2

Eastern and Midlands Region

2.1 Introduction

In this section we introduce the Eastern and Midlands Region and describe the:

- Regional location in the national context;
- Projected population growth and economic development and how this is considered in our water resources planning approach;
- Natural water resources and the environmental status of our groundwater and surface water bodies; and
- Our water supply systems and the impacts of drought and climate change.

2.1.1 Regional Overview

Figure 2.1 shows the location of the Eastern and Midland Region for the purpose of the RWRP-EM. Section 2.3 of our Framework Plan describe the different spatial scales for the management of water supplies. To deliver our RWRP-EM, we have subdivided the Region into smaller management units to enable us to manage the process of identifying potential water supply solutions (Options) and the selection of our Preferred Approach to resolve our water supply and water quality deficits. These smaller units are referred to as Study Areas (SAs) (Figure 2.1). Nine (9) SAs have been defined in the Eastern and Midlands Region.

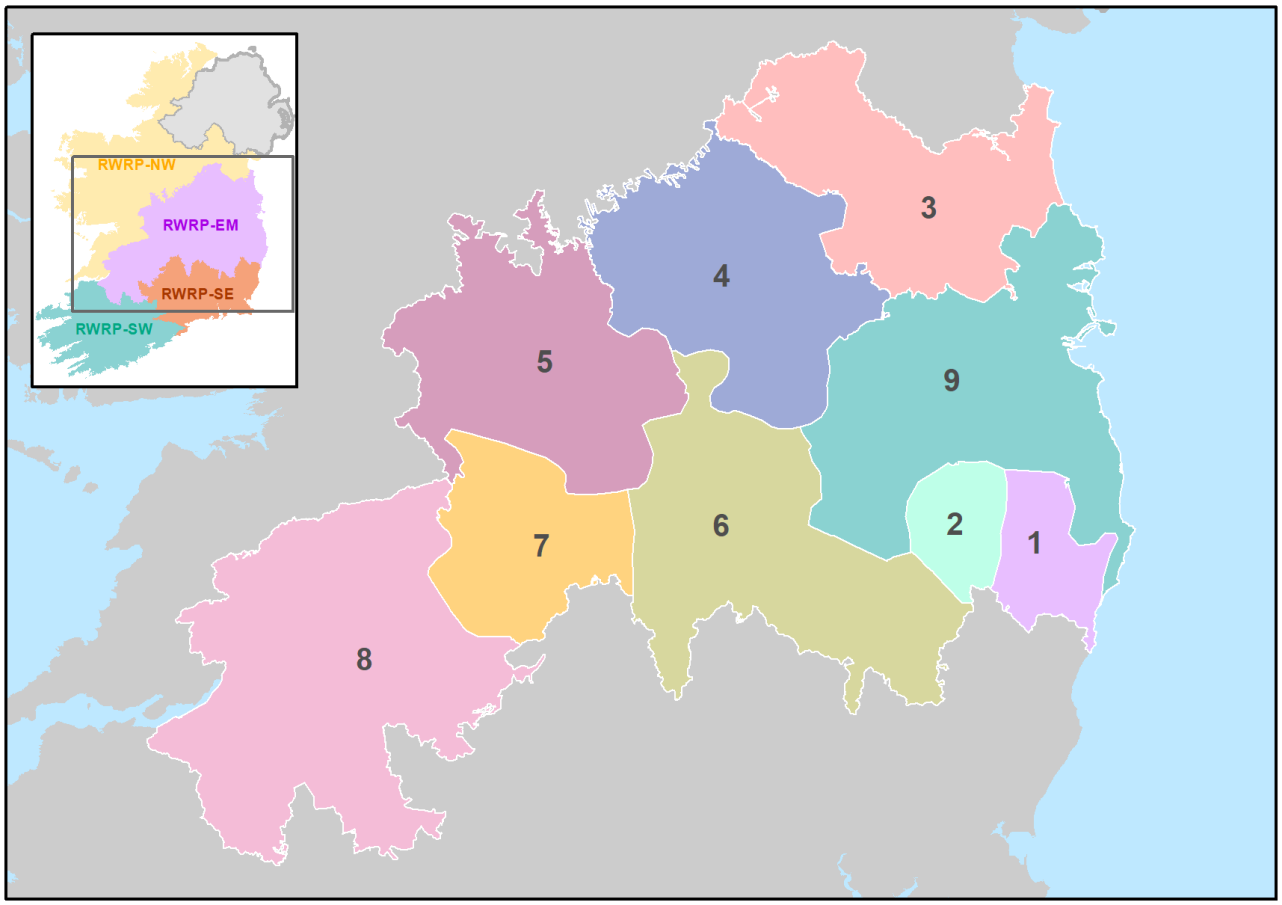


Figure 2.1 Location of the Eastern and Midlands Region

The RWRP-EM is the largest of the four (4) regions defined as part of the NWRP, both in land area and population size. It includes 19 counties encompassing 24 Local Authorities. The Eastern and Midlands Region covers approximately 20,900 square kilometres extending from the Shannon Estuary in the south west, towards the large River Boyne catchment and Greater Dublin Area (GDA) in the North East. The region is the primary economic region of Ireland containing Dublin (the capital city) and Limerick City which provide more than 1 million jobs. The National Planning Framework (NPF)[1] which underpins population growth that is economically, socially and environmentally sustainable (Section 2.2.2), has identified Drogheda and Athlone as two Regional Growth Centres in the Eastern and Midlands Region. They are supported by a strong network of Key Towns and provide secure employment and economic growth potential.

An overview of the key characteristics of the Eastern and Midlands Region is presented on Figure 2.2. The predominant land use is agriculture, representing about 75% of the total land area[2]. The region boasts extensive and diverse areas of natural beauty that support tourism and recreation, with natural habitats and forested areas comprising 11% and 9% of the land area respectively. Urban areas cover just over 4% of the region. The highest population density is located in the east including Dublin and the surrounding area. Irish Water supplies around 887 million litres of water per day to a population of 2.48 million people and 76,000 businesses in the Eastern and Midlands Region. This represents more than 50% of our total supply nationally. In some rural areas there are small communities served by group and private schemes that do not rely on Irish Water's networks.

2.1.2 Study Areas in the RWRP-EM

The nine (9) SAs making up the Eastern and Midlands Region are presented on Figure 2.3 and are described in Table 2.1. Each SA is made up of a number of Water Resource Zones (WRZs), which represent an area where supply and demand are largely self-contained. The determination of Study Area boundaries is discussed in Section 1.7. Almost seventy percent (70%) of the regional population is in SA9 which comprises Dublin City and the surrounding suburbs. The next most populated SA is SA8 containing Limerick City, followed by SA3 in which Drogheda is located (on the north east coast of the region).

Figure 2.2 Regional Overview

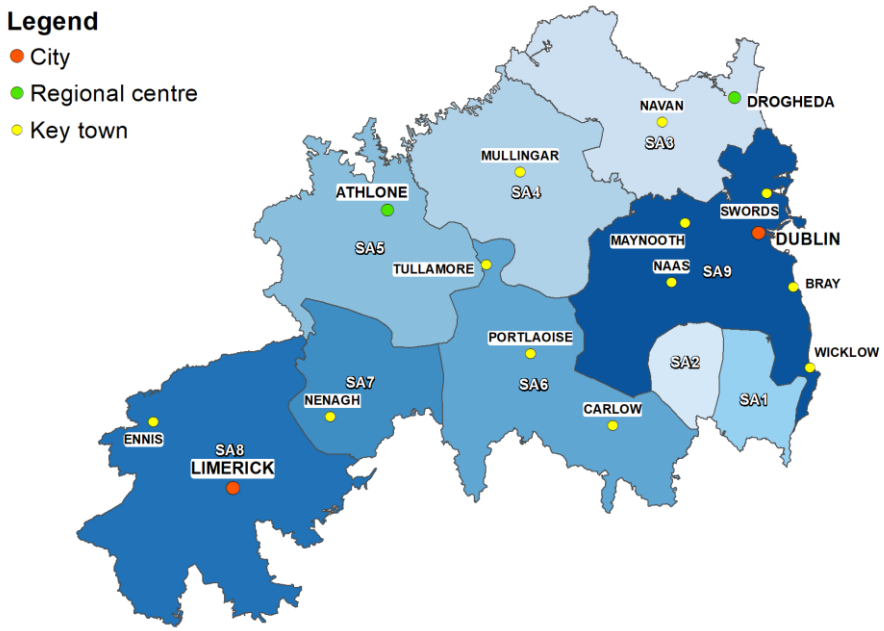


Figure 2.3 Study Areas of the Eastern and Midlands Region

Table 2.1 Study Areas of the Eastern and Midlands Region

SA No.	SA Name	Counties In SA	Total Population Served* (2019)	% of Regional Population	No. Of WRZs
SA1	Mid Wicklow	Wexford, Wicklow	24,050	1.0	18
SA2	West Wicklow	Carlow, Wicklow	6,840	0.3	12
SA3	Meath	Cavan, Louth, Meath	189,980	7.7	11
SA4	Westmeath	Londsford, Meath, Offaly, Westmeath, Kildare	87,870	3.6	13
SA5	Offaly/ Roscommon	Galway, Offaly, Roscommon, Westmeath	71,940	2.9	10
SA6	Laois	Carlow, Kilkenny, Laois, Offaly	126,670	5.1	28
SA7	North Tipperary	Galway, Offaly, Tipperary	31,240	1.3	10
SA8	Limerick Clare	Clare, Cork, Galway, Limerick, Tipperary	233,560	9.4	31
SA9	Greater Dublin Area	Dublin, Kildare, Meath, Wicklow	1,702,250	68.8	1

*Population numbers are rounded to the nearest 10

2.2 Growth and Development

2.2.1 Current Population

The Eastern and Midlands Region has a population of 2.48 million (60% of the national population), with 1.7 million people (almost 70% of the regional population) located within the Greater Dublin Area[3] and 1.17 million within Dublin City itself[3]. The next most populous area is Limerick City which has a population of circa 94,000 people. There are 23 settlements with a population of over 10,000 people, and a further 19 settlements with a population of over 6,000[3]. Twelve percent (12%) of the region's population live in settlements of less than 6,000[3]. Figure 2.4 shows the population density across the

region, highlighting smaller population centres and illustrating how much of the region is sparsely populated.

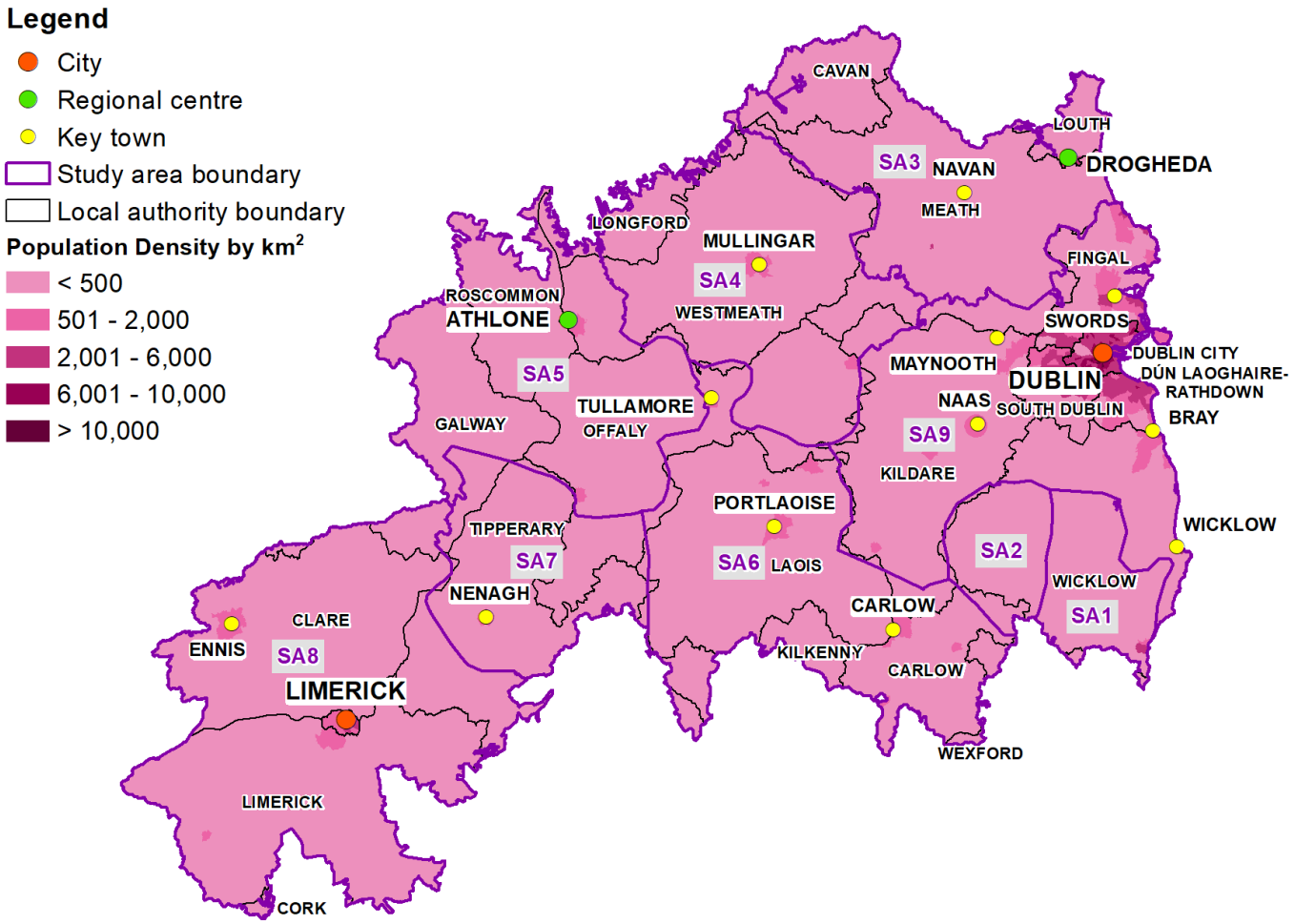


Figure 2.4 Population Density[3]

2.2.2 Growth and Economic Development Policies

Irish Water's National Water Resources Plan (NWRP), which will comprise this RWRP-EM and the three (3) other Regional Water Resource Plans (South West, North West and South East is being developed to ensure water infrastructure can support the proposed growth policies at national, regional and county level. Supporting the National Policy Objectives (NPOs) and Regional Policy Objectives (RPOs) within the National Planning Framework (NPF)[1] and Regional Spatial and Economic Strategies (RSESs)[4] is central to our RWRP.

The National Planning Framework (NPF)[1] is the overarching policy setting out priorities for growth and development at national level over a 25-year period to 2040. A key objective is balancing development across the three (3) regions with 50% of future growth and development concentrated in the Eastern and Midlands Region and the other 50% directed towards the North Western Region and the Southern Region. The objectives are then set out at Regional Level in the RSESs. At county level the regional policy is implemented through County/City Development Plans (CDPs), Local Area Plans (LAPs) and the Dublin and Limerick-Shannon Metropolitan Strategic Plans (MASPs). The County Development Plan sets out the priorities within each Local Authority area for development over a 6-year timeframe setting out local development requirements including Strategic Development Zones. The Office of the Planning

Regulator (OPR) then evaluates, assesses and makes observations on the RSESs, CDPs and LAPs (including growth projections) to ensure they are in accordance with planning policy.

The interaction between the planning system and Irish Water's plans and programmes is summarised in Figure 2.5 below.

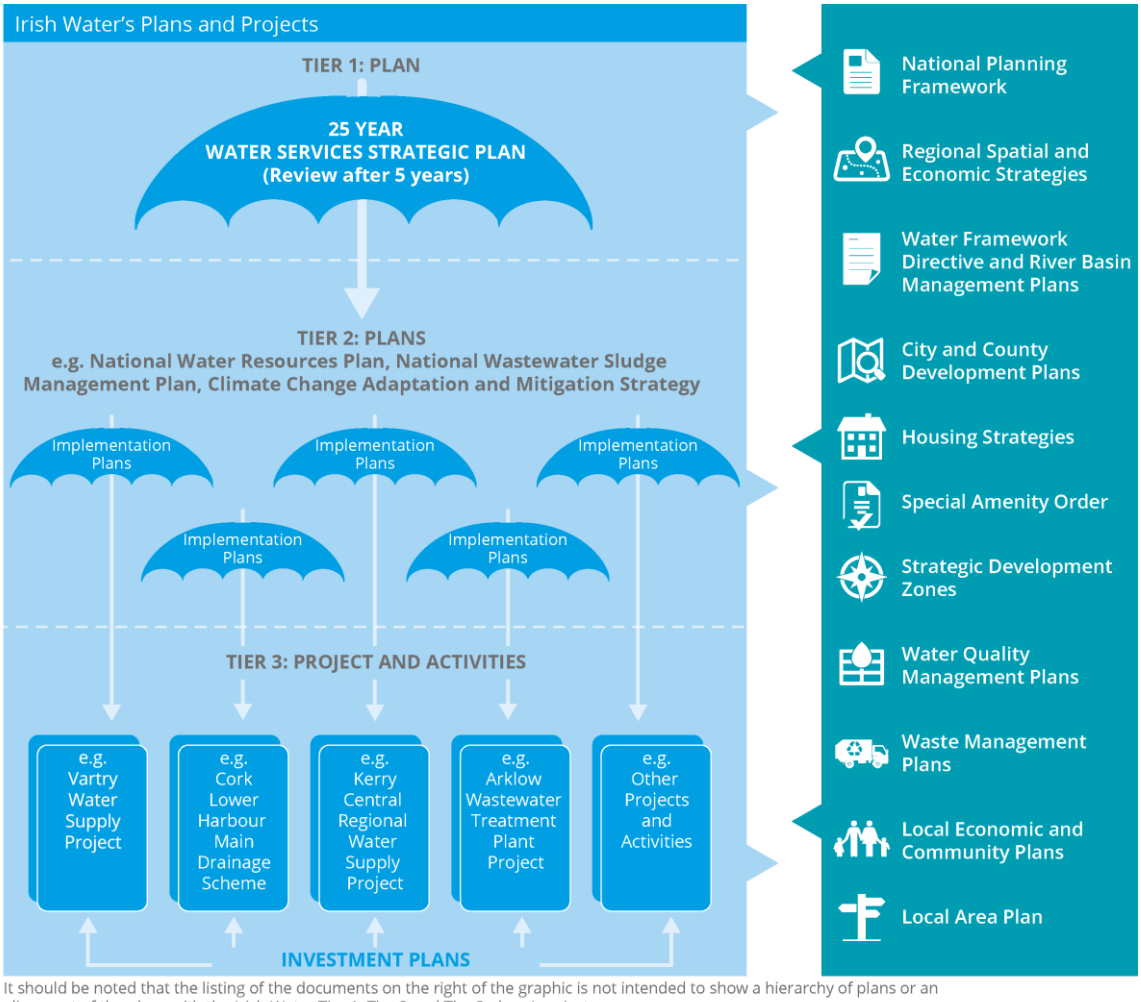


Figure 2.5 Interaction between the Planning System and Irish Water's Plans and Programs

At a Regional Level, there are 3 (three) regional assemblies – East/Midlands Region, Southern Region, North West Region. The 3 regional assemblies have all published Regional Spatial and Economic Strategies (RSESs) for their respective regions in 2020.

