Bedfordshire Natural Capital Assessment

Part 4: Maps and results for Luton Borough

Authors:

Dr Jim Rouquette, Dr Mark Ashby & Dr Valentina Zini

Reviewed by:

Dr Alison Holt, Natural Capital Solutions

Contact details:

Dr J.R. Rouquette

Natural Capital Solutions Ltd

www.naturalcapitalsolutions.co.uk

jim.rouquette@naturalcapitalsolutions.co.uk

Report prepared for and funded by:

Luton Borough Council, in association with Bedford Borough Council, Central Bedfordshire Council and the Bedfordshire Local Nature Partnership

Version: Final

June 2021

Executive Summary

This report describes a project to produce a detailed natural capital (habitat) basemap for Luton Borough, to model and map the physical and economic benefits (ecosystem services) that flow from the natural capital, and to identify opportunities to enhance accessible natural greenspace, biodiversity and a range of ecosystem services. It is part of a larger project to complete a natural capital assessment for the whole of Bedfordshire and separate reports have also been produced for Bedford Borough and Central Bedfordshire. The main Bedfordshire report should be consulted for details on methodology and further background. The overall project was commissioned by Bedford Borough Council, Central Bedfordshire Council, and Luton Borough Council, through the Bedfordshire Local Nature Partnership.

The first part of the project was to produce a detailed map of the current habitats present across Luton Borough. This used Ordnance Survey MasterMap polygons as the underlying mapping unit and then utilised a series of different data sets to classify each polygon to a detailed habitat type. The final basemap covered an area of 4,335 ha or 43 km^2 and contained 271,173 polygons, each of which was classified to an appropriate habitat type. It shows that Luton Borough is dominated by built-up areas, infrastructure, and gardens, together making up 70.5% of the area (3,059 ha). Woodland and scrub habitats take up 4.5% (196 ha) of the area. Semi-natural grasslands make up 2%, while water makes up just 0.2% of the area, as many watercourses have been culverted.

In total, 10 ecosystem services were modelled and mapped: carbon storage, carbon sequestration, air purification, noise regulation, local climate (urban heat) regulation, water flow regulation, water quality regulation, food production, timber production, and accessible nature. Maps showing the demand for air purification, noise regulation, local climate regulation and accessible nature were also produced. The capacity to provide these services was highest within the small areas of woodland and other semi-natural habitats. Such areas should be protected and expanded, even if not important for biodiversity. Across the borough, there is a mismatch between demand and supply.

Overall, the natural capital assets of Luton Borough deliver £27.2 million annually, with a present value of £810 million over 50 years. The most valuable ecosystem service is recreation, generating £17.3 million in benefits annually, with a present value of £442 million over 50 years. Also particularly valuable, are physical health and air quality regulation benefits, delivering annual benefits worth £6.4 and £3.4 million respectively, with a present values (over 50 years) of £237 and £126 million. Carbon sequestration is less important, given the urban nature of the Borough, but still provides benefits valued at £90,000 per year, with a present value of £5.25 million over 50 years.

Habitat opportunity mapping is a Geographic Information System (GIS) based approach used to identify potential areas for the expansion of key habitats to meet different objectives, whilst taking constraints into account. Opportunity maps were created for three different broad habitat types – semi-natural grassland, broadleaved and mixed woodland, and wet grassland and wetland – and for six different ecosystem services.

Few opportunities exist to expand broadleaved and mixed woodland or semi-natural grassland across Luton Borough, although some locations have been identified. Furthermore, wet grassland and wetland habitat networks are represented by a single patch of wet grassland. Opportunities for water flow regulation are most common on the slopes to the south of Luton, while water quality regulation opportunities focus on the areas adjacent to the River Lea and on arable fields on the fringes of Luton. The best opportunities to ameliorate air pollution were located in and around the most urban areas along

road networks and a similar pattern was revealed when considering opportunities to reduce noise pollution and regulate local climate. These opportunities were fairly limited across the study area, due to the number of constraints in such an urbanised area, but locations have been identified, especially for small patches of new habitat creation.

Opportunity maps were combined to highlight areas where new habitat can be created that provides opportunities to enhance more than one of the services mapped previously. Maps were created showing the total number of opportunities that could be delivered by creating new broadleaved woodland, semi-natural grassland, or wet grassland, first treating all opportunities equally, and then by restricting combined opportunities to areas that present a biodiversity opportunity. Additional maps could be created combining opportunities with different weightings if desired.

The maps and GIS layers produced for this project have a wide range of potential applications. Possible projects for enhancing the outputs and taking this work forward are described in the main Bedfordshire report and include dissemination of results, mapping habitat quality (condition), and refining the most promising areas to take forward.

The opportunity maps can be used to assist with the development of nature recovery networks, green infrastructure strategies and planning, locating the best places for biodiversity offsetting and net gain initiatives, for agri-environment scheme targeting, for woodland creation for carbon offsetting, and as an important step towards producing a local natural capital plan or natural capital investment plan for the area.

Contents

1. Introduction

Luton Borough Council have identified the need for an assessment of its natural capital, the benefits that this provides and the opportunities to enhance it, particularly in light of its economic and social development ambitions. Natural capital refers to the stock of assets provided by the natural environment with capacity to produce goods and services that are of value to people (NCC 2014)[1], often classified into provisioning, regulating and cultural ecosystem services (EEA, 2016[2], Hein et al., 2016[3]). Natural capital comprises land and minerals, fresh, tidal and marine waters, air, species and ecological systems, together with supporting natural processes and functions[3]. In many respects, it supports all forms of other capital on which human systems depend, whether man-made, human or social. However, many of the outputs produced by natural capital, such as the regulation of flooding and atmospheric gases by woodlands, are not included in the decisions of individuals or organisations. This is because they often involve non-priced public goods that are not traded in the market place, and are not subject to formal property rights and entitlements (TEEB, 2010[4]). Elements of natural capital are therefore liable to be overused, degraded, depleted and eventually lost, with consequences for long term welfare and the sustainability of economic systems. There is now much greater awareness of the role of natural capital in the design and achievement of economic and social development strategies, with strong links to business and enterprise[5]. Furthermore, the central role of natural capital in delivering quality of place is being increasingly recognised.

Luton Borough lies at the heart of the OxCam Arc, a strategic growth area with developing plans for additional housing, new road and rail links and other infrastructure. This presents both a challenge and an opportunity with regard to the natural environment. A challenge if the environment and environmental regulations are seen as a hindrance to development, but a great opportunity if development can be planned to deliver benefits to both people and the natural world, potentially unlocking large sums of money to deliver ambitious nature recovery and public access programmes. But to achieve those ambitions it is important that people are aware of the current stock of natural capital, the benefits that it provides (and the demand for those benefits), and the best opportunities to enhance those natural capital assets.

Natural capital is also becoming increasingly embedded across multiple policy domains, including the likely inclusion of a mandatory requirement for biodiversity net gain for all new developments subject to the provisions of Town and Country Planning Act, as set out in the Environment Bill. There is further ambition, as expressed in the Government's 25 Year Plan for the Environment, to move towards environmental and natural capital net gain in the future, backed by changes to the National Planning Policy Framework and the new Planning White Paper. The Environment Bill also sets out the requirement for nature recovery networks and strategies, while the Agriculture Bill paves the way for a new Environmental Land Management Scheme (ELMs), with a central tenet of farmers and land managers being paid public money for public goods, based on natural capital principles. Further policy alignment is

[1] NCC 2014. Towards a Framework for Defining and Measuring Changes in Natural Capital. Working Paper 1, Natural Capital Committee.
[2] EEA 2016. Common International Classification of Ecosystem Services (CICES) , European Environment Agency, Copenhagen. https://cices.eu/
[3] Hein, L., Bagstad. K., Edens, B., Obst, C., de Jong, R., Lesschen, J.P. (2016). Defining Ecosystem Assets for Natural Capital Accounting. PLoS ONE,11(11): e0164460. doi:10.1371/journal. pone.0164460
[4] TEEB. 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London and Washington
[5] TEEB. 2012. The Economics of Ecosystems and Biodiversity in Business and Enterprise. Earthscan. London; New York.

achieved through the requirements for action on climate change and commitments to go carbon neutral, including the planting of large areas of new woodland.

Luton Borough Council, therefore, commissioned this project to produce a natural capital assessment for the area. It is part of a larger project to complete a natural capital assessment for the whole of Bedfordshire, and separate reports have also been produced for Bedford Borough and Central Bedfordshire. The project had the following five aims:

1. Create a detailed natural capital (habitat) basemap based on the best available existing data.
2. Model and map the benefits (the ecosystem services) that flow from the natural capital present across the county and the demand for those benefits, where possible.
3. Calculate the monetary value of those benefits wherever possible.
4. Identify the current provision of accessible natural greenspace within the Bedfordshire region and how this compares against national standards.
5. Create habitat opportunity maps for biodiversity enhancement and for a range of ecosystem services, showing where new habitats could be best created, whilst taking constraints into account.

1.1 The natural capital and ecosystem services framework

The natural environment underpins people's wellbeing and economic prosperity, providing multiple benefits to society, yet is consistently undervalued in decision-making. Natural Capital is defined as "*..elements of nature that directly or indirectly produce value or benefits to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions*" (Natural Capital Committee 2014). It is the stock of natural assets (e.g. soils, water, biodiversity) that produces a wide range of ecosystem services that provide benefits to people. These benefits include food production, regulation of flooding and climate, pollination of crops, and cultural benefits such as aesthetic value and recreational opportunities (Fig. 1).

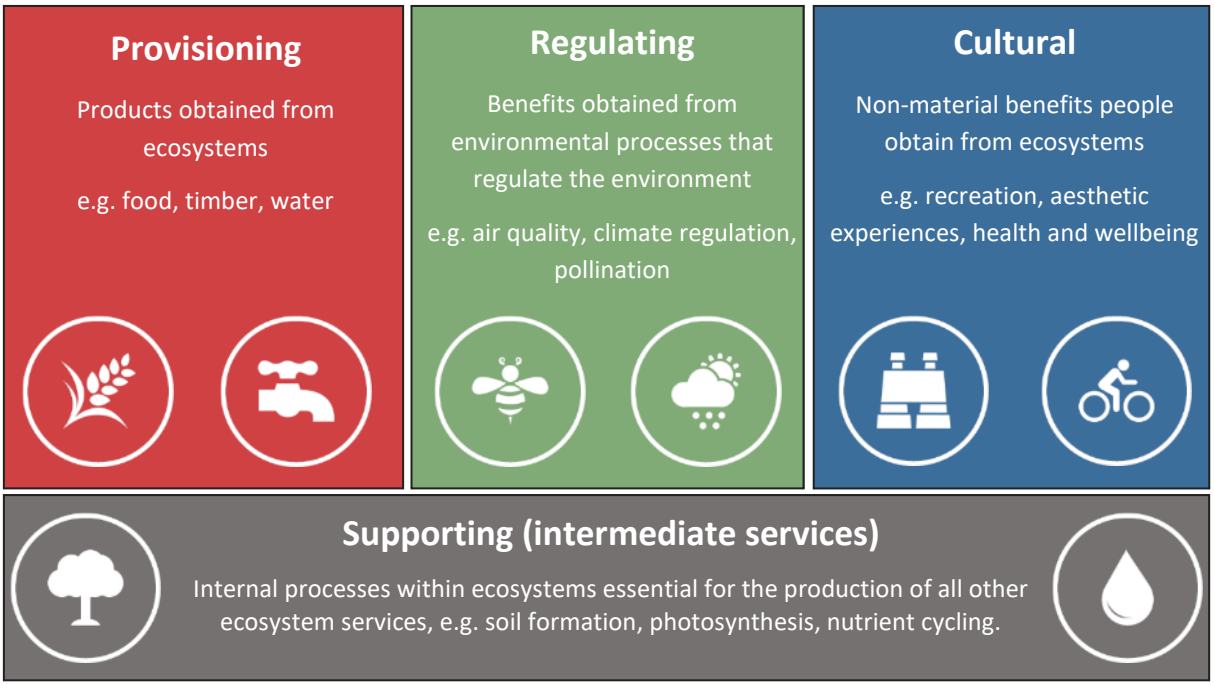

Figure 1 Key types of ecosystem services (based on MA 2005 and EEA 2016).

Much work is progressing on how to deliver the natural capital and ecosystem services approach on the ground and how to use it to inform and influence management and decision-making. One of the most important steps is to recognise and quantify ecosystem service delivery (the physical flow of services derived from natural capital). Additional insight can be gained by taking a spatial perspective on the variation in ecosystem service supply and demand across a study area using a Geographic Information System (GIS). Maps are able to highlight hotspots and coldspots of ecosystem service delivery, highlight important spatial patterns that provide much additional detail, and are inherently more user friendly than non-spatial approaches. When information on supply and demand for ecosystem services is known, it is also then possible to determine objectively the best areas to create habitat to increase the supply of each particular ecosystem services in a process known as habitat opportunity mapping. By overlaying opportunity areas for each objective, it is possible to identify areas where changing habitats could deliver multiple benefits.

