# Environmental Capacity in Industrial Clusters project - Phase 3

## Phase 3 Annex 6 HyNet - Overview of stakeholders, method and responses

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# Acronyms

| | |
|---|---|
| BAT | Best Available Technology |
| CAMS | Abstraction licensing strategies (CAMS process) |
| CCGT | Combined Cycle Gas Turbine |
| CHP | Combined Heat and Power |
| CWAC | Cheshire West and Chester |
| DESNZ | Department for Energy Security and Net Zero |
| DWF | Dry Weather Flow |
| DWMP | Drainage and Wastewater Management Plan |
| EA | Environmental Agency |
| EDI | Electrodeionization is an effective means of polishing reverse osmosis (RO) permeate. |
| EFW | Energy from Waste |
| ERF | Energy Recovery Facility |
| FEED | Front End Engineering Design |
| HPP | Hydrogen production plant |
| HRA | Habitat Regulations Assessment |
| HZI | Hitachi Zosen Inova |
| JEP | Joint Environmental Programme |
| MEA solvent | Monoethanolamine solvent |
| N | Nitrogen |
| NPS | National Policy Statement |
| NRW | Natural Resources Wales |
| NSIP | Nationally Significant Infrastructure Projects |
| PEM | Proton exchange membrane |
| PFAS | Poly- and perfluoroalkyl substances |
| PVC | Polyvinyl chloride |
| PWS | Public Water Supply |
| RAPID | Regulators' Alliance for Progressing Infrastructure Development (RAPID) |
| RO | Reverse Osmosis |
| SEPA | Scottish Environment Protection Agency |
| SPA | Special Protection Areas |
| SSSI | Sites of Special Scientific Interest |
| SuDS | Sustainable Drainage Systems |
| TRaC | Transitional and Coastal waters. |
| UU | United Utilities |
| WFD | Water Framework Directive |
| WRc | Water Research Centre |
| WRW | Water Resources West |

# 1.0 Introduction

The HyNet Industrial Cluster (HyNet) is a planned network of new infrastructure and existing infrastructure that will capture carbon, and produce, transport and store hydrogen in north-west England and north-east Wales.

Water Research Centre (WRc) has been commissioned by the Environment Agency (EA) to complete an evidence review to understand expected emissions to water, water quality impacts, and water demand and availability for HyNet. Alongside a literature review, the project includes a programme of stakeholder engagement to gather evidence.

This report summarises the findings of the stakeholder engagement. Section 0 outlines the approach to stakeholder engagement adopted by the EA for HyNet. The stakeholder meeting summaries are provided in section 3.0, with section 0 for hydrogen or carbon capture companies planning infrastructure as part of HyNet, section 3.2 summarising meetings with key trade organisations (Hydrogen Trade Associations, Energy UK and the Carbon Capture and Storage Association), and section 3.3 covering engagement with other regulators, water companies and local authorities. Section 4.0 provides conclusions and recommendations.

# 2.0 Engagement Methodology

The Environment Agency arranged online meetings with stakeholders between December 2023 and March 2024 inclusive. The meetings lasted 1-2 hours. Meetings with multiple stakeholders (i.e. trade associations, regulators, local authorities) comprised a presentation delivered jointly by the EA and WRc, following by a semi-structured interview with questions adapted to the stakeholder(s). The smaller meetings with individual companies were conducted by the EA only and comprised a shorter presentation and semi-structured interview.

Meetings were generally recorded, and a transcript was automatically generated. The following summaries are based primarily on the transcripts. In some cases, the transcripts failed to accurately record technical language. All information provided during the meetings has been taken in good faith and has not been independently verified.

# 3.0 Stakeholder Meeting Summaries

## 3.1 Individual Hydrogen or Carbon Capture Companies

The summaries for each company follow the same structure:

- What infrastructure does the company plan to upgrade, create or use as part of HyNet?
- Do they have details of the technology that they plan to use?
- How much water will be needed?
- Where might water be sourced from?
- What is the expected volume, composition and potential impacts of wastewater arisings?
- Any other comments or concerns raised relevant to the impact of HyNet on the water environment.

### 3.1.1 Viridor (01/02/2024)

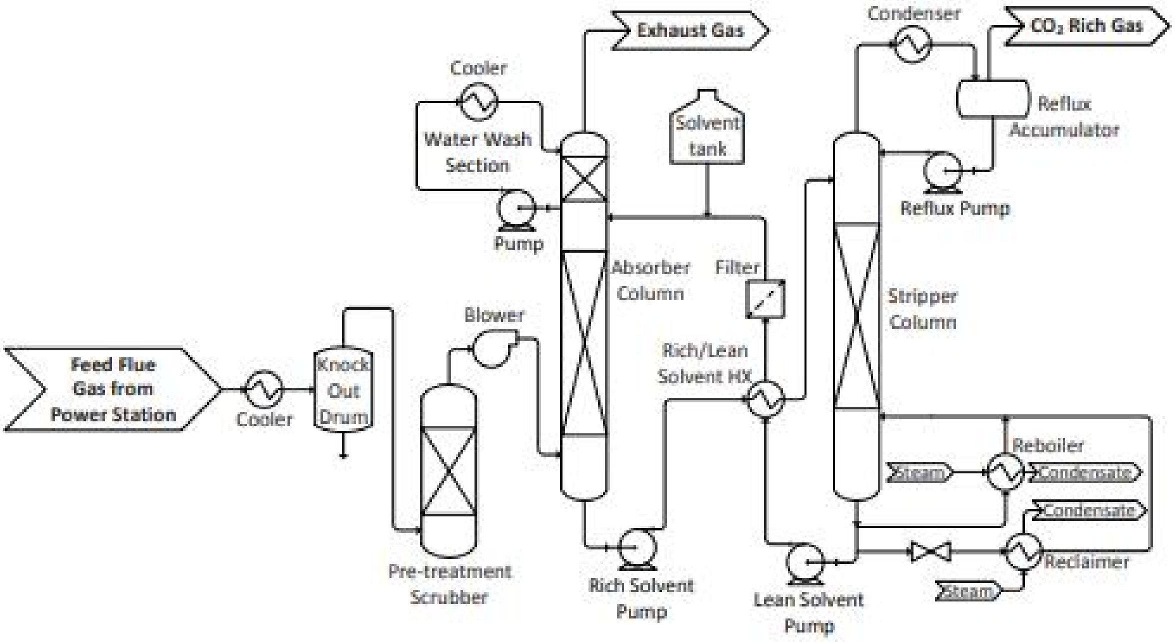
Viridor plans post-combustion carbon capture technology at a site near Runcorn.

#### Technology

Proposed technology for the Viridor site includes post combustion carbon capture technology using a proprietary amine-based solvent. The design life of the carbon capture plant is expected to be 25 years. A Front-End Engineering Design (FEED) study is planned to refine their approach. Their Runcorn site is connected to an Energy Recovery Facility (ERF) which is permitted for 1.1 million tonnes/year of waste and the plant would have a carbon capture efficiency of 95% of the $CO_2$ from the ERF. Viridor aims to use hybrid coolers to make use of the generated direct cool condensate, as its disposal is difficult due to lack of sewer capacity, and also because the water supply required for direct cooling is much more than the water availability in United Utilities' (UU) network.

The flue gas entering the post combustion carbon capture system is around 150-160 degrees and should be cooled down to 40-60 degrees. As seen in Fig 1., once the flue gas is treated, it is passed through an absorber[1] which absorbs $CO_2$ using Monoethanolamine (MEA) solvent or an amine-based proprietary solvent, which is fed into the absorber. The water wash section is added to the absorber to reduce the ammonia content of emissions from the absorber. Viridor aims to use water wash instead of a water wash as it is proven to reduce the ammonia content from the emissions significantly, thus reducing the risk of air pollution. The shift from water wash to acid wash has been factored into the overall water demand.[1]

**Figure 1 Post combustion carbon capture process[2]**




## How much water will be needed?

The post combustion carbon capture technology would generate large amounts of direct cool condensate. To make use of this condensate, Viridor is looking to use hybrid coolers. The direct cool condensate would be treated and input into the hybrid coolers, and it would be supplemented in periods of higher temperature which would require additional water to achieve the desired cooling.

Some of the existing capacity of the cooling towers could be used since the load (heat demand) on the existing cooling towers is reduced under the proposals.

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[1] Absorber is a column in the process which absorbs the $CO_2$ from the feed it receives.

[2] Bui, Mai, et al. "Dynamic Modeling and Validation of Post-Combustion $CO_2$ Capture Plants in Australian Coal-Fired Power Stations." Energy Procedia, vol. 37, 2013, pp. 2694–2702, https://doi.org/10.1016/j.egypro.2013.06.154.

### Where might water be sourced from?

The additional water for the hybrid coolers, especially required during summer periods, would be supplied by Inovyn Ineos, abstracted from River Dee. They also supply the ERF. Currently Viridor is in discussion with Inovyn for further supply and partial transfer to the carbon capture facility as well via the same route as for the ERF.

### Volume, composition and potential impacts of wastewater arisings

The cooling towers would have an 'elemental purge' which would go through a water treatment facility and would be put through the hybrid coolers for multiple cycles, similar to the cooling towers at the ERF, where the water is used for up to 77 cycles before being purged.

The waste from the acid wash from the absorber tower generates reclaimed water and hazardous amine sludge waste which would be disposed off-site. After being used in multiple cycles, the 'purge' (effluent) from the hybrid cooling towers would still be of sufficient quality to be discharged into the Manchester Ship Canal.