The RSES is a 12-year regional plan (2019-2031) which primarily aims to support the delivery of the programme for change set out in Project Ireland 2040, the National Planning Framework (NPF) and the National Development Plan 2018-27(NDP)[5].

The RSES for each region sets out the high-level statutory framework within which each Local Authority in that region develops their City and County Development Plans and LAPs and MASPs aligning them with regional and national objectives.

Given the scope of the RWRP-EM which extends south as far as Limerick and Clare, and north west as far as Roscommon, it would fall within the planning policy of all three (3) regional assemblies, therefore the policy provisions in the RSESs for all three (3) regions are applicable for this RWRP-EM.

Irish Water continually engages and interacts with the relevant public bodies in the planning process at all levels: national, regional and county level. Irish Water is committed to taking account of national,

regional and local spatial planning policy, such as the designation of Strategic Development Zones, when developing investment planning (including the NWRP process) within technical, environmental, and budgetary constraints (and taking into account our sustainability policy).

Irish Water's NWRP has therefore been developed to ensure that water infrastructure can support the proposed growth policies at a national, regional and county level. The National Planning Framework recognises that "investment in water services infrastructure is critical to the implementation of the National Development Plan". It refers to the development of "a new long-term water supply source for the Eastern and Midlands Region…needed by the mid-2020s to provide for projected growth up to 2050 and contribute to resilience and security of supply for the region". The Eastern and Midlands RSES states that a water supply project is required to ensure sufficient treated water is available to service the Growth Centres and Key Towns identified in the strategy including Arklow, Athlone, Athy, Carlow, Drogheda, Mullingar, Navan, Portlaoise and Tullamore. Other Strategic Water Services Projects supported by the strategy and identified in Project Ireland 2040, include Irish Water's National Programme of Investment to tackle leakage and the Vartry Water Supply Scheme. These programmes are discussed further in Section 4 of this Plan. This RWRP therefore supports the NPOs and RPOs within the NPF and RSES.

2.2.3 Population Forecasts in the RWRP-EM

Growth projections used within our RWRP were based on best available data from the NPF and RSESs at the time of compiling our RWRP, i.e. the growth projections for the cities were taken from the NPF and RSESs, with projections for the Regional Growth Centres and Key Towns taken from the RSESs. For all other areas, the growth projections were taken from the Draft NPF. In addition, we recognise the ongoing work between the Regional Assemblies and the local authorities over the course of the development of the Local Authority County/City Development Plans and the MASPs. As these plans are finalised, Irish Water will incorporate the increasingly refined growth rates into our demand forecasts – see Section 2.2.3.1 below for further details.

The forecast population used in our demand forecasts for WRZs at our regional planning SA level is shown in Table 2.2.

Table 2.2 Study Area Population Growth (2019 to 2044)

SA No.	SA Name	Total Population *		Change in Population
		2019	2044	%
SA1	Mid Wicklow	24,050	29,090	21.0
SA2	West Wicklow	6,840	7,890	15.3
SA3	Meath	189,980	230,580	21.4
SA4	Westmeath	87,870	107,080	21.9
SA5	Offlay/Roscomon	71,940	90,960	26.4
SA6	Laois	126,670	153,500	21.2
SA7	North Tipperary	31,240	37,440	19.8
SA8	Limerick Clare	233,560	319,710	36.9
SA9	Greater Dublin Area	1,702,250	2,118,530	24.5
	TOTAL	**2,474,400**	**3,094,780**	**25.1**

* Population values are rounded to the nearest 10

The overall regional population growth is 25% from 2019 to 2044. All SAs in the Eastern and Midlands Region have a projected growth rate that exceeds the 12% national rate observed in the 10-year period from 2006 to 2016. The Limerick Clare SA has the highest projected growth rate at 37%, which is driven by the Limerick City forecast growth of 61% by 2044. Population growth at a WRZ level is presented in Figure 2.6.

It should be noted that settlements and associated growth rates are not exactly aligned with the existing water supply asset base, as our water supplies can serve large areas covering urban and rural settlements through an interconnected asset base. Where this is the case, we have attributed the differing growth rates to the proportion of the supply that is in the urban and rural settlements, in order to ensure that the overall growth is aligned with the NPF (and Draft NPF where applicable). For example, a growth rate of 26% is applied for urban areas in Dublin, whereas a growth rate of 15% is assumed for settlements with a 2016 population less than 1,500. Therefore, the overall population growth rate for SA9 is 24.5% as shown in Table 2.2.

A summary of the population growth rates that we have assumed for the settlements in the RWRP-EM is presented in Section 3, which explains the demand forecast projections across the region.

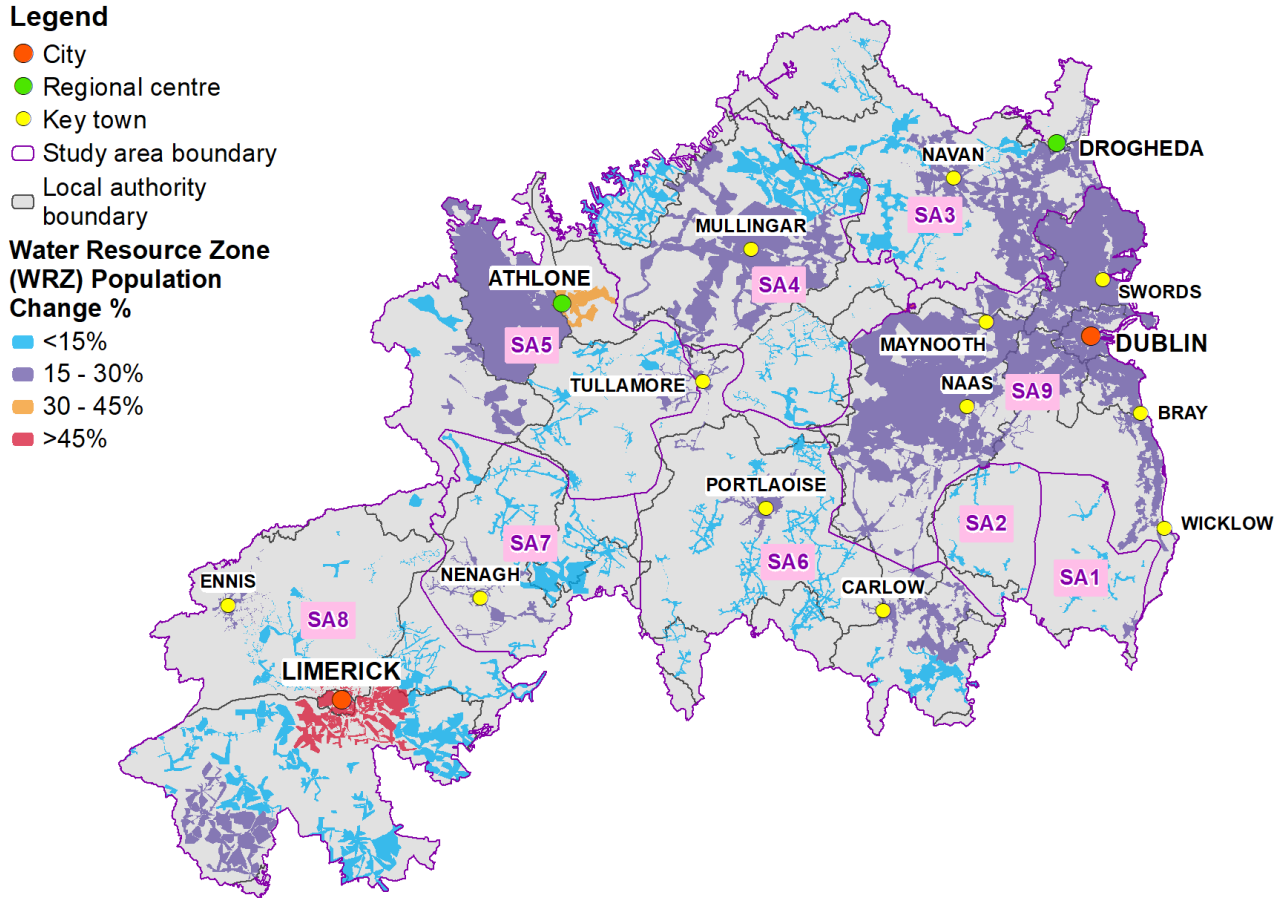


Figure 2.6 Percentage Change in Population (2019 to 2044) for WRZs in the Eastern and Midlands Region

2.2.3.1 Future Updates to Growth Projections

We recognise the ongoing work between the Regional Assemblies, the Office of the Planning Regulator and the local authorities over the course of the development of the Local Authority County/City Development Plans. As these plans are finalised, Irish Water will incorporate the increasingly refined growth rates into our demand forecasts. In addition to the Framework Plan, Irish Water have developed a 10-year capacity register based on an amended Supply Demand Balance (SDB) to provide Local Authorities with an indication of settlements which have potential capacity constraints. These will be made available for use in Development Plans. This process will involve an ongoing feedback loop between the Resources Planning process and the forward planning processes in Irish Water, the Regional Assemblies and the Local Authorities. Irish Water will update the SDB annually in line with the data received. This will allow Irish Water to respond to growth and development needs and prioritise water supply investment in collaboration with local authorities and with reference to the County/City Development Plans LAPs and MASPs.

The methods for forecasting water demand utilising the population projections are detailed in the NWRP Framework Plan Section 4. Projections of water demand and the resulting challenges for the Eastern and Midlands Region are set out in Section 3 of this report.

2.2.3.2 Non-Domestic Growth

Within the RSES and the NPF there are also projections of non-domestic growth. The precise nature of the business activity created to drive non-domestic growth can have a significant impact on water demand as non-domestic water demand varies enormously from sector to sector and property to property. Therefore, an allowance has been made for non-domestic growth in towns and cities identified as strong growth areas in Project 2040[1]. For other areas it has been assumed that there will be no significant increase in non-domestic demand. This approach and the assumptions made are addressed

in Section 4.3.2.3 of the Framework Plan. We will review policy and trends in relation to this over the coming years and refine our forecasts as per the monitoring and feedback process set out in Section 8.3.8 of the Framework Plan and Chapter 9 of this Plan.

2.2.4 Tourism and Recreation

As outlined in the NPF[1], tourism is a key aspect of rural job creation now and in the future. In 2019 over 11.3 million tourists visited Ireland, representing an increase of more than 100k compared with the previous year[6].

Tourism in the Eastern and Midlands Region plays an important role, particularly in rural areas. The region contains Ireland's largest national park, the Wicklow Mountains (located in SA1), emphasising outdoor recreation as a key asset for the county of Wicklow[7]. Our water bodies are also identified as important assets in the RSESs and are presented as opportunities to further economic growth in the Eastern and Midlands Region. The River Boyne in Meath (SA3), is a renowned angling waterway with extensive stocks of Wild Brown Trout and the Grand and Royal Canal and their associated greenways provide an amenity for navigation, walking and cycling. Lough Ree (SA5) and the River Shannon, one of the most scenic waterways in the region, are a key recreation and amenity attraction.

The region encompasses Ireland's Hidden Heartlands and Ireland's Ancient East, two of Fáilte Ireland's tourism programmes in the country. Ireland's Hidden Heartlands is located in the Mid-West, focussing on rural communities[8]. Ireland's Ancient East, which is part of a tourism development strategy that covers the South, East and part of the Midlands, places emphasis on the importance of historic sites in the area[9]. The county of Meath (SA3) has been described as "Ireland's ancient capital", containing Ireland's United Nations Educational Scientific and Cultural Organisations (UNESCO) World Heritage Site at Brú na Bóinne (Newgrange and Knowth) as well as Ireland's largest Anglo-Norman castle at Trim[9].

Both Dublin city in SA9 and Limerick city in SA8 have been identified as two of Ireland's best prospects for growing tourism by the National Tourism Development Authority (2016). Limerick City is known as the city of culture with sports playing an important role in its touristic appeal[10]. In addition to its unique position as a capital city, Dublin's access to the surrounding bay and mountains presents a variety of experiences for visitors.

Tourists benefiting from access to waterbodies within the Eastern and Midlands Region

In planning our water resource infrastructure, we consider the increase in water demands resulting from the influx of tourists, particularly during summer months when local demand is elevated. In cases where the holiday population is high relative to the resident population these demand peaks may be pronounced during hot, dry weather periods in the summer season. We have accounted for the impact of tourism in our water demand forecasts. The demand forecasts are used in our Supply Demand Balance calculations to determine future water supply deficits within the region.

2.2.5 Impact of the Covid-19 Pandemic

We recognise that data relating to population forecasts, economic trends and tourism are based on information gathered before the Covid-19 pandemic. Therefore, trends and patterns may need to be revised as enough data and information is available to understand the long-term impact of the pandemic. Key considerations will be potential changes to demographics in relation to commercial and office settings, changes in hospitality and tourism impacts. Irish Water will incorporate any future changes as outlined in the monitoring and feedback process summarised in chapter 8 of the Framework Plan. One of the benefits of a more interconnected water supply network will be the flexibility to adapt to changing growth patterns.

2.3 Natural Resources

A sustainable supply of clean water to support our growing communities depends on our understanding and protection of natural resources. At a fundamental level this includes the catchment that feeds surface water and groundwater bodies and the extent of ecosystem services that these waterbodies provide. Improving sustainability is at the heart of our plans and the NWRP assessment methodology incorporates Strategic Environmental Assessment (SEA) objectives into the decision-making process and this includes taking account of cumulative impacts within catchments. Examples of waterbodies that provide significant environmental, social and cultural values for communities in the RWRP Eastern and Midlands Region include the lakes in the Midlands, the inland waterways of the Royal and Grand Canals and the Shannon Corridor, river systems within Wicklow Mountains, raised bogs, wetlands and aquifers.

Our freshwater systems support the provision of drinking water needs, livestock and firefighting as well as other uses including industry, irrigation, electricity generation, navigation, and recreation and amenities. In a water scarce climate, some of these uses are competing. The supply of water from Lough Owel in West Meath for navigation along the Royal Canal and for water supply in Mullingar is an example of competing use. Box 2.1 provides further details of these supplies.

Irish Water understands that in addition to anthropogenic uses our freshwater resources also need to sustain habitats that rely on the quality, flows and volumes within these systems. We recognise that the protection of the aquatic environment/habitat requires the maintenance of water quality, physical habitat, hydrological processes, flow regimes and broader biological diversity.

In the following sections we describe the features of our natural environment that impact water quality and describe the sensitivities of the riverine ecology to changes in the flow regime. This is an important consideration for understanding the impact of abstractions and hydromorphological modifications (such as large-scale damming and channelisation). We also describe the environmental status of our surface water bodies and ground water systems.

Box 2.1 – Competing Demands for Water Supply and Navigation

The Grand Canal (132 km in length) and Royal Canal (145 km in length) were historically developed as navigation routes in the 19th century connecting the River Shannon to Dublin. Today they have both been restored and developed as a public amenity and are of great significance to tourism and recreation in the Eastern and Midlands Region, as well as serving as wildlife corridors. The Royal Canal takes a northern route, traversing Westmeath County; whilst the Grand Canal starts on the south side of the River Liffey in Dublin's Docklands and heads westwards through the Midlands via Tullamore with the River Shannon.

Lough Owel[11] is situated at the top of the River Brosna catchment, which is part of the River Shannon basin. The source is designated as a Special Area of Conservation, meaning that consideration must be given to its conservation objectives which are under threat from abstraction.

The Royal Canal was originally designed with Lough Owel as its primary source of water, and its location and level are critical to its operation and viability. However, Lough Owel is also the only water supply for Mullingar and surrounding townlands.