1.2 Report structure and scope

All methods used herein are described within the Bedfordshire main report. A key first step in any natural capital project is to understand the natural capital assets present across the study area. To this aim, Section 2 outlines the habitats present across Luton Borough. It also highlights the most important habitats for biodiversity, and maps the sites that have received international, national or local designation for their nature conservation interest. We also include a range of additional maps to give a more complete picture of the state of natural capital across Bedfordshire, covering air, water, and agricultural quality, and public access.

Section 3 then uses this natural capital basemap to model and map the ecosystem services delivered by that natural capital. We assess ten different ecosystem services and whenever possible we also map the demand for these services across the area. Section 4 estimates the annual monetary flows from seven ecosystem services and Section 5 assesses accessible natural greenspace in relation to national standards.

Section 6 then considers opportunities for enhancing biodiversity and ecosystem services across Luton Borough. We consider three different broad habitats – broadleaved and mixed woodland, semi-natural grassland, and wet grassland and wetland – and six different ecosystem services. The individual opportunity maps are then overlain in Section 7, to identify opportunity areas where multiple benefits could be delivered, creating maps that focus on biodiversity, and which focus on all benefits equally. Conclusions and further steps are briefly presented in Section 8.

Please note that the habitat basemap is based on existing data, and although it has been checked by local experts, it has not been extensively ground-truthed, so will be prone to some error. It does, however, provide the most comprehensive and detailed coverage that is possible at this time. Note also that the opportunity mapping identifies areas based on landscape-scale ecological principles and ecosystem services models and does not take into account local site-based factors that may impact on suitability. Any areas suggested for habitat creation will require ground-truthing before implementation. The maps should be seen as a tool to highlight key locations and to guide decision making, rather than an end in themselves.

One of the key outputs from this project are the numerous GIS maps and layers. These have been supplied to Luton Borough Council and key project partners. The main Bedfordshire report provides maps and comparative data across the three local authority areas, and separate reports are available for Bedford Borough and Central Bedfordshire, focussing on the results from those areas.

2. The baseline – natural capital assets

2.1 Broad habitats

The approach used to map habitats is described in the main Bedfordshire report, along with comparative data for the three local authority areas. The final basemap covered an area of 4,335 ha or 43 km^2 and contained 271,173 polygons, each of which was classified to an appropriate habitat type.

Figure 2 (overleaf) shows the distribution of broad habitat types across Luton Borough and the area and percentage cover is shown in a little more detail in Table 1. Luton Borough is dominated by urban land uses: built-up areas and infrastructure make up 41.2% of the area (1,788 ha), and gardens make up an additional 29.3% (1,271 ha). Note that gardens are likely to include a variety of different surfaces, including lawn, hard standing, flowerbeds, shrubs, trees and so on and no attempt is made to distinguish habitats further. Amenity grasslands make up 14.2% of the land area. The combined cover of all woodland, scrub and tree habitat types make up 4.5% of the area (196 ha), although note that this does not include individual street or garden trees. Semi-natural grasslands make up 2%, while water makes up just 0.2% of the area.

Table 1 Area and percentage cover of broad habitat types across Luton Borough

Broad habitat	Area (Ha)	% cover
Arable	159	3.67
Uncertain agriculture	103	2.38
Improved grassland	19	0.43
Amenity grassland	615	14.17
Semi-natural grassland	86	1.98
Marshy grassland	0	0
Other grassland	56	1.29
Heathland	0	0
Fen, marsh and swamp	7	0.16
Scrub	14	0.32
Trees / Parkland	53	1.21
Broadleaved woodland	128	2.95
Coniferous woodland	0	0
Mixed woodland	2	0.04
Hedgerows	7	0.16
Water	7	0.17
Built-up areas	1,143	26.35
Infrastructure	645	14.87
Garden	1,271	29.30
Rock, exposure and waste	0	0
Unclassified (land currently under development)	23	0.54
Mixed / other / uncertain	1	0.02
TOTAL	**4,339**	**100**

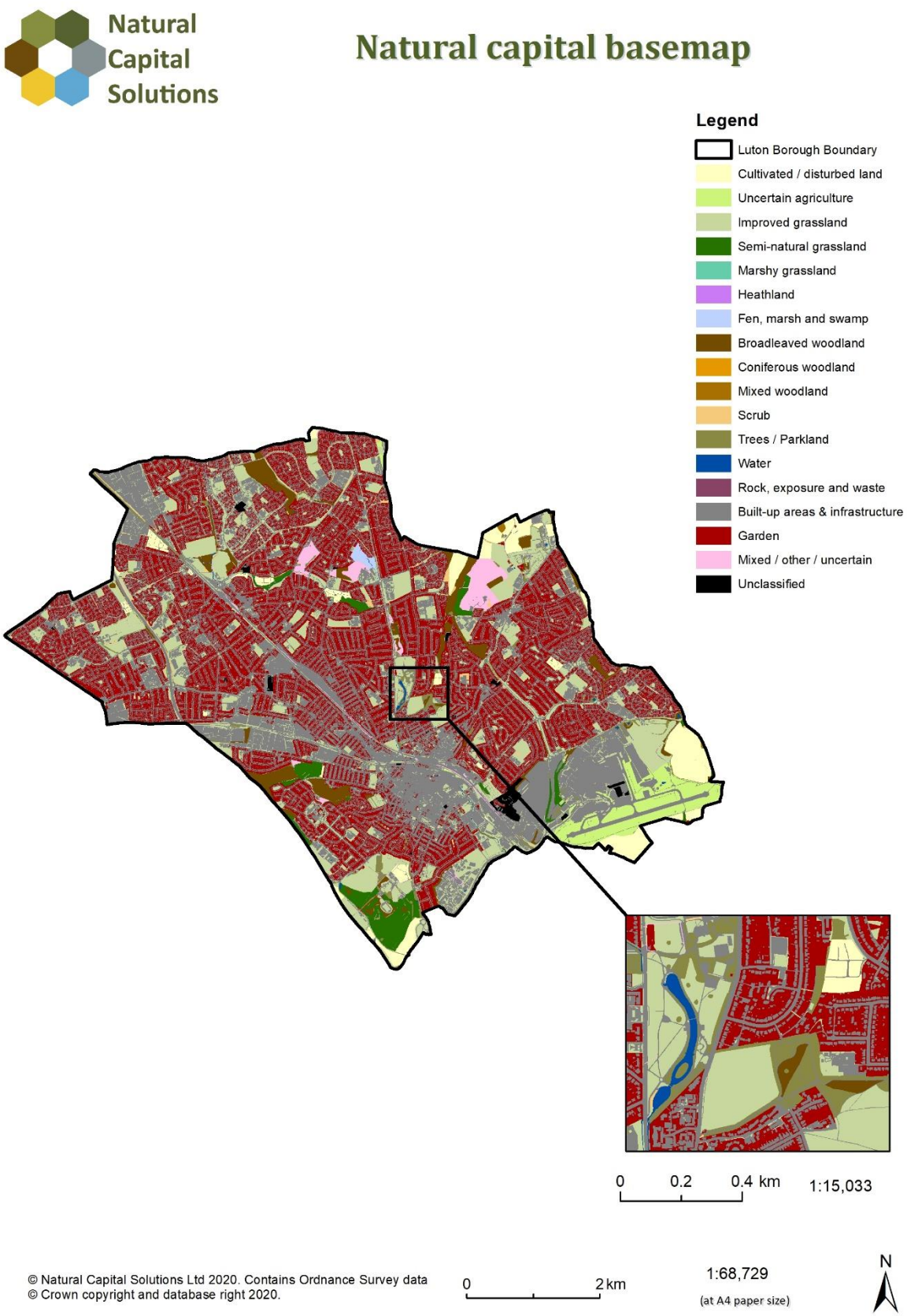

Figure 2 Broad habitats across Luton Borough. Note that Unclassified sites are those that are currently under development.

2.3 High quality habitats

The highest quality semi-natural habitats can be identified from the basemap and are shown in Figure 3, although note that this is based on habitat type and not on condition, which was not assessed here. In total 188 ha, which represents 4.3% of Luton Borough, contain these high-quality habitats. The greatest amounts are 128 ha of broadleaved woodland, 2 ha of mixed woodland and 42 ha of neutral grassland. However, this includes all broadleaved and mixed woodland, some of which will not have been high quality. There are also 9 ha of calcareous grassland and 7 ha of fen and swamp. Note that it was not possible to distinguish high quality parkland from any areas containing scattered trees, or higher quality rivers, streams and standing water, hence these habitat types have not been included on this map. Mixed habitats were also not included as although some of these areas are likely to be high quality habitat, not all such areas will be.

2.4 Nature conservation designations

The location of designated sites is shown on Figure 4. In total, Luton Borough contains 26 ha of the Chilterns AONB (0.60% of the total land area). There are no areas designated as LNRs, NNRs or SSSIs within the areas.

However, as this project neared completion, two sites were notified as SSSIs on 14th October 2020. These are Dallow Downs & Winsdon Hill, a chalk grassland on the western outskirts of Luton, and Cowslip Meadow, a flower-rich meadow located in a residential area to the north of Luton. Together these make up 48 ha or 1.1% of the land area of Luton Borough.

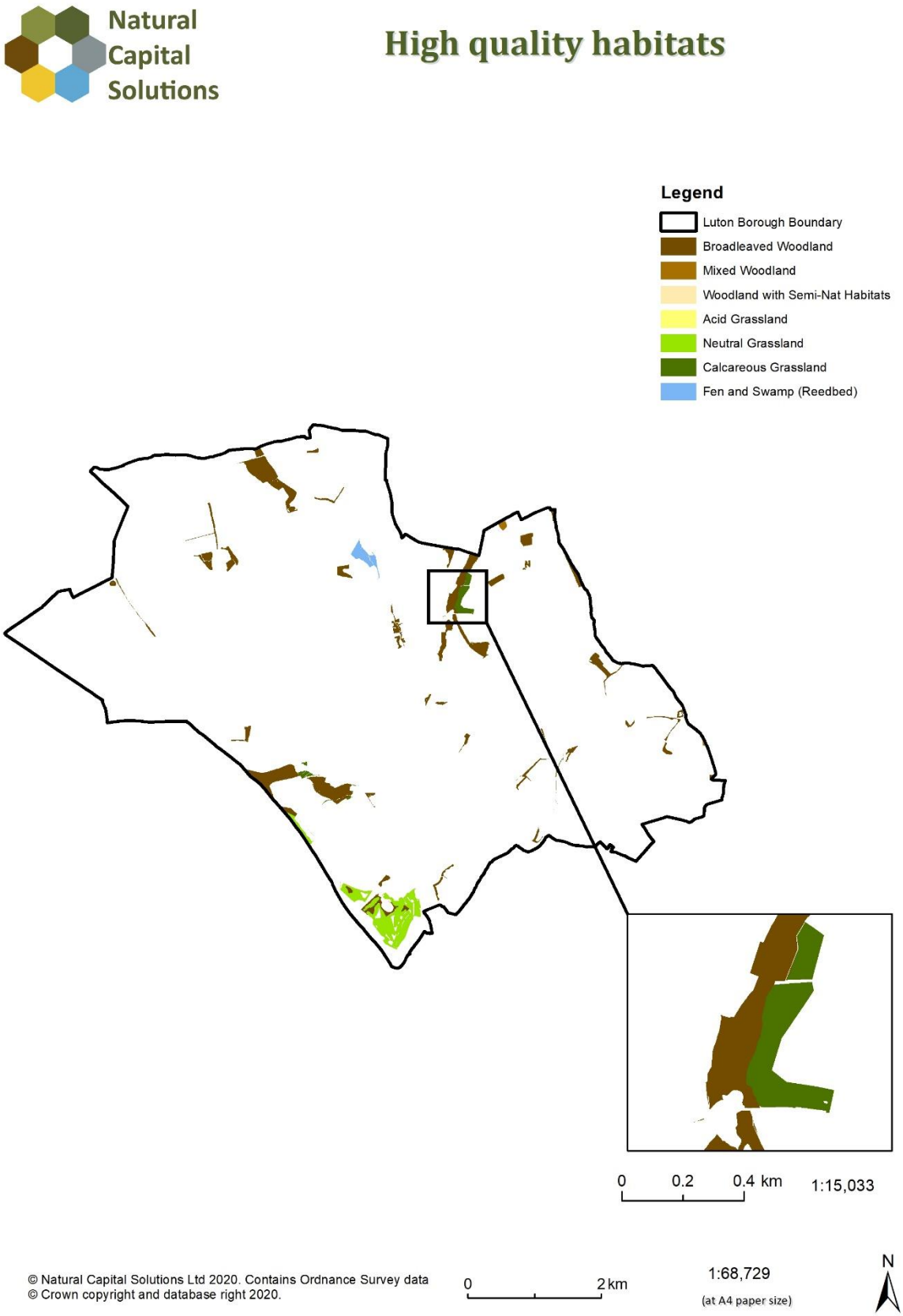

Figure 3 High quality habitat types, identified from the basemap.