### Other comments

Viridor have applied for an initial permit, based on an MEA solvent. However, a new application or variation to the application will be submitted because of their planned process variation from MEA solvent to proprietary amine solvent (following the FEED study).

## 3.1.2 Tata Chemicals (13/02/2024)

Winnington site at Northwich: Converting boilers providing Combined Heat and Power (CHP) to hydrogen. The site currently burns natural gas which also provides $CO_2$ for manufacturing.

British Salt operation site at Middlewich: Three options are currently being assessed: electrification, fuel switch to hydrogen and carbon capture plant. Each option will be a similar size and capacity to the Winnington site.

### Technology

Winnington CHP operates a baseload gas turbine with a heat recovery boiler which raises the steam to high pressures and lets it through a stream turbine, from where it is distributed to both the Lostock and the Winnington sodium carbonate and sodium bicarbonate plants.

The British Salt plant has a couple of boilers and steam turbines. Tata Chemicals are very familiar with the technology which is used at both sites so there are low technological risks.

The carbon capture plant at the Winnington site recovers flue gas. The solvent used in the carbon capture plants is MEA.

## How much water will be needed?

Winnington carbon capture plant has high water demands for cooling purposes.

Additional water would only be required if the carbon capture plant capacity at Winnington is increased for sodium bicarbonate production.

The water demand of the carbon capture unit is about 1000 $m^3$/hr which is pumped from the river.

Planning permission for a larger sodium bicarbonate plant is in place, which would potentially have a larger $CO_2$ demand that exceeds the current capacity of the carbon capture plant. However, the existing infrastructure and grounds were built with a second carbon capture plant in mind. The boilers would provide the flue gas as is done for the existing carbon capture plant and it would have a similar non consumptive cooling water demand.

Tata Chemicals is currently working on a climate change risk assessment, particularly in terms of flooding and the resulting availability of cooling water.

They are still considering if acid wash systems should be used for any new carbon capture plant or the existing one but this is not seen as an ideal option due to the potential wastewater stream produced which would have to be treated and perhaps discharged into nearby rivers.

## Where might water be sourced from?

The existing abstraction licenses for the rivers have hands-off flow conditions on them.

The water for cooling demand for the Winnington site is river water. Water for the gas turbines would be sourced from the river as well. The Winnington site uses condensate recovered from the ‘Lostock site’. British Salt abstracts water from the River Wheelock for cooling purposes.

The abstraction license at the Winnington site only allows supply for the Winnington bicarbonate plant and the carbon capture unit. The Grade 1 water supplied for CHP is from a third party with their own abstraction license.

Other sources of water have been considered for the carbon capture plant such as rainwater harvesting and groundwater from boreholes.

### Volume, composition and potential impacts of wastewater arisings

Switching to hydrogen fuel would not produce a waste stream, as when natural gas was used, however, there would be a bigger heat load to dissipate, potentially into the rivers.

Should an acid wash be required for future projects, the only feasible disposal route at this location is to UU sewer network.

### Other comments

None.

## 3.1.3 Ineos (24/01/2024)

Proposed infrastructure within HyNet:

- Hydrogen storage site between Rudheath and Middlewich.
- Runcorn site – Have been producing hydrogen on this site for 125 years, which is burned in boilers.

### Technology

Unpurified and unfiltered river water, returned warm from Tata chemicals, is pumped straight down the boreholes to dissolve salt to produce brine. To provide saturated brine, it is passed again through a second cavern and any silt insoluble in the water ends up in the bottom of the cavern. The clear saturated brine still possesses impurities (e.g., magnesium and calcium carbonates) and so is sent to a purification plant at Lostock where sodium hydroxide and sodium carbonate are added to precipitate magnesium hydroxide and calcium respectively. The clear, pure brine obtained is then provided to , Runcorn site, for chlorine/hydrogen production and to Runcorn saltworks for salt production.

Runcorn site currently has an existing 200MW Hydrogen production capacity using electrolysis. Their plants in Europe are in the 60 to 100+ Megawatts scale, up to 200 Megawatts. However the business models and finance regimes in the UK make hydrogen production challenging. Hydrogen production uses the chlor-alkali process, which uses a membrane between electrodes permeable to sodium (Na) but not chlorine (Cl) allowing simultaneous $Cl_2$, $H_2$, and NaOH production. The hydrogen production plant operates at reduced capacity where 10,000 tonnes of hydrogen is produced in a year, most of which is burned in the boilers. 'Green electricity' comes from energy from waste and some electricity from grid is used as well.

Ineos produces chlorine for the water industry and ethylene dichloride is sold abroad for production of PVC. In terms of achieving Net Zero, Ineos plans to potentially sell the produced hydrogen to road transport, in which case steam generated from Viridor’s Energy from Waste (EFW) plant would be burned in the boilers instead of natural gas.

### How much water will be needed?

An average of 70,000 $m^3$/day of water can be abstracted by Ineos across all three of its permits, from three water bodies. As of today, the brine production averages 2,000 $m^3$/day which is lower than before. Previously, brine was supplied to Tata chemicals at Winnington as well as Lostock, but now the soda ash production at Winnington has been shut down. There used to be several facilities for chlorine and hydrogen production at Runcorn, of which three are shut down currently. The brine produced at the ‘westside saltworks’ has also reduced compared to previous years.

As part of HyNet, the solution mining from the developed gas caverns is expected to begin by 2027. Once this project commences, Ineos’ water demand would not change as Ineos would perform the solution mining by displacing the existing brine production.

No additional water is required for hydrogen storage at Runcorn. The water abstracted from rivers is solely for brine production. Potable water required for the cooling towers and other processes in the chlorine/hydrogen plant and salt plant are obtained from River Dee water connections and UU, which provides more than sufficient supply required for the other processes.

### Where might water be sourced from?

Ineos believes that its current abstraction permit offers enough capacity for their future needs up to 2050. However, no analysis has been done to date on the impacts of climate change and whether low flows, especially in summer, might impact whether abstractions can take place. Ineos felt that flooding and high flows were more likely to be an issue than low flows in the north west.

Ineos has been solution mining for decades to extract brine for customers. In the process, Ineos creates brine mining caverns or gas storage caverns based on customer demands for brine.

Ineos abstracts water from rivers and offers it to Tata chemicals at Lostock who use the water as a coolant by passing the river water through their heat exchangers. Ineos then uses that warm water for solution mining.

Ineos has an abstraction license and mainly abstracts water from the river Dane near Middlewich, Wincham brook at Northwich, and Trent and Mersey canal. Abstraction is permitted even during minimal flow in the rivers for salt production or hydrogen storage. Currently, less water is abstracted than the maximum permitted.

Currently brine demand is low, and if demand for gas storage increases, Ineos is able to purge brine to the Mersey and develop gas storage quickly. Until 2050, regardless of brine or gas caverns, the supply of water provided by existing permits would be sufficient considering the water demand.

#### Volume, composition and potential impacts of wastewater arisings

The calcium or magnesium carbonate impurity removed while purifying the brine at Lostock is sent down local boreholes and - as permitted by the EA - small amounts of brine are disposed down old, depleted boreholes or purged 'along the way to the drainage system'. There is limited consent to discharge into Waybrook. *(Note that 'Waybrook' has not been found on maps of the area – details may need to be confirmed with Ineos.)*

There are two discharge licenses, one each for saltworks and chlorine production which allows brine discharge into Mersey. The purge from Runcorn saltworks ends up in the Mersey. This purge is from the salt evaporation process which would make it a strong brine that contains sodium sulphate and some other impurities. If it is not purged then all their evaporation processes would need to be scaled up. The Runcorn site uses the provided brine for chlorine and hydrogen production via electrolysis. The existing membrane electrolysis process produces a weak waste brine which is treated in a weak brine treatment plant, where the pH is adjusted, and is then discharged into the western canal where ultimately it flows into the Mersey. There is an agreement with the EA regarding the amount of brine allowed to be discharged into Western canal and Mersey, and this is currently maintained under the limit.

#### Other comments

High levels of water in rivers and flooding are seen as threats and could potentially lead to significant delays. In recent years, flooding of the river Dane has risked the dam settling pond infrastructure and on Wincham brook the pumphouse and equipment was flooded and destroyed.

Ineos is still dealing with the government regarding hydrogen storage business models and finance processes to commence their part of HyNet. Currently, salt mines for hydrogen production are not viewed as financially viable by Ineos. Solution mining from these developed caverns is expected to begin by 2027.

### 3.1.4 Evero (24/01/2024)

Evero is planning a carbon capture facility adjacent to Ince Bio Power.

#### Technology

Mitsubishi Heavy Industries makes the technology chosen by Evero for its proposed projects. Similar process to Encyclis. The flue gas is extracted from the existing operation and fed into the $CO_2$ gas separation process. The process consists of an absorber column, heat exchanger, desorber column, and a $CO_2$ exporting plant to get to the specification required to inject into HyNet. The process uses proprietary solvents. The cooling towers in the facility are conventional air-cooled condenser cooling towers. For further treatment of the potable water, a reverse osmosis unit is being considered.

The current assumption is that there would be a single stage water wash at the top of the absorber to reduce the ammonia content in the air emissions from the absorber tower. An acid wash system is also being considered by Evero during the FEED phase.

The carbon capture plant aims to achieve 95% capture efficiency.

### How much water will be needed?

The water is mainly used in the process for flue gas quench and in cooling towers.

51 $m^3$/hr additional potable water required for carbon capture plant (this is a maximum not annualised value). The table below, from Evero, provides additional details.