In recent years, Lough Owel has reached critically low levels on several occasions, with consumers in Mullingar required to conserve water to reduce the risk of summer outages. Water levels to support navigation in the Royal Canal could also not be guaranteed at these times. Waterways Ireland have facilitated Irish Water during these events to ensure continuity of the public water supply and protection of the flora and fauna in both the Lake and the Canal. Irish Water are committed to finding an alternative source of water for Mullingar in order to protect the environmental designations on the lake and the viability and environmental status of the canal.

2.3.1 Geology

Understanding the geology of our catchments is vital to the provision of clean water. Geology is responsible for shaping mountain ranges, defining river network systems and determining their character, i.e., slope and erosivity. The bedrock geological maps developed by the Geological Society of Ireland (GSI) are the foundation maps upon which groundwater protection and vulnerability maps have been constructed and upon which WFD groundwater bodies and monitoring programmes have been established by the EPA. The geology in the environment can impact the quality and quantity of water in the area through differences in drainage, chemical composition, filtration and resultant land use. The water supply can be heavily impacted by the type of aquifer in the area, as they impact the system's ability to store and transmit groundwater. The resultant land use can have a significant impact on water quality.

The oldest geology of the Eastern and Midlands Region comprises marine sedimentary rocks such as greywackes, slates and quartzites formed during the Cambrian Period, 545 – 495 million years ago (mya), and represents 1% of the geology of the Eastern and Midlands Region. Bands can be found on Howth Head to the north of Dublin Bay, around Bray Head and the Sugarloaf in northeast Wicklow. The Ordovician and Silurian Periods, when present, in northwest and southeast Ireland lay along the margins of separate continental masses and divided roughly along the Shannon Estuary and are represented by 15% of the geology of the Eastern and Midlands Region. During the closure of the Lapetus Ocean, the subduction of oceanic crust was responsible for the formation of a volcanic island arc. These volcanic rocks were erupted and intruded into the Silurian marine sedimentary sequences, which include greywackes, mudstones, lavas and tuffs. The rhyolitic volcanic rocks at Avoca, Co. Wicklow contain ore bodies of copper, lead, zinc and gold (Sleeman et al., 2004). Six percent (6%) of the geology belongs to the Caledonian Orogeny, also known as the mountain building era and associated granite intrusion. It was caused by the collision of the two continents during the closure of the Lapetus Ocean between 420 – 390 mya. In the Eastern and Midlands Region large granite bodies were intruded in Carlow – Wicklow. The Devonian period – 'old red sandstone rivers and desert' is also represented by ~6% in the Eastern and Midlands Region, most notable in the north and east of Munster in upland areas such as the Slieve Bloom, Slieve Aughty and Slieve Phelim. They comprise a widespread and relatively thin (<300 m) sequence of conglomerate, sandstone, siltstone and mudstone.

Most of the bedrock geology of the Eastern and Midlands Region (64%) falls into the Lower Carboniferous period (350 mya), characteristic of limestones which are sediments derived from the breakdown and disintegration of calcareous shells of invertebrate animals. The limestones of the East Midlands stretch from the River Shannon to the Irish Sea and from Monaghan to Kilkenny and because they are overlain by glacial and recent sediments, their landscape is represented by eskers, drumlins, raised bogs and river flood plains (Daly et al., 2000). The Upper Carboniferous is represented by 5% of the Eastern and Midlands Region, dominated by deep water shales such as at Foynes in Limerick. In the Paleogene period (66 – 34 mya) the Irish Sea Basin formed due to faulting and this was accompanied by the development of new drainage systems tied to the marine basin, i.e. the Boyne, Glendalough and Glenmacnass.

2.3.2 River Systems

Relative to other European countries, Ireland has twice the EU average of lake coverage (12,000 lakes covering ~2% land area[12]. In the RWRP-EM there are 1561 lakes covering 0.02 % of the regions land area (35,875 hectares) with 6 lakes making up ~75% of the area, Lough Derg, Lough Ree, Poulaphouca Reservoir, Lough Sheelin, Lough Ennell and Lough Owel. The larger known rivers within the Eastern and Midlands Region include the Shannon, the Boyne, the Liffey, the Avoca and the Barrow, however, they represent only a fraction of the extensive 18,985 km network currently mapped by the EPA in the region. Our surface water river systems are shown in Figure 2.7.

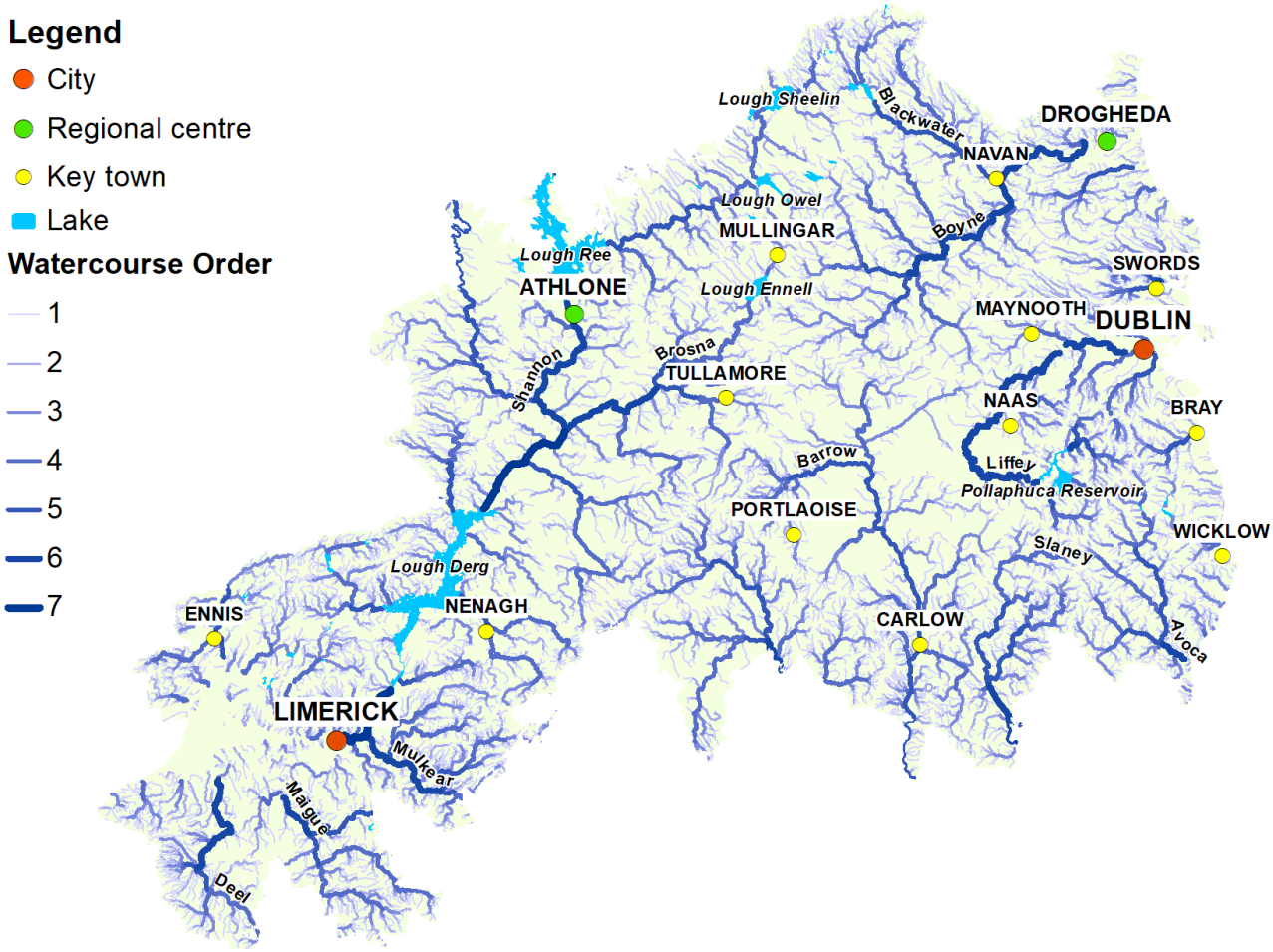


Figure 2.7 Rivers of the Eastern and Midlands Region

The riverine ecology of at least a quarter of our river systems are considered highly sensitive to changes in flow and water level. The parameters identified to reflect this sensitivity include geology, gradient and altitude[13]. Figure 2.8 represents the different river typologies within the Eastern and Midlands Region. The most sensitive rivers are those within the A2, C2 and D2 categories which are representative of headwaters, low nutrient, low pH and salmonid spawning and nursery areas. The salmonid spawning and nursery areas are particularly sensitive to low flows and impounding structures.

In the Eastern and Midlands Region the dominant river typology is represented by B1 - Hard limestone and sandstone; low-medium altitude; and low-medium slope (720 river water bodies).

The method by which waters of a similar ecological sensitivity are grouped into types for the Water Framework Directive, is referred to as a **typology**. For example, a river may be assigned to types based on altitude and alkalinity.

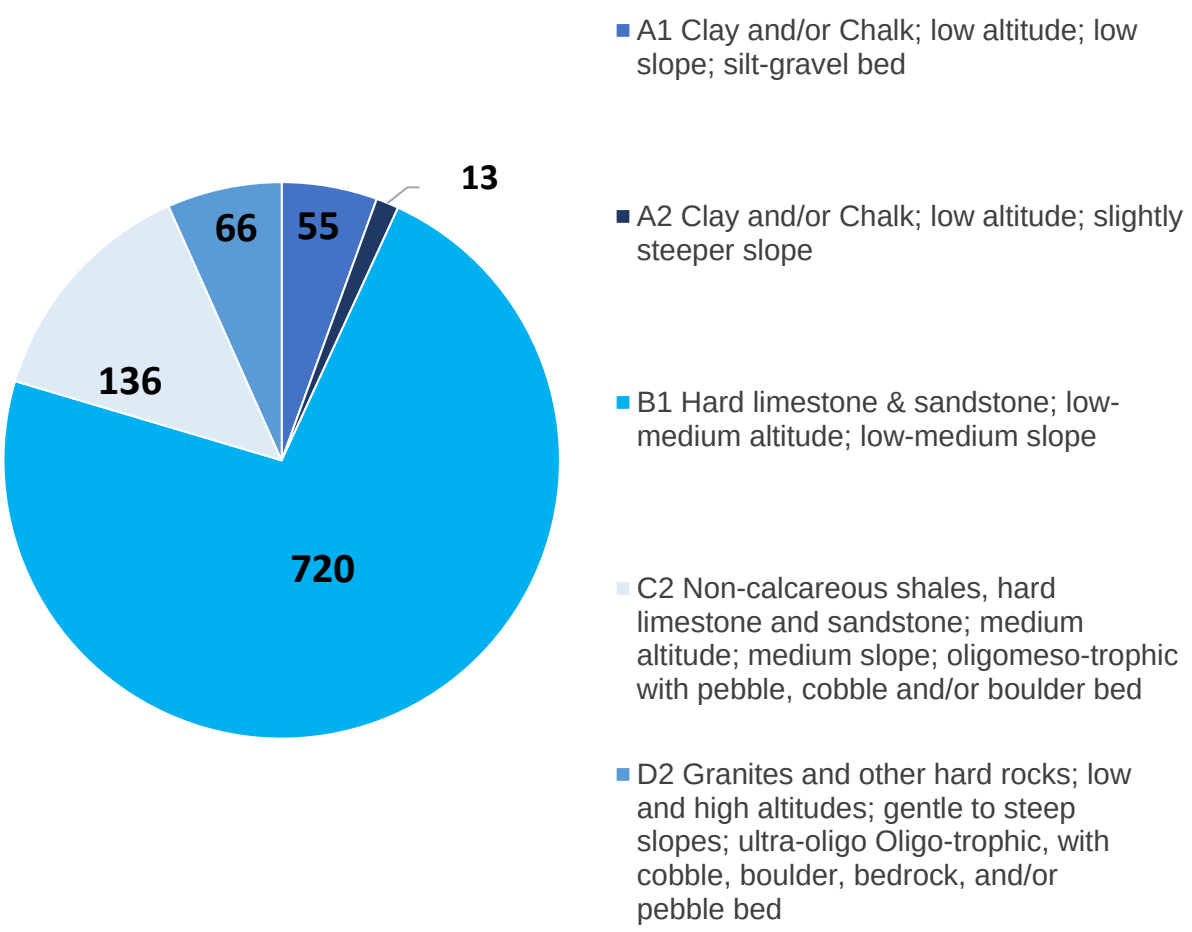


Figure 2.8 Main River Typologies in the Eastern and Midlands Region

2.3.3 Groundwater

The geology of our catchments is vital to the quantity and quality of water which we can abstract. The quantity of water which can be abstracted from a groundwater source is impacted by the depth, porosity and connectivity of the target geological formation/layer. Geological horizons such as clay and igneous rocks have limited porosity and are therefore low yielding (poor aquifers) whilst geological formations such as chalk and limestone are associated with higher porosities and can yield substantial quantities of water (good aquifers). For water to move through an aquifer the internal voids and fractures must be connected. The porosity and degree of fracturing and interconnectivity therefore impacts not just the available quantity of water but also the level of recharge of the groundwater body which in turn impacts the potential sustainable abstraction rate. The majority of Ireland is occupied by poorly and moderately productive aquifers, meaning large rates of abstraction at a single point are often impossible and most of the bedrock is relatively poor at storing and transmitting groundwater.

About 13% of the water supply for Eastern and Midlands Region is abstracted from underground aquifers, either from boreholes, springs or infiltration galleries. The major aquifers in the RWRP-EM are shown in Figure 2.9.

Geological Survey Ireland has classified and mapped nine aquifer categories across the country. The broad criteria used to determine aquifer categories include hydrogeological data, the presence of large springs, geology and stream density. The categories describe both resource potential/value (Regionally important, Locally important, or Poor) and groundwater flow type (through fissures, karst conduits or intergranular).

Additionally, GSI usefully grouped and summarised the aquifer categories into high-level groupings that succinctly describe the broad types:

- Sand/gravel;
- Karstic;
- Productive fissured bedrock ; and
- Poorly productive bedrock.

These general types can be considered as groundwater systems that have similar properties with a good indication of resource, extent and risk. Table 1.2 in Appendix C of the Framework Plan describes the nine (9) aquifer categories in detail.

The predominant aquifer type of the RWRP-EM (52%) is poorly productive bedrock, with a relatively even split among the remaining categories of gravel (18%), karstic (17%) and productive fissured (13%) aquifers. The poor bedrock aquifers are represented mostly by Granites to the east in Carlow and Wicklow and the Silurian metasediments and volcanics in North Tipperary. There are also large swathes of Dinantian (Lower Carboniferous) Upper Impure Limestones across North Dublin, Westmeath and to a lesser extent in North Limerick. The limestones are often characterised by a high shale content and are primarily of moderate permeability and low productivity. In poorly productive bedrock groundwater flow will mainly occur laterally through the upper weathered zone of the aquifer.

Large parts of the Midlands (Portlaoise, Offaly and Roscommon) karst form a regionally important aquifer, particularly around the towns of Ballinasloe, Athlone and Tullamore. The Midlands is predominantly characterised by a more diffuse network of flow pathways, where the distribution of permeability, and hence yield, is more homogenous.

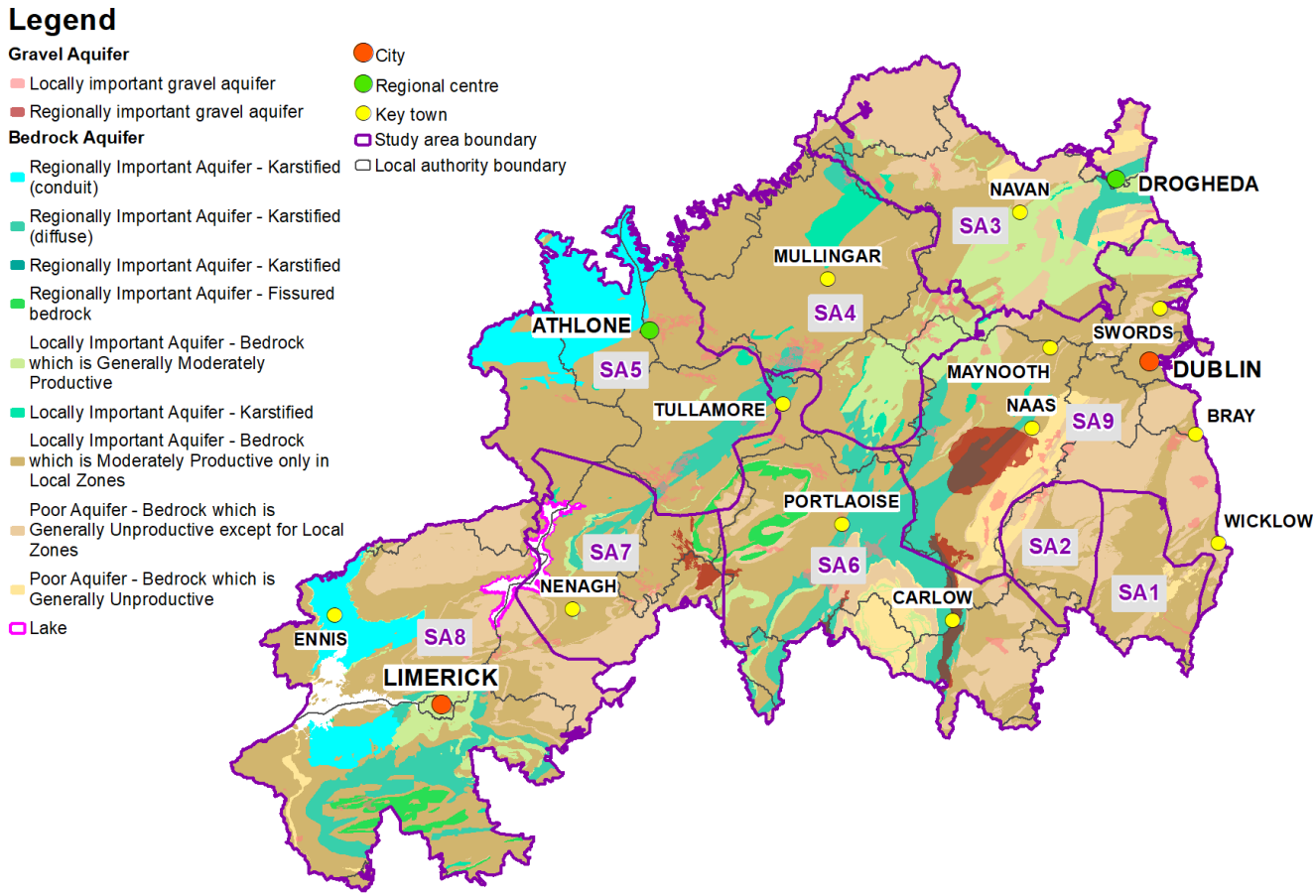


Figure 2.9 Spatial Extent of Major Aquifers in the Eastern and Midlands Region

The differing spatial extents and permeabilities of sand/gravel aquifers results in a variable development potential. They act as areas for groundwater filtration owing to the intergranular flow mechanics, which offers good protection against microbial contamination. Kildare is noted for a large gravel aquifer in the Curragh overlying the limestone bedrock. The sand/gravel deposits, when overlying areas of bedrock aquifers, can improve the overall flow and storage to the aquifer and also protect against pollution.

