

Draft

Drought Plan 2020:

Annex 1a – North Eryri Ynys Mon WRZ

March 2019

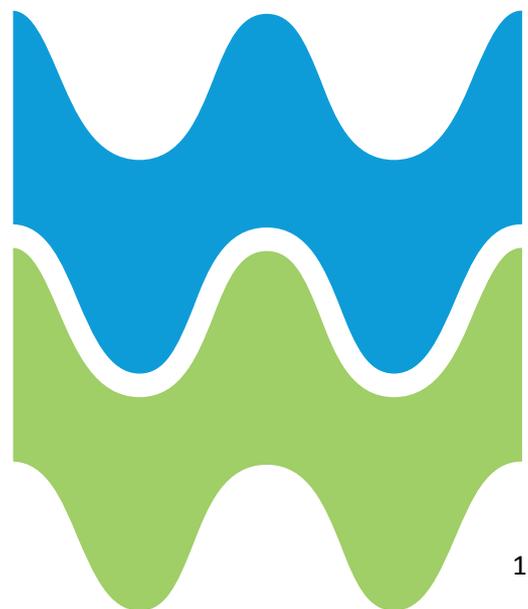


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1. North Eryri Ynys Mon – WRZ Reference no. 8001

1.1. North Eryri Ynys Mon (NEYM) Water Resources Overview

This Water Resource Zone covers the mainland adjacent to the Menai Straits (North Eryri) and Anglesey (Ynys Môn), including the major towns of Bangor, Caernarfon and Holyhead (see Figure 1).



Figure 1 - Map of the North Eryri Ynys Mon WRZ

The water resources within the zone consist of five impounding reservoirs (Ffynnon Llugwy, Llyn Cwellyn and Llyn Marchlyn Bach on the mainland and Llyn Alaw and Llyn Cefni on Anglesey). We also have one mothballed source on the Afon Rhythallt. A list of our raw water sources for the zone is presented in Table 1.

Site Name	Licence No.	Source Type	Status
Ffynnon Llugwy	23/66/8/0010	Impounding Reservoir	Operational
Llyn Cwellyn	23/65/15/0024v2	Impounding Reservoir	Operational
Marchlyn Bach	23/65/16/0071	Impounding Reservoir	Operational
Llyn Alaw	23/102/6/0006	Impounding Reservoir	Operational

Llyn Cefni	23/102/2/0007	Impounding Reservoir	Operational
Afon Rhythallt	23/65/16/0009	River Intake	Mothballed

Table 1 - Licensed sources in the North Eryri Ynys Mon WRZ

The three reservoirs on the mainland feed into two water treatment works with the reservoirs on the island supporting two independent treatment works.

The reservoirs and their associated treatment works are operated conjunctively by using a set of rules which govern the amount of water we feed to each works, depending on the relative amount of water in storage. When stocks allow, the mainland reservoirs are prioritised as they can gravitate supplies across to Anglesey, minimising our operational costs. As the storage in the reservoirs on the mainland declines, the amount of water supplied to Anglesey is reduced or stopped altogether. This preserves the reservoir storage on the mainland to ensure that demand in this area can always be met. The use of Llyn Alaw and Llyn Cefni on Anglesey is increased to offset this reduction.

There are no exports of water from this zone. During dry weather we can import a small volume into the zone from Cwm Dulyn in the Llyn Harlech zone which helps to preserve the storage in Llyn Cwellyn.

1.2.Drought Triggers

During the drought of 2018 we made a number of temporary network improvements which increased the connectivity within the NEYM zone. Once all these schemes are made permanent we will essentially be able to supply most customers from at least two sources of water, giving us much more flexibility in how we operate and respond to different types of drought. We are in the process of modifying our operational control rules to ensure we make optimal use of our resources and draw from the right reservoir at the right time.

The Drought Action Zones (DAZs) for this plan have been defined for Llyn Cwellyn, Ffynnon Llugwy, Llyn Alaw and Llyn Cefni combined. This is a change from our last plan when individual reservoir DAZs were used and the drought status of the zone was determined by the storage levels against these DAZs in either Cwellyn on its own, or two of either Ffynnon Llugwy, Alaw or Cefni. With the schemes being made permanent the zone will be much more conjunctive and so it is now appropriate to assess the drought status using the combined reservoir storage position. The use of the DAZs are described in more detail in Section 2 of the main report and are shown below in Figure 2.

