor voorkomt het natte voeten in de winter, en droogte in de zomer.

5		Conclusie: een WADI werkt het beste wanneer deze schoon is, onderhoud is noodzakelijk en jij kan helpen, door de WADI schoon te houden. Samen zorgen we voor een goed functionerende WADI.

5.7 Final requirements

Requirement	**Must**	**Should**	**Could**	**Won't**
Animation	X			
Easily viewable by residents	X			
Easily showable on information evenings	X			
Inform residents about the buffer function of WADI's	X			
Teach residents how to look after WADI's	X			
Voice over in Dutch	X			
Subtitles in English	X			
Show what the effects are of a contaminated WADI	X			
Show that the municipality is responsible for the clean-up of natural contamination (leaves, etc.)	X			
Show that the residents are responsible for the clean-up of human contamination (litter, etc.)	X			
Use of brown coloured water for sewerage	X			
Inform residents about the drain function of WADI's		X		
Interactive video		X		
Show the benefits of a WADI to residents		X		
Use sound effects for immersion		X		
Avoid discrimination		X		
Subtitles in Dutch			X	
Use suiting music			X	
Entertain			X	
Use realistic animations			X	
Explain the function to employees of housing corporations, municipalities, etc.			X	

6. Realisation

In the realisation phase, the (interactive) animation is made. To produce the animation, a few tools are used, which will be described. Also, the process of producing the animation is explained.

6.1 Tools

Several different tools are used in the making of the animation. These are divided in video and audio.

6.1.1 Video

6.1.1.1 Adobe Illustrator

To make all the artwork that is later used in the animation, Adobe Illustrator (2019) is used [30]. This software is chosen because it is the benchmark in its class and works great with other Adobe software like After Effects [31] and Premiere Pro [32]. All the drawings are made using a pen tablet that is connected to the computer.

6.1.1.2 Pen Tablet

To draw all the artwork in Illustrator, a Wacom Intuos S was used [33]. This is a small drawing tablet that uses a pen. The movements made with the pen on the tablet are not directly visible on the tablet itself because it does not have a screen but are visible on the monitor of the computer the tablet is connected to. Using this tablet, the artwork that can be made is digital, but still looks drawn by hand. This also is the desired look of the animation.

6.1.1.3 Adobe After Effects

To animate all the drawings made in Illustrator [30], Adobe After Effects is used. The drawings are prepared in Illustrator [30] and are then imported into After Effects [31]. Here, all the separate parts of the drawings are animated to make the final animation. Apart from the Illustrator [30] drawings, also built in effects from After Effects [31] are used like the falling rain.

6.1.1.4 Adobe Premiere Pro

To combine the different scenes made in After Effects [31], Premiere Pro [32] is used. Here, all the After Effects [31] files are imported, put in the right order and rendered.

6.1.1.5 YouTube

To make the animation interactive, YouTube [34] is used. This video platform offers to redirect to other videos at the end of a video, see figure 31. When this option is chosen, the thumbnail of the two videos are visible for the last 20 seconds of the video. Then, a choice can be made between these two videos by clicking on one of them. This works on your computer's internet browser, on smartphones and even on smart tv's. This click directly links to the chosen video which starts playing. As the first video is in a playlist together with all other option videos, the next video will also automatically start playing if no choice is made.

Figure 31. Smartphone screenshot of the first choice moment.

6.1.2 Audio

6.1.2.1 Voice Recorder

To record the voice over, the Olympus LS-11 [35] is used. This voice recorder is put on a small tripod, facing the voice over's mouth. To dampen the echoes, a beach towel was put over the voice over's head. This resulted in crisp audio.

6.1.2.2 Zapsplat

Next to the voice over, sound effects are used. These are obtained from Zapsplat [36]. This site offers free sound effects, as long as the website is mentioned in the project. E.g. when the video is uploaded to YouTube, the credits should be added to the video description. Sound effects are used for the sound of falling rain, flowing water, ambient noise, etc.