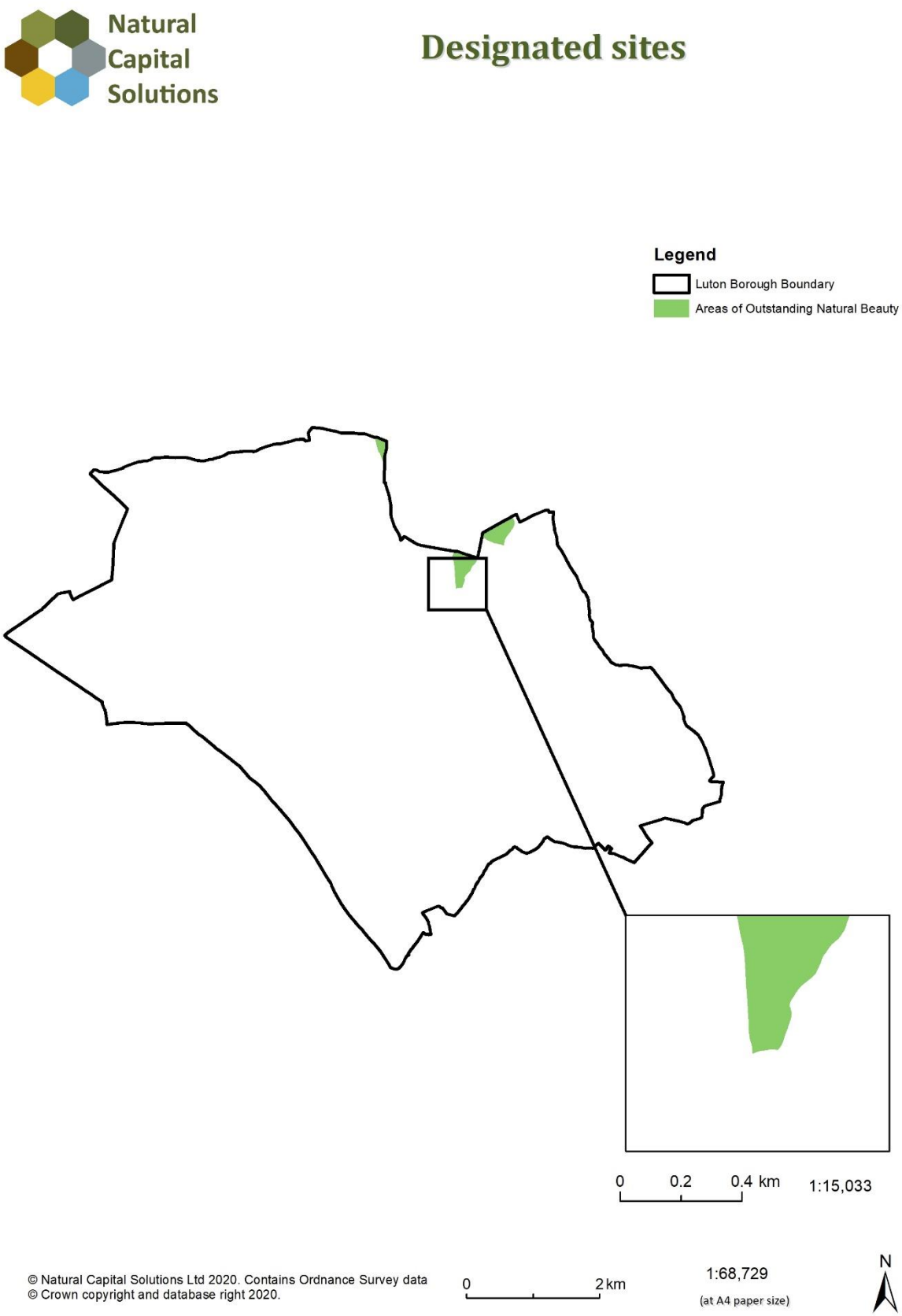

Figure 4 International, national and locally designated sites for nature conservation.

2.4 Environmental quality and natural capital assets

Mapping the type, extent and location of habitats is a key component of a natural capital asset register. However, to build a more complete picture, we have also created maps that provide indicators of environmental quality across air, land and water, canopy cover and information on public access:

- **Modelled background air pollution data** was obtained from Defra, and was used to create a map showing $PM_{2.5}$ (particulate matter at 2.5 µm, Figure 5a) and another showing NO_x (nitrogen oxides, Figure 5b). The resolution of these maps is quite coarse compared to the scale of the area. However, when compared to the whole of Bedfordshire, Luton Borough has relatively high levels of air pollution. $PM_{2.5}$ is particularly high by the M1 and on the west side of the town, whereas NO_x is worse around the airport and the M1 corridor.
- **Overall water body class of WFD River Waterbody Catchments** combines ecological status with chemical status to form an overall assessment of the quality of the waterbody. There are five classes (high, good, moderate, poor, or bad). This is mapped in Figure 5c and shows that the river water body that most of Luton occupies is in bad condition, with waterbodies with moderate and poor condition to the east and sout-west respectively.
- **Agricultural Land Classification** assesses the potential for land to support different agricultural uses, based on a combination of climate, site and soil characteristics. The map for the study area is shown in Figure 5d and shows that while the majority of Luton is non-agricultural, agricultural areas around the edges are Grades 2 and 3.
- **Canopy cover** was mapped for each Ward across the study area based on data from the UK Ward Canopy Cover Map, coordinated by Forest Research. The map (Figure 6a) highlights that canopy cover is highly variable across Luton. The Ward with highest canopy cover is Bramingham Ward with 22.3% canopy covet and is adjacent to the ward with the lowest cover (Northwell Ward with 6.5%).
- **Public Rights of Way** were mapped, based on a layer supplied by LBC and is shown in Figure 6b. Although perhaps less relevant in an urban context, this shows that a number of PRoWs exist that link urban areas to the surrounding countryside.

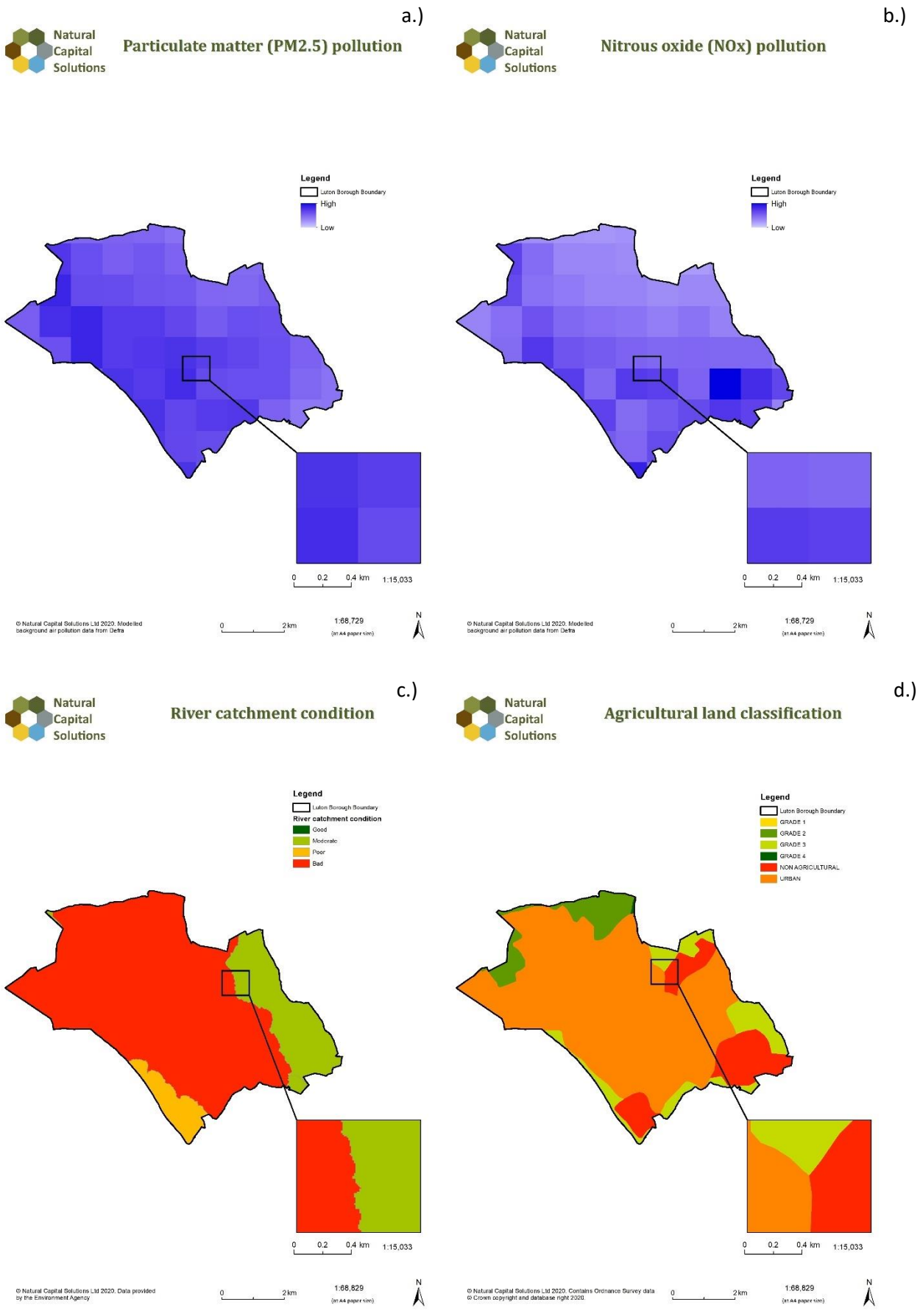

Figure 5 Environmental quality and natural capital asset maps showing a.) air quality with respect to $PM_{2.5}$, b.) air quality NO_x, c.) overall water body class, and d.) agricultural land classification.

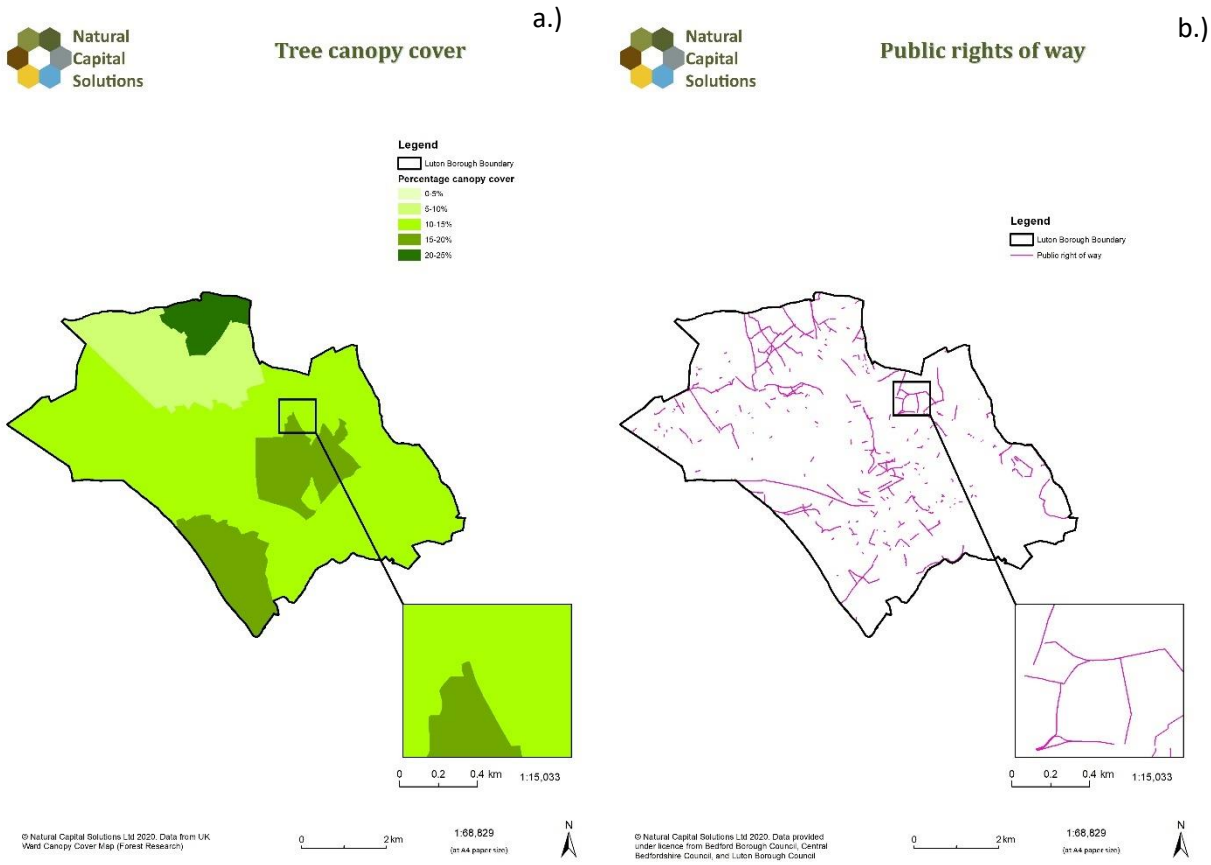

Figure 6: Environmental quality and natural capital asset maps showing a.) canopy cover for each Ward, and b.) Public Rights of Way.