The productive fissured aquifers are most dominant in the northeast and can be found in large swathes across much of Meath, North Dublin and North Kildare. The high-yielding and high-productivity wells are largely clustered in a relatively small area, likely associated with a particular major fault zone. The aquifer classification for this area of upper impure limestones is a “locally important aquifer which is generally moderately productive”. In general, optimum well yields from these upper impure limestones will be from wells that penetrate to a depth of at least 50-100m and which encounter one of the many fault zones of the region. The geology impacts the water quality due to chemical interactions between the ‘rock’ and waterbody. Where groundwater is connected to the surface/surface water bodies due to high porosity the groundwater quality may be impacted by sources of pollution such as agricultural, industrial and urban contaminants e.g. nitrates, trace metals, and microorganisms.

2.3.4 Groundwater – Surface Water Interaction

Surface water and groundwater interactions are an important consideration when considering both the quality and quantity of groundwater which may be abstracted, identifying options to support increased water demands and in managing the water quality we supply. As mentioned above interaction between surface water and groundwater can impact groundwater recharge rates and therefore sustainable abstraction rates as well as water quality through interactions with sources of pollution.

Groundwater and surface water are closely linked at certain karst features such as springs and swallow holes. For example, Westmeath in Study Area 4, is characterised by karst topography (where soluble rocks such as limestone, dolomite and gypsum dissolve) which can form sinkholes, caves and underground river systems. In Westmeath, mapping and tracing has shown a connection between Lough Lene (surface water) and the springs at Fore (groundwater). In these karstified environments any surface water contaminants can be easily transported to groundwater and vice versa. Similarly, to the west of the region in the Shannon basin, the Suck catchment is dominated by a flat undulating topography underlain by karstified limestone where the groundwater and surface water drainage systems are highly interlinked throughout.

In the case of the Bog of the Ring in North Dublin, the degree of groundwater surface water interconnection is dependent on the nature of the subsoil. Where the bog is underlain by till there is no or very limited interconnection between the surface water and groundwater and therefore little or no reduction in water level caused by abstraction pumping. In areas where there are gravel deposits there is a direct connection, and therefore abstraction from the groundwater leads to surface water features drying out completely[14]. Similarly, to the west of the region in the Shannon basin, the Suck catchment is dominated by a flat undulating topography underlain by karstified limestone where the groundwater and surface water drainage systems are highly interlinked throughout. These groundwater surface water interactions are of importance for Groundwater Dependent Terrestrial Ecosystems (GWDTEs).

2.3.5 WFD ‘Ecological Status’ of Waterbodies

Our water planning approach, as set out in the Framework Plan, is developed to meet the environmental objectives of the European Union WFD (Directive 2000/60/EC) and the EPA’s River Basin Management Plan (RBMP) (a requirement under the WFD). The WFD contains a standard European approach for managing waterbodies in our natural environment from abstraction to final discharge, while the RBMP outlines the WFD objectives for Ireland. It is underpinned by the following statement, “Water is not a

commercial product like any other but, rather, a heritage which must be protected, defended and treated as such"[15]. The EPA coordinate WFD implementation in Ireland and carry out monitoring, assessment and setting of objectives for waterbody status nationally. Under the WFD, waterbodies are assigned an ecological status. The categories of ecological status are described in Box 2.2. Irish Water considers the ecological status through the requirements for abstraction licences and discharge permits. The ecological status impacts drinking water quality and Irish Water work to support the ecological status of waterbodies through our catchment-based management programmes. It should be noted that whilst the WFD cycle 3 RBMP data has been presented in the sections below it was undergoing consultation at the time of writing and is therefore subject to change.

Box 2.2 – Water Framework Directive (WFD) River Basin Management Plan Ecological Status Categories

Surface water bodies are classified according to their **ecological status** which is assessed by the abundance of aquatic flora and fish fauna. The biology of a waterbody is supported by the chemistry (including general physio-chemical measurements and chemical pollutants), the hydrology (flow and water levels) and the morphology (physical structure). Hydromorphological quality is only used during the assessment of high ecological status waterbodies. The ecological status shows the influence of pressures (e.g. pollution and habitat degradation) and a good ecological status is defined as 'a slight variation from undisturbed conditions'.

The classification scheme for ecological status for surface water includes five categories: High, Good, Moderate, Poor and Bad. 'High status' means no or very low human pressure. 'Good status' means a 'slight' deviation from this condition, moderate means a 'moderate' deviation whilst a Poor or Bad status recognises that the waterbody has been affected by an altered habitat and or/is polluted.

2.3.5.1 Surface Water

The RBMP considers the actions Ireland will take to improve water quality and achieve "Good" ecological status in waterbodies (rivers, lakes, estuaries and coastal waters) by 2027. In doing so it influences from where, in what quantities and under what conditions we can abstract water for public water supply. It also sets the legislative framework within which any new abstractions Irish Water develop must conform.

The status of the regions surface water bodies, classified using data from 2013 -18, is depicted in Figure 2.10. Table 2.3 summarises the water body classification for each Study Area. Surface water bodies currently classified as Moderate or lower status number 610, representing 57% of total surface water bodies.

High Status rivers are currently located in all Study Areas apart from SA3. Three WFD river reaches are currently identified as 'Bad' Status – two reaches on the Avoca River in SA1, polluted from old mines and wastewater, and Ahavarraga stream in SA8 due to high nutrient levels.

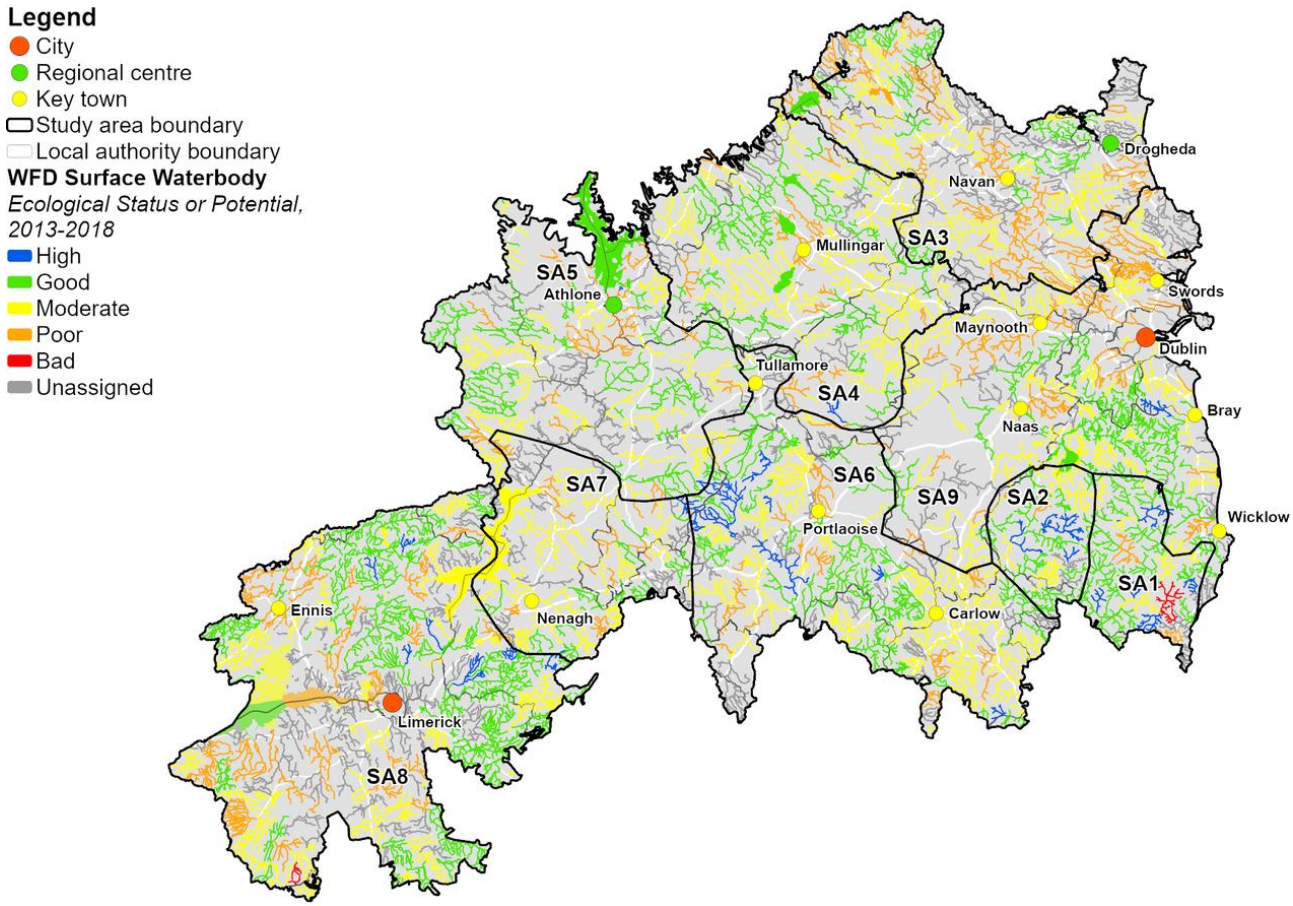


Figure 2.10 WFD 'Ecological Status' of Surface Water Bodies.

2.3.5.2 Groundwater

The bedrock geological maps developed by the Geological Survey Ireland (GSI) are the foundation maps upon which groundwater protection and vulnerability maps have been constructed and upon which Water Framework Directive (WFD) groundwater bodies and monitoring programmes have been established by the EPA. The Eastern and Midlands Region has a total of 216 groundwater bodies (GWBs) 196 of which are currently at 'good' overall WFD status and 20 of which are currently at 'poor' overall WFD status (Figure 2.11).

GWBs are classified by the EPA as either 'good' or 'poor' status depending on the outcome of five chemical tests and four quantitative tests. The failing of even one of these tests determines a 'poor' status for that waterbody. Two (2) GWBs in the East Midlands Region are currently at 'poor' Quantitative Status - Bettystown and GWDTE-Clara Bog. Eighteen (18) GWBs are currently at 'poor' Chemical Status[16] - Durrow GWB, Groundwater Dependent Terrestrial Ecosystem (GWDTE)-Caherglassaun Turlough GWB, ten (10) Industrial Facility GWBs, five (5) Historic Mine GWBs and one (1) Waste Facility GWB. Durrow GWB has changed from the 2010-2015 'Good' status due to nitrate failures.

Table 2.3 Water Body WFD 'Ecological Status' for each Study Area [17-20]

Study Areas	WFD Catchment areas	Number of Surface Water bodies			Number of Groundwater bodies	Number of Waterbodies Rated Below Moderate (SW) or poor (GW) [21]	
		Rivers	Transitional and Coastal	Lakes		Surface Water	Groundwater
SA1	2	44	2	6	7	4	3
SA2	4	48	0	1	5	2	0
SA3	5	120	6	8	32	48	2
SA4	7	121	0	15	35	19	1
SA5	7	123	0	9	38	19	2
SA6	5	186	0	0	55	24	3
SA7	4	81	0	2	27	16	1
SA8	7	215	9	20	82	49	6
SA9	5	184	16	11	41	47	5
Region	**46**	**969**	**33**	**66**	**216**	**219**	**20**

*Some river, lake and groundwater bodies are located in more than one Study Area.

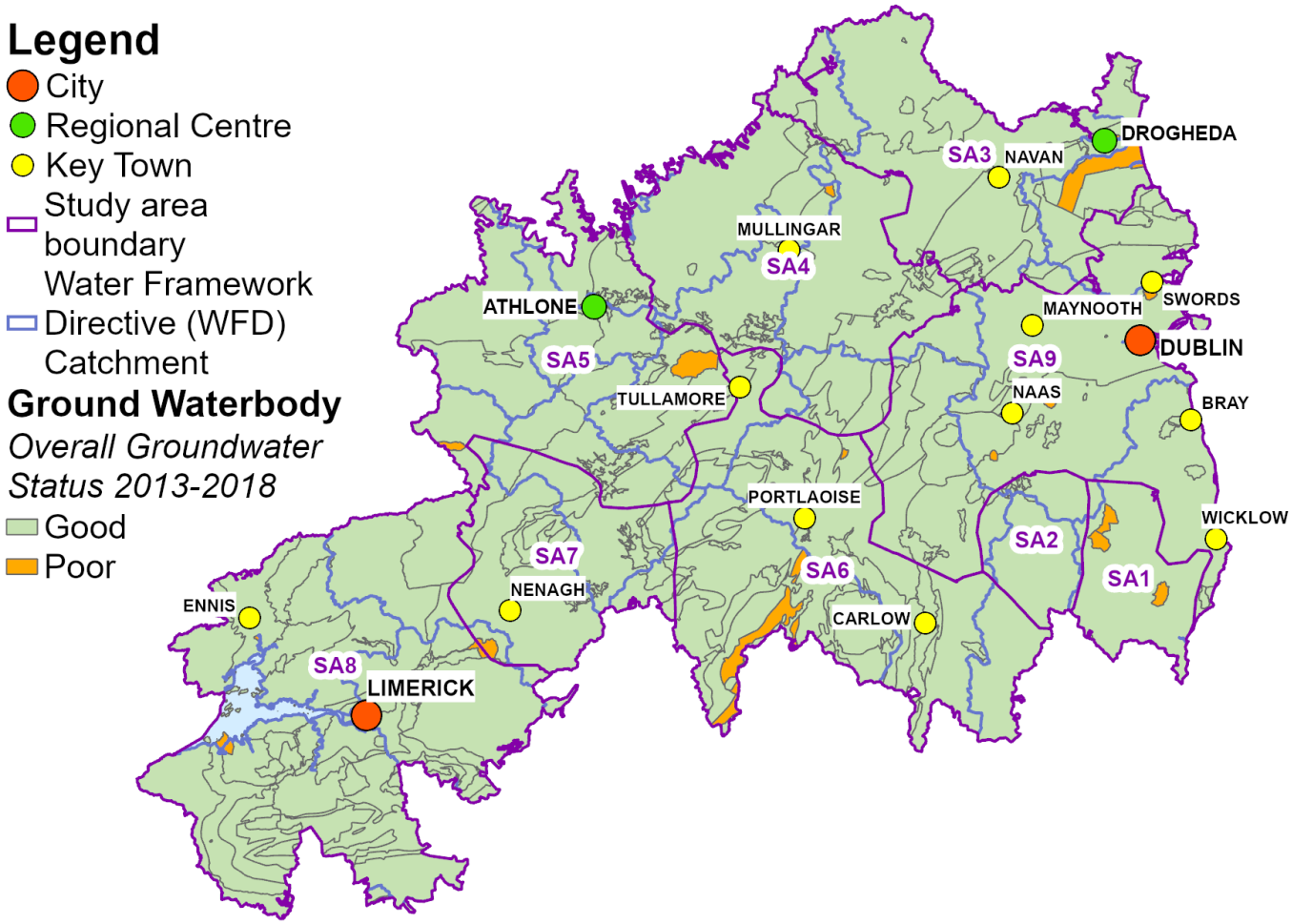


Figure 2.11 WFD Groundwater Body Status (2013-2018)

2.3.6 WFD 'Risk Status' of Water Bodies and Associated Pressures

2.3.6.1 Surface Water

Risk assessment data produced to support Cycle 3 of the RBMP identifies water bodies at risk of failing WFD objectives or at risk of deteriorating from their current status due to a number of pressures.