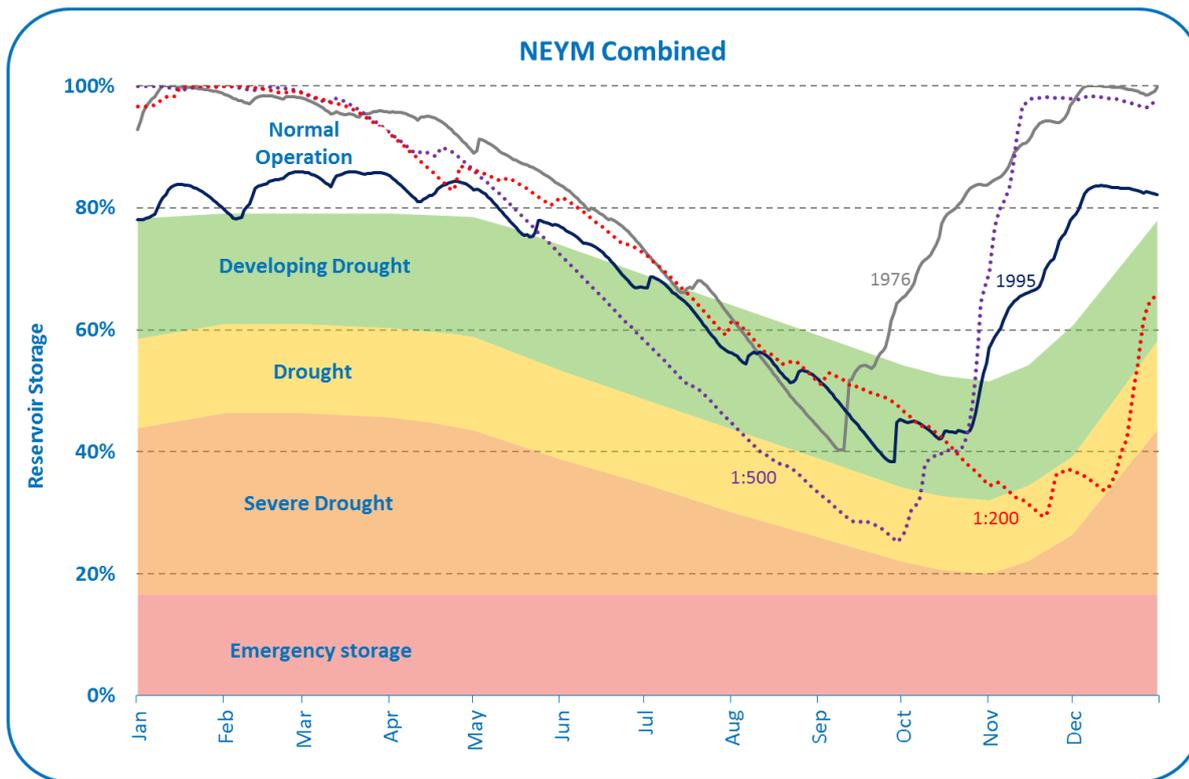


Figure 2 - NEYM Combined Reservoir Drought Action Zones showing the results of scenario testing

1.3. Assessment of Drought Risk

1.3.1. Scenario Testing

Using a stochastically generated time series, we've looked at the performance of our reservoirs against the most severe events in our historic record. Figure 2 shows a sample of results from the drought library scenario testing together with output from our baseline scenario testing. The plots show that the zone is resilient to historic events such as 1976 and 1995, and we're unlikely to need a hosepipe ban to preserve resource. The testing also shows that even under more extreme events such as a 1:500 year return period drought (i.e. a drought that has a 0.2% chance of occurring in any year) that we are unlikely to need to impose wide spread pressure management and local water rationing on our customers.

Although the risk of needing to implement extreme supply side measures is low during these more severe drought events, we need to ensure careful management of our water resources as reservoir storages will fall to very low levels. Based on this information we have therefore chosen to retain four drought order/permit options to provide additional support, should these ever be required. Section 1.5 provides details of these.

1.3.2. Drought Response Surface

As outlined in Chapter 3, application of the Drought Vulnerability Framework (DVF) screening methodology indicated that the NEYM WRZ is at high risk of significant drought impact and so advanced techniques (DVF method 1a) have been used to generate the data necessary to produce a Drought Response Surface (DRS) chart. Utilising DVF method 1a, long length time series of inflows (c 10,000

years) are produced using novel weather and flow generation techniques. As we are unable to run such a long timeseries through our WRAPSim water supply model, sub sampling was undertaken to allow the production of 'Drought Libraries' of 500 years' worth of 6, 12, 18, 24 and 48 month drought events, of varying return periods between 1:50 and 1:5000. These were then run through WRAPSim in order to provide the outputs necessary to produce the Drought Response Surface charts. Full details of the approach taken in North Eryri Ynys Mon are given in Appendix 1.

The DRS charts in Figure 3 and Figure 4 confirm that it would take an extreme drought event, greater than a 1:500 year return period, to cause the combined storage levels to cross into our Emergency Storage action zone. There is a slight risk for 18-24 month type events when Alaw and Ffynnon Llugwy reservoirs don't refill over the winter. Although the 48 month event for the 'ending October' scenario contains some failures, analysis of the individual events confirmed that this was entirely driven by the inclusion of a shorter (24 month) event within the four year period – i.e. it highlights the care required in interpreting the data used in these charts.