3. Modelling and mapping ecosystem services (physical flows)

Once a detailed habitat basemap had been created for Luton Borough, it was then possible to quantify and map the benefits that these habitats (natural capital) provide to people. The following benefits (ecosystem services) have been assessed for this project:

- Carbon storage
- Carbon sequestration
- Air purification
- Noise regulation
- Local climate regulation
- Water flow regulation
- Water quality regulation
- Agricultural production
- Timber production
- Accessible nature

The list of services assessed was considered to capture the most important services provided by the natural environment, supported by expert knowledge from within the project team. A variety of methods were used, and these are described for each individual ecosystem service in the sections below. In all cases the models were applied at a 10m by 10m resolution to provide fine scale mapping across the area. The models are based on the detailed habitat information determined in the basemap, together with a variety of other external data sets (e.g. digital terrain model, UK census data 2011, open space data, and many other data sets and models mentioned in the methods for each ecosystem service). Note, however, that many of the models are indicative (showing that certain areas have higher capacity or demand than other areas) and are not process-based mathematical models (e.g. hydrological models). In all cases the capacity and demand for ES is mapped relative to the values present within the study area.

For every ecosystem service listed, the capacity of the natural environment to deliver that service – or the current supply – was mapped. For air purification, noise regulation, local climate regulation, and accessible nature, it was also possible to map the local demand (the beneficiaries) for these services. The importance and value of ecosystem services can often be dependent upon its location in relation to the demand for that service, hence capturing this information provides useful additional insight. Mapping demand was not, however, possible, for the other services where there was no obvious method to apply, or local demand is not relevant, such as food or timber production (demand for food and timber production is national and does not vary by location in a meaningful way).

3.1 Carbon storage capacity

Figure 7 (overleaf) shows baseline carbon storage capacity across the study area. The score is out of a maximum possible of 100 (given to broadleaved woodland).

Carbon storage capacity in the Borough is clustered in areas of habitats such as broadleaved woodland, which are particularly efficient at carbon storage. However, most green spaces in the region support some level of carbon storage, with much lower levels in urban areas dominated by buildings and sealed surfaces.

3.2 Carbon sequestration

The baseline carbon sequestration map displayed in Figure 8 shows high areas of carbon sequestration in red. These are areas of mostly broadleaved woodland, which are scarce in Luton Borough.

3.3 Air purification capacity (air quality regulation)

Woodland is by far the best habitat at intercepting and absorbing air pollution, with the very highest scores from coniferous forests. The lowest scores (dark blue) are from man-made sealed surfaces and water features which effectively have zero capacity to ameliorate air pollution.

Of particular note are the woodland areas, apparent as dark red patches of high air purification capacity in Figure 9. Luton is a predominantly urban area, which generally display much lower levels of air purification capacity than elsewhere in Bedfordshire.

3.4 Air purification demand

Air purification demand (Figure 10) is highest in urban centres such as Luton as these have both higher air pollution levels and higher populations that would benefit from better air quality. The main road network is also clearly visible as a major pollution source, and where these main roads pass through built up areas, there is increased demand for air purification. There are a few areas of low air purification demand that are located on the outskirts of Luton town.

3.5 Noise regulation capacity

This model is similar to the air purification capacity model and similarly to that, woodland is by far the most effective habitat at absorbing noise (Figure 11). However, the effects are modest, with reductions of 2-4 dB typically recorded across dense tree belts. Noise regulation capacity is relatively low in urban areas such as Luton Borough, and highest in woodland areas, which are few in number across the study area.

3.6 Noise regulation demand

Figure 12 shows noise regulation demand across Luton Borough. Noise regulation demand is generally greatest in residential areas close to major roads, as these contain large populations, with potentially poor health scores, that would benefit from noise abatement from the main roads. Thus, there is moderate to high noise regulation demand across much of Luton Borough. Luton Airport is also included, although most of the noise is focussed away from residential areas, hence demand is reduced in our model.

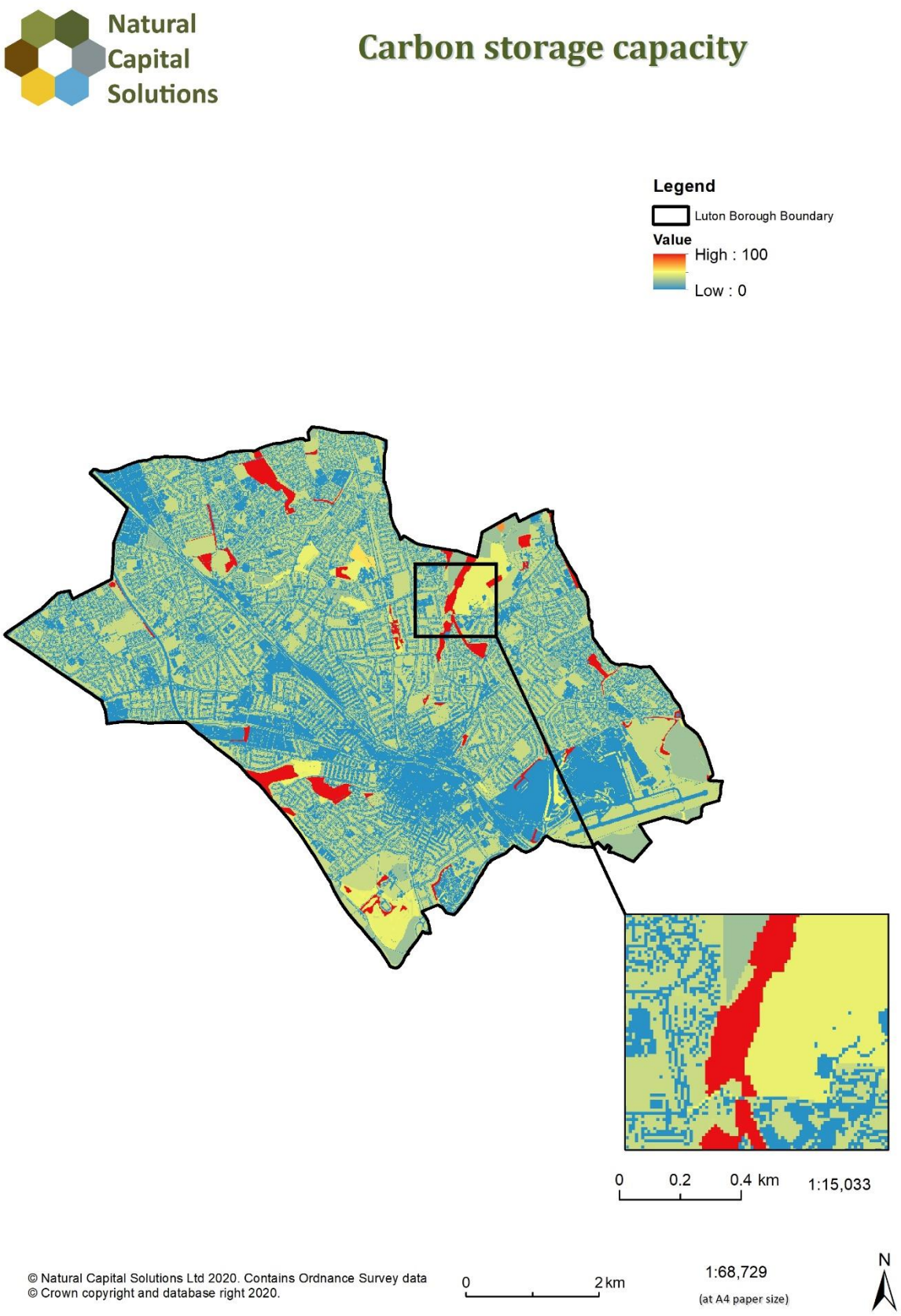

Figure 7 Carbon storage capacity across Luton Borough. Inset map shows level of detail in the map for a representative location.

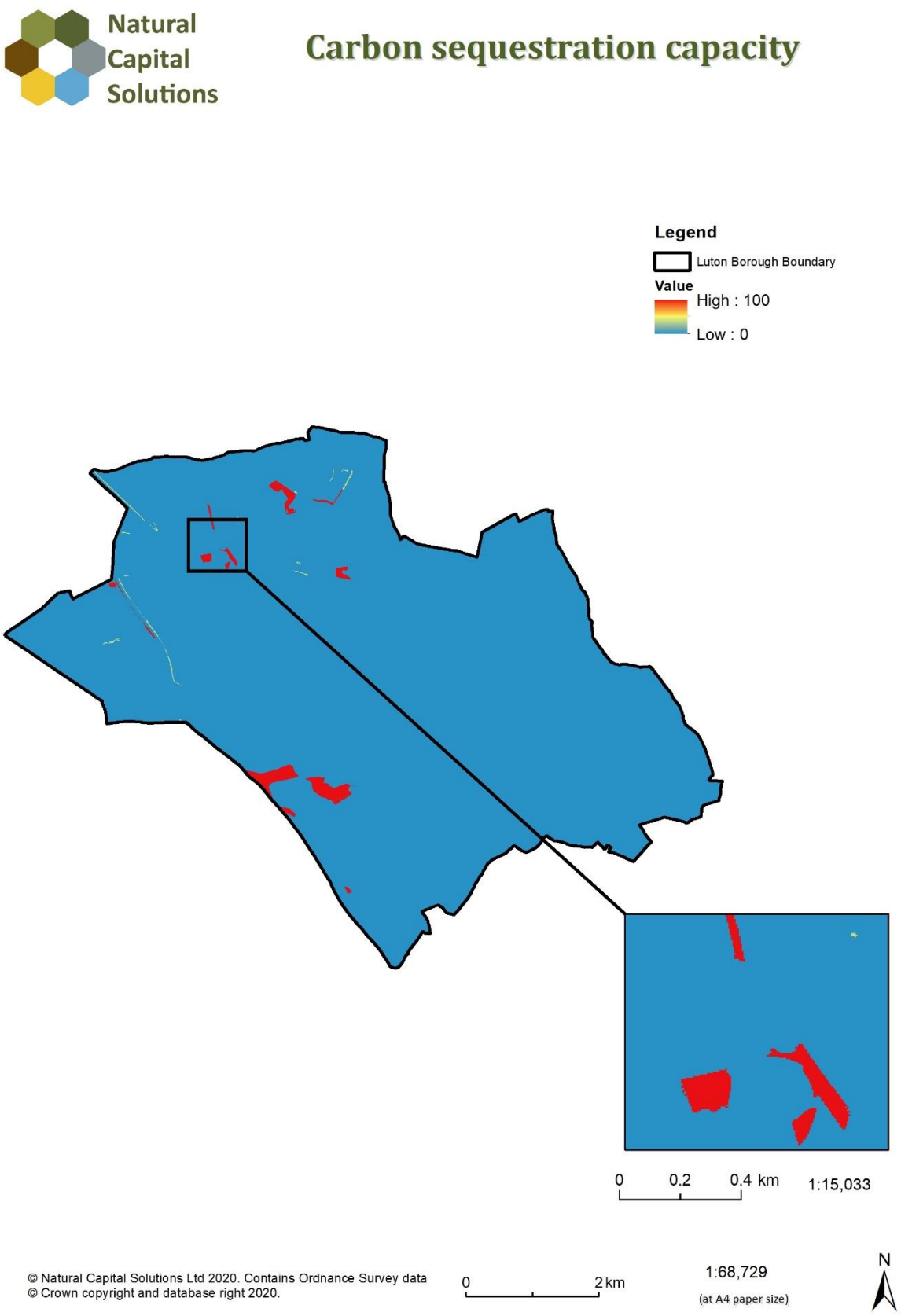

Figure 8 Carbon sequestration capacity across Luton Borough.