Cycle 3 of the RBMP indicates that currently 47% (453 out of 969) River Water Bodies (RWBs) in the Eastern and Midlands Region are 'At Risk', 32% (312 out of 969) are 'Not at Risk' and the remaining 21% (204 out of 969) are 'Under Review'[21].

Seventeen (17) out of 66 Lake Water Bodies (LWBs) are 'At Risk', 23 are 'Not at Risk' and 26 are 'Under Review'. Figure 2.12 shows a summary of risk status of water bodies in the region.

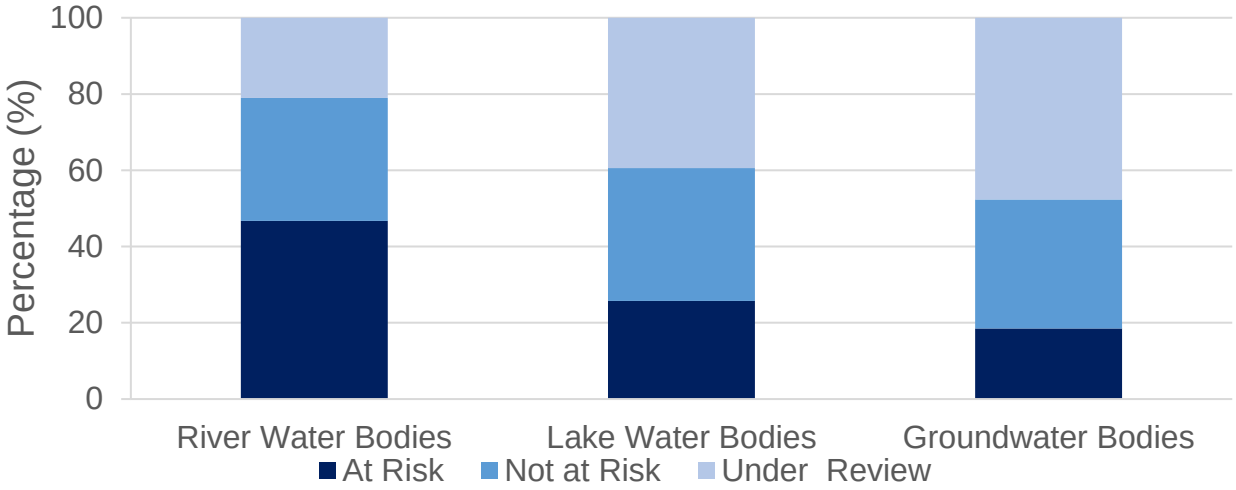
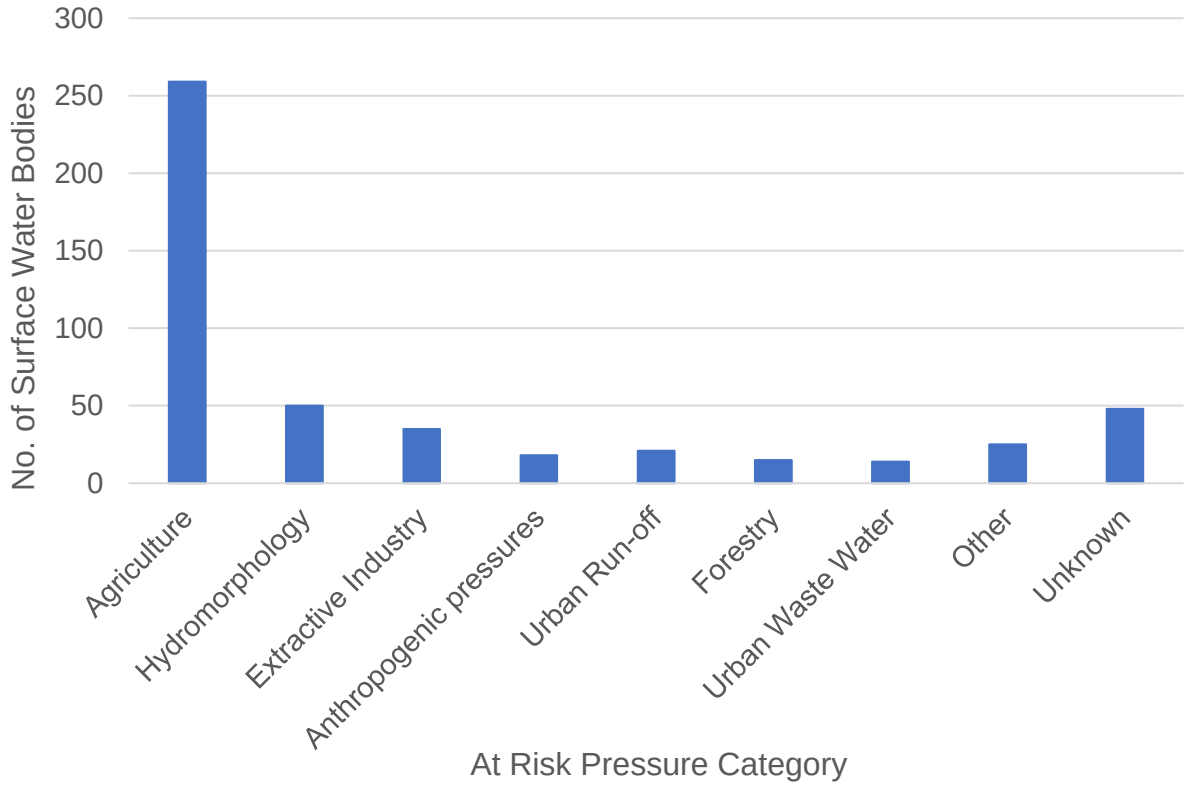


Figure 2.12 The 2013 – 2018 WFD Risk associated with River, Surface and Groundwater Bodies in the Eastern Midlands Region

Figure 2.13 presents the Surface Water Bodies (SWB) 'At Risk' of not achieving the environmental objectives according to pressure categories. Those SWB that are 'At Risk', may be at risk due to one pressure or as a result of the combination of multiple pressures. For this reason, the sum of SWB presented across the pressure categories exceeds the total number of SWB reported as 'At Risk.

The predominant pressure on SWBs in the region is agriculture followed by hydromorphological pressures and the impact extractive industries.



*WWTS – Wastewater Treatment System

Figure 2.13 Number of Surface Water Bodies with Associated 'At Risk' Pressure Category[22]

2.3.6.2 Groundwater

The 2013 – 2018 WFD Risk associated with the Ground Water Bodies (GWB) in the RWRP-EM indicates that 103 are currently 'under review', 73 are 'not at risk' and 40 GWBs are 'At Risk' (Figure 2.12).

Of the GWB 'At Risk' the predominant pressure associated with them is Agriculture, followed by industry and historically polluted mine sites. (Figure 2.14).

The sustainable management of groundwater abstraction is challenging due to the difficulties in developing large abstractions due to the Regions' hydrogeological conditions. Irish Water are committed to active participation in collaborative multiagency working forums, to draw on the expertise of stakeholder agencies with subject experts, for optimum management of Ireland's water resources. Irish Water will work with the EPA and the GSI to develop desktop and site investigation systems to better understand the sustainability and water quality of their groundwater sources. Further information regarding this ongoing work is presented in Section 9 of this Plan (Monitoring and Feedback).

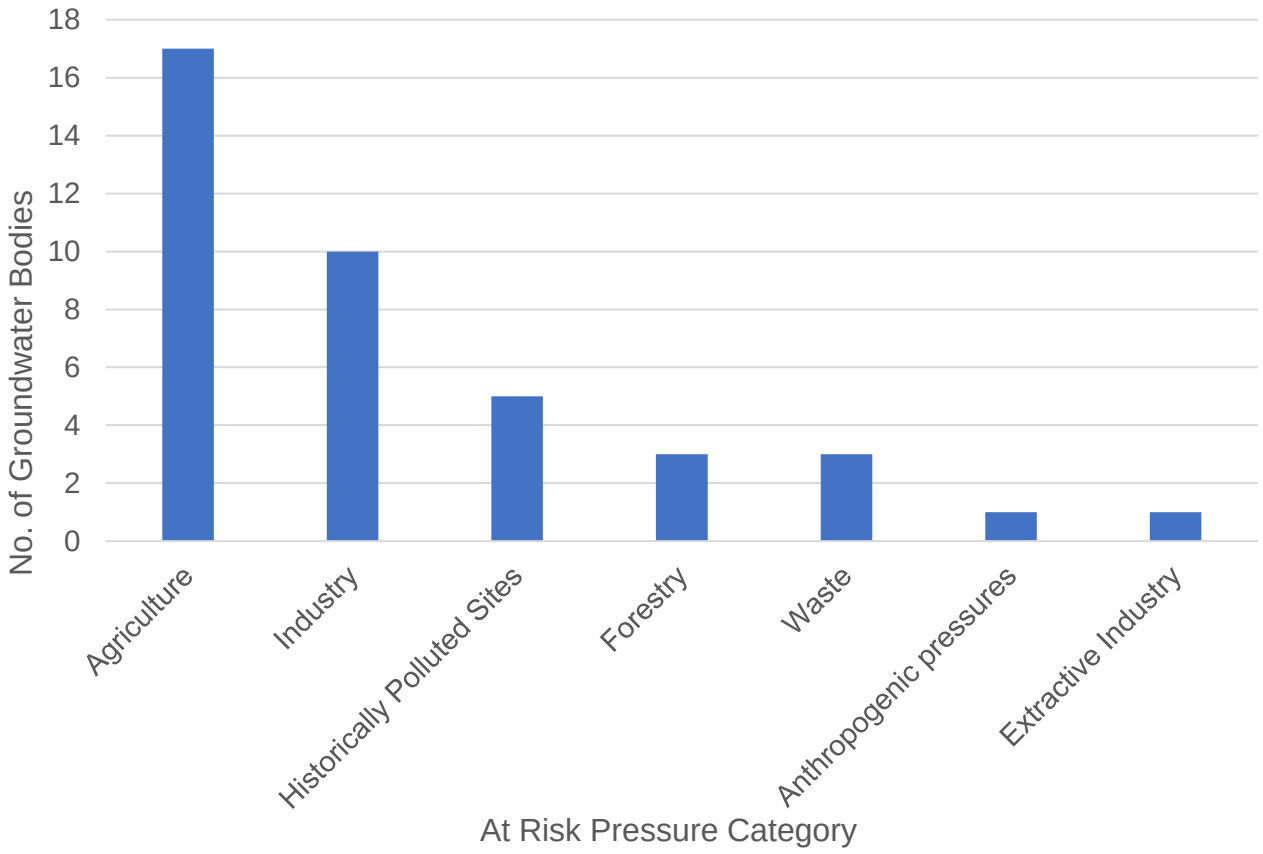


Figure 2.14 Number of Groundwater Bodies with Associated 'At Risk' Pressure Category[22]

2.3.7 Abstraction Pressures

In developing our Preferred Approach, Irish Water has undertaken an independent assessment to identify surface water sites that may exceed future abstraction thresholds. We have used this information to assess the potential impact of the pending Abstraction Legislation on our Supply Demand Balance, and to consider opportunities to improve environmental outcomes through our Plan solutions.

Whilst standards for the new abstraction regime are being developed, we have based our assessment on the technical guidance from the United Kingdom Technical Advisory Group (UKTAG), to identify sites potentially at risk from abstraction. UKTAG comprises of the Environment Agency, Natural Resources

Wales, Scottish Environmental Protection Agency and Northern Ireland Environment Agency. The application of their guidance is explained in Appendix C and Appendix G of the Framework Plan. Research work will continue to refine Ireland-specific standards over the coming years.

The UKTAG standards for alteration to river flows (hydrological alteration), permit a degree of modification from natural conditions. The standards are defined as an allowable percentage variation from natural flows. For "Good" ecological status watercourses, the allowable percentage variation from natural flows depends on river typology, season and flow rate. More restrictive limits apply between April and October compared to the period between November and March. The standards for "High" ecological status water bodies are defined as a lower allowable percentage variation from natural flows compared to "Good" ecological status water bodies. The UKTAG allowable abstraction standards are detailed in Appendix C of the Framework Plan. The standards are only a supporting element of the overall ecological status indicator, and the EPA will utilise its own assessment methodology, which will have the benefit of containing more detailed project information and analysis. The assessment of potential future abstractions is used in this plan as a conservative guide / indicator of abstractions which might be at risk. As further data becomes available, and more specific Irish standards are developed, Irish Water will update the NWRP as appropriate using the monitoring and feedback process set out in Section 9 of the RWRP-EM.

A summary map showing the degree of modification of natural flows [which may be required] during periods of low flows is shown in Figure 2.15 for surface water bodies in the Eastern and Midlands Region.

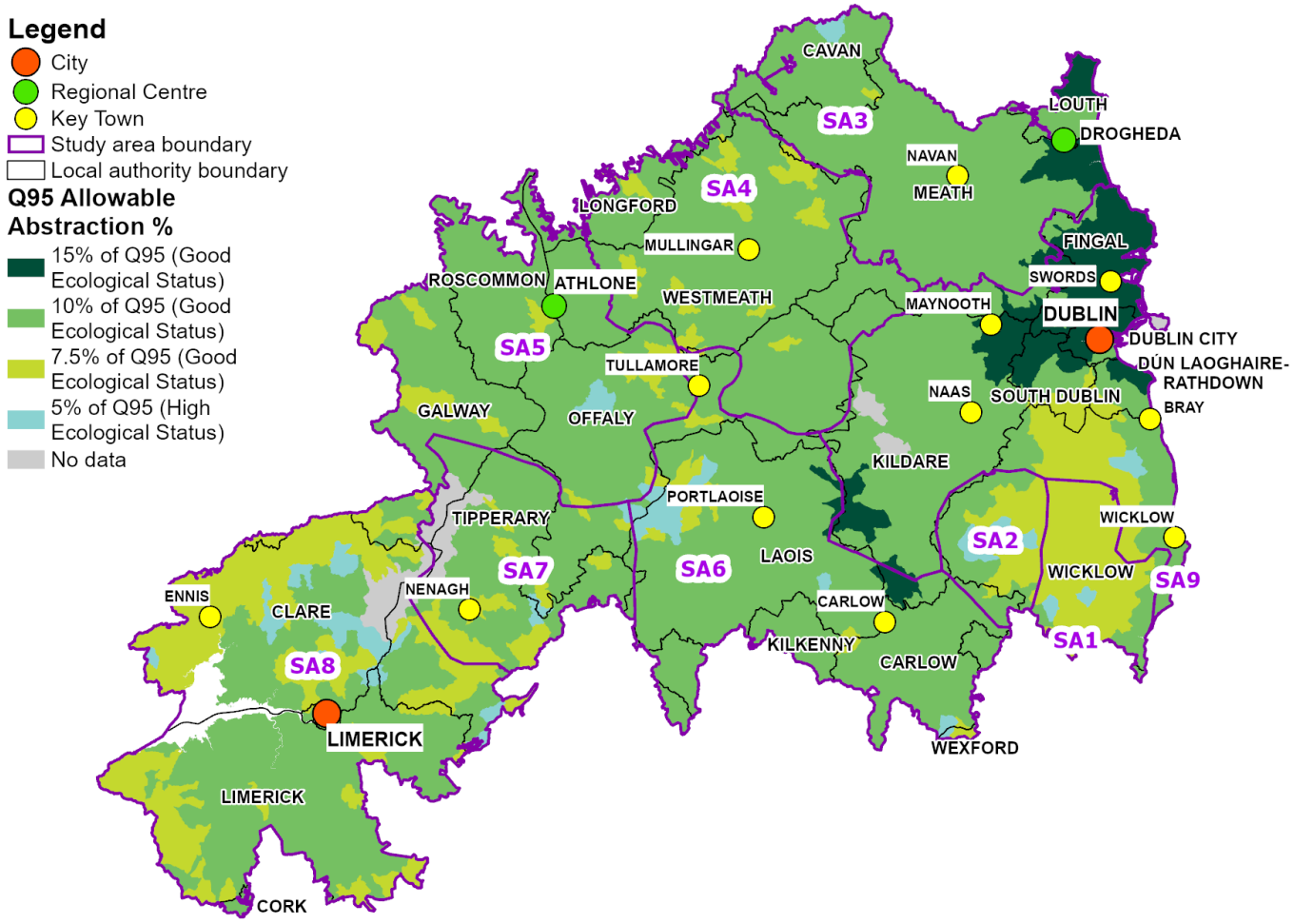


Figure 2.15 Percentage of natural flow at Q95 that can be abstracted to meet 'Good' Status

The UKTAG method for determining the allowable abstraction for lakes requires detailed bathometry and water level data, which are not widely available in Ireland. Instead, the methodology set out in a 2009 report by the EPA[3] was used to estimate the potential ecological limit of abstraction at lakes. This method sets the threshold for abstraction from lake sources at 10% of the Q50 of the rivers flowing into the lake.

The number of waterbodies identified at below target conditions based on this conservative methodology are listed in Table 2.4 and presented in Figure 2.16. The outcomes of the assessments for each Study Area are included in the respective Technical Reports (Appendix 1 - 9). These sites will require further detailed site investigations to confirm the impacts of abstraction.

The potential abstraction reductions which may be implemented in the future are presented in Section 3.5 of this Plan.