6.1.2.3 Premiere Pro

Next to the editing and rendering of the video, the audio was also edited using Premiere Pro [32]. Here, the voice over and audio effects are mixed, added to the video and exported together.

6.2 Interactive Animation

6.2.1 Illustrations

The final storyboard and lo-fi prototype are used as a basis for the illustrations that are used in the final animation. To make the animation more realistic, a technical drawing of a WADI supplied by the client was used. The final shape of the WADI and its underground components is based on this drawing. All the illustrations are drawn with the pen tablet, which results in a unique handmade look. This was first used for the storyboard, but later the decision was made to continue with this style for the final illustrations to be used in the animation. The reason of this decision is that this style may evoke sympathy, in contrast to formal drawing styles that only use straight even lines. This style also includes the colouring of the illustrations: the outside edges (stroke) of the objects are fully saturated, while the inside colouring (fill) of the objects is less saturated. This theme is applied to all objects to achieve unity, see figure 32.

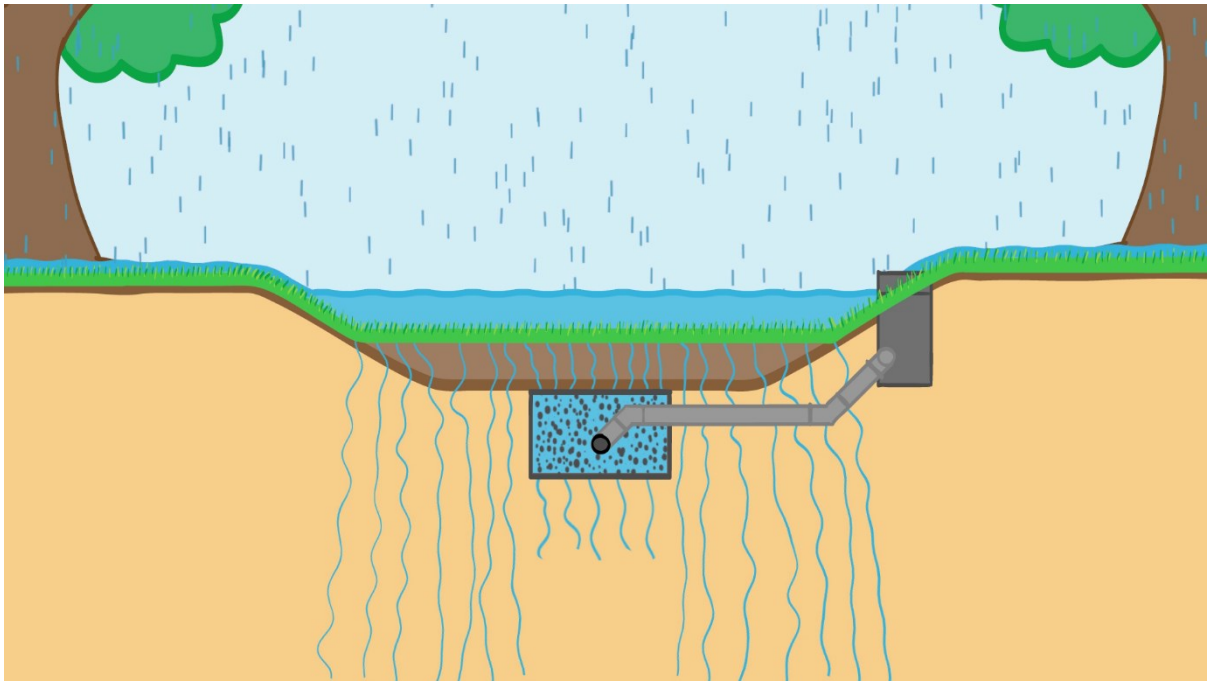

Figure 32. Snapshot of animation showing colour scheme

All illustrations are made in Adobe Illustrator [30] which are then imported into After Effects [31]. When an issue was found animating the illustrations in After Effects [31], the problem could directly be fixed in Illustrator [30] after which the illustration is updated in After Effects [31] and the animation work could be resumed. This is possible because many Adobe programs are very well integrated.