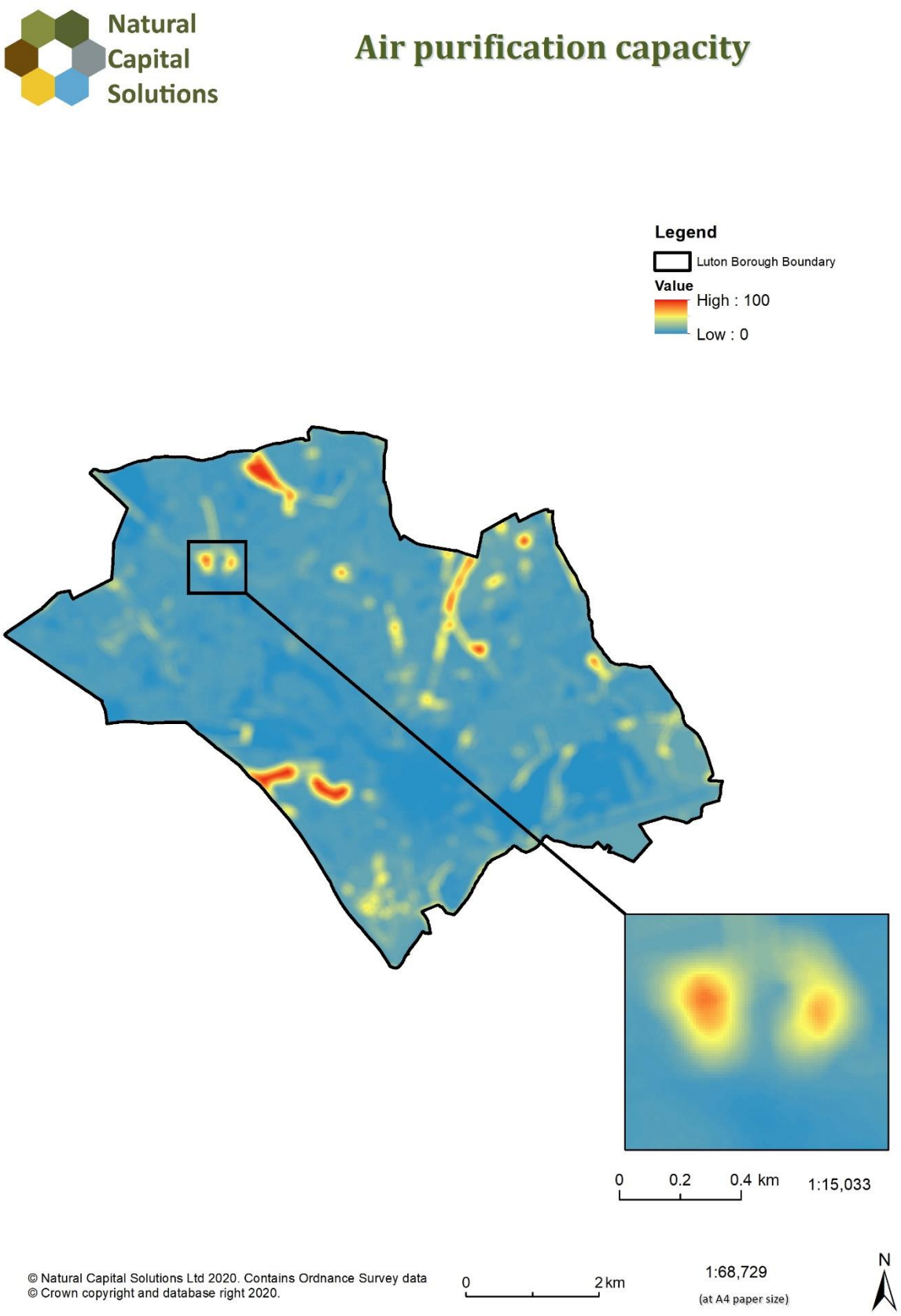

Figure 9 Air purification capacity across Luton Borough.

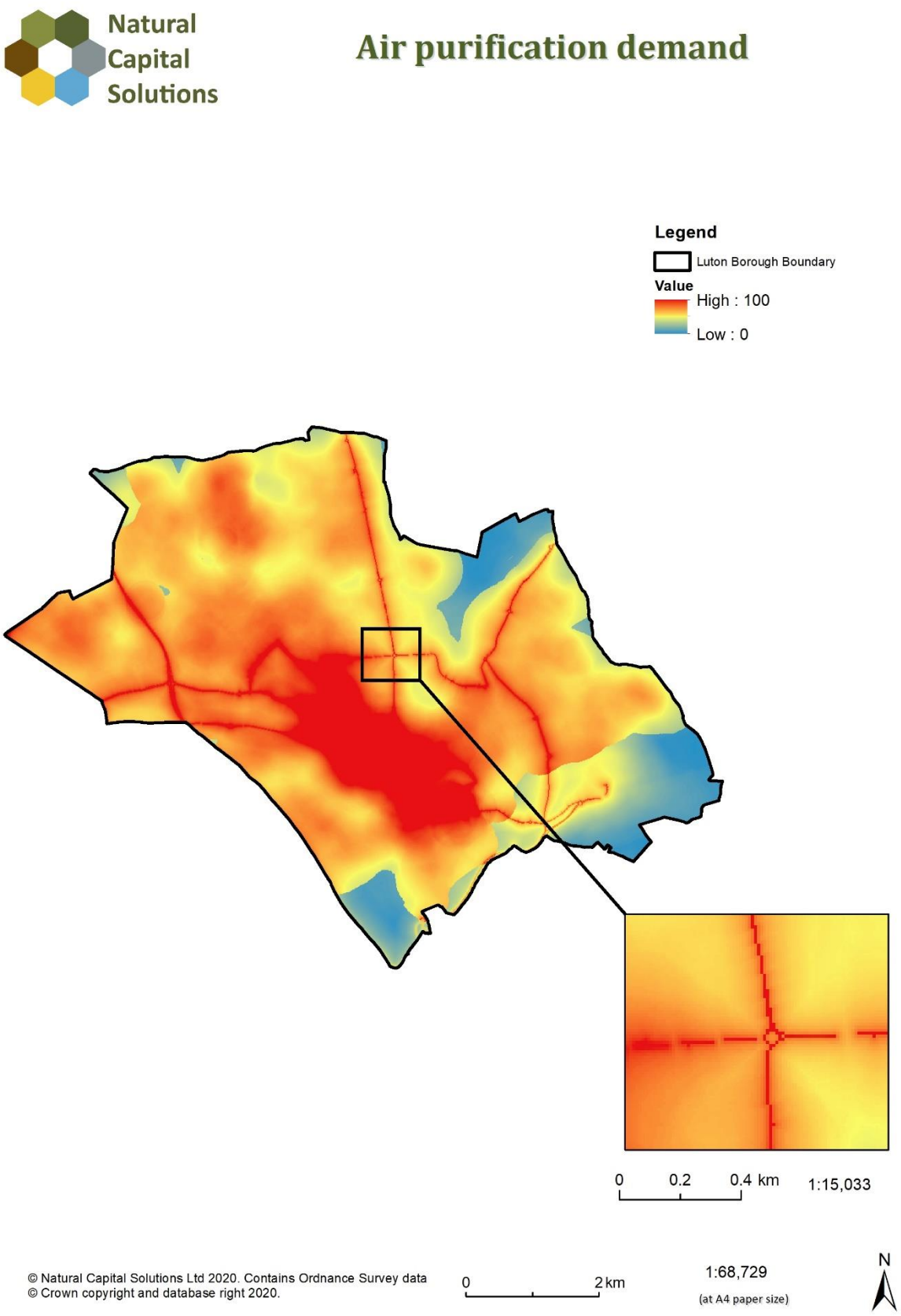

Figure 10 Air purification demand across Luton Borough

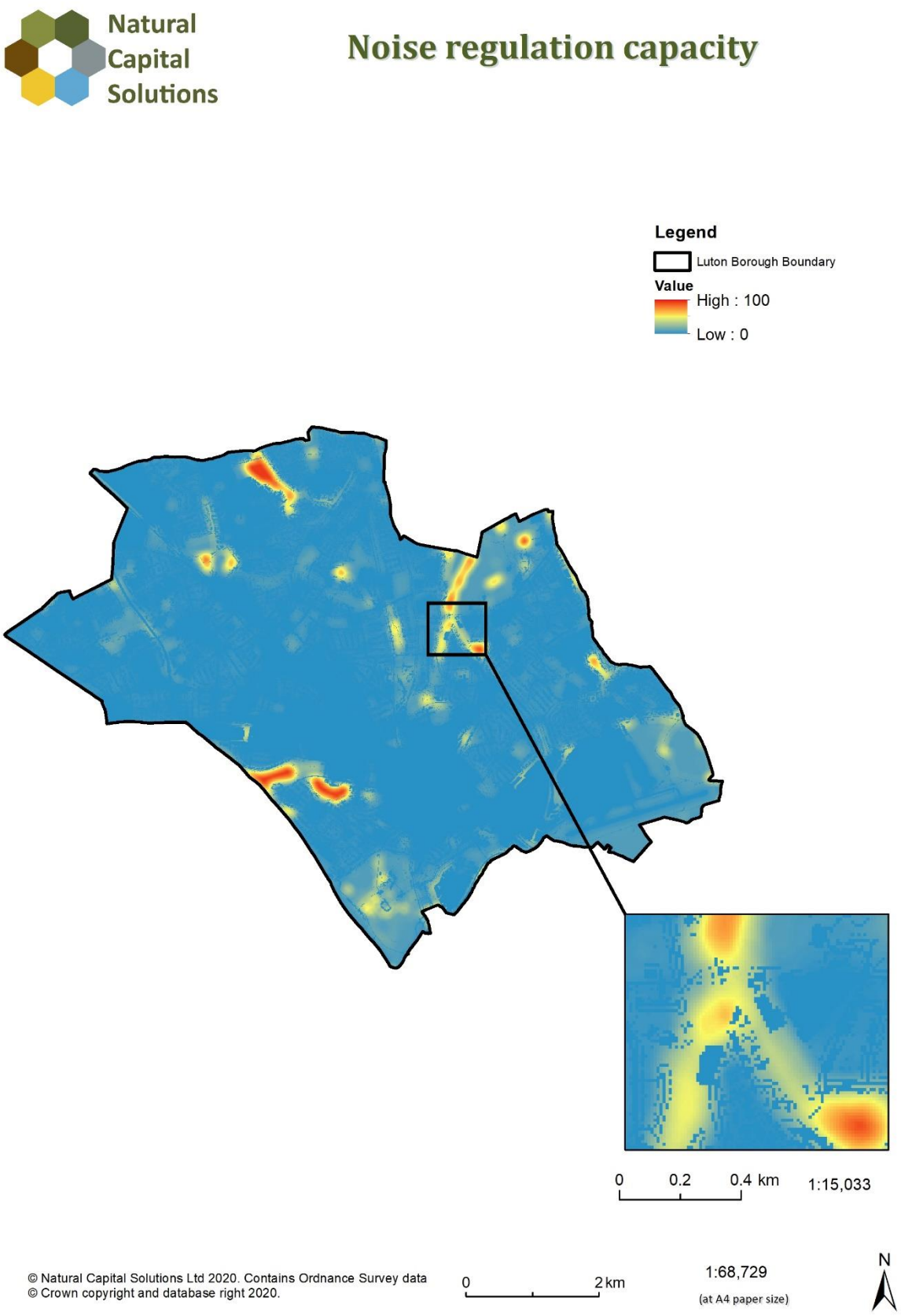

Figure 11 Noise regulation capacity across Luton Borough.

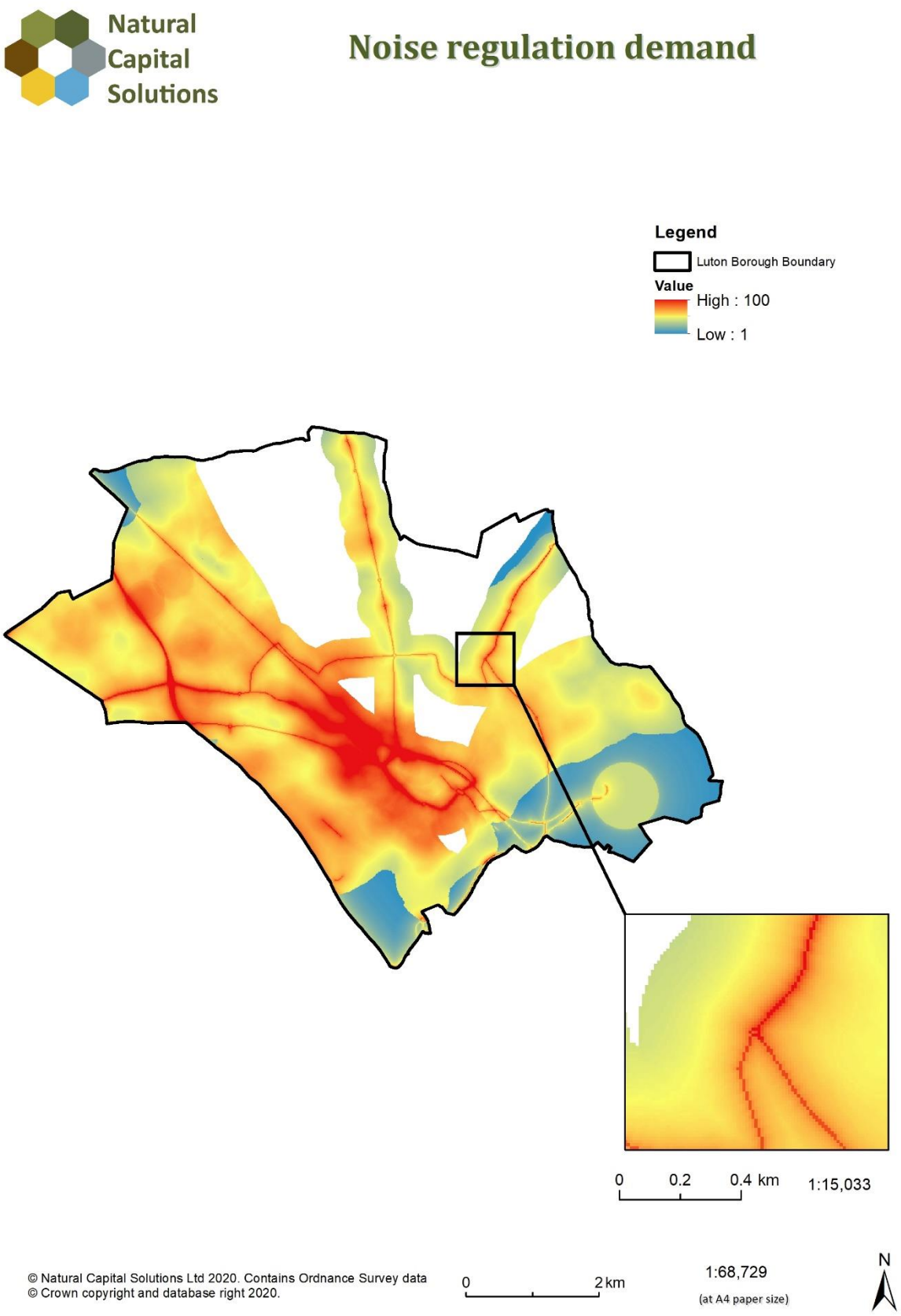

Figure 12 Noise regulation demand across Luton Borough. Areas with zero demand have been excluded to improve map legibility.