Table 2.4 Surface Water Abstractions Potentially At Risk of Exceeding Sustainable Abstraction Thresholds

Study Areas	Surface Water Abstractions Potentially At Risk of Exceeding Sustainable Abstraction Thresholds	
	Number of Abstraction Sites	Site Name (WRZ) / WFD Waterbody Name
SA1	4	Derry River (Tinehely Regional Supply) / Derry River Tributary of Avonberg Ballinder (Rathdrum Public Supply) / Mill Glen Stream Three Wells Stream (Aughrim Annacurra Public Supply) / Three Wells Stream Tributary of Avonberg River (Avoca Ballinclash Public Supply) / Avonbeg Tributary
SA2	0	n/a
SA3	3	Lough Skeagh (Bailieboro RWSS) / Lough Skeagh River Blackwater – Liscarton (Navan-Mid Meath) / River Blackwater Lough Bane (Kells-Oldcaslte) / Lough Bane
SA4	2	Lough Lene (Ballany) / Lough Lene Lough Owel (Mulliingar Regional) / Lough Owel
SA5	1	Gageborough River (Clara/Ferbane/Moyclare) / River Gageborough
SA6	2	Clodiagh River (Tullamore) / River Clodiagh Burren River (Carlow Central Regional) / River Burren
SA7	1	Little Brosna River (Roscrea) / Little Brosna
SA8	3	River Deel (Shannon Estuary Water Supply) / River Deel Loobagh River (Glenosheen/Jamestown/Kilmallock) / River Loobagh Mulkear River (Newport RWSS) / River Newport
SA9	4	River Liffey - impoundment (Greater Dublin Area) / Leixlip Reservoir Dodder River (Greater Dublin Area) / Glenasmole Upper Vartry River (Greater Dublin Area) / River Vartry River Liffey (Greater Dublin Area) / Pollaphuca

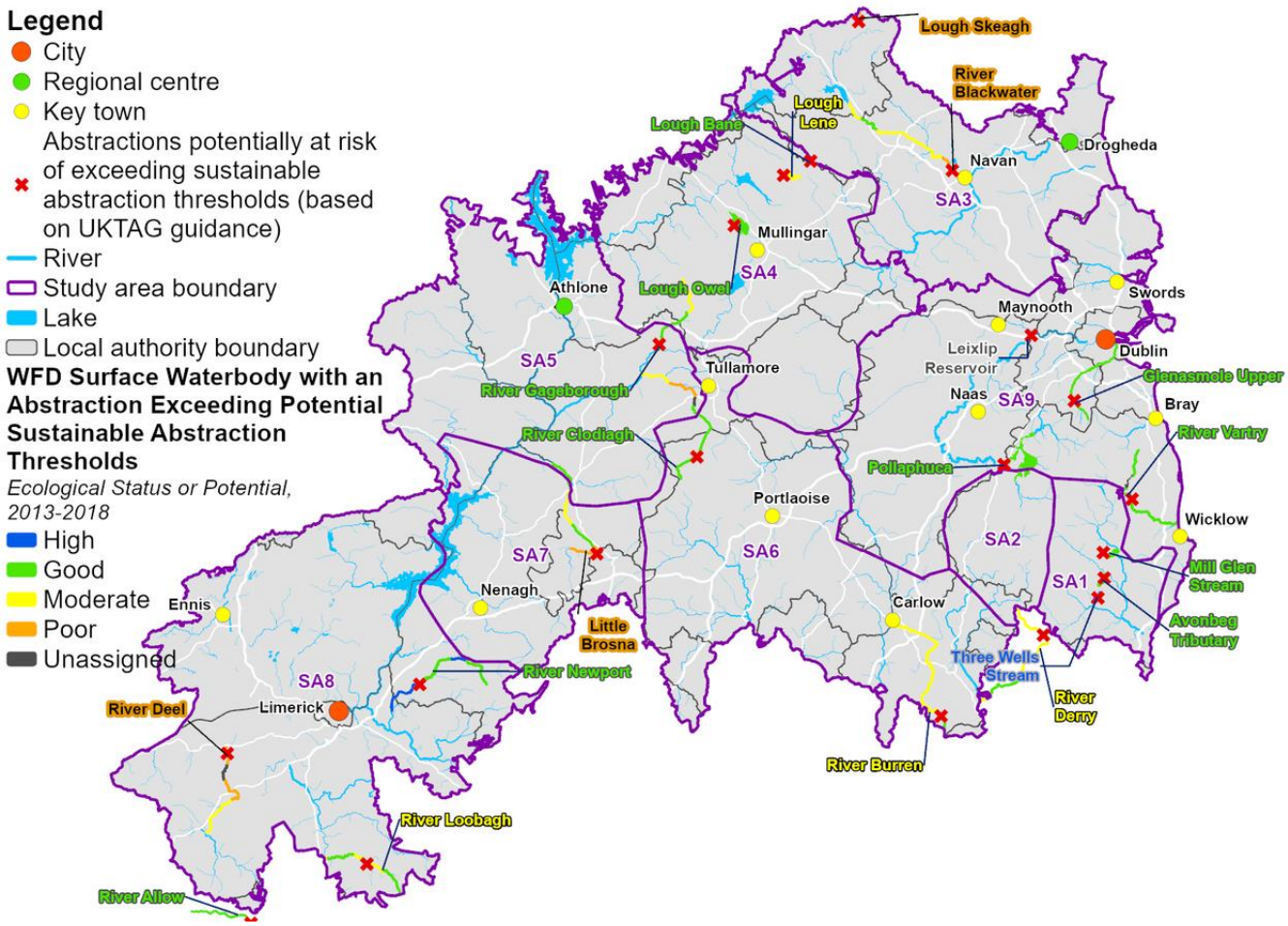


Figure 2.16 Surface Water Abstraction Sites Abstraction Thresholds (based on UKTAG guidance)

2.3.8 Designated Sites in the RWRP Eastern Midlands Region

Our habitats and species are protected under the Habitats Directive[23]. The habitats and species that are designated to afford protection are listed in the: Habitats Directive and the Birds Directive (2009/147/EC), Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). There are 618 designated sites associated with the RWRP-EM (Table 2.5 and Figure 2.17).

Water abstractions from both groundwater and surface water have been identified as being a potential threat to some habitats and species listed in the Annexes to the Habitats Directive. A full list of water dependent species and their sensitivities to sedimentation and changes to flow regime is provided in Appendix C of the NIS on the draft Framework Plan available at the following link:

https://www.water.ie/projects/strategic-plans/national-water-resources/

Protected sites with the greatest coverage in the RWRP-EM include the Wicklow Mountain SAC and SPA and the Lower River Shannon SAC. These are described in Box 2.3.

Table 2.5 Total Number of Designated Sites in the RWRP-EM*

Designated Sites	Number Of Sites
Special Protection Areas (SPAs)	44
Special Areas of Conservation (SACs)	144
National Heritage Areas (NHA)	62
Proposed National Heritage Areas (pNHA)	327
Ramsar Sites	16
Nature Reserves	24
National Parks	1

* Note some SACs or SPAs may fall within more than one Study Area.

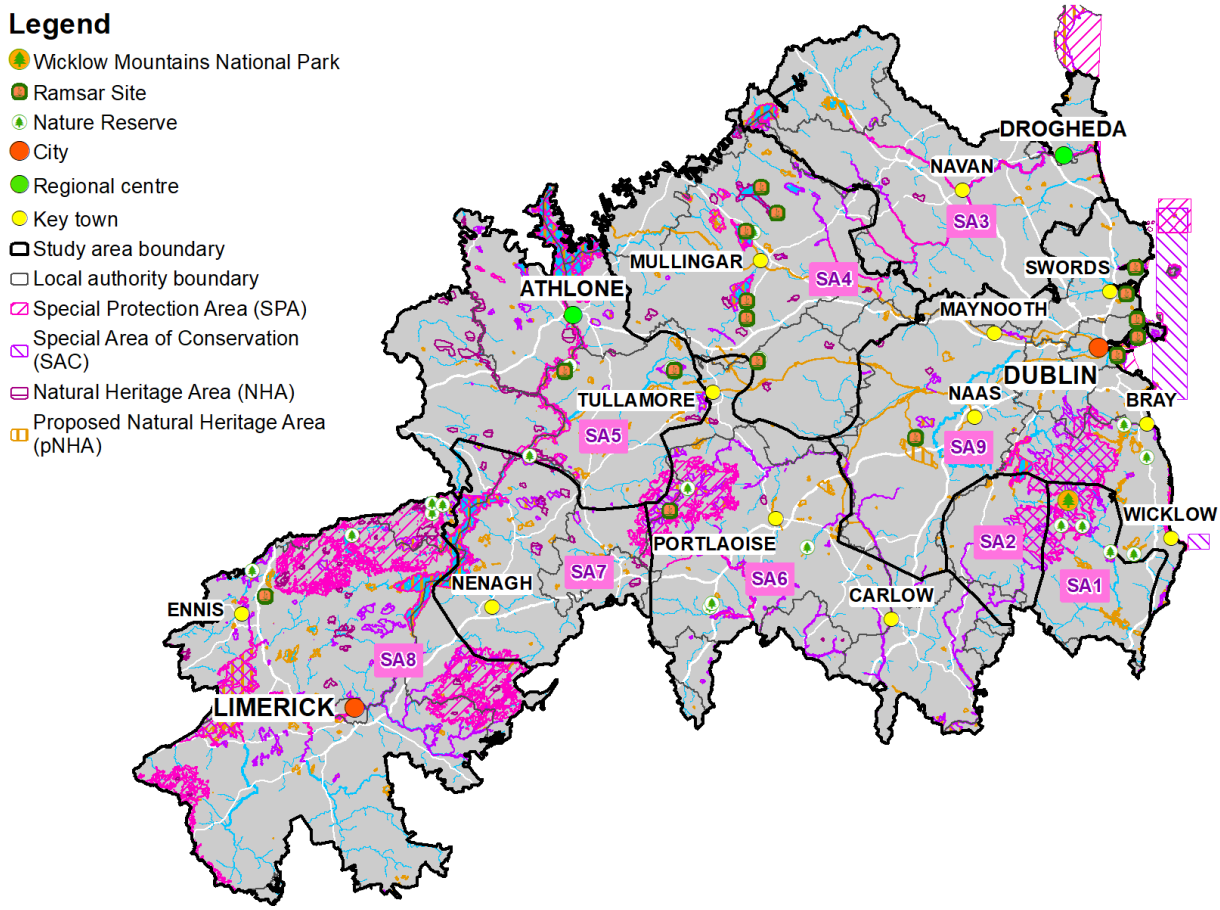


Figure 2.17 Designated Sites in the Eastern and Midlands Region

Box 2.3 – Protected Sites with the Greatest Coverage

A) Wicklow Mountains SAC and SPA: A large area (30,000 hectares) of upland (300 – 600m) encompassing Lugnaquilla mountain (925 m) drained by the Dargle, Liffey, Dodder, Slaney and Avonmore rivers and bordered by Blessington and Vartry reservoirs. The western part of the site is covered with peat giving rise to the brown colour in the draining rivers which is heightened during floods. The underlying geology and peaty nature of the site gives rise to the protected habitats - 'Oligotrophic Waters containing very few minerals', 'Dystrophic Lakes', 'Wet Heath', 'Dry Heath', 'Alpine and Subalpine Heaths', active 'Blanket Bogs', Siliceous Scree' 'Calcareous Rocky Slopes' and 'Siliceous Rocky Slopes'. The site is a Special Protection Area for Merlin and Peregrine. The area is also designated as a National Park. The status of the bog habitats of the Wicklow Mountains is reported as unfavourable and all have a 'restoration' conservation objective. There are multiple benefits associated with undertaking such restoration including biodiversity, carbon storage, tourism and recreation and water quality.

B) Lower River Shannon SAC: A large site stretching 120km (and covering 37,000 hectares) encompassing estuarine and river habitats of the Shannon, Feale, Mulkear and Fergus. The Shannon Estuary river systems are contrasting in character - the Shannon, broad and slow flowing and naturally eutrophic; the Fergus is smaller and alkaline, while the Cloon is narrow, fast flowing and naturally acidic. The site lists 21 qualifying interests, 14 habitats and seven species. Five Annex II fish species have been recorded within the site - Sea Brook and River Lamprey, Twaite Shad, Salmon and Freshwater Pearl Mussel in parts of the Cloon River. There is a restoration conservation objective set for Salmon, Sea Lamprey and Freshwater Pearl Mussel at this site.

2.3.9 Opportunities for Protection, Restoration and Enhancement

Irish Water's long-term approach to protecting drinking water sources and therefore our natural resources will be the increasing implementation of catchment management for drinking water source protection in partnership with key stakeholders. This approach is in accordance with Article 7(3) of the Water Framework Directive and has the joint benefit of protecting our water habitats and managing the risk to our drinking water sources.

In 2019, the Irish Government declared a National Climate Change and Biodiversity Emergency to highlight the significant concerns around Ireland's biodiversity and recognizing the urgency to act on these interconnected global crises. Irish Water recognises the need to urgently increase and accelerate efforts to halt the decline of biodiversity. We are committed to ensuring that we build and manage our infrastructure responsibly so that our ecosystems are protected, and where possible enhanced.

Biodiversity protection is a key part of Irish Water's Biodiversity and Sustainability Policies. The overall aim of Irish Water's Biodiversity Policy is that in association with the provision of water and wastewater services, biodiversity and the natural environment are conserved, protected and where practical enhanced through our responsible stewardship, sustainable water services and strong partnerships. Irish Water launched its Biodiversity Action Plan (BAP)[24] in 2021 to deliver on this aim.

One of the key objectives of BAP is the promotion of nature-based solutions (NBS) for water protection and wastewater treatment, which have significant potential to deliver biodiversity. NBS are multi-functional measures that aim to protect water resources and address water-related challenges by restoring or maintaining ecosystems, as well as natural features and characteristics of waterbodies using natural means and processes[25]. The main functions are to improve water quality, reduce flood risk, and create habitats. NBS have many additional benefits that include reduction in energy usage, carbon sequestration, and amenity use for local communities. NBS include a broad range of measures such as: wetlands, basins and ponds, reedbeds, buffer strips and hedges and forest riparian buffers.

Some examples of NBS being utilised by Irish Water in the Eastern and Midlands Region include:

- Working in partnership with Local Authorities to support biodiversity across many of its sites including Integrated Constructed Wetlands in Clonaslee, Co Laois.
- Delivering Sludge Drying Reed beds at several sites in Co. Carlow by working alongside our Carlow County Council partners.
- Working in partnership with catchment stakeholders to support initiatives such as native tree planting and bog rehabilitation, which also help to protect and restore source waters.
- Biodiversity enhancement measures which have been in place for several years, at Ballymore Eustace, the site of Ireland's largest water treatment plant occupying 56 hectares, with habitats including wildflower meadows and native woodland.

An example of catchment management activities is described in Box 2.4.

Identifying opportunities for the incorporation of NBS, and catchment management activities within our abstraction catchments, will continue to be encouraged and promoted through the NWRP.

Box 2.4 – Source Protection and Catchment Management Activities

Irish Water is actively involved in pilot source protection projects in Ireland to trial catchment scale interventions to reduce the risk of pesticides causing exceedances in water supplies. The two key projects are described below:

A) Source to Tap Project: is a cross-border partnership project that focuses on the River Erne and the River Derg catchments which cross the border between Ireland and Northern Ireland. Irish Water is a project partner on this project which is funded by INTERREG with match-funding having been provided by the Department of Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland and the Department of Housing, Local Government and Heritage (DHPLG) in Ireland. The project began in 2017 and will continue until 2021. It aims to develop sustainable, catchment-scale solutions for the protection of rivers and lakes, which are the main sources of our shared drinking water. Source to Tap also delivers a learning and outreach programme targeted at informing and empowering the public about their role in protecting our clean and healthy freshwater environment. An Agricultural Land Incentive Scheme is being delivered focused on changing land management practices for the protection of our water.

B) Pilot Drinking Water Source Protection Project: as committed to under the River Basin Management Plan (RBMP). Irish Water is coordinating a pilot drinking water source protection project to "*trial innovative monitoring and management strategies aimed at reducing the risk of pesticide contamination of drinking waters*". Catchment management interventions to be undertaken as part of the project will involve a combination of behavioural-change initiatives and promotion of the sustainable use of pesticides. Scoping, consultation and planning of the project began in 2019 and is continuing. Our key stakeholders in catchment management include the National Pesticides and Drinking Water Action Group (NPDWAG), the National Water Forum (An Fórum Uisce), the Local Authority Water Programme (LAWPRO), Geological Survey Ireland, Department of Housing, Local Government and Heritage (DHLGH), Department of Agriculture, Food and the Marine, National Federation of Group Water Schemes, Inland Fisheries Ireland, the EPA Catchment Science Team and the National Parks and Wildlife Service (NPWS).

2.4 Water Supply

2.4.1 Rainfall

Rainfall is the key climatic variable that affects the availability of water resources. Understanding the variability across the Eastern and Midlands Region and the impact that climate change may have on rainfall patterns is important to planning our water infrastructure.

The rainfall across Ireland is varied. Figure 2.18 shows that the lowest areas of rainfall across Ireland occur across the Eastern and Midlands Region. Most of the region experiences average annual rainfall between 800 and 1,000 mm per year. Counties Dublin and Kildare (located in Study Area 9) experience the driest weather with average annual rainfall less than 800 mm. There are pockets of high rainfall areas within the RWRP-EM. The Wicklow Mountains (within SA1, SA2 and SA9) receives the highest rainfall, exceeding 2000 mm/year on average. Flows from the mountains drain to the River Liffey system and have enabled the development of electricity generation and water supply. This compares with the south-west and mid to north western parts of the country where precipitation in most areas exceeds 1,500 mm per year, with some locations in the west experiencing between 2,000 to 2,800 mm per year.