6.2.2 Animations

After all the illustrations were made in Illustrator [30], these were animated in After Effects [31]. Some of the elements of the illustration are always visible in the animation, like the sand and grass. Other elements are made to move and (dis)appear. E.g. when the house is not relevant in a certain scene, it is not shown. This choice was not made for all irrelevant objects, as the removal of the trees would result in an uninteresting plain field. The water is animated so it would flow in a certain direction by not only revealing the water, but also adding a wave effect to it so it looks like it is really flowing, see figure 33.

Figure 33. Snapshot showing water flowing into the WADI from left and right.

The transitions between the scenes was made by panning the camera upwards at the end of each scene and downwards at the start of the next scene. This smooth transition is possible because the background colour of each scene is the same light blue colour. By having a clear blue background at the end of each scene, the options that can be chosen are also very clear and there is no distraction caused by other elements. When there is no option to be chosen, this still ensures a clear but smooth cut between different scenes.

6.2.3 Audio

Apart from the illustrations that are made into animations, the story is also clarified using a voice over. The voice over is in Dutch. The script of the voice over can be found in chapter 5 in Dutch and Appendix A in English. To make the animation even clearer, use was made of sound effects for several elements. Examples of these are: the sound of rain, water flowing in a pipe, water flowing out of the pipe, water in the sewerage, draining water, wind, and raking leaves. When none of these sounds are applied, an ambient noise can be heard. This consists of white noise with the sound of birds and bees.

7. Evaluation

In the evaluation phase, the interactive animation was evaluated with the client and another water designer from the municipality of Enschede, Koen Wagelaar. Also, the requirements are ranked on whether they have been met or not, also see section 3.4.

7.1 Evaluation Session Setup

In this session, the idea was to watch the interactive animation with the client and together make the choices, so everyone saw the same scenes at the same time. The platform that was used for this session was BigBlueButton, the web conference application within Canvas. This, however, did not work properly with how the video was developed in YouTube. The presenter could make a choice at the end of the video and the chosen video would play for this person, but for all other people present the first scene would start over again instead. The choice was then made to give everyone 10 minutes to watch the whole animation where all could make their own choices and explore the animation by themselves. After these 10 minutes, general feedback was asked.

7.2 General Feedback

As much feedback as possible was asked, so the animation could be improved in the best possible way. Starting with the positive feedback, then points that need to be improved. Some of these points already have been improved for the final version. Other, larger, feedback points still need to be looked into and are for future work, see chapter 9.

7.2.1 Positive Feedback

1. Information in the video is very nice
2. Beautifully designed
3. Fun to watch
4. Understandable and easily visualised
5. Clear consideration that the two functions are presented separately, so people do not get all the information at once.

7.2.2 To Be Improved

1. Proportions not realistic, the WADI almost looks like sea.
2. “Menselijke vervuiling” (human pollution) is weird phrasing.
3. Too dramatic that the houses are flooded because of some leaves.
4. Comes across as pedantic: if you don’t maintain the WADI, your house will flood.
5. The municipality should remove the leaves, so when people see that there is a leaf in the WADI, they might call the municipality because their house might be flooded by tomorrow. It can have a disadvantageous effect: the municipality is being kept too sharp.
6. The groundwater is visualised that it will run into the houses when extremely high, where in reality only the walls of the house get damp at most.
7. The horizontal water streams out of the box under the WADI should only appear after the spillway is also filled, not already when the water is entering the box and draining from the box.
8. Choices should be removed when there is only one option.