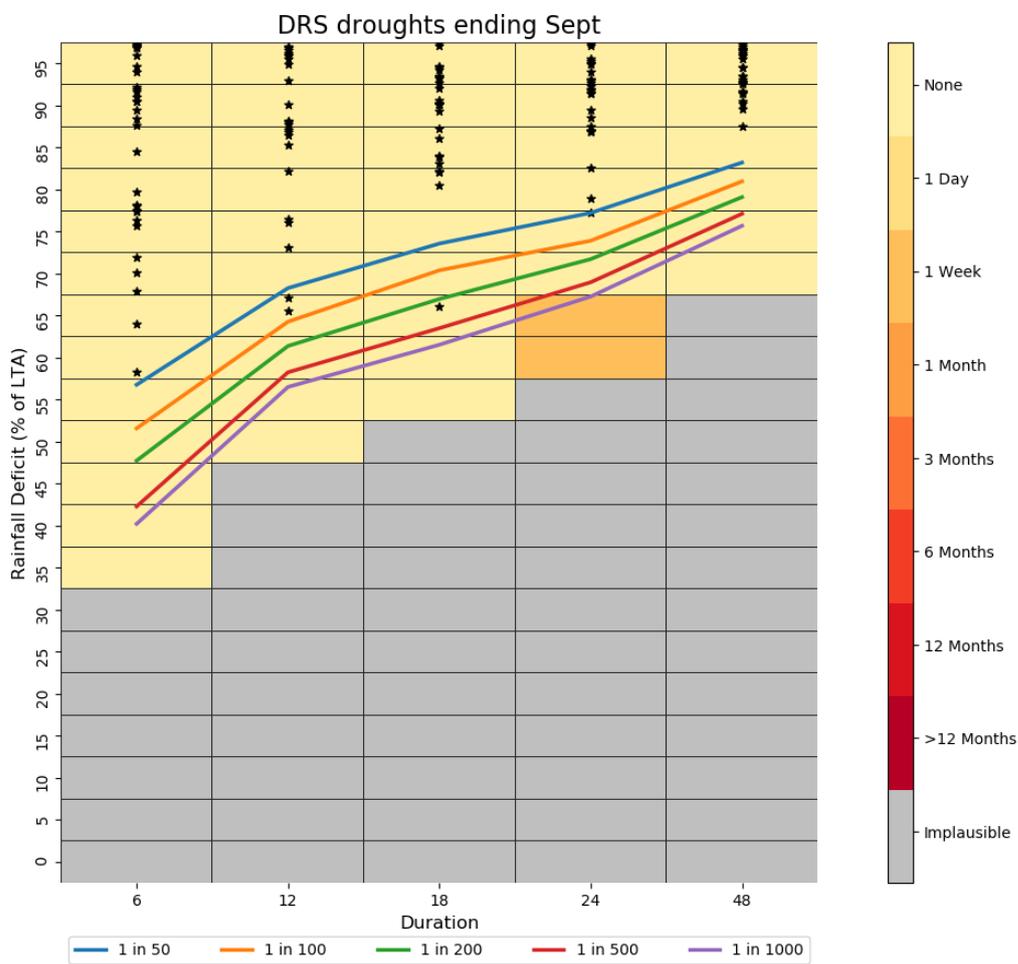


Figure 3 - NEYM DRS Chart for droughts ending September with climate change included