**Table 3-5 – Process Water Requirements - Overview**

| | | MHI |
|---|---|---|
| Additional process water to Existing Facility Demineralised Water Production Plant [12] | $m^3$/hr | 0.63 [13] |
| Process Water Make-up for Cooling Towers [15] | $m^3$/hr | 71.35 |
| **Total Process Water Required for CCP** | **$m^3$/hr** | **71.98** |
| **Total Recovered Water from Wastewater (Recycle) Plant** | **$m^3$/hr** | **20.89** |
| **Additional Potable Water Required** | **$m^3$/hr** | **51.09** |

### Where might water be sourced from?

Evero are in discussions with Peel, an infrastructure developer, about whether the existing network capacity for Protos can cover its anticipated water demand (acknowledging the demand from other developments). They understand Peel are exploring opportunities to reinforce network capacity with United Utilities.

They do not anticipate having to apply for and operate under an abstraction license.

### Volume, composition and potential impacts of wastewater arisings

The process water effluent, discharged at 5 $m^3/h$, that cannot be further recycled in Evero's water recycling treatment plant, would potentially be discharged into the Manchester Ship Canal. The water quality is thought to be suitable for discharge into a watercourse; at no point do amines come in contact with the process water. Evero intends to advise on temperature or flow impacts. The other option being considered is disposing the effluent into a local drain at Protos Park.

The concentrated sludge discharged from the water recycling process is periodically tankered for disposal. The spent solvent stream is also expected to be tankered away periodically.

It is hoped that process water effluent from the water wash at the absorber tower can be discharged to UU sewers, with approval.

On site effluent treatment and reuse have been considered in their base design.

**Table 3-4 – Wastewater Treatment Plant - Summary**

| | | MHI |
|---|---|---|
| **Flue Gas Quench Treatment Process** | | |
| Flue Gas Quencher / Scrubber Waste – Effluent In | $m^3/hr$ | 18 |
| Recovered (Treated) Water [10] | $m^3/hr$ | 14.94 |
| Concentrated Effluent (Cannot be recycled) | $m^3/hr$ | 3.06 |
| **Cooling Tower Blowdown Recovery Process** | | |
| Cooling Tower Blowdown – Effluent In | $m^3/hr$ | 7.93 |
| Recovered (Treated) Water [11] | $m^3/hr$ | 5.95 |
| Concentrated Blowdown Effluent (Cannot be recycled) | $m^3/hr$ | 1.98 |
| **Total Recovered Water from Wastewater Recycle Plant** | **$m^3/hr$** | 20.89 |
| **Total Concentrated Effluent (Cannot be recycled)** | **$m^3/hr$** | 5.04 |

### Other comments

Evero intends to set up pre-permit application meetings with EA and the local authority in March. Evero hopes to submit the permit application (could be by first half of 2025) and a FEED contractor is to be appointed in the second half of this year. They hope to have received investment by the end of 2025, with the site being online by 2029.

### 3.1.5 Encyclis (22/01/2024)

Encyclis plans to construct a carbon capture facility at the Ince Protos Park as part of HyNet. A 'very small amount of hydrogen' is expected to be used by the carbon capture process.

#### Technology

Encyclis plans to install carbon capture technology at their Protos ERF. The contractor for the post combustion carbon capture technology is Hitachi Zosen Inova (HZI), who would be designing the concept for the carbon capture plant. The company is experienced in dealing with energy from waste facilities and heat exchange recovery and has a carbon capture department. The capture rate for the absorber is designed to achieve a capture rate of 95% for $CO_2$. The post-combustion carbon capture process uses amine solvents and involves an absorber and stripper, including pre-cooling for the absorber and post heating via a reboiler that enables the capturing and stripping of $CO_2$. The plant aims to be operational by Q4 of 2027.

HZI has similar processes/ model plants already installed in district heating systems in Basel and at other energy from waste systems which include similar technology; cooling of hot gases and using heat energy within a 'thermal energy reclaim process'.

#### How much water will be needed?

There is no large water demand for the carbon capture facility as Encyclis uses an external service for the provision of water for oxygen removal from the $CO_2$.

The water supply per tonne of carbon dioxide captured is effectively zero as the water consumed for the carbon capture processes is generated through drops from the flue gas from the ERF or through wet gas combustion; the processes generate lots of water which is reused elsewhere.

The carbon capture site will make use of an existing water supply connection for the ERF. The water would primarily be used for storage in the fire water tank and for sanitary facilities on site, so the net clean water consumption from public supply for the carbon capture plants is expected to be low. No additional water demand on top of that discussed above is foreseen in the future.

#### Where might water be sourced from?

Sufficient water is available for existing operations. The supply of water is obtained from the utilities' supply through the ERF, where the incoming water from the break tank is pumped around the ERF. The two adjacent Encyclis sites are operated as a single facility and an extra connection in the pressurised side of the pumps would supply the carbon capture facility. Potable water supply for the carbon capture facility is taken from the existing water supply connection of the ERF.

In terms of the process water makeup for the amine system, or the solvent system for the absorber, minimal water will come from the potable water supply. Water from boiler blow downs is of good quality that generally goes to process effluent. This could be utilised within the processes as the connection between the two water systems enables the ‘water balance’. Based on the current design, the effluent produced from the ERF is reused.

The condensate generated from the flue gas, as it comes from energy from waste facility into the carbon capture facility, is either re-entrained into the carbon capture facility or can be used in the facility’s coolers which require water.

The hot flue gas coming from the ERF is cooled down from 140 degrees to 40 degrees to pass it through the absorber columns. This negates the requirement for external cooling water sources. *(Not clear how.)*

### Volume, composition and potential impacts of wastewater arisings

There is no foul wastewater discharge from the carbon capture facility. Only clean surface water is discharged into the drains near the Ince Protos Park. Based on the FEED study conducted, the effluents from the water treatment processes on site could be used within the overall process. Any excess foul water to be discharged is collected in a cesspit. There is no foul sewer connection. Encyclis is looking into options for either tankering the liquid waste stream from the cesspits on site to a licensed facility or working with an external service to reclaim the waste to be reused.

Acid wash is used to control the amines in emissions from the carbon capture stack. The blowdown from the coolers and the acid wash on site is treated and the polished water is reused in the carbon capture process. Currently Encyclis is looking at options for reverse osmosis (RO) with Electrodeionization (EDI), in which case the return from the RO unit would not be discharged from the carbon capture facility but rather sent to the ERF to be included in the process. Encyclis is aiming to integrate these processes across both its facilities.

### Other comments

The $CO_2$ transport and storage company for HyNet have made Encyclis aware of very strict composition requirements for the $CO_2$, such as a very low percentage of oxygen as a contaminant. Once the flue gas is passed from the absorber column to $CO_2$, some entrained oxygen in the liquid will remain. Converting this oxygen to water consumes a very small amount of hydrogen.

### 3.1.6 Trafford Green Hydrogen, Carlton Power (15/02/2024)

Carlton Power is planning the following developments as part of the Trafford Green Hydrogen scheme:

- Trafford Park – The proposed capacity at the Trafford site for the first phase is 15 MW and is permitted for up to 200 MW. Currently looking to get additional grid connections to expand capacity to 100 MW.
- Barrow site at South Cumbria – To construct a hydrogen production facility and a hydrogen pipeline that will provide hydrogen to Kimberly-Clark at Trafford, replacing their boilers to be 100% hydrogen.
- Sterling project – No details given.
- Heinz project, Wigan – Heinz would be converting their boilers to be 'hydrogen ready'.
- Other sites discussed are outside the HyNet region.

The project capacity would be scaled up based on the hydrogen user's (or 'offtaker's') demands, land and grid capacity. If the liquid air storage scheme, battery energy scheme and hydrogen scheme progress, Carlton Power would not focus on its CCGT (Combined Cycle Gas Turbine) project any longer. All the current sites are under agreement to produce hydrogen for 15 years, at the end of which expansion of these projects would be explored.

#### Technology

Green hydrogen is produced using a containerised electrolyser. Water from the public supply undergoes water purification via an RO plant and the treated water is fed into the electrolyser. The electrolyser is then powered by green electricity to enable green hydrogen production.

For each 5 MW block, three shipping containers are present. Based on the size, Trafford would have three sets of three shipping containers, the Barrow site would have six sets of three shipping containers. Langage Power Station, which is outside HyNet (near Plymouth) would have two sets of three shipping containers. A storage facility is also installed with capacity for approximately a day's worth of produced hydrogen. When the electrolyser system is on, two-thirds of the hydrogen produced would be sent to the offtaker via pipeline and the remaining one-third will go into the storage which could be sent to offtakers when the electrolyser is turned off.

Carlton chose to adopt green hydrogen production as blue hydrogen requires significant development expenditure and there would be a lot of different companies involved whereas if there is a production facility, storage and pipeline/ tanker then green hydrogen production can be more easily delivered.

#### How much water will be needed?

Water required for the electrolysis at Trafford is 2.5 litres/s for a 15 MW project.

Based on the proposed electrolyser process, for a 5 MW block, 1300 kg/h of potable water supply would be required. The reject from the water purification process would be approximately 335 kg/h. The RO reject from the back end of the electrolyser would be discharged as 125 kg/h of reject water. Both kinds of reject water would be sent into the sewer. *(This appears to be less than 2.5 l/s.)*

#### Where might water be sourced from?

For all the projects, the water is to be sourced from UU's public water supply. The option of abstracting water for bigger units would also be considered.

#### Volume, composition and potential impacts of wastewater arisings

Small quantities of wastewater discharged from the electrolysis process are suitable to be released into the sewage system in Trafford.

#### Other comments

No further comments.