7.2.3 Processed Feedback

1. “Menselijke vervuiling” (human pollution) and “natuurlijke vervuiling” (natural pollution) is changed to “vervuiling door toedoen van de mens” (pollution by man) and “vervuiling door toedoen van de natuur” (pollution by nature), respectively.
2. Groundwater running into houses is changed to groundwater touching the walls of the house and causing mouldy walls.
3. Horizontal water streams directly showing after the box is filled is changed to only showing after the spillway is filled and water is transported to the drainpipe.
4. Possible choices when there is only one option is changed to only showing choices when there is more than one option. Where these choices were, now there is just a small pause.

7.3 Requirements Evaluation

The final list of requirements is available below, rated on whether they have been met or not: green when met, yellow when partially met and red when not met. Where necessary, argumentation is provided in black, italic text below the corresponding requirement.

Requirement	Must	Should	Could	Won't
Animation	X			
Easily viewable by residents *As the animation uses YouTube as a platform, the video can be viewed online via the link that can be sent via e-mail or placed online. The video can also easily be embedded on websites like Groenblauw Enschede.*	X			
Easily showable on information evenings *The animation can be shown on a large screen or beamer at information meetings, where the choices can be made collectively, and one person controls the animation.*	X			
Inform residents about the buffer function of WADI's	X			
Teach residents how to look after WADI's	X			
Voice over in Dutch	X			
Subtitles in English	X			
Show what the effects are of a contaminated WADI	X			
Show that the municipality is responsible for the clean-up of natural contamination (leaves, etc.)	X			
Show that the residents are responsible for the clean-up of human contamination (litter, etc.)	X			
Use of brown coloured water for sewerage	X			
Inform residents about the drain function of WADI's		X		
Interactive video		X		
Show the benefits of a WADI to residents		X		
Use sound effects for immersion		X		
Avoid discrimination *This is done by showing people of different gender, age and skin colour at the end of the video after the conclusion is drawn.*		X		
Subtitles in Dutch *These are not realised yet but are very easy to implement as the voice-over text is already in Dutch. There is an automatically generated version available in YouTube, but this one is not flawless.*			X	
Use suiting music *As the choice was made to use ambient noise when there were no other sound effects, there was no need for music. This would only be confusing and distracting.*			X	
Entertain *The atmosphere of the video is joyful, and the animations and sound effects are not formal. There also is an 'Easter egg' in the form of the painting in the house.*			X	
Use realistic animations			X	

Most animations are fairly realistic, like the water flowing from the roofs into the WADI. The animations, however, are not physically realistic, as the water does not accelerate when falling from the roof through the rain pipe, and the walking animation is not physically accurate. This, however, does not really matter, because of the cartoony style of the animation.				
Explain the function to employees of housing corporations, municipalities, etc. *The animation explains the buffer and drain function of the WADI, but not in detail. To properly do this, a different, more technical, version of the video should be developed. Also see future work.*			X	

7.4 Conclusion

In this chapter, the interactive animation was evaluated with the client and Koen Wagelaar, another water designer from the municipality. Their general feedback was asked, and the requirements that were set in section 5.7 were ranked. This showed that there was room for improvement and not all requirements have been fully met, which leaves room for further work. Some of the feedback points already have been processed in a second, final version of the animation. Overall, the Municipality of Enschede was very pleased with the realized animation. They would like to develop the animation further towards a final product which they can use for their information provision about WADI's.

8. Conclusion

This chapter will give a conclusion on whether the goals of the project have been achieved and the research questions stated in section 1.3 can be answered.

8.1 Conclusion

The municipality of Enschede suggested to develop an animation that explains how a WADI works. The municipality gets a lot of questions about the WADI's. Currently, the municipality only has a website with written information and some images. This form might not be attractive or informative enough to all residents. Apart from informing residents about the function of the WADI's and how they exactly work, the goal was also to involve the residents and make them look after the WADI's. Based on the context and challenge, the following research questions were stated:

RQ: How to develop an animation that communicates the relevance of a WADI to a neighbourhood?

Sub RQ1: Why are WADI's installed in the neighbourhood?

Sub RQ2: How does a WADI work?