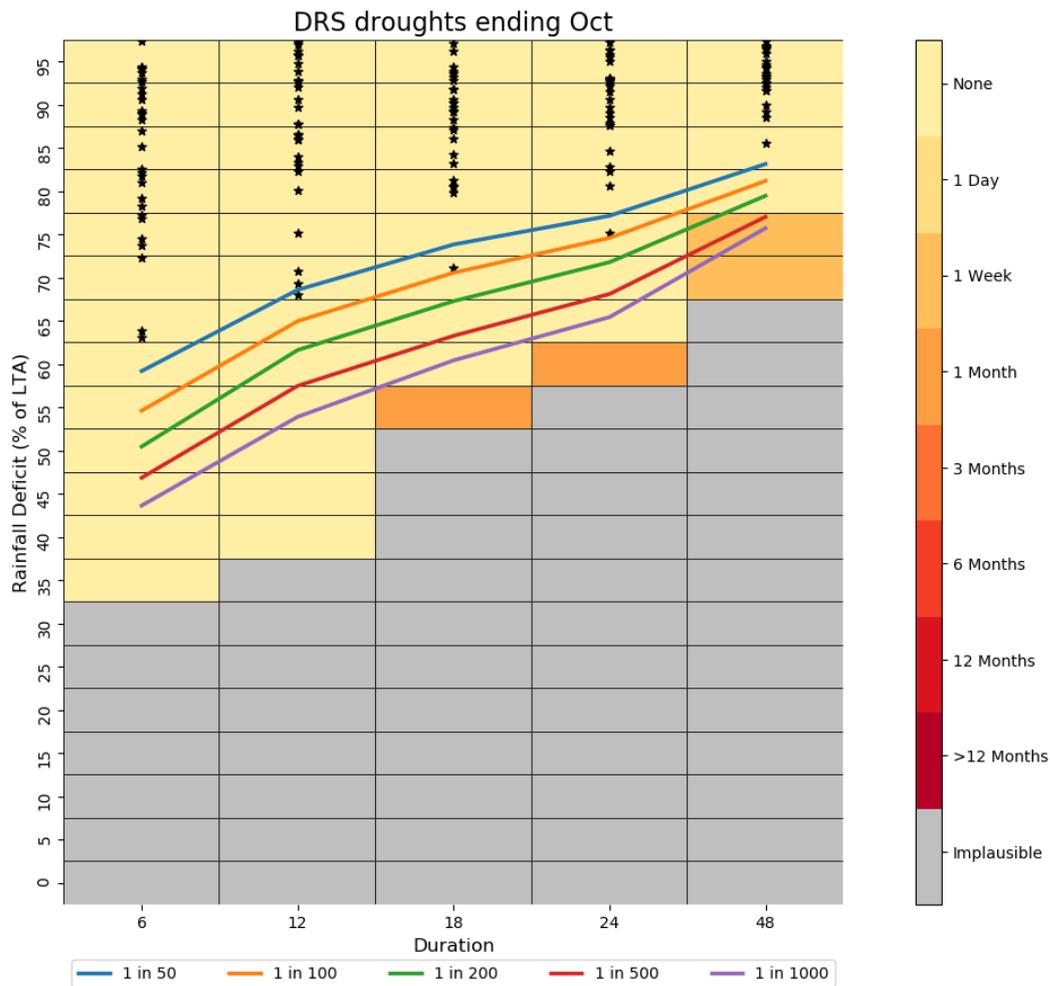


Figure 4 - NEYM DRS Chart for droughts ending October

The DRS charts in Figure 5 and Figure 6 show that with the inclusion of climate change there is a notable increase in risk for droughts 'ending September' under a 24 month scenario. The shape of the DRS also changes notably for the 12 and 24 month events, particularly for the droughts ending September as the predicted lower summer rainfall take effect.

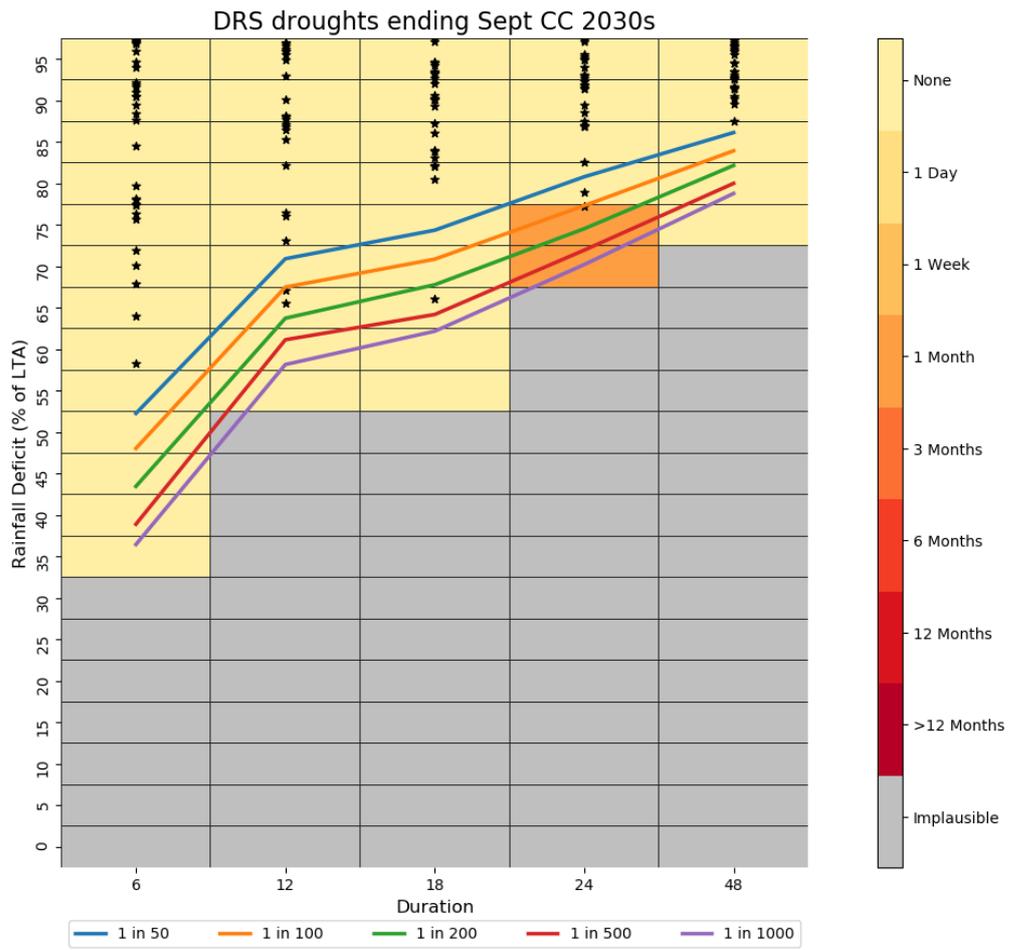


Figure 5 - NEYM DRS Chart for droughts ending September with climate change included