### 3.1.7 Progressive Energy (02/02/2024)

Progressive Energy is the lead developer of a consortium of companies responsible for the development of HyNet. HyNet are developing a large amount of carbon capture and low carbon hydrogen infrastructure in the North-West of England and North Wales:

- A Blue Hydrogen production facility located at the Stanlow Oil Refinery
- Multiple Carbon Capture plants
- One site for hydrogen storage in salt caverns in mid Cheshire.
- 20 plants converting to hydrogen burners or boilers.
- 'Progressive Energy is also the lead developer of a joint venture between Progressive Energy, Statkraft and Foresight. This Joint Venture, Grenian Hydrogen Ltd, are developing the following electrolytic hydrogen projects;
- Cheshire Green hydrogen facility located at South of the River Mersey (one of the seven green hydrogen projects within the area).

- Plants at Northwich and British Salt's site (currently on hold by Tata).
- Green hydrogen production at the Kellogg's Trafford Park site located within the manufacturing facility, producing hydrogen to be used in boilers and ovens.
- Green hydrogen production project at the Pilkington glass site in St. Helens - aiming to develop to a commercial scale.
- Hydrogen production in Liverpool (Speke) and Wrexham.


**Figure 2 Hydrogen production plants as discussed by Progressive Energy**

Note that the below plans all relate to work being completed by Grenian Hydrogen only and not the full range of activities Progressive Energy are developing in the area.

## Technology

Grenian Hydrogen produce hydrogen using electrolysis (green hydrogen). Grenian Hydrogen's sites use an electrolyser manufacturer called Accelera. The electrolyser comes in ISO containers[3] (one ISO container for all the power equipment, and one ISO container for all the process equipment) designed to

[3] ISO Certified container

be ‘plug and play’. The demineralisation technology, deionisation technology, and other elements of water treatment are also built into the container. The process involves feed consisting of nitrogen and water, buffer and tank.

### How much water will be needed?

The water demand required by the electrolyser is governed by the stoichiometric reaction to produce hydrogen. Typically for this electrolytic process, 20 litres of water would be required to produce a kg of hydrogen. (The stoichiometric limit for electrolysis is 9kg of water to 1kg hydrogen.) 50% of the water used is rejected from the water treatment process and the rest goes into producing hydrogen.

### Where might water be sourced from?

The project intends to use potable water supply to meet its water needs. As the scale of the plant is not large, there have been no issues in securing water supply as UU could supply the required volumes within their existing network.

The process requires high quality inlet water as the treatment facilities are part of the design. Grenian Hydrogen had arranged for potable water supply, deemed suitable for the process, to the Cheshire green hydrogen project site from United Utilities (UU). This would be finalised once UU has installed a new water main at the Protos Park where this site is located, and this water main is confirmed by UU to have sufficient capacity for the process.

For the Kellogg’s and Pilkingtons sites, the water required is taken from the co-located manufacturing sites which have big water connections that have excess water supply.

In the future, Grenian Hydrogen may investigate treating raw water supply to be fed into the process rather than potable water supply.

### Volume, composition and potential impacts of wastewater arisings

The wastewater discharge is determined from the demineralisation and deionisation process.

It has been challenging for Grenian Hydrogen to understand wastewater likely to arise as the water treatment part of the containerised technology is not designed by Accelera but by one of their suppliers.  The water initially fed into the process is of drinking water quality and through the process minerals are removed from the water used for electrolysis. The waste product is a concentrated stream which is considered readily dischargeable at the Cheshire green site due to the high quality of the input water.

Protos Park does not have any foul drain networks near the site, so the wastewater may be discharged into the local SuDS network at Protos, which eventually feeds into river water bodies. Progressive Energy engaged with the EA as part of the preapplication process, i.e. before applying for the discharge permits, to gain available data on the rivers to achieve required discharge specification. Due to lack of data held on the rivers, Grenian Hydrogen conducted six months of water quality assessments of the river and was able to verify using H1[4] assessment that further wastewater treatment during the electrolyser process was not required and the waste stream could be directly discharged into the rivers.

One of the main concerns within the effluent was copper. However, from the assessment it was concluded that the level of copper in the wastewater discharged from the Cheshire green site was very low compared to the flowrate and volumes within the river.

Unlike the Cheshire green site, the Kellogg's site and Pilkington Glass site are located at the existing manufacturing sites and these sites already have drainage networks or wastewater treatment processes or demineralisation plants, thus the wastewater here would not be directly discharged into local environments. The surface water pollution risk assessments at these sites are yet to be updated.

#### Other comments

The limitations of green hydrogen production without storage were discussed, that is, the variability of the renewable energy supply leads to variability in the production of green hydrogen.

### 3.1.8 EET Essar (16/02/2024)

EET at Stanlow are initially proposing to produce blue hydrogen, later green hydrogen and also to be a hydrogen user. They also plan to install carbon capture on the FCC, a hydrogen fired CHP as well as small energy improvement projects. They have a ten-year plan and this includes permit changes that might be needed to implement this, beyond 2030, plans are less clear. They have a premise when developing plans that there will be no more water available.

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[4] H1 risk assessment is a software tool developed by the EA to assess the impact of hazardous pollutants released within discharges to surface waters.

## How much water will be needed? Where might water be sourced from?

The initial hydrogen production plant HPP1 has enough water available and sourced through an existing United Utilities consent from the River Dee, approximately 25,000 t/day has been secured which is enough for HPP1 but not the second phase HPP2. This is insufficient for development of a second hydrogen production plant HPP2, which will need to consider alternative sources, and EET currently have a study being undertaken to assist with this that aims to report by end March 24. Essar hold abstraction licences for Thornton Brook and River Mersey although neither will be used for the projects planned.

The study will include recovery of effluent for re-use, groundwater abstraction through an under used abstraction licence and rainwater harvest, the latter already included within the HPP1 & 2 projects. Desalination although part of the study is unlikely to be an option as it is easier to clean the plants effluent. Brackish water would only be used for cooling because of the energy cost of cleaning it for any other use, and this would be the same for some of the groundwater.

The carbon capture and storage plant is also being developed on the premise of no additional water, and to do this air cooling will be utilised as much as possible, where this does not adversely affect energy efficiency or $CO_2$ capture rate. An effluent from the condensate will be available from the plant which after cleaning of $SO_x$ and $NO_x$, can be reused.

Green hydrogen production will require a clean water supply and water from United Utilities will initially be used for small scale generation with effluent from the process being reused as it is relatively clean.

The CHP project is associated with an electrification programme and is expected to result in a net reduction in water requirements on site, by reducing steam use and eliminating condensing steam turbines which are large cooling water users.

Other plant improvement projects are being designed to maximise air cooling and minimise water use.

## Volume, composition and potential impacts of wastewater arisings

The Essar Plant currently has two consents for water discharge one to a water course and one to sewer and are proposing to use both of those. They anticipate that there will be no new pollutants from the low carbon technology to those currently produced at the refinery as they currently handle amines.

They have a current discharge to United Utilities and aim to stay within the confines of this long-term contract.

There are no solid waste emissions planned except for the solids removed from treatment of condensate from the carbon capture plant which is essentially solid containing catalysts down to 0.5 micron. This waste stream will be recyclable into cement manufacture. Where raw water is treated to remove solids, the solids are currently sold to a local farm as a fertiliser and it is planned to continue doing this for water treated for the blue hydrogen production planned.

#### Other comments

The power delivery for green hydrogen is heavily dependent on a good mains grid connection and in that respect the site has a 99KV connection that can be used for both blue and green hydrogen production and therefore there are no problems with capacity anticipated.

EET meet regularly with the local community neighbourhood groups about the proposed plant decarbonisation and stated that there has been no opposition to their proposals.

## 3.2 Trade Organisations

The following summaries of the trade organisation meetings cover:

- Estimated water demand for HyNet.
- Where might water be sourced from?
- Volume, composition and potential impacts of wastewater arisings.
- Other comments or considerations.

### 3.2.1 Hydrogen Trade Associations (21/02/2024)

#### How much water will be needed? Where might water be sourced from?

Attendees suggested a cap in funded and planned hydrogen projects should be set according to the amount of freshwater available to sustain future hydrogen production projects and that the freshwater required for these projects should be incorporated into future demand modelling. Without full consideration there might otherwise be delays to HyNet or potential expansion of industry.

The estimated water demand-availability balance should not be solely based on the process water demands but also considering the lifespan of the existing water supply assets and storage. If they require upgrading or if they should be modernised to increase efficiency.

Opportunities for reuse of wastewater, from wastewater produced onsite or from neighbouring sites, should be considered in both hydrogen production and carbon capture processes. Attendees questioned whether Ofwat, the financial regulator of the water industry, should have improved legislation and incentivisation to encourage more use of treated effluent. There are some examples of treated effluent re-use in the UK, however the UK is thought to lag other countries in this. Currently, there are no known plans for desalination units in the HyNet cluster.

Attendees highlighted that potential investors in HyNet could make decisions based on data provided by this environmental capacity project, therefore it is important that any data used is as current and accurate as possible. There were concerns that abstraction management strategies being used for analysis dated from 2013-2020. Improving data confidence was considered important. Attendees asked for investment in hydrogen to be ‘as easy as it possibly can be’, albeit ‘not at the expense of massive environmental degradation.’

### Volume, composition and potential impacts of wastewater arisings

A recent report highlighted high concentrations of Poly- and perfluoroalkyl substances (PFAS) in the Mersey Estuary. Attendees questioned whether this might impact on any intended discharges from HyNet infrastructure.

One attendee highlighted conversations that they had had with the Scottish Environment Protection Agency (SEPA). SEPA reportedly indicated that potable water supplies had elevated levels of some parameters that would exceed environmental limit values, e.g., copper, before even passing through the facility. They indicated potential misalignment with Drinking Water Standards.