Sub RQ3: How to make the neighbourhood look after the WADI's?

Commissioned by the Municipality of Enschede and together with the Municipality of Enschede, the interactive animation was developed. With this design, the inhabitants are informed about the function of the WADI, the reason of installation of WADI's and motivated to look after the WADI's.

The inhabitants should take care of the WADI because this can prevent flooding. In the interactive animation, after the general function of the WADI is explained, the choice can be made to explore pollution by man or nature. When the choice is then made to find out more about pollution by man, firstly the problem is explained and shown. Then, based on the chosen option, either the effect of this pollution is shown or immediately the solution is explained. If first the effect of the pollution by man is viewed, then directly afterwards the solution to this problem is explained. By presenting the elements like this, the residents not only know about the problem and its possible consequences, but also how to act on it to prevent it from happening in the first place. This is also important according to Hines et al: next to having the knowledge, it is of great importance to know what to do and translate this knowledge to action [11].

To make the residents look after the WADI and create ownership, a few things are done. Firstly, the drainage function of the WADI is explained, where the resident can see how the water runs from the roofs and streets into the WADI. It also shows how the water is buffered and infiltrated by the WADI. Secondly, the effects are shown of a polluted WADI and what needs to be done to solve problems caused by pollution. Thirdly, the drainage function of the WADI is explained by showing the ground water levels directly in the animation, but also in the graph. Lastly, the conclusion is drawn and the voice over tells that together we ensure a well-functioning WADI. This is said while the animation shows all the residents working together. All these elements together aim to make the residents look after the WADI and create ownership. Whether this is successful, still needs to be tested.

The client was very happy with the animation: “The information is super cool and beautifully designed. Very nice.” He also said that it is fun, understandable and visualized in a simple way, that’s great. He appreciated the fact that some of the feedback that came up in the evaluation session could already be processed before the end of the project and said that the right tone and message was picked up. The client concluded: “It is very nice, I’m very happy now with the last few things: this is how the WADI works and I think everybody can notice know. It spares me a lot of talking.”

The choice to make the animation interactive was made to keep the users attention to the video by interacting with the video. Normally, people have a fairly short attention span, and the interactive animation copes with this by actively asking the user to make choices after which a new attention span is started. By having to make multiple choices, the attention of the users is kept to the video.

9. Future Work

In this chapter, recommendations are made for future work. Most of these are mentioned during the evaluation session but could not be realised yet.

9.1 Further Development

The Municipality of Enschede was very happy with the result of the project and would like to continue to make the final prototype into a product that can be used for their information provision about WADI's. From the evaluation session, a few feedback points came up that still need to be processed.

As mentioned before, one of the goals of the project was to make an animation that makes the neighbourhood look after the WADI and creates ownership. Whether this is successful, still needs to be tested. This can be evaluated by doing research about the level of ownership and knowledge before the residents have watched the video, and after. When there is a significant difference, it can be said that the creation of ownership and knowledge is successful.

Apart from the ownership, more things need to be tested. One of these is the balance between reality and clarity. One of the feedback points was that the WADI almost looked like a sea, and the proportions were not realistic. Although the final drawings used in the animation are based on technical drawings provided by the client, these are altered slightly for the sake of clearness. In the animation, the WADI is less wide than on the technical drawing which results in a relatively deeper WADI. When the drawing of the WADI would have been technically correct, the water in the WADI would have been less visible. Also, the difference between the water level with and without use of the spillway would almost be invisible. It needs to be tested whether the animation can be altered to be more realistic while still being clear and getting the message across.

Another aspect that needs to be tested is the pace of the video. This should not be too fast to clearly get the message across, but also should not be too slow because then the users might lose their attention.

The final aspect that needs to be tested is the tone of the video. The current tone in the video might come across as pedantic. This might cause resistance and thus the opposite of the desired effect. The tone of the video should be less harsh but can still be a little provocative.