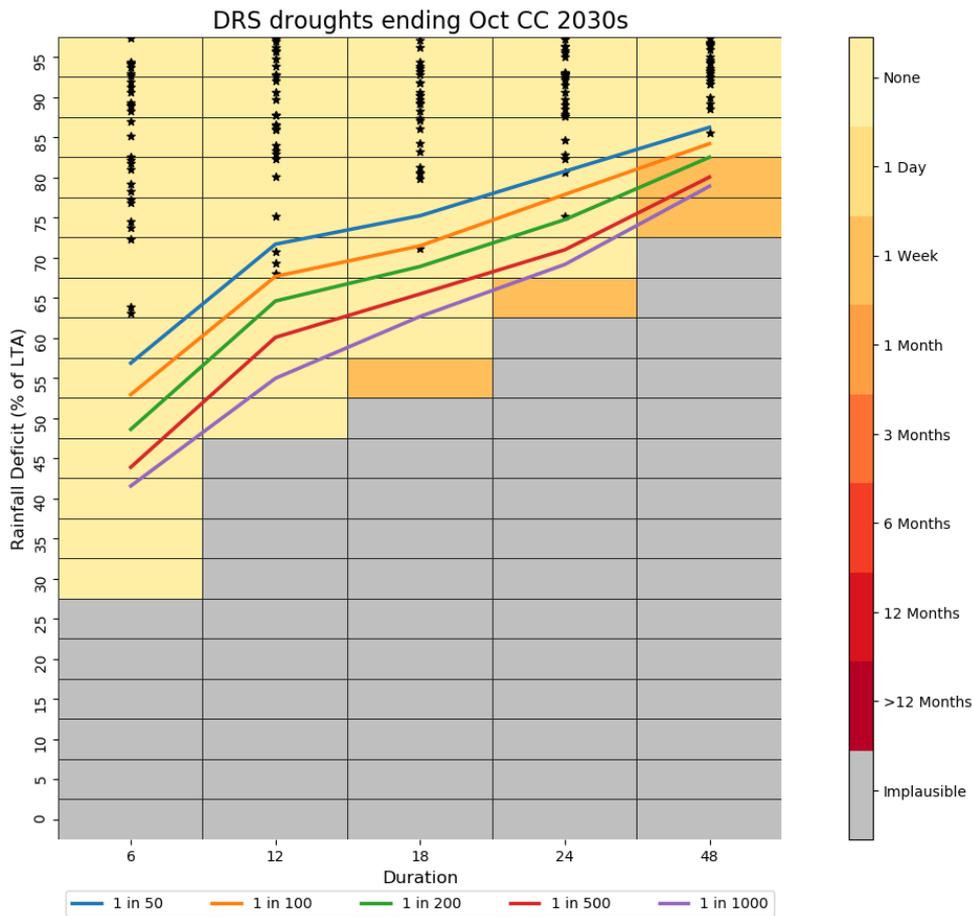


Figure 6 - NEYM DRS Chart for droughts ending October with climate change included

1.4. Drought Management of the WRZ

As the identified drought risk in the zone is relatively low then our management philosophy is to ensure we operate our water resources in line with our control curves and take all necessary actions in good time, in order to maintain this high level of drought resilience.

The following sections describe the operation of the zone as we move into a drought period and the actions that we will take to ensure that we minimise the impact on our customers. In the event of extreme drought, options to increase the quantity of water resource available for public water supply may be required – these are also outlined, with supporting summary information on the requirements of those options.

1.4.1. Normal Action Zone

During normal weather conditions we optimise our sources to minimise the cost of operations. In the NEYM zone this means that we make maximum use of Cwellyn and Mynydd Llandegai treatment works that gravitate supplies to our customers. As reservoir storages start to decline we stop transferring water over to Anglesey from the mainland and make more use of Alaw and Cefni treatment works.

The compensation release from Cwellyn is high relative to the storage available to us, as a result the reservoir draws down quickly during dry weather. The network schemes delivered during the summer 2018 were primarily due to concerns around storage levels in Llyn Cwellyn and so we can now better

support this reservoir. We are now able to supply customers in Tan y Coed and Waunfawr from Mynydd Llandegai water treatment works and use Cwellyn to just supply Caernarfon and Beddgelert. We can also import some treated water from Cwm Dilyn in the Lley Harlech zone to supply customers in the south of the zone which further reduces the water needed from Cwellyn.

1.4.2. Developing Drought Action Zone

As reservoir storages move into the developing drought action zone, we are more likely to have to carry out operations which are not usually undertaken and as a result this increases the risk of impacting our customers. To authorise these activities, the 'Gold' command centre may convene. In 2018 local action plans were provided to Gold command which instructed teams to commence a number of operations which are not routinely undertaken.

As the zone is almost fully conjunctive we can manage the reservoirs to ensure that they all drawdown at a similar rate. Initially this will usually mean stopping the transfer from the mainland across to Anglesey and making more use of Alaw and Cefni but if the dry weather continues we can bring water back on to the mainland and move water between the Mynydd Llandegai and Cwellyn zones.

Bringing treated water back onto the mainland from Anglesey to help supply Bangor from Cefni and/or Alaw adds to our overall resilience but although the pipework is in place, a temporary pumping station would need to be installed and so some planning and capital works would be required before this supply can be operational.

Pumping water from the Cwellyn zone to supply Deiniolen and the surrounding area would help reduce demands on Ffynnon Llugwy. This would require a temporary generator to be installed and so would also take time to implement. This option is most likely to be used during late summer/ autumn when Cwellyn is refilling/ spilling but levels in Ffynnon Llugwy may still be falling.