### Other comments

This project does not aim to provide stakeholders with recommendations or improvement objectives to gain discharge or abstraction permits. Instead, the information gained from these stakeholder meetings will help the EA in assessing consultation responses and whether any changes are required to the EA’s regulatory approach.

Questions were raised around overall environmental benefits or impacts of HyNet and how these might be considered more holistically in future. Biodiversity Net Gain, Net Zero, nutrient neutrality and water availability were all discussed, particularly how these could be better integrated into holistic assessments of environmental impact or benefit. Discussions between the EA, Natural England, Natural Resources Wales and Defra were suggested, to enable policy alignment in future. Comparisons between the environmental impacts of hydrogen generation and the environmental impacts of other energy generation methods against the environmental impacts on water should be considered. Attempts should be made to show that how hydrogen generation compares with the methods it replaces.

The impact of individual developments should be measured in the future to assess if the limits and agreed conditions are delivered.

One attendee said that they welcomed the EA's approach to HyNet, envisaging future challenges and mitigations in collaboration with industry and other stakeholders.

### 3.2.2 Energy UK (05/02/2024)

#### How much water will be needed?

Whilst no specific demand values were given, there was concern that the estimated demand for HyNet, based on available literature, was too low. The extent of future development within HyNet was thought to be much bigger. Companies may not have made some plans public yet, and a lot more small-scale projects were thought to be happen than were presented during the meeting. This is being explored further in the final project report using national targets for hydrogen production and carbon capture, and other reports that have attempted to make regional estimates of water demand. Any uncertainties in forecast water demand or availability need to be very clear in the final report.

#### Where might water be sourced from?

Discussion centred around current policies and processes related to water abstraction and whether these could be improved.

Attendees noted that the 15-20 currently planned strategic water resource options (large-scale project designed to manage future water demand) are focused on public water supply and exclude consideration of water requirements in other sectors. This was considered 'short-sighted'. Concerns were also raised around common end dates that can be placed on abstraction licenses, which can mean that abstraction licenses expire before the end of an asset's operational life, or at worse before assets start to operate. There was concern about access to sufficient water for existing and future operations. An abstraction license with validity for the lifetime of the project, i.e. 25-30 years, would give investors confidence in a project. Based on the funding models for the payback period of a project, if the abstraction validity is short/unclear and guarantee of water over that period is unclear, investors may lose confidence.

Attendees suggested that a more strategic approach to water allocation should be considered, rather than the 'first come, first served' approach that applies to abstraction licenses currently. This might include allocating water for 10-15 years' time to ensure net zero is achievable. The EA noted this suggestion and intends to discuss further internally.

#### Volume, composition and potential impacts of wastewater arisings

Limited information was provided on wastewater arisings during the meeting. Comments were made about climate change increasing temperatures in future.

#### Other comments

It was noted that some attendees may have been reluctant to provide too many details with competitors on the call, and that 1-2-1 sessions with individual companies may be more fruitful.

### 3.2.3 Carbon Capture and Storage Association (CCSA) (12/02/2024)

#### How much water will be needed?

An attendee noted that the presentation indicated the proposed hydrogen plant would produce 20 megawatts of hydrogen by 2030, having a water demand of 0.16 megalitres per day. This seems close to a 100% load factor. A realistic situation of 60-80% load factor should be considered to understand the annual water demand which would ultimately be lower than for the discussed load factor.

The JEP reports by Regional Water Resource Group provide a regional prediction of the water usage for power and hydrogen production until 2050. These reports could provide useful information for this project.

Uniper highlighted that the day prior to the meeting they had uploaded a new project to the planning inspectorate website. They could not talk about the project earlier, but it is now in the public domain. They plan to construct a new carbon capture facility at Connah's Quay. For details see: https://infrastructure.planninginspectorate.gov.uk/projects/wales/connahs-quay-low-carbon-power-project/?ipcsection=overview

One attendee highlighted National Grid's four planning pathways or scenarios, including one 'do not do net zero' pathway and three others. It was suggested that these could provide valuable insights for this project.

#### Where might water be sourced from?

Reclaimed water usage is being considered by companies involved in HyNet. There's a wastewater treatment plant near HyNet that discharges 10 $m^3$/min in Dry Weather Flow (DWF) and could provide flow to HyNet that would be cleaner than the river or estuary. However, the company that had explored this option had struggled to get permission to use the effluent, as ‘they were told that there was no mechanism for the water company to provide the water to HyNet’, potentially linked to the role of the financial regulator, Ofwat. It would be necessary to confirm that removing the treatment works effluent from the environment wouldn’t have adverse impacts. One company commented that its Seabank Power Station uses water from an adjacent wastewater treatment works as its supply, so there is a precedent to follow. Another company has started to explore whether nearby traders with discharge permits could provide water.

Desalination was discussed as an alternative water source. Uniper commented that it has one site at Medway Power Station that has a small desalination plant. However, it’s not considered a first choice for water supply. Silt in estuaries makes it difficult to abstract and treat. Fish and eel protections can make it more difficult to get abstraction licenses in estuaries than from other sources. Dealing with the sediment is also difficult, although examples of end users who might buy sediment were given.

As in the meeting with Energy UK, concerns were raised around strategic water transfers and their failure to consider industry needs. Application of common end dates to abstraction licences were also a concern. There may be a need to collaborate with other potential water suppliers to source additional water, as requesting for large water supply from existing networks may be difficult considering the other assets connected to it.

Rainwater harvesting was discussed, but finding space for the harvested water to be stored was difficult. One attendee suggested that UU’s raw water network could supply HyNet in short-term, but there were technical difficulties in connecting to the raw water main.

### Volume, composition and potential impacts of wastewater arisings

Cumulative effects of ammonia need to be considered. Progressive Energy is aware of ammonia concerns in the area currently and has tried not to worsen these with any planned developments in HyNet.

### Other comments

The figures and information highlighting the water availability, demand and supply must be presented carefully and in detail.

Evidence that household demand can be reduced, in the UK or globally, could be included in any final reports, to understand likely effectiveness of water company plans to reduce demand to improve water availability.

It was noted that technology is evolving rapidly in this area, and it may be difficult to account for any possible changes to technology as part of this project.

## 3.3 Regulators, water companies and local authorities

The following sections discuss each organisation's awareness of HyNet, consideration of water availability issues, consideration of wastewater arisings and other pertinent comments.

### 3.3.1 Environment Agency (13/12/2023)

In addition to meeting external stakeholders, the EA facilitated an internal workshop with staff from different EA teams to gather relevant information on HyNet.

#### Awareness of HyNet

100% of the workshop attendees agree that, based on the presentation, low carbon technology deployment presents a risk to water availability and water quality.

81 % of the attendees said there is a risk that the environment will reach a limit that would challenge further deployments of low carbon technology.

79% of the attendees think that a changing climate will have a direct impact on the sustainable operation of low carbon technology.

Pre-permit application discussions with some of the companies involved in HyNet covered the type of technology, sources of water, discharge processes and energy efficiency. The carbon capture proposals seemed to focus more on air quality than water. The figures of water consumption from applications seemed much higher than discussed in the delivered presentation.

#### Water availability considerations

Potential impact on water availability due to competition from other users of the same resources (e.g. the RAPID programme5 may provide insights).

Potential sources for cooling water demand could be water from Transitional and Coastal (TRaC) waters, e.g. coastal waters for power station cooling.

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[5] Regulators' Alliance for Progressing Infrastructure Development (RAPID) programme works with stakeholders, taking opportunities to improve regulation and remove barriers, helping the sector respond to long term water resources challenges while promoting the best interests of water users, society and the environment.

Engagement with water companies needs to include discussions on the conflict between the national targets for reduced demand by 2030 and 2050 and the potential increase in demand on the public water supply network as a result of HyNet.

There is a need for EA teams to coordinate their responses during the pre-application stage for HyNet. It will be key for EA planning and permitting teams to work closely together in enabling these schemes as consents for the activities associated with the HyNet scheme will be sought through the licencing / permitting regime. Engagement with water companies and local authorities at early stages is also important.

In addition to managing water resources and quality, UU may engage with local authorities to align HyNet's contributions with their strategic plans for water availability and ensuring network capacity for growth. The councils' Local Development Plans will set priorities for growth, including infrastructure, and planning policies to manage such development going forward. The cumulative impacts on water resource / quality may not be fully assessed by local councils, to ensure there is sufficient water availability for delivering future development and infrastructure (i.e. HyNet).

A strategic plan for abstraction licenses required by proposed projects should be developed to prevent shortages in the limited available water for early projects. The number of cooling water discharges that could be required as part of HyNet could cause constraints on development. The cooling water discharges from the proposed hydrogen production and carbon capture plants could create thermal plumes.

### Wastewater arisings considerations

The Lower Mersey catchment requires a lot of investment from UU to improve the effluent quality from their wastewater treatment works, thus improving overall water quality. Further information could be provided by the EA Catchment Coordinator for the Lower Mersey.

A potential tidal power scheme on Mersey is under consideration and could result in significant changes to the behaviour of the Mersey estuary. This would require assessment of the potential discharges of industry into Mersey estuary and how the upcoming tidal scheme would affect them.

The Habitat Regulations Assessment process should be investigated more as it is an important tool for dealing with many permit applications. Including development of habitat assessments based on combination effects through modelling could be considered. Identification of impacts on habitats from combination effects from multiple projects to be deployed in a short space of time or relatively close together in terms of time scale could be considered for this study.