3.7 Local climate regulation capacity

Figure 13 shows local climate regulation capacity across Luton Borough. In the absence of large bodies of water, larger areas of woodland provide the highest local climate regulation capacity in the region. For this reason, the areas of high climate regulation capacity in Figure 13 align with the areas of broadleaved woodland in Figure 3. In much of the remaining area, away from woodland, local climate regulation capacity is significantly lower.

3.8 Local climate regulation demand

Figure 14 shows local climate regulation demand across the Luton Borough. By removing areas of zero demand, it is immediately clear that demand is heavily clustered around the urban areas across Luton Borough, which means that much of the study region has a high climate regulation demand. Demand for local climate regulation is effectively zero outside of these urban areas, and so interventions looking to reduce the disparity between capacity and demand in this service would benefit heavily from investing in capacity in urban areas to meet this concentrated demand.

3.9 Water flow capacity

The worst locations for slowing water runoff (blue on the map, Figure 15) are areas of impermeable surface and slopes. Impermeable sealed surfaces are prominent in urban areas, where water flow regulation capacity is quite poor. In comparison, the best areas for water flow regulation capacity are woodland patches with gentle slopes (red on the map, Figure 15). This is because woodland and gentle slopes which both help to slow the surface water flow.

Note that it would be possible to incorporate information on soil type and permeability into the model, which is another important aspect of runoff, so would improve the model further.

3.10 Water quality capacity (soil erosion reduction)

Figure 16 shows water quality capacity across Luton Borough. Capacity is generally higher in areas away from watercourses with woodland land covers, which is why much of Luton Borough has high water quality capacity. Note that this model focuses on soil erosion and hence rural diffuse pollution, and not on urban diffuse pollution, which is why the built-up areas score highly. Soil erosion is only one aspect affecting water quality and it is likely that urban diffuse pollution is heavily impacting on the water quality of the River Lea.

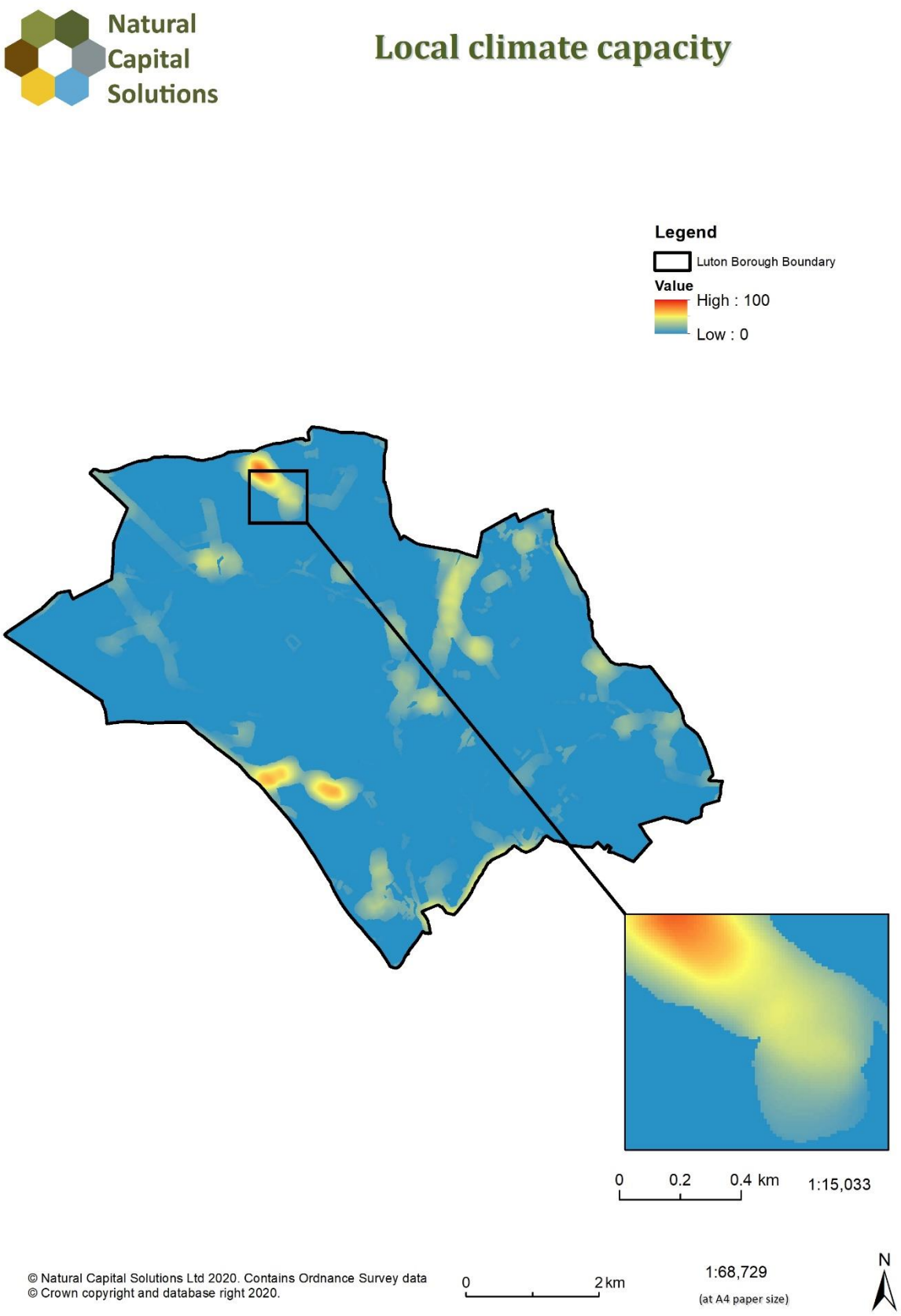

Figure 13 Local climate regulation capacity across Luton Borough.

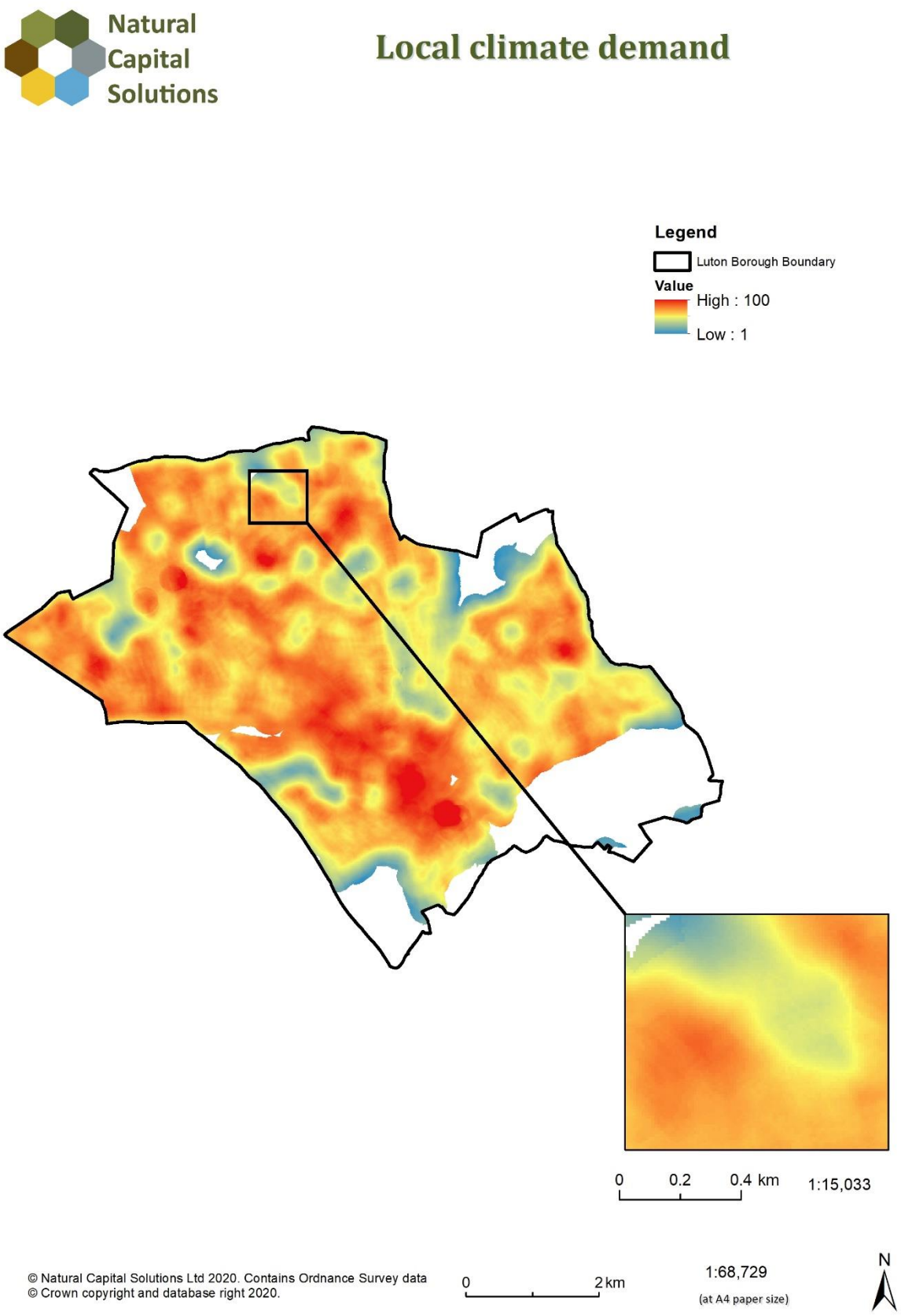

Figure 14 Local climate regulation demand across Luton Borough. Areas with zero demand have been excluded to improve map legibility.

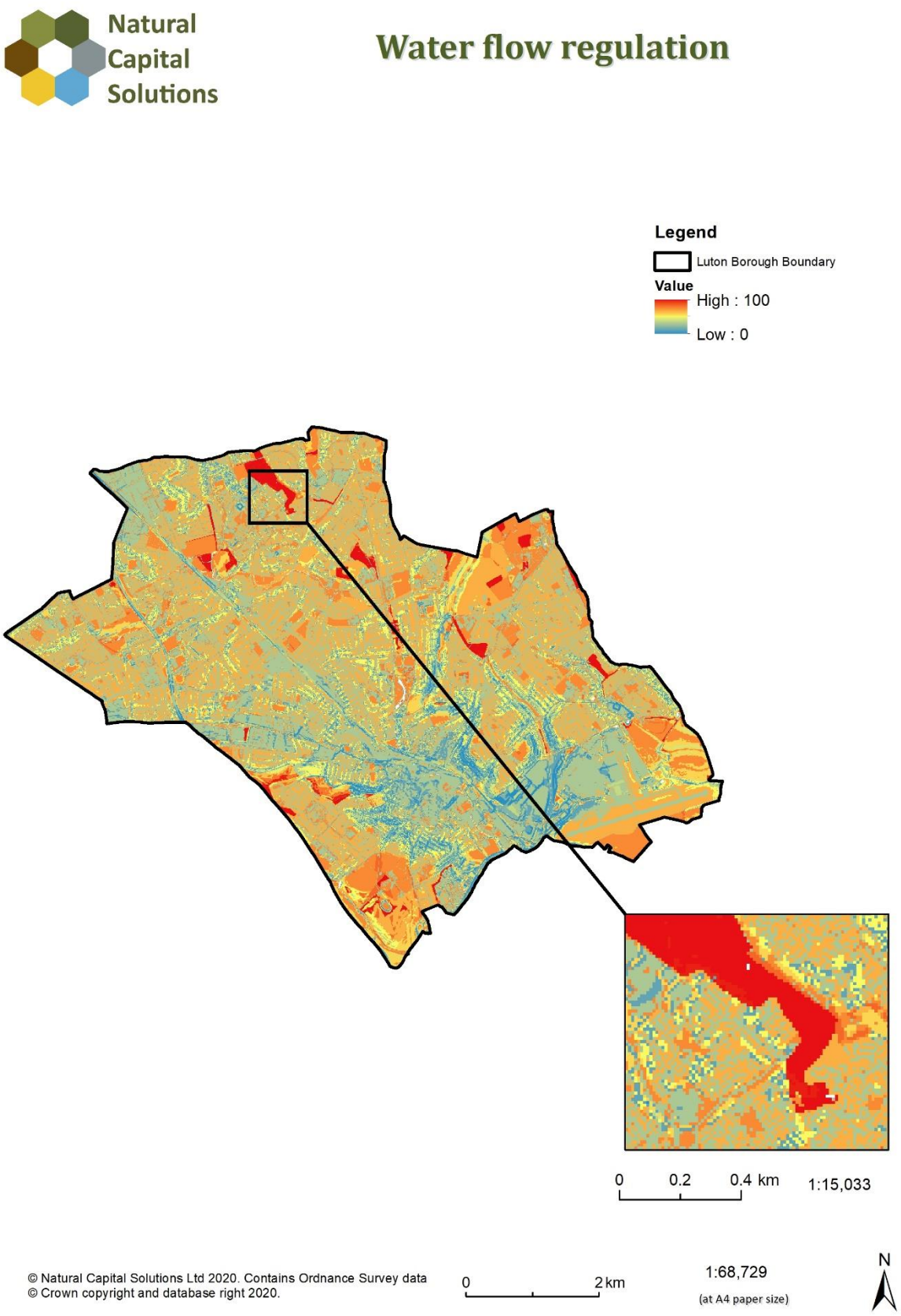

Figure 15 Water flow regulation capacity across Luton Borough.