We are looking to make both the temporary pumping station and the temporary generator permanent during AMP 7, which will increase the speed at which we can respond to the developing drought conditions.

To supplement these changes to our supply systems we will increase our leakage targeting efforts to minimise losses in the network.

1.4.3. Drought Action Zone

In the Drought action zone we will continue to balance the storage across our reservoirs through the changes made to our networks, as described above. At this stage we will also start work to make use of our mothballed source (Afon Rhythallt) in any way to provide additional resource. This requires a significant amount of work as we will need to ensure that this source is compliant with drinking water quality governance prior to being used.

In the event that dry weather continues and our forecasts indicate that storage will continue to decline, we would then consider implementing temporary use bans (hosepipe bans) and will start preparations to request drought permits/orders. Our modelling shows that to reach this trigger we would be experiencing an unprecedented level of drought not seen in our historic records. These permissions from NRW and Welsh Government would enable us to take more water from the environment at Cwellyn and preserve more water within our reservoirs. To support these requests, we will commence environmental monitoring in line with our Environmental Assessment Reports (Appendix 5 to 8) and submit our applications for the options identified in Section 1.5.

1.4.4. Severe Drought Action Zone

As reservoir storage enters the Severe Drought Action zone, subject to receiving the necessary permissions from NRW and Welsh Government, we will consider implementing non-essential use bans and our four drought order/permit schemes. As set out in Section 1.5, the options available to us are: 1) remove the Llyn Cwellyn 10MI/d abstraction limit, 2) reduce the compensation flows at Alaw, 3) reduce the compensation flows at Ffynnon Llugwy and 4) reduce the compensation flows at Llyn Cefni. Option 1 removes the need to cut back supply from Cwellyn if all reservoir levels are low and we can't meet the demand from elsewhere. Options 2-4 all have the effect of preserving storage in our reservoirs which will enable us to maintain customer supplies for longer.

1.5. Supply-side drought management action

The following tables (Table 2, Table 3, Table 4 and Table 4) provide the information required by Appendix G of NRW's Water Company Drought Plan Technical Guideline (Dec 2017). The tables summarise the key information from within the associated Environment Assessment Reports (EARs) including any potential environmental impacts, risks to the scheme implementation and any necessary mitigation that may be required.

Action Implementation Assessment	Name:	Removal of Llyn Cwellyn 10 MI/d abstraction limit
	Trigger(s)	Combined storage of reservoirs in NEYM crosses into Severe Drought Action Zone.
	Deployable Output or yield of the action	2 MI/d yield
	Location	Cwellyn reservoir
	Implementation timetable	Preparation time: We assume a decision from NRW within 14 days of submitting the Drought Order application. The practical implementation of the option could be effected immediately. Time of year effective: The option is most likely to be implemented during May to October. Duration: Drought orders are valid for up to six months, but is most likely to be three months.
	Risks associated with action	The application, as applied for, is not approved Reduced storage in Llyn Cwellyn, which is designated as an SAC.
	Other considerations	N/A
Environmental Assessment: alone & in-combination	Risk to the Environment	Negligible – very slightly lower lake levels
	Summary of likely environmental impacts	The assessment has concluded that there is a negligible impact on river flows as a result of implementing the drought order. Consequently, there are negligible impacts on the physical environment of the river, including water quality.
	Baseline information used	Continuous monitoring is undertaken by Welsh Water to monitor its operations at Llyn Cwellyn and data sets include: <ul style="list-style-type: none"> • daily water levels at Llyn Cwellyn, from 1989 to date • daily abstractions at Llyn Cwellyn, 1987 to date. <p>The monitoring of compensation releases and the spill of excess water from Llyn Cwellyn is undertaken by Welsh Water immediately downstream of Llyn Cwellyn, and previously at a flow gauge at Nant Mills on the Afon Gwyrfai downstream of the impoundment and includes:</p> <ul style="list-style-type: none"> • daily mean river flows at Nant Mills from August 2000 to August 2012 (although there are concerns over the data quality at this gauge, due to weed growth and gravel accumulation) • daily mean river flows at Llyn Cwellyn Outlet from August 2012 to date. <p>Continuous monitoring of river level is undertaken by NRW at the Bontnewydd flow gauge on the lower Afon Gwyrfai. The measurement weir experienced a structural failure in 2005; the weir was rebuilt in late 2009 and river levels continued to be recorded thereafter.</p> <p>Available flow data includes:</p> <ul style="list-style-type: none"> • NRW Bontnewydd river flow gauge on the Afon Gwyrfai daily river flow from 1970 to 2005, and from 2010 to date following the reconstruction of the weir.
	Summary of additional monitoring requirements	<ul style="list-style-type: none"> • daily river flow at NRW's permanent Bontnewydd flow gauge on the Afon Gwyrfai • daily Welsh Water abstractions from Llyn Cwellyn • daily Llyn Cwellyn water level. • daily river flow at Welsh Water's permanent flow gauge downstream of Llyn Cwellyn

	Mitigation & Compensation measures	N/A
	Impact on other activities	It is anticipated that there will be no significant impacts of drought order implementation on landscape and visual amenity, recreation, or archaeology and cultural heritage. Impacts on angling, for both the reservoir and the river, are anticipated to be significant.
	Any permissions or approvals required and constraints that apply	N/A