Another wish from the municipality is to make a version for professionals. The current version is targeted to the inhabitants of Enschede and does not dive deeply into the technical details of a WADI. The version for professionals would be made for municipalities, contractors and other people who have to work with WADI's.

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Appendices

A: English Script

Scene	Choice	Script
1		WADIs are being built in more and more neighbourhoods in the Netherlands. But what exactly is a WADI, and how does it work?
2		At first glance, a WADI seems to be a drop in the grass, with nothing else going on. But nothing is less true. If we look underground, we see that a WADI has a very sophisticated system. A WADI namely consists of several parts. There is a special sand layer directly under the grass. Below is a container filled with clay granules. In this box, a drainage pipe is located. To the right of the WADI is a spillway. This is connected to the drainage pipe with tubes. Normally, the water flows from the streets and roofs into the sewage system. Here also the wastewater is added, while rainwater is actually very clean water! In a neighbourhood with a WADI, the water runs from the streets and roofs not into the sewer, but into the WADI. This is filled with rainwater and acts as a buffer. From here the water infiltrates into the ground. If more rain falls, the water level in the WADI rises and the spillway comes into action. The spillway brings the water directly to the drainage pipe under the WADI. This accelerates the infiltration into the soil. If the overflow can't handle it either, there's another emergency spillway. This is how a WADI works in the ideal world. Unfortunately, the world is not ideal, and the WADI sometimes suffers from pollution. Make a choice now to see how pollution by man or nature works. → **3a** (human) → **3b** (nature)
3a		As mentioned earlier, a WADI works great in the ideal world, but a WADI is usually located in a neighbourhood where people simply live. Henk, for example. He just mowed his yard, and that container is just a little too far away. Henk discovers a drop in the grass and decides to throw in his freshly cut grass. Can't hurt, right?

		Litter is unfortunately also common. This is taken by the wind and ends up in the WADI. Over time, the WADI fills with litter. Now make a choice to remove the dirt or to drop rain. → LITTER → RAIN
	LITTER	The litter is removed from the WADI. Now let's add the water to the WADI. → CLEAN
	RAIN	Because the litter forms a layer in the WADI, it blocks the rain and the water cannot flow properly into the ground. During heavy rain, the water cannot drain properly, and can even enter the houses. Maybe we should remove the dirt first? Let's do that now. → LITTER
	CLEAN	Now that the WADI is clean again, the water can drain into the ground. Now let's see how pollution by nature works. Or continue to the next part of the video. → **3b** → **4**
3b		There are often trees around a WADI. In autumn, the trees drop their leaves, which can end up in the WADI. Eventually, a large layer of leaves can accumulate in the WADI. Now make a choice to remove the leaves, or to drop rain. → LEAVES →RAIN
	LEAVES	The municipality comes to take the leaves out of the WADI, but also to cut the grass, to empty the overflows and to hose down the drainage. Now let's add the water to the WADI. → CLEAN
	RAIN	Because the leaves form a layer in the WADI, it blocks the rain and the water cannot flow properly into the ground. During heavy rain, the water cannot drain properly, and can even enter the houses. Maybe we should remove the leaves first? Let's do that now. → LEAVES

	CLEAN	Now that the WADI is clean again, the water can drain into the ground. Now let's see how pollution by man works. Or continue to the next part of the video. → **3a** → **4**
4		In addition to the buffer function, the WADI also has a drainage function. In winter, the groundwater is very high. Without a WADI, the groundwater could rise to such an extent that people will get wet feet or mouldy walls. Fortunately, the WADI ensures that the groundwater level does not rise above the drainage pipe. This then takes the water to drier areas or ponds nearby. This is a graph of the groundwater level in a normal situation. It is high in winter and low in summer. A WADI ensures that the level does not get too high in winter, but also not too low in summer. This prevents wet feet in winter and drought in summer.
5		Conclusion: A WADI works best when it is clean, maintenance is necessary, and you can help by keeping the WADI clean. Together we ensure a well-functioning WADI.