The comparison with population density also shown in Figure 2.18 highlights that the areas of lowest rainfall within the Eastern and Midlands Region also have the greatest population density, meaning resources in our most populated areas can become stressed.

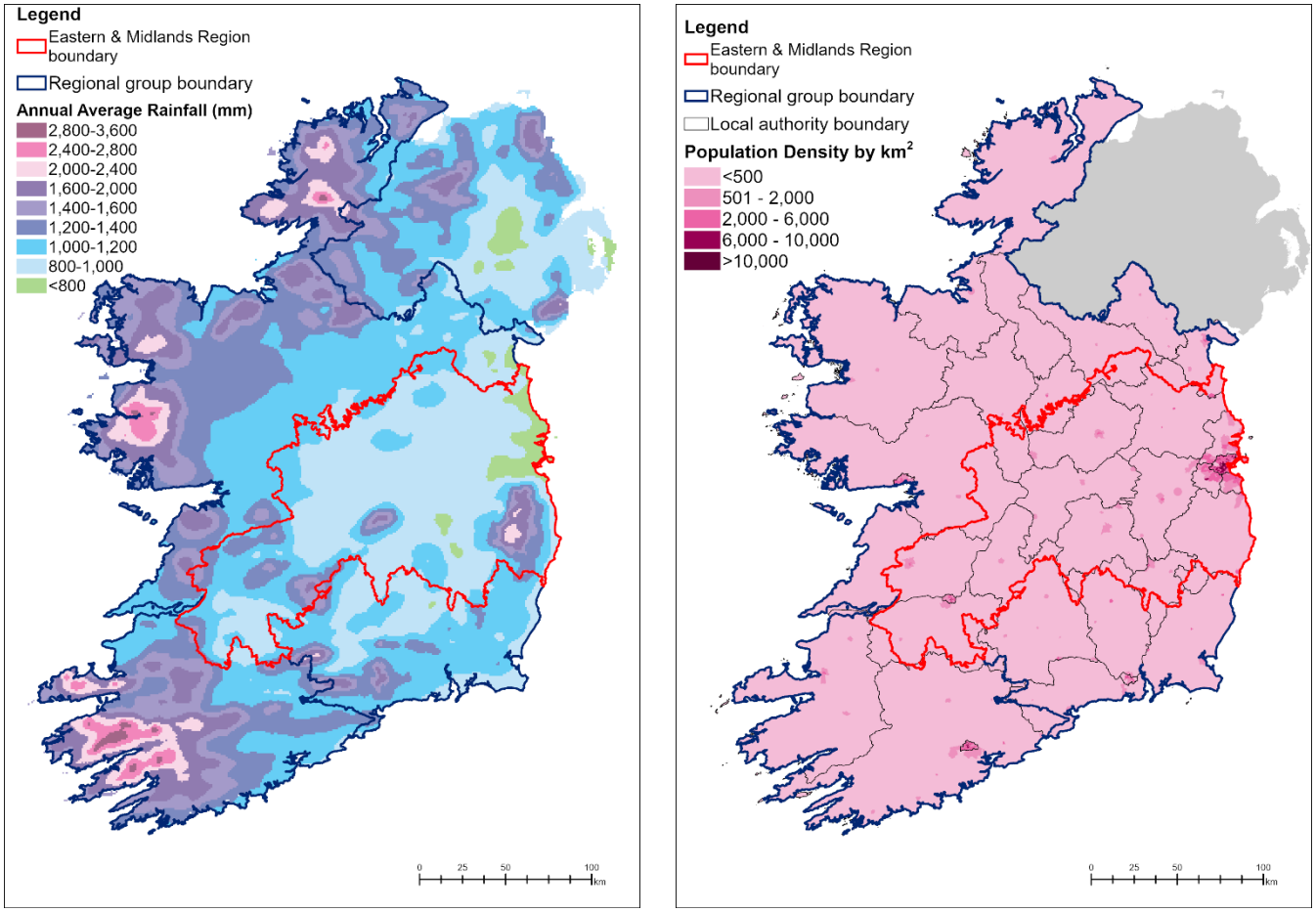


Figure 2.18 Rainfall across Ireland compared with Population Density[26]

Seasonal and annual variability of rainfall is an important consideration in water supply planning. The variability in time and magnitude will determine infrastructure requirements. For example, water reservoirs are required to store water, captured during high flow periods, to supply customers during periods of low flow.

Across the Eastern and Midlands Region, the variability in seasonal rainfall is higher in the west than the east (Figure 2.19). In the western part of the region near Shannon, monthly average rainfall across the year has a range of 46mm, varying from 59 mm in April to 105 mm in October. The eastern area near Dublin shows reduced seasonal variability, with a range of 30 mm between the minimum average monthly rainfall in February (49 mm) and the maximum average monthly rainfall in October (79 mm). Climate change is likely to increase the within year variability, with wetter winters and drier springs and summers (Section 2.4.6).

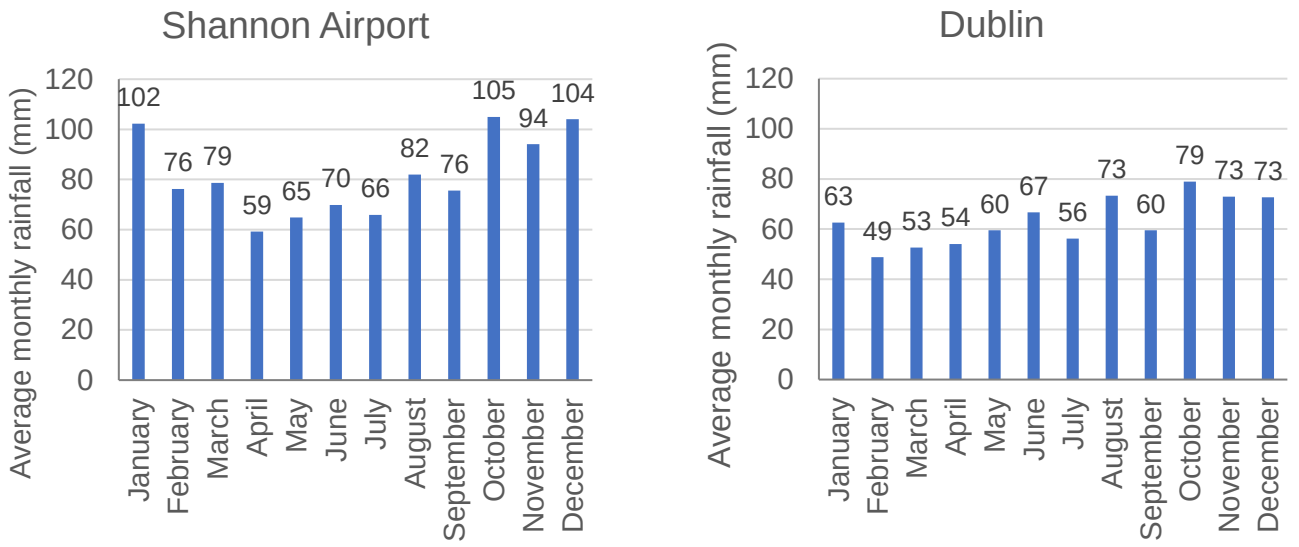


Figure 2.19 Monthly Rainfall Variability – 1981 to 2010[26]

2.4.2 Drought

Droughts occur when a period of lower-than-average rainfall causes a shortage of water. The shortage of water affects both the natural environment and sectors such as agriculture and water supply to our customers. The duration, timing and intensity of a drought can vary considerably, and these factors combine to affect different sectors in different ways. Although Ireland is considered to be a country with large amounts of rainfall, the country does experience drought events. The number of events of severe drought periods that would affect our key supplies is shown in Figure 2.20. The drought events experienced in 2018 and 2020, although severe, were short in duration and are therefore not registered when compared to historical droughts. As a result, they are not represented in Figure 2.20.

The late spring and early summer of 2018 saw some of the lowest rainfall totals on record leading to drought conditions. Whilst the drought event was not defined as ‘severe’ based on historical records (due to its short duration) it was still substantial enough to impact our water supply availability. Low rainfall levels resulted in low river flows and stress to water supplies. Customers experienced reductions in water pressure and some temporary loss of supplies, principally as a result of a lack of capacity in our existing infrastructure. Demand for water was also higher than normal during this period, driven by high temperatures. As climate change continues droughts are expected to become more frequent and therefore infrastructure needs to be in place to enable the provision of reliable supplies during these periods.

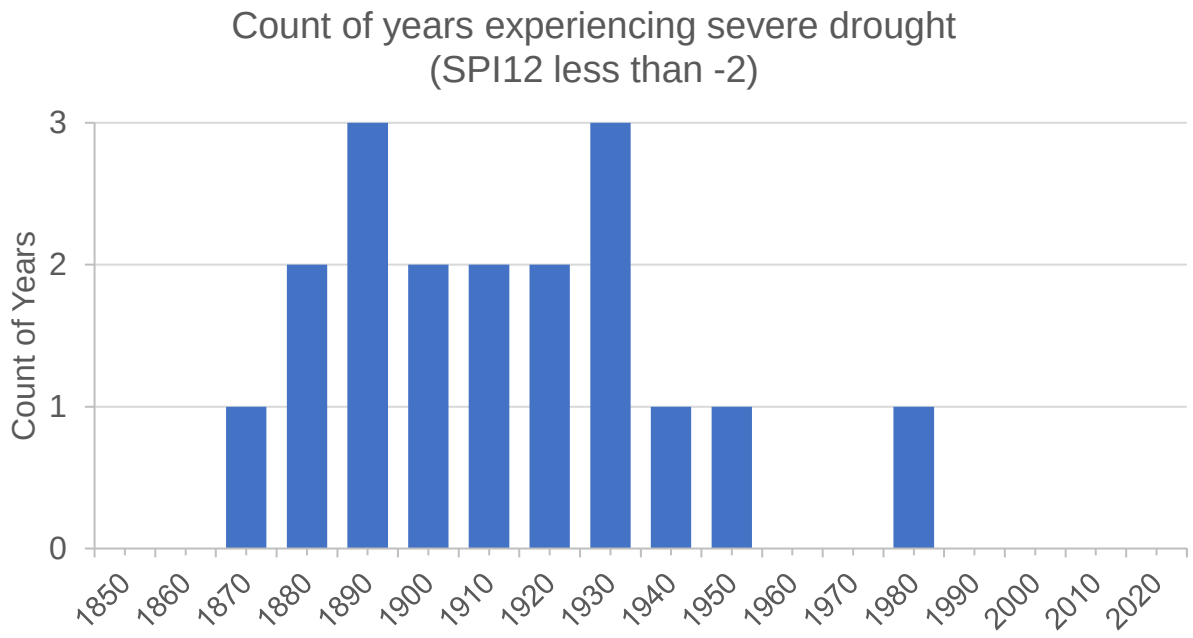


Figure 2.20 Number of Events of Severe Drought (The 12-month Standard Precipitation Index = -2)[27]

Valuable learning on strategic and tactical drought management was gained during the 2018 drought period, which helped to improve our response during drought conditions experienced in the Spring of 2020. Actions taken during the 2018 drought event and key lessons learnt are outlined in Box 2.5. Further information regarding our drought management approach is given in Appendix E of our Framework Plan.

Box 2.5 – 2018 Drought Experience

The late spring and early summer of 2018 saw some of the lowest rainfall totals on record, resulting in low river flows and stress to water supplies. Demand for water was also higher than normal during this period, driven by high temperatures.

In 2018, disruption to customers and environmental impacts were minimised as a result of emergency plans and activities carried out by Irish Water and Local Authority operational staff, including:

- Convening a crisis management team;
- Tracking drought indicators and planning responses and activities;
- Optimising existing supplies;
- Tankering water to maintain storage levels;
- Commissioning back-up supplies;
- Controlling pressures in networks to improve water availability;
- Night-time restrictions in critical areas to conserve supplies;
- Communication campaigns to promote water conservation;
- Introduction of the first ever National Water Conservation Order;
- Working with stakeholders including but not limited to the; Department of Housing, Local Government and Heritage (DHPLG), National Federation of Group Water Schemes (NFGWS), EPA, Electricity Supply Board (ESB), Inland Fisheries Ireland (IFI), National Park and Wildlife Service (NPWS), Met Éireann and Waterways Ireland (WI);
- Providing alternative water supplies to customers (Bowsers, stand pipes and bottled water), attention to critical customers, healthcare customers and vulnerable customers; and
- Engagement of our Key Account Managers with large customers.

Unfortunately, customers experienced some impacts, including reductions in water pressure and some temporary loss of supplies, principally as a result of a lack of capacity in our existing infrastructure.

A key learning from this recent drought experience, was that we need to undertake further research and investigation to increase our understanding of the hydrology and hydrogeology relating to some of our water sources and support our operational management with:

- Site specific level and flow monitoring
- Live operational data
- Controls within some areas of our distribution networks to allow us to manage supplies more effectively.

2.4.3 Hydropower

As described in Section 2.3.2, the Eastern and Midlands Region is drained by several major river catchments - the Inny, Suck, and Brosna feeding into the Shannon in the western half of the region, and the Barrow, Boyne and Liffey in the eastern half (Figure 2.7). In addition to providing public water supply and sector demands such as agriculture, the Shannon and Liffey rivers support hydropower generation.

The River Shannon is the longest river traversing the Eastern and Midlands Region (360.5 km) and has three lakes that are formed along its length – Lough Allen, Lough Ree and Lough Derg. Lough Ree and Lough Derg are located within Eastern and Midlands Region, while Lough Allen is situated near the headwaters in the North Western Region. The flows of the Shannon River are used to power the largest river hydroelectric power station in the country, the Ardnacrusha power plant. It harnesses the 30-metre fall between Lough Derg and the Shannon Estuary.

The River Liffey is the largest system in the east, consisting of more than 100 smaller rivers and streams. It drains from the Wicklow mountains and flows through the counties of Wicklow, Kildare and Dublin, entering the Irish Sea at Dublin Bay. Poulaphouca, the largest artificial reservoir in Ireland supplies three power stations along the River Liffey – Poulaphouca, Golden Falls and Leixlip. The Poulaphouca Reservoir is one of the two major sources of Dublin's water supply and is owned and operated by the Electricity Supply Board (ESB).

As some of Irish Water's abstractions are reliant upon the hydropower generation infrastructure, we maintain ongoing cooperation with the ESB to facilitate both water supply and energy generation.

2.4.4 Flood Risk

Guidelines for Planning Authorities on flood risk management (November 2009)[28] highlight that flooding of the water supply network (this includes pumping stations electricity substations and water treatment works) can result in a loss of supply over large areas and magnify the effects of flooding beyond the immediate community directly affected. Irish Water has considered the number of WTPs within areas of flood risk, where vulnerability to the effects of flooding need to be considered (Table 2.6). WTPs that are known to be at risk, are under review and where needed, protection measures will be considered for sites at risk. All new options will be reviewed in terms of their risk from flooding, and this will be taken into account in the detailed siting and design to ensure improved flood risk resilience for the supply network.

Table 2.6 Total Number of WTPs at Risk of Flooding

	Number of Water Treatment Plants at Risk of Flooding	
	1 in 10-year Flood Risk (10% Annual Exceedance Probability)	1 in 100-year Flood Risk (1% Annual Exceedance Probability)
Fluvial Flooding[29]	18	26
Pluvial Flooding[28]	3	3
Coastal Flooding[28]	0	0
Groundwater Flooding[28,30]	0	0

2.4.5 Water Supply Systems

The water supply systems across the Eastern and Midlands Region draw from 209 sources (Table 2.7) and are treated in 201 Water Treatment Plants (WTPs). Although the majority of our water supply sources are groundwater, surface water sources supply 87% of the total water delivered to our customers, either from rivers or lakes.

Table 2.7 Number of Water Sources in RWRP-EM

Study Area	No. Of WRZs	Total Network Length (km)	Water Sources		
			Total	Surface Water	Groundwater
SA1	18	320	20	5	15
SA2	12	135	12	1	11
SA3	11	1,927	20	7	13
SA4	13	1,341	15	3	12
SA5	10	1,123	19	7	12
SA6	28	1,723	44	6	38
SA7	10	757	19	3	16
SA8	31	3,205	48	7	41
SA9	1	8,474	12	7	5
TOTAL	**134**	**18,685**	**209**	**46**	**163**

2.4.6 Climate Change

2.4.6.1 Potential Impact on Water Availability

Climate change will have significant effects on the availability of water at our sources in the future. Mean annual temperatures for Ireland are expected to increase by 0.5ºC to 1.7ºC by 2050, with increases closer to 3ºC in the east of the country. The projected increase in temperature will affect the amount, timing and intensity of local precipitation. In Ireland, this is expected to mean wetter winters but also drier springs and summers. Climate change simulations for Ireland show the precipitation in the autumn and winter months could increase by between 5% to 35%, while summer precipitation could decrease by a range of 0% to -30%. Under the medium to high carbon emissions scenarios dry periods are projected to increase in frequency, duration and/or magnitude from between 12% to 40% for the spring and summer months[31]. The historical analysis of average rainfall data undertaken by Murphy in 2018[32] confirms a continued trend of drier summers and wetter winters.