Construction/ development risk could be vast and would depend on the processes and location of each project. One of the HyNet $CO_2$ pipelines caused issues from a Water Framework Directive (WFD) perspective and was required to be supported by a WFD Assessment which included an understanding of impacts on water bodies from a water resource / quality perspective: https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/advice-note-18/.

Carbon capture plants using amine solvents require a final stage of acid wash to minimise emissions of amines and breakdown products (ammonia and nitrosamines) to air. This acid scrubbing liquid becomes a waste and will need treatment before discharge (on or off-site). This causes potential for nutrient (N), ammonia and new pollutants in receiving waters.

An in-combination assessment must be conducted at an early stage to understand the potential combined impact of all the developments, although at present the details of all potential developments might not be known. A conservative and iterative approach could be taken with this, where if with worst case discharges and conservative model assumptions, the predicted environmental impact is insignificant, no further investigation is required and if not a more advanced and less conservative model could be developed. If at the outset the discharges are so large, it is obvious there will be a significant environmental impact, more complex modelling could be used at the outset.

An example of a potential approach in dealing with permit applications in this case could be: Early discharge permit applications may be determined on the basis that the receiving waters can attenuate the temperature increases without impacts on ecology (e.g. a thermal plume of +1ºC for 0.5km may be acceptable). However later discharge permit applications may either be rejected or accepted with more stringent limits, if the cumulative impact of multiple discharges means that the receiving water can no longer attenuate the temperature increases without impacting ecology (e.g. multiple discharges could result in a thermal plume of +2ºC for 2km, which may not be acceptable). The attenuation ability of the receiving waters may also reduce as climate change impacts worsen.

### Other considerations

The HyNet cluster does not have a single legal entity dealing with abstraction licenses, etc.

Ongoing proposals for change of regulatory approaches, permit authorisation, abstraction licenses, etc. will be considered for this project.

Attendees agreed that early engagement with industry for HyNet was critical. The EA could consider its own review of Best Available Technology (BAT) to inform reviews of planned projects as part of permitting.

### 3.3.2 Natural Resources Wales (NRW) (16/01/2024)

#### Awareness of HyNet

NRW are trying to monitor HyNet projects happening within Wales and the wider context. Net Zero Industry Wales is an organisation that keeps track of relevant projects in Wales. Bigger projects, with national significance, were generally thought to be easier to keep track of, with less awareness of smaller schemes.

Cheshire Green hydrogen project on the Protos Park at Ince is looking to use an electrolysis process. Use of PEM (Proton exchange membrane) or alkaline technology has not been observed by NRW yet.

#### Water availability considerations

The DESNZ water availability for hydrogen report focused mostly on water availability on a regional basis. According to NRW, the report indicated there is sufficient water available for hydrogen production across UK whereas this may not be the case in particular areas and this needs to be made clearer.

Based on the figures shown in the presentation, the required volumes of water required by HyNet from Deeside may not be available as Deeside seems to be at full capacity and to acquire spare water may be difficult.

Moving water between regions, e.g. via the canal system, brings forth issues as the chemical footprint of water varies in different places. This must be carefully considered. Discussions with UU and Water Resources West should include this point, discussing potential transfer of water from Wales to England to support the HyNet projects. Movement of water from Wales to other regions is a very sensitive issue.

Desalination was discussed, but concerns were raised about the energy required and whether this would negate the Net Zero ambitions that HyNet is founded on. Wastewater re-use is also being explored for an industrial cluster in South Wales.

#### Wastewater arisings considerations

Regarding discharges into the water bodies, three key considerations are: temperature / high salinity of the discharges, nitrosamine/ammonia discharge, and volume of water abstracted and discharged back. Impacts of temperature may be worse in future because of climate change.

#### Other considerations

An option to request pre application advice is available in Wales.

### 3.3.3 Natural England (25/01/2024)

#### Awareness of HyNet

Natural England's upcoming engagement with Progressive Energy is intended to include discussions on issues relating to the Mersey Estuary and Special Protection Areas (SPA), potential issues on functioning lands (supporting habitats for SPA) and water availability issues in relation to the River Dee.

During the application review process, Natural England are providing support to the Habitat Regulations Assessment (HRA) and are looking into potential impacts on designated European sites such as the green space and grasslands occupied by some of the developments.

Internal team discussions are to be held within Natural England to discuss potential in-combination issues across HyNet.

Natural England suggests more engagement with the EA would be useful during the examination process to help understand the impacts and priorities surrounding the new decarbonisation technology. This would help with developing a more strategic approach for the permit application process.

#### Water availability considerations

No comments.

#### Wastewater arisings considerations

No comments.

#### Other considerations

Natural England is aware of ongoing research into saline discharges from desalination in coastal areas, which might be useful for this study.

### 3.3.4 Local Authorities (08/02/2024)

#### Awareness of HyNet

In general, HyNet is not currently included in Local Development Plans across the region.

A Cheshire West and Chester planning policy team member confirmed there aren't any decarbonisation proposals recognised in their current local plan currently. The local plan is split into two categories: strategic policies and detailed policies. The authority declared a climate emergency in 2019 and by 2027 will form new local plans which are intended to include policies on low carbon developments with the upcoming development of HyNet.

Like Cheshire West, Warrington council also does not have policies on decarbonisation proposals included in their local plans currently. The current local plan was adopted late in 2023. There are general policies relating to climate change, water quality and water availability but none in relation to HyNet.

Cheshire East Council has a sustainable and inclusive growth support program for businesses funded through the Shared Prosperity Fund, which assists with engaging business implementing low carbon technologies. They had linked AstraZeneca to the Cheshire region's HyNet in the past. HyNet is not specifically recognized in their local plans however the local plans have policies which provide support for renewable and low carbon energy schemes, including community led initiatives subject to potential acceptable impacts on local environment and amenity. The policies also encourage energy efficient development and the use of district heating networks in certain designated areas. They also have policies that require major developments to provide 10% renewable or low carbon energy on site.

Although outside the HyNet region, Suffolk County Council hosts a regular meeting involving many local authorities, who discuss the NSIPs. The EA could consider joining for further collaboration or seek similar forums in the HyNet region.

Halton local plans also currently do not have any specific policies related to HyNet. Liverpool City Plan will sit above other local plans in region – e.g. for the St Helens area. *(Note: Believe this is a reference to the Liverpool City Region Spatial Development Strategy.)*

#### Water availability considerations

Cheshire West and Chester Council (CWAC)

Engagement with water companies

The local authorities have engaged with water companies through periodic discussions with Welsh Water and United Utilities regarding strategic investment in water and wastewater treatment infrastructure.

The utility companies have also been consulted by the local authorities at each stage of Local Plan development and the council has contributed into the water companies' 5-year investment plans. A HRA has also assessed the potential impacts of policies on wastewater and protected species and sites. The most recent consultation responses submitted were for the following documents:

United Utilities

- Revised draft Water Resources Management Plan 2024
- Drainage and Wastewater Management Plan (DWMP) 2023

Dŵr Cymru Welsh Water

- Water Resource Management Plan – CWAC liaison meeting March 2023

Water Resources West

- Emerging Regional Plan – consultation response submitted 2022

Engagement with Developers

CWAC currently assess incoming applications on an ad hoc basis and are reliant on the EA's advice as statutory consultees regarding water quality and water availability.

### Wastewater arisings considerations

The key consideration has been Sites of Special Scientific Interest (SSSIs) and Ramsar sites. During Local Plan engagement, Natural England highlighted the importance of protecting areas of peat from further development and on promoting restoration of these areas. There are peatland areas close to HyNet and there have not been significant oppositions from the stakeholders yet. However, this could present potential challenges to HyNet's development in the future, depending on the water abstraction plans and planned locations of the multiple carbon capture plants/ hydrogen production plants, especially if outside the Stanlow area or Protos site boundary. It should be noted that sterilisation of minerals should also be avoided as some of the proposed locations for low carbon technology development may be on Mineral Safeguarding areas6. The need for HRA had also been highlighted.

#### Other considerations

The former industrial area within Stanlow oil refinery could display potential contamination issues. This would be investigated further as part of the planning application review process, on an ad hoc basis.

### 3.3.5 Water Resources West and UU water resources (26/01/2024)

#### Awareness of HyNet

WRW and UU were presented with a slide pack on the project background, history and scope, followed by the evidence baseline on water availability and water quality, current state of the environment and forecast water demand for low carbon technology. The maps on the slide pack covered both hydrogen production and carbon capture.

A query was raised on the hydrogen production project in Runcorn that WRW weren't aware of. The EA confirmed this was the green hydrogen production project proposed by the Grenian Green Energy part of Progressive Energy.

EA confirmed the hydrogen production capacity of 30MW which WRW were not aware of.

#### Water availability considerations

WRW were aware of the Essar EET, Protos, Ineos, Viridor projects and requested more granular information on water demand figures that were presented from published research.

WRW suggested that the EA recheck the requirement of 0.16 Ml/d for 20MW of hydrogen production up to 2030 for the hydrogen production plants in Cheshire, Trafford and Runcorn as they believe this figure underestimates the likely demand.

WRW confirmed they have worked with the CCSA, Energy UK and Progressive Energy to work out a range of water demand figures for different types of low carbon plants.

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[6] Mineral safeguarding areas are areas of known mineral resources that are of sufficient economic or conservation value (such as building stones) to warrant protection for generations to come.

WRW have taken data from the regional plan to prioritise engagement work with abstractors in specific catchments. These include the Weaver, Dane and Gowy. They consider these catchments to be their highest priority for any ongoing work. There is an interesting overlap of issues affecting these catchments involving environmental constraints, the catchments are dominated by non PWS abstractors in terms of consumptive abstraction, and large amounts of water abstracted from the catchments is for the chemicals sector. They are already expecting additional pressures from low carbon technology projects. WRW are undertaking a programme of work to engage with abstractors in order to understand their current water resource issues and their plans for future growth or plans to cut back their water use. WRW are running a joint project with the catchment partnership to raise WRW's profile and reach more abstractors, they intend to put comms out soon on this project.