Table 2 - Option 8001-2 Removal of Cwellyn 10Ml/d abstraction limit

Action Implementation Assessment	Name:	Reduction of Alaw compensation water to 1.7MI/d
	Trigger(s)	Combined storage of reservoirs in NEYM crosses into Severe Drought Action Zone.
	Deployable Output or yield of the action	1.5 MI/d
	Location	North Anglesey
	Implementation timetable	Preparation time: We assume a decision from NRW within 14 days of submitting the Drought Permit application. The practical implementation of the option could be effected immediately. Time of year effective: The option is most likely to be implemented during July to December. Duration: Drought orders are valid for up to six months, but is most likely to be three months.
	Risks associated with action	The application, as applied for, is not approved. Reduction in compensation releases have potential environmental impacts. These will be assessed through the EAR submitted with the application.
	Other considerations	N/A
Environmental Assessment: alone & in-combination	Risk to the Environment	Reduced flow in the Afon Alaw.
	Summary of likely environmental impacts	The hydrological assessment has concluded that there is a major impact on flows in the Afon Alaw as a result of implementing the drought permit. These hydrological impacts are assessed as leading to moderate impacts on the physical environment of the river, including minor beneficial impact on water quality. The environmental assessment has concluded that there are minor to major impacts on fish, moderate impacts on macroinvertebrates, macrophytes, on phytobenthos. Impacts on the Llyn Alaw SSSI and the Beddmanarch Cymran SSSI are assessed as negligible.
	Baseline information used	Continuous monitoring is undertaken by Welsh Water to monitor its operations at Alaw Reservoir, including: <ul style="list-style-type: none"> • Daily Alaw water level data, 1997 to 2016 (weekly data is available for 1983 to 1987) • Daily Alaw compensation flow data, 1991 to 2016 • Daily Alaw abstraction flows, 2000 to 2016. There is no continuous measurement of the Afon Alaw catchment flow downstream of the Alaw Reservoir. A very limited number of spot flow gauging results are available for locations within the Alaw catchment. The only continuous monitoring of river level undertaken by NRW on the Isle of Anglesey is at Bodffordd on the Afon Cefni. The Cefni catchment is located some 10km to the south of the Alaw catchment, however this gauging station represents the most relevant continuous river flow record to the study area. Available flow data include: <ul style="list-style-type: none"> • NRW Bodffordd river flow gauge on the Afon Cefni upstream of the Cefni Reservoir impoundment; daily river flow from 1988 to 2014 The reference conditions of Alaw Reservoir and the Afon Alaw catchment are summarised below, based on the available hydrological data as set out above.
	Summary of additional monitoring requirements	Reach 1 monitoring; <ul style="list-style-type: none"> • Macrophytes • Macroinvertebrates • Fish

	Mitigation & Compensation measures	<p>The mitigation measures that could be considered at the on-set of drought, during implementation of the drought permit and post-drought permit implementation include:</p> <ul style="list-style-type: none"> • Temporary reduction or cessation of the terms of the drought permit • Fish distress monitoring with triggers and response plan • Protection of 'spate flows' • Reduction of fish predation • Physical in-river works • Provision of alternative compensation flows • Provision of alternative water supplies if other water users are at risk of derogation. <p>Potential mitigation measures have also been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.</p>
	Impact on other activities	<p>It is anticipated that there will be no significant impacts of drought order implementation on landscape and visual amenity, recreation, or archaeology and cultural heritage. Impacts on angling, for both the reservoir and the river, are anticipated to be significant.</p>
	Any permissions or approvals required and constraints that apply	N/A

Table 3 - Option 8001-3 Reduction of Alaw compensation flow

Action Implementation Assessment	Name:	Reduce Ffynnon Llugwy compensation flow by 44%.
	Trigger(s)	Combined storage of reservoirs in NEYM crosses into Severe Drought Action Zone.
	Deployable Output or yield of the action	2 Ml/d yield
	Location	Ffynnon Llugwy
	Implementation timetable	Preparation time: We assume a decision from NRW within 14 days of submitting the Drought Permit application. The practical implementation of the option could be effected immediately. Time of year effective: The option is most likely to be implemented during July to December. Duration: Drought orders are valid for up to six months, but would be removed sooner if the risk to water resources was ameliorated sooner.
	Risks associated with action	The application, as applied for, is not approved. Reduction in compensation releases have potential environmental impacts. These will be assessed through the EAR submitted with the application.
Other considerations	N/A	
Environmental Assessment: alone & in-combination	Risk to the Environment	Reduced flows in the Afon Llugwy.
	Summary of likely environmental impacts	The hydrological assessment has concluded that there is potential for major impact on flows in the Afon Llugwy and moderate impacts on the physical environment of the river, including minor impacts on water quality. This has the potential to lead to major environmental impacts on Eryri SSSI, aquatic ecology, specifically: major impacts on fish and bryophytes, moderate to minor impacts on macrophytes and macroinvertebrates, as well as minor impacts for phytobenthos.
	Baseline information used	Hydrological data: <ul style="list-style-type: none"> • Daily Ffynnon Llugwy water level data • Daily Ffynnon Llugwy compensation flow data • Daily Ffynnon Llugwy abstraction flows • Spot flow gaugings • NRW river flow gauge on the Afon Conwy at Cwmlanerch Ecological data: <ul style="list-style-type: none"> • SSSI and SAC designation data • Bryophyte survey data • Macrophyte survey data • Macroinvertebrate survey data • Electric fishing survey data by APEM and NRW
	Summary of additional monitoring requirements	<ul style="list-style-type: none"> • Walkover survey during low flow conditions including mapping of sensitive habitats, communities, species and any monitoring sites that are required in order to improve understanding of the baseline communities. • Spot flow gauging surveys • Biochemical water quality sampling • Macrophyte surveys • Bryophyte surveys • Macroinvertebrate surveys • Fish surveys (including Atlantic salmon, brown/sea trout, other fish species)