Section 15 of the Climate Action and Low Carbon Development Act 2015 (as amended in 2021) sets a new "national climate objective" for Ireland, which provides that "The State shall, so as to reduce the extent of further global warming, pursue and achieve, by no later than the end of the year 2050, the transition to a climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy". The amended Act requires public authorities, including Irish Water, to take account of, so far as practicable, perform their functions in a manner consistent with the furtherance of the national climate objective and the relevant national and sectoral plans and strategies to mitigate greenhouse gas emissions and adapt to the effects of climate change.

The Department of the Environment, Climate and Communications' Climate Action Plan(CAP)[33] published November 2021, replacing CAP 2019, commits to achieving a 51% reduction in overall greenhouse gas emissions by 2030 and reaching net zero carbon emissions by 2050. The aim is for more sustainable growth and to create a resilient, vibrant and sustainable country. The CAP defines a

roadmap to this goal and initiates a set of policy actions to achieve this. A detailed sectoral roadmap has also been set out, which is designed to deliver a cumulative reduction in emissions, over the period 2021 to 2030. CAP 2021 updates existing targets with renewable energy to provide 80% of electricity by 2030 and setting targets for agriculture and forestry and improving land management to support carbon sequestration.

The Climate Change Sectoral Adaptation Plan for Water Quality and Water Services Infrastructure[31], identifies the following key priority impacts of climate change for the water services infrastructure sector:

- Hot-weather related changes in demand.
- Increased drawdown in the autumn/winter for flood capacity, leading to resource issues in the following spring/summer.
- Reduced availability of water resources (surface and groundwater sources).

These impacts are considered in our approach to supply forecasts when assessing the Supply Demand Balance across our planning period. Our assessment of the impact of climate change on the water resources of the Eastern and Midlands Region is discussed in Section 3 of this Plan.

2.4.6.2 Further Work

Whilst there is recent work on potential climate effects on rainfall, there is less work on the projected impacts of climate change to river flow regimes across Ireland. There is also no Ireland-wide guidance available at present outlining the effects of future climate change on flows. Recognising this, we commissioned the Climate Sensitive Catchments Project (see Box 2.6).

Box 2.6 - Climate Sensitive Catchments Project

Project Partner: Maynooth University Irish Climate Analysis and Research Units (ICARUS)

The Climate Sensitive Catchments research project improved our understanding of how river flows may change due to climate change and how best to prepare for a hotter climate. This research concluded in April 2019.

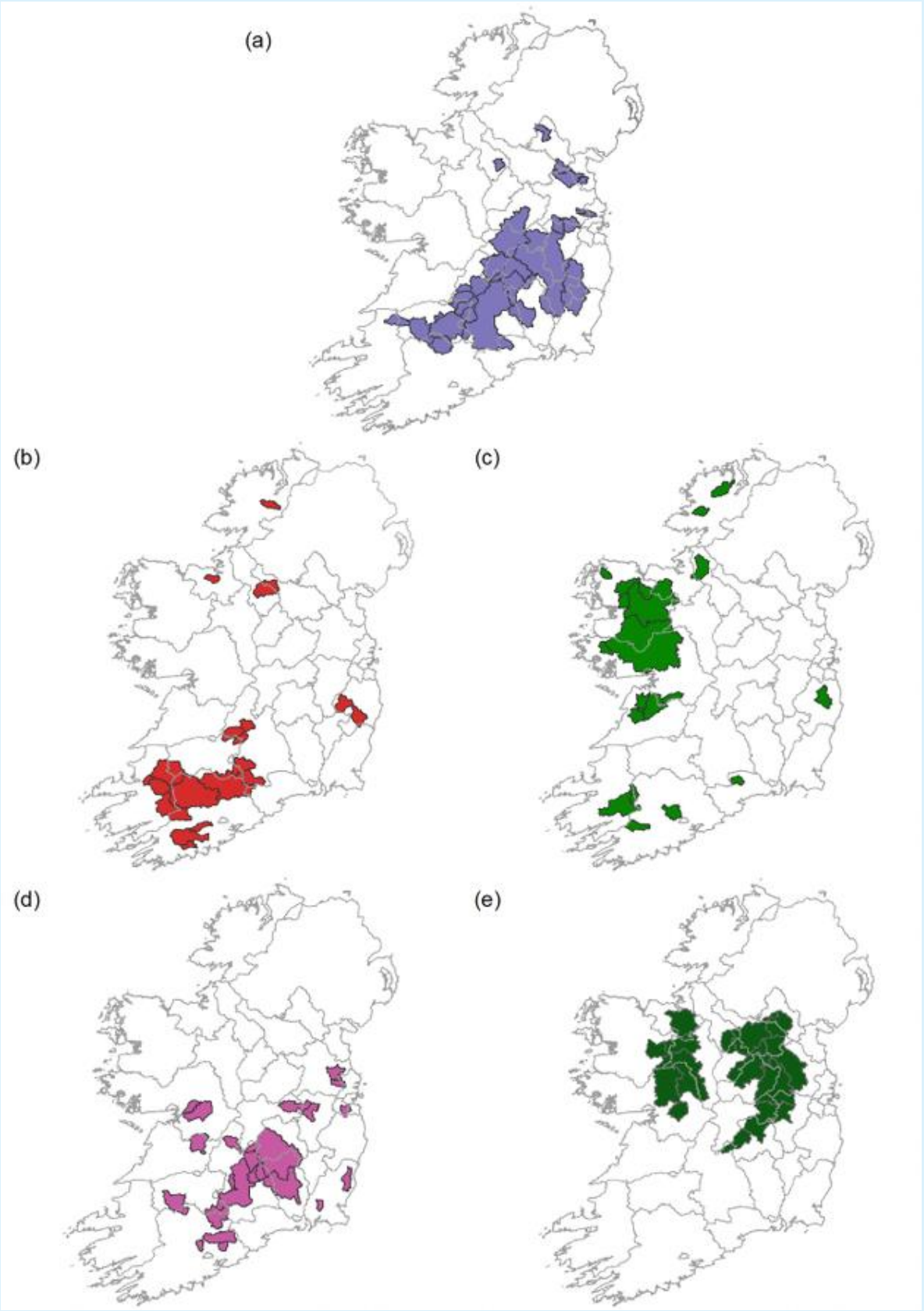
The traditional methodology to identify and assess catchments vulnerable to climate change takes a 'top down' approach, which applies information about large-scale climate change trends to small areas. This can result in inaccurate forecasting for catchments because it does not take area-specific information into consideration. This project applied a 'bottom up' methodology, which assessed how sensitive catchments are to climate change by building a catalogue of data specific to each catchment. This allowed us to identify the particular stressors and vulnerabilities in each area. By better assessing the sensitivity of catchments to climate change, we aim to increase the effectiveness of our national water management and to develop a more resilient water service.

The 206 river catchments included in this research were characterised into 5 catchment sensitivity types (a) to (e) as illustrated below. The research concluded that catchment types (a) are the least sensitive to changes in seasonality of wetter winters and drier summers due to high groundwater storage in these catchments. Catchment types (b) and (c) have lower natural water storage and see the greatest decreases in flow due to wetter winters and drier summers. Catchment types (d) and (e) lose more water due to evaporation and are mostly drier catchments in the midlands and east. Catchment types(d) are most sensitive to changes in annual mean precipitation. When changes in seasonality and mean quantity are considered together, catchment type (d) are also the most sensitive and types (b) the least. Catchment type (e) experience less evaporative losses than (d) and while sensitive to changes in seasonality and mean amount are less sensitive to these changes than catchment type (d).

This research projected low flow allowances for each of the 5 catchment sensitivity types. These low flow allowances provide resilience for lower river flows in the future due to climate change. The project concluded that in some instances an allowance for a 30% reduction in low flow would be insufficient to avoid future climate change impacts.

The findings of this research project will address the water quantity aspects of climate change, but because of changes either to temperature or flow regimes, changes in water quality will also have a bearing. In addition, climate change may result in land use changes which may compound the observed effects.

Box 2.6 continued- Climate Sensitive Catchments Project



2.4.6.3 Reducing Our Carbon Footprint

The impact of climate change will be felt by every individual, household, and community in Ireland and there is now a high level of awareness and understanding of this. There is, therefore, an onus on us to mitigate the magnitude of long-term climate change by taking action to reduce GHG emissions, and to increase the capacity of carbon sinks such as forests and wetlands. The European Green Deal frames Europe's response to these challenges. It is the new growth strategy that will lead the transformation in Europe to a climate-neutral, fair and prosperous society, with a modern, resource-efficient and competitive economy.

In line with EU ambition, Ireland commits to achieving a 51% reduction in Ireland's overall GHG emissions from 2021 to 2030, and to achieving net-zero emissions no later than 2050.

Section 15 of the Climate Action and Low Carbon Development Act 2015 (as amended in 2021)[36] sets a new "national climate objective" for Ireland, which provides that "The State shall, so as to reduce the extent of further global warming, pursue and achieve, by no later than the end of the year 2050, the transition to a climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy". The amended Act requires public authorities, including Irish Water, so far as practicable, to perform their functions in a manner consistent with the furtherance of the national climate objective and the relevant national and sectoral plans and strategies to mitigate greenhouse gas emissions and adapt to the effects of climate change.

The Department of the Environment, Climate and Communications' Climate Action Plan (CAP)[37] published November 2021, replacing CAP 2019, commits to achieving a 51% reduction in overall greenhouse gas emissions by 2030 and reaching net zero carbon emissions by 2050. The aim is for more sustainable growth and to create a resilient, vibrant and sustainable country. The CAP defines a roadmap to this goal and initiates a set of policy actions to achieve this. A detailed sectoral roadmap has also been set out, which is designed to deliver a cumulative reduction in emissions, over the period 2021 to 2030. CAP 2021 updates existing targets with renewable energy to provide 80% of electricity by 2030 and setting targets for agriculture and forestry and improving land management to support carbon sequestration.

Irish Water is committed to improving energy efficiency and reducing carbon emissions. In 2020, we achieved a 32% improvement in our energy efficiency performance, saving an equivalent of 95,000 tonnes of carbon. We are on track to meet our target of 33% energy efficiency improvement, putting us in a strong position to meet our new target of 50% by 2030.

Irish Water is committed to reducing energy consumption through a range of energy initiatives, including asset replacement and the commencement of sustainable energy pilots at two wastewater treatment plants to install solar panels to generate renewable energy. We are also reviewing the potential to produce more renewable energy from on-site wind turbines.

Irish Water have made significant progress on the journey to become a low carbon, energy efficient, sustainable water utility. Our strategy and energy management programme take a business wide approach with 36 Energy Action Plans and 255 discrete energy projects, including energy efficient design, innovation, energy retrofits, renewable energy, lighting and heating, energy audits and planning, process optimisation, staff awareness and training. An example of this is the provision of 230 Solar Panels at the new WTP in Thurles, see Box 2.7.

We have also developed and published a Biodiversity Action Plan (BAP)[24] in 2020. It will help us to conserve, enhance and work with the natural environment. Our approach will protect and enhance biodiversity at our sites whilst also providing additional benefits such as carbon sequestration and drinking water source protection. We have implemented Biodiversity Management Plans and Enhancement Measures for 85 sites nationally.

Measures taken in 2020 to reduce our Carbon Footprint include;

- Decarbonising our energy consumption including installation of solar renewable energy sources.
- Implementing an energy governance model, using an asset management approach aligned with ISO 5000.
- Implementing energy efficiency projects across our operations including pumping, aeration, renewables, lighting and heating.
- Roll out the water conservation awareness campaign.
- Preparing a climate change mitigation and adaptation strategy.

The NWRP approach to assessing and selecting solutions to meet our existing and future water supply challenges, is aligned with national policy objectives. For example, Carbon Costs and Operational Costs (including energy costs) are included in the development of the overall Net Present Value (NPV) of all Options. Therefore, it is a key consideration in the determination of the Preferred Approach.

Further to this, one of the six Approach Categories considered in the determination of the Preferred Approach is the Lowest Carbon Approach (Table 7.1 Section 7). The Lowest Carbon Approach is the Option or Combination of Options with the lowest embodied and operational carbon cost.

At project development stage, further considerations will be given to energy efficient design and the potential to reduce greenhouse gas emissions and improve energy efficiency of the project by the development of clean renewable energy on-site and the use of innovative technology to reduce energy demand. Section 6.4 provides a further description of the project development stage.

Box 2.7 - Thurles Renewable Energy Project

Irish Water, working in partnership with Tipperary County Council, has recently completed a solar energy project at the new water treatment plant in Thurles Co. Tipperary. This project involved the installation of 230 solar panels at the recently constructed water treatment plant, generating clean, renewable energy for the plant. This project will generate 83,264 kWh (kilowatt hours) electricity per year, improve energy efficiency at the plant and reduce carbon emissions.

This project will:

- Reduce the plant's carbon footprint, which will equate to a 40 tonnes reduction in carbon emissions.
- Generate 83,264 kWh (kilowatt hours) per year of electricity, which is equivalent to the electricity required to power 20 houses per year.
- The generation of clean renewable energy will lead to a 10% reduction in imported electricity at the site.
- Reduce greenhouse gas emissions and improve energy efficiency at the plant.

2.5 Summary

In this section we have outlined the following key characteristics of the RWRP-EM:

Population and Growth

- Irish Water supplies around 887 million litres of water per day to a population of 2.48 million people (60% of the national population) and 76,000 businesses in the Eastern and Midlands Region. Almost 70% of the regional population is located with the Greater Dublin Area.
- The overall regional population growth is 25% from 2019 to 2044. All Study Areas in the Eastern and Midlands Region have a projected growth rate that exceeds the 12% national rate observed in the 10-year period from 2006 to 2016. The Limerick Clare SA has the highest projected growth rate at 37%, which is driven by the Limerick City forecast growth 61% by 2044.

Natural Resources and Environmental Pressures

- In the Eastern and Midlands Region there are 1561 lakes covering 0.02 % of the regions land area (35,875 hectares) with 6 lakes making up ~75% of the area, Lough Derg, Lough Ree, Poulaphouca Reservoir, Lough Sheelin, Lough Ennell and Lough Owel. The larger known rivers within this region include the Shannon, the Boyne, the Liffey and the Avoca.
- The riverine ecology of at least a quarter of our river systems is considered highly sensitive to changes in flow and water level.
- Surface water bodies classified as Moderate or lower WFD 'Ecological Status' represent just over 14% of total surface water bodies. High Status rivers are in Study Areas 1, 2 and 6 in the south-east of the region and in Study Area 8 (Limerick and Clare). Two rivers are identified as 'Bad' Status - Avoca in SA1(Mid-Wicklow), polluted from old mines and wastewater, and Ahavarraga stream in SA8 due to high nutrient levels.
- WFD cycle 3 assessed both GWB's and SWB's to determine which are currently considered to be at risk of failing WFD objectives or are at risk of deteriorating from their current status. There are 218 GWBs in the region of which 40 are currently determined to be 'At Risk of failing WFD objectives in WFD Cycle 3. There are 76 GWBs in the region currently considered to be 'Not at Risk' and 102 which are currently under review. Forty-seven (47%) of our river water bodies, 25% of our lake water bodies and 18% of our groundwater bodies are currently 'At Risk' with the predominant pressure being agriculture.
- In developing our Planned Approach to securing future water supplies we have undertaken a desktop independent assessment to identify existing surface water sites where abstractions have the potential to exceed sustainable abstraction thresholds. We have identified 21 sites which we consider to be below target conditions. This was a conservative assessment based on plan level information. The EPA will be the authority to adjudicate with the benefit of more detailed project level information.
- There are 618 nationally and internationally designated sites listed in the Eastern and Midlands Region. Protected sites with the greatest coverage in the Eastern and Midlands Region include the Wicklow Mountain SAC and SPA and the Lower River Shannon SAC).

Water Resources and Existing Challenges

- Surface water abstractions make up 87% of the water delivered to customers in the Eastern and Midlands Region, with the remaining 13% being supplied from groundwater sources.
- The Eastern and Midlands Region contains areas that experience the lowest rainfall in the country while the region's water supplies serve 60% of the nation's population.
    - The availability of water is anticipated to change over the 25-year planning period due to climate change with water availability increasing during autumn/winter and decreasing during the

summer. Precipitation responsible for the recharge of our groundwater and surface water sources could increase by 5-35% during the autumn and winter months decrease by 0 -30% during the summer.

Environmental and Climate Change Initiatives

- Irish Water is implementing Nature Based Solutions within the Eastern and Midlands Region. Some of these include; integrated constructed wetlands in Clonaslee, Co Laois, sludge drying reed beds at several sites in Co. Carlow and biodiversity enhancement measures at Ballymore Eustace, the site of Ireland's largest water treatment plant. Identifying opportunities for the incorporation of NBS, and catchment management activities within our abstraction catchments, will continue to be encouraged and promoted through the NWRP.
- Key Sustainability objectives planned for 2021 include:
    - Developing and implementing a sustainability strategy aligned with the Government Climate Action plan and UN Sustainable Development Goals.
    - Continuing the implementation of our sustainable energy strategy.
    - Implementing and communicating our climate change strategy.
    - Developing a carbon neutrality roadmap.
    - Continuing to decarbonise our energy consumption through energy efficiency improvement and renewable energy.
    - Improving energy efficiency by upgrading and replacing inefficient plant and processes.
    - Continuing to protect and enhance biodiversity on our assets.
    - Embedding energy efficiency design into our activities in collaboration with the Sustainable Energy Authority of Ireland (SEAI).
    - Implementation of a waste management strategy, with a particular focus on circular economy.

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