WRW mentioned that broadly across WRW region there is enough water to go round. All the growth WRW have projected for all sectors is less than the water available for one example catchment and significantly less than the demand reductions that water companies have in their plans. However, there is a complication, there is uncertainty over the abstraction licences coming up in the future. Environmental Destination will potentially change abstraction licences to make sure they comply with Water Framework Directive requirements now and looking ahead to the longer-term challenges of climate change and lower flows to ensure that environmental protection can remain in place.

WRW mentioned secondary use of water, one abstractor has a licence with a historical agreement to supply a neighbour with water.

UU mentioned that they have received applications from the EET project and Protos project on water supply for parts of the projects they have funding for. For this area of HyNet the water demand figure they have received is for 30ML/d, UU have included this figure in their forecast. The water is currently available for supply. The water supply/demand balance is tight they have reached the end of their surplus, further demand would require additional abstraction to supply further low carbon technology projects.

UU mentioned that the water supply to the HyNet and Protos projects asks abstractors to consider three options if they require more water: either choose a designated source, UU to make upgrades to the network, or the projects themselves offset the demand by reducing water use and finding an alternative source such as water reuse. UU relies on information from local planning authorities for water demand figures.

UU mentioned that the water demand from the Protos site is speculative.

UU are not considering desalination or groundwater abstraction due to environmental constraints. UU are not considering water transfers from Welsh water companies. The water abstraction from the Dee is for UU.

WRW mentioned that low carbon technology would attract secondary services who choose to move to the area due to the availability of hydrogen supply and a transportation system for captured $CO_2$. These secondary services will place additional pressure on water demand.

#### Wastewater arisings considerations

Not discussed.

#### Other considerations

WRW discussed the catchment licence reviews under the EA Environmental Destinations work. The EA are working out how these catchment licence reviews will work. Water abstraction licences work to common end dates, the catchment license reviews will happen in the next two years. It is possible that abstractors will have their licenses changed which could have knock on consequences for operations. There is uncertainty at the moment about which abstractors will be affected. Indications from WRW looking at Catchment Abstraction Management Strategies (CAMS), those catchments flagged as red will be affected. There could be a significant impact on abstractors as a result of the water company abstraction reduction work regarding non-PWS (Public Water Supply) abstractions reduction by catchment. WRW's advice to the EA is that the catchment reviews are prioritised as this will impact investor confidence of low carbon projects if there is no guarantee that water can be supplied for the lifetime of the plant.

WRW have not forecast for demand on PWS if non PWS use is reduced.

From early EA water licence reviews, WRW took a high-level estimate on future water abstraction licence loss of 300ML/d across the WRW region, of which 1/3 could impact UU.

WRW asked that the EA keep them informed on our water demand forecasts and external messages to present a consistent messaging and for updates from the EA catchment licence reviews.

### 3.3.6 United Utilities – wastewater (04/03/2024)

The notes below cover engagement with UU's wastewater teams.

### Awareness of HyNet

UU has had conversations with the HyNet industries regarding water demands. UU gained an approximate idea of volumes of water required such as for water washing, etc.

UU was only aware of the water supply requirements of HyNet and the Protos sites through its water resource management planning. UU was later able to factor in a fixed volume of water in their planning once the water requirements from HyNet were made known. However, for wastewater management plans, the requirements for HyNet or Protos were not included due to the unknown volumes of trade effluents. UU are currently not aware of any extension of sewage systems to Cheshire and Protos Park where the HyNet plants are situated.

### Water availability considerations

Agreements were made between UU and developers of two companies within HyNet for supply of water. The discussion between UU and developers only revolved around the water availability required for the processes in hydrogen production and did not involve wastewater arisings. The agreement was to fulfil complete water supply requirements at the current capacity of the companies' hydrogen production, and UU indicated that they would not be able to provide the full volumes of water requested if their plants ramp up to their expected capacities over the next 10-15 years.

The estimated volume for water supply, within UU's existing license condition for the non-potable water system, is a maximum of 31 megalitres/day for the phase 1 and 2 requirements of the HyNet and Protos development. When HyNet works at full capacity, UU estimated the water demand would be approximately 141 megalitres/day (by 2030) which would not be possible to supply with UU's current license.

The concern for UU, in terms of delivering the license maximum for HyNet and running the system, is the effects on supply of water to the other important customers who are supplied off the same system. The water in this system is abstracted from the River Dee and through a pumping station at Heron Bridge supplies all the assets connected, including the only treatment works which goes into public supply on the Wirral.

The drought triggers at River Dee, estimated as 1% annual risk, cause a supply risk in which case UU would bring in water from other regions to support its network.

### Wastewater arisings considerations

No comments.

### Other considerations

No comments.

# 4.0 Conclusions and Recommendations

After conducting 17 workshops and meetings involving around 250 stakeholders, several themes have emerged regarding water availability and wastewater management within HyNet.

Wastewater management has not been considered in detail in the planning stages by most HyNet developers (see Table 4.1 for summary). Overlooking this aspect could require modifications to existing permits or necessitate new permits, potentially causing significant delays to HyNet. Most developers have not yet detailed the composition and potential pollutants within their wastewater discharges.

Water demands and potential sources of water have been considered in more detail by companies involved in HyNet. Most companies indicated their preferred water source. HyNet companies have also explored technological processes that minimise water usage. Water re-use was being considered, however, desalination does not currently appear to be part of company plans. It was suggested that focusing on known developments within HyNet would lead to underestimates of likely future water demand – many projects are not yet publicly known.

The impacts of climate change on future water availability and future discharges from HyNet were rarely mentioned in the workshops. Some consideration of future flood risk and temperature was evident.

Across each of these issues, stakeholders noted the inherent uncertainties in predicting future water demands and environmental impacts of HyNet, and that these uncertainties need to be clear in any reports from this work.

Local authorities in the region currently do not have clear, specific policies related to HyNet in their local plans. Water Resources West and United Utilities, however, had considered HyNet in their planning where details were available at the time of assessment.

Suggested improvements to policy were made, to remove potential barriers to HyNet's development:

- Application of common end dates to abstraction licences was a key concern. Investors may choose not to invest in HyNet if water cannot be guaranteed throughout the operational life of an asset.

- Concerns were raised around strategic water transfers and their failure to consider industry needs. Focus of Strategic Resource Options (water transfers) on public water supply needs was considered limited by some attendees.

- How can re-use of effluent from wastewater treatment works and other industry be incentivised?

- Holistic environmental impact assessments were discussed, to enable a balanced assessment of the overall impacts of HyNet on the environment, encompassing impacts to water, Biodiversity Net Gain, Net Zero, etc. This was suggested as an alternative to focusing on water or air quality independent of other environmental issues. This is likely to require further collaboration between Natural England, Natural Resources Wales, Environment Agency, and Defra.

- An in-combination assessment of the impact of all discharges from HyNet was suggested, to better understand the likely overall environmental impact, as opposed to assessing each site individually.

All information provided during the meetings has been taken in good faith and has not been independently verified.

Stakeholders were supportive of these early discussions about HyNet. Addressing these concerns promptly could mitigate potential delays, ensure compliance with regulatory standards, provide investors with confidence in the long-term sustainability of HyNet, and ultimately facilitate the successful realisation of HyNet.

**Table 4.1 Summary of insights into likely water demand, wastewater arisings and water sources for planned HyNet assets.**

| Asset (Company) | Type | Water Demand | Wastewater arisings | Preferred water sources | Other comments relating to water environment |
|---|---|---|---|---|---|
| Essar/ Vertex (EET Essar) | Blue Hydrogen | No numerical values given. | Essar Plant currently has two discharge consents: one to a water course and one to sewer. They plan to use both. No new pollutants anticipated, c.f. those currently produced at the refinery as they currently handle amines. No solid waste emissions planned except solids removed from treatment of condensate from the carbon capture plant which is essentially solid containing catalysts down to 0.5 micron, recyclable into cement manufacture. Where raw water is treated, removed solids are currently sold to a local farm as fertiliser. Plan to continue this. | Initial hydrogen production plant (HPP1) has enough water from an existing UU consent from the River Dee. Approx. 25,000 t/day secured - enough for HPP1 but not the second hydrogen plant (HPP2). Considering alternative sources for HPP2, inc. groundwater abstraction through an underused abstraction licence and rainwater harvesting; report on this due by end March 2024. Desalination being considered but unlikely, except for cooling. Essar hold abstraction licences for Thornton Brook and River Mersey but neither will be used.<br>A carbon capture and storage plant is also being developed assuming no additional water, hence air cooling will be used. Hydrogen production will require a clean water supply and water from UU will initially be used. | Essar/Vertex has a ten-year plan, including permit changes that might be needed. Beyond 2030, plans are less clear. |
| Cheshire Green | Green Hydrogen | Typically for this electrolytic process, | Not clear what wastewater is likely to arise as containerised | Public water supply. As the scale of the plant is not large, there have been no | - |