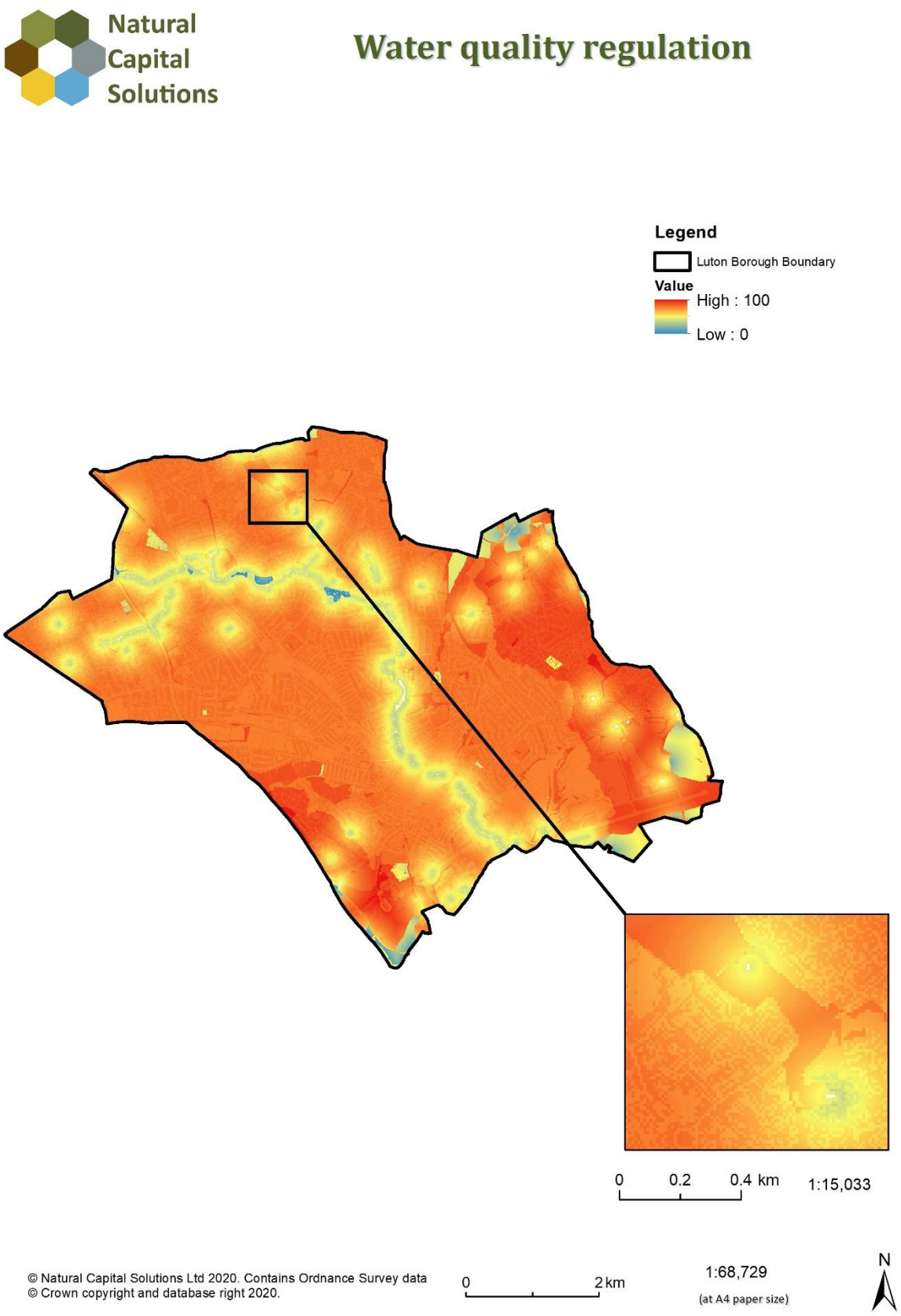

Figure 16 Water quality regulation capacity across Luton Borough.

3.11 Food production capacity

The majority of Luton Borough has a low food production capacity (blue in Figure 17), which is to be expected as it is a predominantly urban area. Indeed, urban areas have a very low production capacity reflecting the limited production resulting from gardens (however, this can be high in some cases, but it is beyond the scope of this project to consider this).

3.12 Timber / woodfuel capacity

Figure 18 displays the timber and woodfuel production capacity across Luton Borough. The study area contains a few areas of moderate timber and woodfuel production capacity shown in yellow, which are small areas of broadleaved woodland.

3.13 Accessible nature capacity

Figure 19 shows accessible nature capacity for publicly accessible land only. Accessible nature capacity is highest in Stockwood, Farley Hill, Marsh Farm, Waulud's Bank and Wigmore. Access is lowest in more urban areas within the centre of the Borough, where there are few publicly accessible greenspaces.

3.14 Accessible nature demand

Demand for accessible nature (see Figure 20) is focussed around where people live, hence there is significant demand across the entire borough.

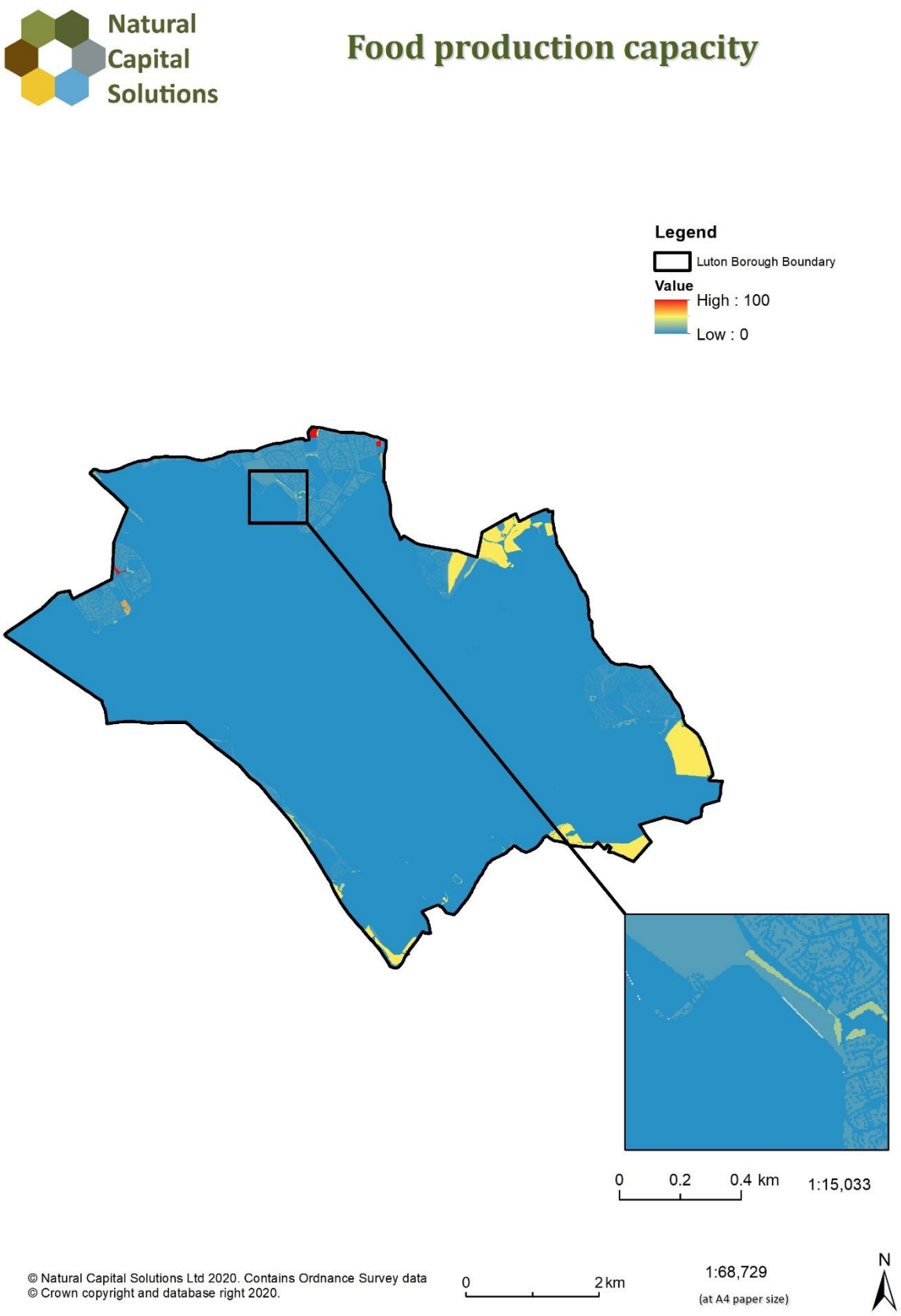

Figure 17 Food production capacity across Luton Borough.

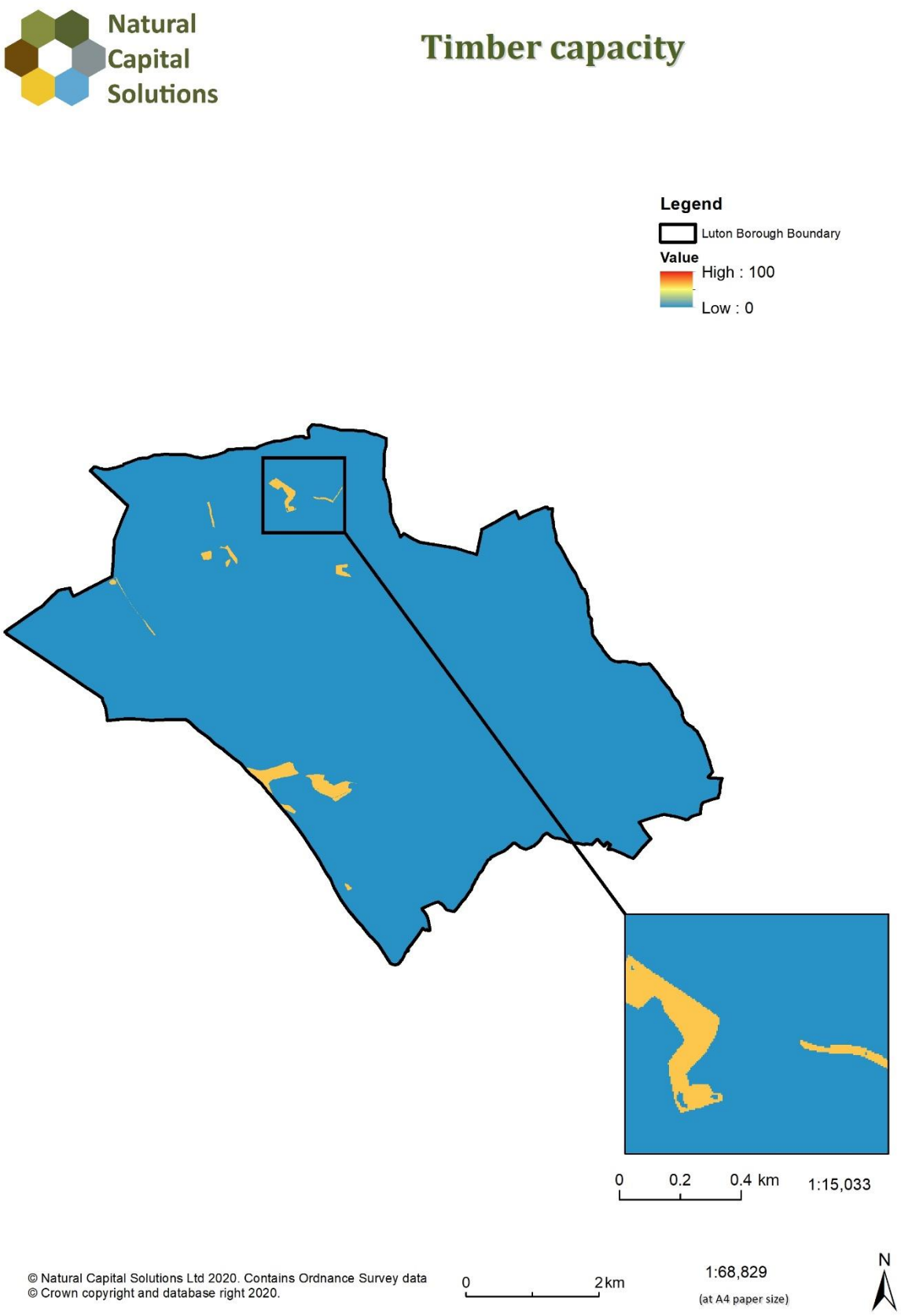

Figure 18 Timber / woodfuel capacity across Luton Borough.