	Mitigation & Compensation measures	<p>The mitigation measures that could be considered at the on-set of drought, during implementation of the drought permit and post-drought permit implementation include:</p> <ul style="list-style-type: none"> • Temporary reduction or cessation of the terms of the drought permit • Fish distress monitoring with triggers and response plan • Protection of 'spate flows' • Reduction of fish predation • Physical in-river works • Provision of alternative compensation flows • Provision of alternative water supplies if other water users are at risk of derogation. <p>Potential mitigation measures have also been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.</p>
	Impact on other activities	<p>Ffynnon Llugwy and the Afon Llugwy are within Snowdonia National Park. The reduction of the compensation release may affect the landscape and visual amenity by reducing the quantity of water cascading down the mountainous stream. This will only be temporary and will be ameliorated once the drought has passed.</p> <p>Any reduction in wetted width and depth of the watercourse may influence water-dependent recreational activities. However, water levels will be naturally low in times of drought and impacts will be temporary in nature.</p>
	Any permissions or approvals required and constraints that apply	N/A

Table 4 - Option 8001-4 Reduction of Ffynnon Llugwy compensation flow

Action Implementation Assessment	Name:	Reduce Cefni compensation flow by 50%.
	Trigger(s)	Combined storage of reservoirs in NEYM crosses into Severe Drought Action Zone.
	Deployable Output or yield of the action	0.9 Ml/d
	Location	Cefni reservoir
	Implementation timetable	<p>Preparation time: We assume a decision from NRW within 14 days of submitting the Drought Permit application. The practical implementation of the option could be effected immediately.</p> <p>Time of year effective: The option is most likely to be implemented during July to December.</p> <p>Duration: Drought orders are valid for up to six months, but is most likely to be three months.</p>
	Risks associated with action	The application, as applied for, is not approved. Reduction in compensation releases have potential environmental impacts. These will be assessed through the EAR submitted with the application.
Other considerations	N/A	
Environmental Assessment: alone & in-combination	Risk to the Environment	Reduced flow in the Afon Cefni.
	Summary of likely environmental impacts	<p>The assessment has concluded that there is a major impact on flows in the Afon Cefni as a result of implementing the drought permit. These hydrological impacts are assessed as leading to moderate impacts on the physical environment of the river, including minor beneficial impact on water quality.</p> <p>The environmental assessment has concluded that during periods when release from Cefni Reservoir is restricted to compensation flow only there are major impacts on fish, and moderate impacts on macroinvertebrates and macrophytes and minor impacts on phytobenthos. The impacts on Malltraeth Marsh / Cors Ddyga SSSI are assessed as minor and as major on the Dingle / Nant y Pandy Local Nature Reserve.</p>
	Baseline information used	<p>Continuous monitoring is undertaken by Welsh Water to monitor its operations at Cefni Reservoir, including:</p> <ul style="list-style-type: none"> • Weekly Cefni Reservoir water level data, 1983 – 1987 and daily levels from 1989 to present; • Daily Cefni Reservoir compensation flow data, 1998 to present; • Daily Cefni Reservoir abstraction flows, 2005 to present.
	Summary of additional monitoring requirements	<ul style="list-style-type: none"> • Walkover survey during low flow conditions - mapping of sensitive habitats, communities and species. • Biochemical water sampling • Fish surveys (including salmon, brown trout, lamprey, bullhead, eel)
	Mitigation & Compensation measures	<p>The mitigation measures that could be considered at the on-set of drought, during implementation of the drought permit and post-drought permit implementation include:</p> <ul style="list-style-type: none"> • Temporary reduction or cessation of the terms of the Drought Permit • Fish distress monitoring with triggers and response plan • Protection of 'spate flows' • Reduction of fish predation • Physical in-river works • Provision of alternative compensation flows

		<ul style="list-style-type: none"> • Provision of alternative water supplies if other water users are at risk of derogation. <p>Potential mitigation measures have also been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.</p>
	Impact on other activities	Because flows would be naturally low at the time of the drought permit, it is uncertain how significant further reduction in flows would be on the visual appeal of the rivers, and recreational activities in the area include angling, riding, cycling, walking and canoeing.
	Any permissions or approvals required and constraints that apply	N/A

Table 5 - Option 8001-5 Reduction of Cefni Reservoir Compensation flow