| Asset (Company) | Type | Water Demand | Wastewater arisings | Preferred water sources | Other comments relating to water environment |
|---|---|---|---|---|---|
| Hydrogen, Protos Park, Ince (Progressive Energy) | | 20 litres of water would be required to produce a kg of hydrogen. (The stoichiometric limit for electrolysis is 9kg of water to 1kg hydrogen.) 50% of the water used is rejected from the water treatment process and the rest goes into producing hydrogen. The Cheshire green hydrogen project is a 30 MW electrolytic hydrogen project. | technology being used and few details of treatment available. Water fed into the process is drinking water quality and through the process minerals are removed. Waste product is a concentrated stream which is considered readily dischargeable due to high quality of input water.<br>No nearby foul drainage, so wastewater may be discharged into local SuDS network, and from there into river. Progressive Energy conducted six months of water quality assessments of the river and was able to verify using H1 assessment that further wastewater treatment during the electrolyser process was not required and the waste stream could be directly discharged into the rivers. Copper was one of the main effluent concerns, but assessment found that the level of copper in the wastewater was very low compared | issues in securing water supply from UU. Process requires high quality inlet water. | |

| Asset (Company ) | Type | Water Demand | Wastewater arisings | Preferred water sources | Other comments relating to water environment |
|---|---|---|---|---|---|
| | | | to the flow rate and volumes in the river. | | |
| Carlton Power, Trafford Green (-) | Green Hydrogen | Water required for the electrolysis at Trafford is 2.5 litres/s for a 15 MW project. Based on the proposed electrolyser process, for a 5 MW block, 1300 kg/h of potable water supply would be required. | Reject from the water purification process would be approximately 335 kg/h. The RO reject from the electrolyser would be discharged as 125 kg/h of reject water. Both kinds of reject water would be sent into the sewer. (This appears to be less than 2.5 l/s.) Small quantities of wastewater from the electrolysis process suitable for the sewage system in Trafford. | For all projects, water is to be sourced from UU's public water supply. The option of abstracting water for bigger units would also be considered. | - |
| Inovyn CV, Quill II, Runcorn (Ineos) | Green Hydrogen | No additional water required for hydrogen *storage* at Runcorn. | Not discussed. | Average of 70,000 m$^3$/day of water can be abstracted by Ineos across all three of its permits, from three water bodies. Brine production averages 2,000 m$^3$/day (lower than before). Water from rivers is solely for brine production. Potable water required for cooling towers and water for other processes in the chlorine/hydrogen plant and salt plant are obtained from River Dee water connections and UU, which provides more than sufficient | Ineos abstracts water from rivers and offers it to Tata chemicals at Lostock who use the water as a coolant by passing |

| Asset (Company) | Type | Water Demand | Wastewater arisings | Preferred water sources | Other comments relating to water environment |
| --- | --- | --- | --- | --- | --- |
| | | | | supply. Ineos believes its current abstraction permit offers enough capacity for their future needs up to 2050. However, no analysis has been done to date on the impacts of climate change and whether low flows, especially in summer, might impact whether abstractions can take place. | the river water through their heat exchangers. Ineos then uses that warm water for solution mining. |
| Kellogg's, Trafford Park (Progressive Energy) | Green Hydrogen | - | Located at the existing manufacturing sites and these sites already have drainage networks or wastewater treatment processes or demineralisation plants, thus the wastewater here would not be directly discharged into local environment. | Water required is taken from the co-located manufacturing sites which have excess water supply. In the future, Progressive Energy would investigate treating raw water to be fed into the process rather than potable water supply. | - |
| Pilkington's Glass, St Helen's (Progressive Energy) | Green Hydrogen | - | | | - |
| Connah's Quay (Uniper) | Carbon capture | - | - | - | - |

| Asset (Company) | Type | Water Demand | Wastewater arisings | Preferred water sources | Other comments relating to water environment |
|---|---|---|---|---|---|
| Protos Encyclis ERF (Encyclis) | Carbon capture | No large water demand for the carbon capture facility as Encyclis uses an external service for the provision of water for oxygen removal from the $CO_2$. Effectively zero water demand for the carbon capture as water comes from drops from the flue gas from the ERF or through wet gas combustion; the processes generate lots of water which is reused elsewhere. | No foul wastewater discharge from the carbon capture facility. Clean surface water is discharged into the drains near the Ince Protos Park. Based on a FEED study conducted, the effluents from the water treatment processes on site could be used within the overall process. Any excess foul water to be discharged is collected in a cesspit. There is no foul sewer connection. Encyclis is looking into options for either tankering the liquid waste stream from the cesspits on site to a licensed facility or working with an external service to reclaim the waste to be reused. | Sufficient water is available for existing operations. The supply of water is obtained from the utilities' supply through the ERF. Water from boiler blow downs is of good quality that generally goes to process effluent. This could be utilised within the processes as the connection between the two water systems enables the 'water balance'. Based on the current design, the effluent produced from the ERF is reused. External cooling sources not thought to be required. | - |
| Viridor ERF (Viridor) | Carbon capture | Volumes not given, but technology described. | Purge from cooling towers will pass to water treatment facility. Sludge from acid wash (amine) will be disposed of off-site. Cooling tower | Supplied by Inovyn Ineos, abstracted from R. Dee. Viridor in discussion with Inovyn about further supply. | Proprietary amine solvent likely to be used, |

| Asset (Company ) | Type | Water Demand | Wastewater arisings | Preferred water sources | Other comments relating to water environment |
|---|---|---|---|---|---|
| | | | effluent discharged to Manchester Ship Canal. | | FEED study planned to test. |
| Evero EfW/MHI, BECCS, Ince (Evero) | Carbon capture | 51 $m^3$/hr additional potable water required for carbon capture plant (this is a maximum not annualised value). | Process water effluent, discharged at 5 $m^3$/h, that cannot be further recycled in Evero’s water recycling treatment plant, would potentially be discharged into the Manchester Ship Canal. The water quality is thought to be suitable for discharge into a watercourse; at no point do amines meet the process water. Evero intends to advise on temperature or flow impacts. Also considering disposing the effluent into a local drain at Protos Park. Concentrated sludge from the water recycling process is periodically tankered for disposal. The spent solvent stream is also expected to be tankered away periodically.<br>Hope that process water effluent from the water wash at the | In discussions with Peel, an infrastructure developer, about whether the existing network capacity for Protos can cover anticipated water demand (acknowledging the demand from other developments). They understand Peel are exploring opportunities to reinforce network capacity with United Utilities.<br>They do not anticipate having to apply for and operate under an abstraction license. | - |

| Asset (Company ) | Type | Water Demand | Wastewater arisings | Preferred water sources | Other comments relating to water environment |
|---|---|---|---|---|---|
| | | | absorber tower can be discharged to UU sewers, with approval.<br>On site effluent treatment and reuse have been considered in their base design. | | |
| Padeswood Cement Works (-) | Carbon capture | - | - | - | - |
| Winnington CHP with CCU (-) | Carbon capture | Water demand of the carbon capture unit is about 1000 $m^3$/hr, pumped from the river. | Considering if acid wash systems should be used for the carbon capture plant but not seen as ideal due to potential wastewater stream which would have to be treated and perhaps discharged into nearby rivers.<br>Acid wash wastewater would be disposed into United Utilities' sewer network. No amine emissions expected from the absorber. | River water for cooling at Winnington site and for gas turbines. Winnington site uses condensate recovered from the 'Lostock site'. British Salt abstracts water from the River Wheelock for cooling.<br>The abstraction license at the Winnington site only allows supply for the Winnington bicarbonate plant and the carbon capture unit. The Grade 1 water supplied for CHP is from a third party with their own abstraction license.<br>Other sources of water have been considered such as rainwater harvesting and groundwater. | Planning permission for a larger sodium bicarbonate plant being considered. |

| Asset (Company) | Type | Water Demand | Wastewater arisings | Preferred water sources | Other comments relating to water environment |
|---|---|---|---|---|---|
| Ince Low Carbon Power Project | - | - | - | - | - |
| Hydrogen Storage (Ineos) | Hydrogen storage | Expected to begin solution mining by 2027. Once this starts, water demand would not change as Ineos would displace its existing brine production. | Calcium or magnesium carbonate removed while purifying the brine at Lostock is sent down local boreholes and - as permitted by the EA - small amounts of brine are disposed down old, depleted boreholes or purged 'along the way to the drainage system'. Limited consent to discharge into Waybrook. Hold two discharge licenses, one each for saltworks and chlorine production which allows brine discharge into Mersey. The purge from Runcorn saltworks ends up in the Mersey. This purge is from the salt evaporation process which would make it a strong brine that contains sodium sulphate and other impurities. The Runcorn site uses the provided brine for chlorine | Water from rivers is solely for brine production. Potable water required for cooling towers and other processes in the chlorine/hydrogen plant and salt plant are obtained from River Dee water connections and UU, which provides more than sufficient supply. Ineos believes its current abstraction permit offers enough capacity for their future needs up to 2050. However, no analysis has been done to date on the impacts of climate change and whether low flows, especially in summer, might impact whether abstractions can take place. Ineos abstracts water from rivers and offers it to Tata chemicals at Lostock who use the water as a coolant by passing the river water through their heat exchangers. Ineos then uses that warm water for solution mining. | Currently brine demand is low, and if demand for gas storage increases, Ineos is able to purge brine to the Mersey and develop gas storage quickly. Currently, salt mines for hydrogen production are not viewed as |

| Asset (Company ) | Type | Water Demand | Wastewater arisings | Preferred water sources | Other comments relating to water environment |
|---|---|---|---|---|---|
| | | | and hydrogen production via electrolysis. The existing membrane electrolysis process produces a weak waste brine which is treated in a weak brine treatment plant, where the pH is adjusted, and is then discharged into the western canal where ultimately it flows into the Mersey. There is an agreement with the EA regarding the amount of brine allowed to be discharged into Western canal and Mersey, and this is currently maintained under the limit. | | financially viable by Ineos. |