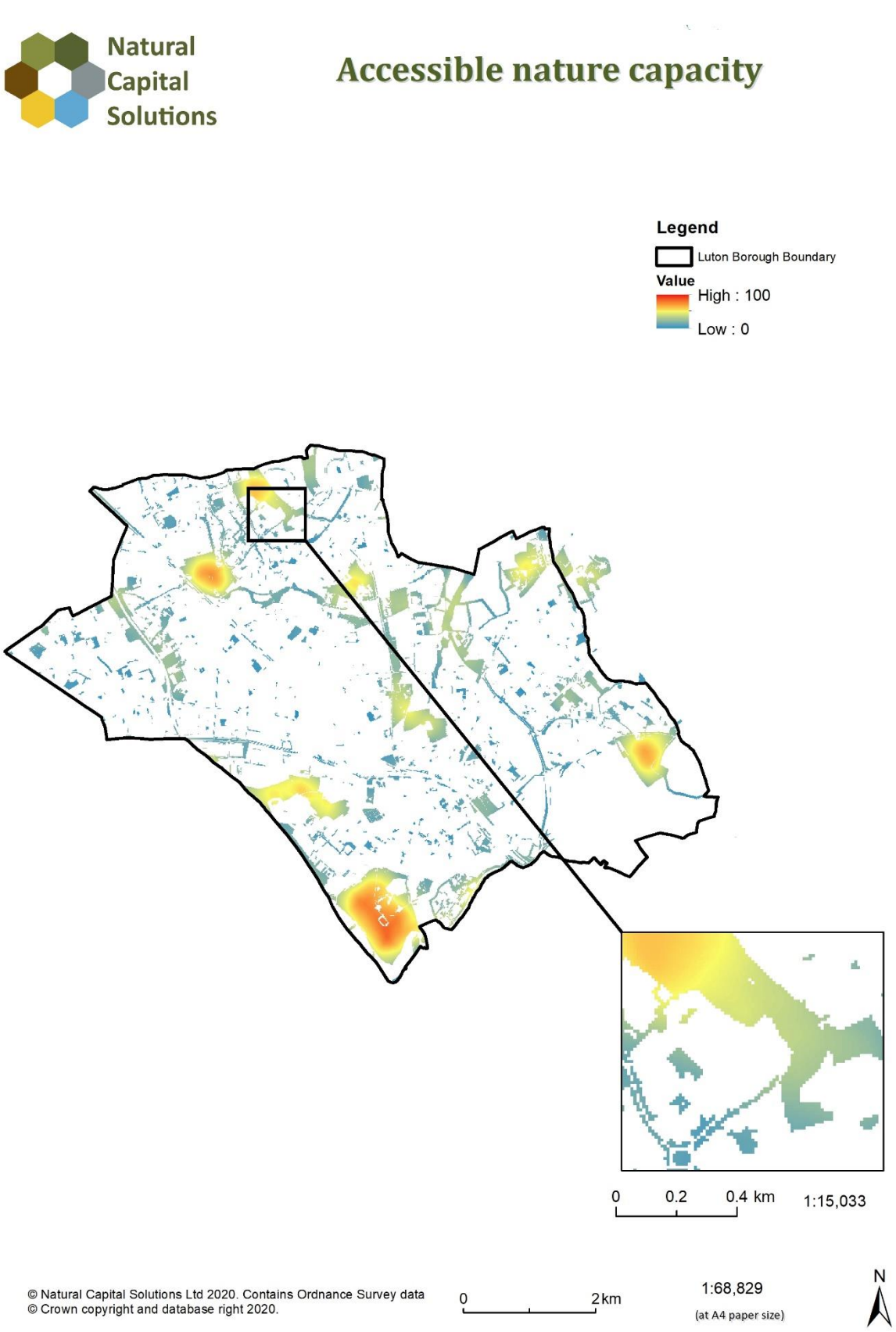

Figure 19 Accessible nature capacity across Luton Borough. Areas with zero capacity have been excluded to improve map legibility.

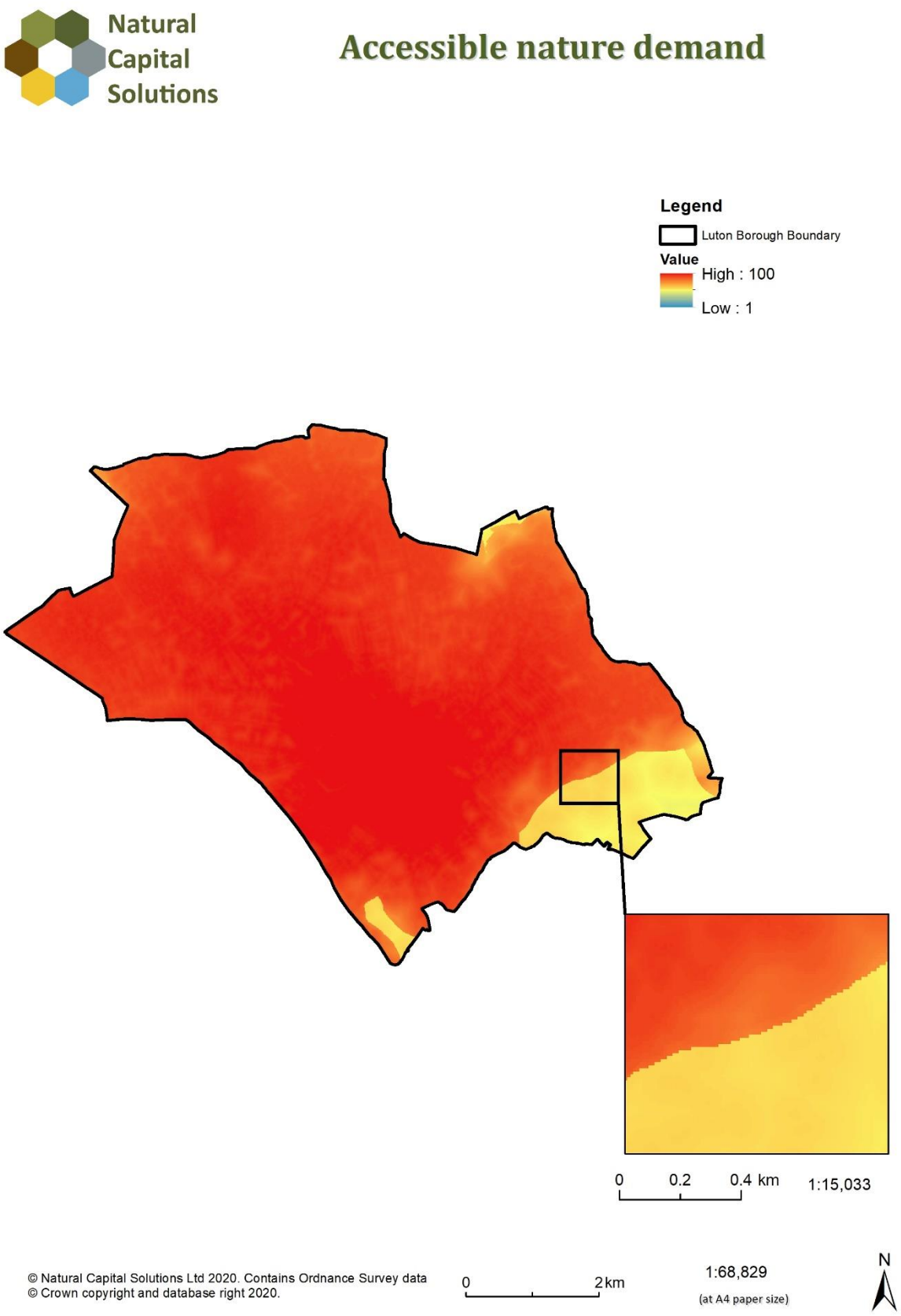

Figure 20 Accessible nature demand across Luton Borough

4. Baseline ecosystem service valuation (monetary flows)

We estimated the annual monetary flow of the following ecosystem services: air quality regulation, carbon sequestration, GHG emissions from agriculture, recreation, physical health, agricultural production and timber production. Table 2 outlines the indicators used to quantify both the physical and monetary flows of these services.

Table 2 Ecosystem services and indicators for physical and monetary measurement.

Ecosystem service	Physical flow	Valuation
Air quality regulation	Tonnes of $PM_{2.5}$ and SO_2 absorbed	Costs avoided £/tonne of $PM_{2.5}$ and SO_2 /year
Carbon sequestration	Quantity of CO_2 sequestered	£/tonne of CO_2
Greenhouse gas emissions from agriculture	GHG/ha	£/ha/year
Recreation	Number of visits	Welfare value/visit/year
Physical health	Active visits	£/QUALY/year
Agricultural production	ha	£/ha/year
Timber/woodfuel production	m^3/ha	£/m^3/year

Annual monetary flows of ecosystem services have been calculated based on the latest valuation techniques available in the scientific literature and approaches adopted by the Office for National Statistics (ONS 2017[6]), and recent Defra guidance to standardise approaches to the valuation of ecosystem services[7]. The physical and monetary flows of the ecosystem services are presented below for Bedfordshire as a whole. The methods used to calculate these are described in more detail in the Technical Appendix at the end of the main Bedfordshire report (Annex 2).

Vegetation can be effective at contributing to **air quality regulation**, with surface area being the most important determinant of capacity. Trees are much more effective than grass at this, and capacity increases significantly as trees grow and their surface area increases. The woodland and grass vegetation across Luton Borough is estimated to absorb 16 tonnes of $PM_{2.5}$ (particulate matter 2.5 micrometres of less in diameter) annually, at an annual value of £3.4 million with a present value (over 50 years) of £126 million (Table 3).

Carbon sequestration is the uptake of carbon by plants as they grow, with woodlands being much the most effective habitat at this in Luton Borough. In total, the average annual carbon sequestration in Luton is of 1,300 tonnes of carbon per year (tCO_2e) at an annual value of £90,000 and a present value (over 50

[6] ONS (2017) Principles of Natural Capital Accounting. Office for National Statistics
[7] Defra (2020). Enabling a Natural Capital Approach (ENCA).

years) of £5.3 million. Overall, **agricultural GHG emissions** within Luton Borough are 423 tCO_2e per year, at a **cost** of £29,000 annually, and a present value of £1.7 million (Table 3).

Table 3 Annual physical flows, annual monetary flows (2020, £) and present value over 50 years (£M) of ecosystem services for Luton Borough.

Ecosystem service	Annual physical flow	Annual monetary flow (£)	Present value over 50 years (£M)
Air quality regulation	16	3.41M	126
$tPM_{2.5}$			
Carbon sequestration	1,300	90,000	5.25
tCO_2e			
GHG emissions from agriculture	-423	-29,000	-1.71
tCO_2e			
Recreation	5,720,000	17.3M	442
Visits			
Physical health	428	6.42M	237
QALY			
Agricultural production	150	10,000	0.263
Hectares			
Timber/woodfuel production	1,200	20,000	0.509
m^3			
Total vlaues:	**NA**	**27.2M**	**810**

NB. Figures shown to 3 significant figures. Any discrepancies due to rounding

Luton Borough has high recreational value. Using the ORVal tool (see Technical Appendix in the main report) we were able to estimate the number of **recreational visits** made to publicly accessible greenspaces in Bedfordshire (Tables 3). Across the Bedfordshire region there are an estimated 5.72 million recreational visits per year. The same tool estimates the welfare value derived from these visits, and these are valued at £17.3 million annually, with a present value (over 50 years) of £442 million. A subset of these visitors will also receive **physical health benefits** through making regular active visits that meet national physical activity guidelines (20 minutes of moderate intensity exercise every day). It is estimated that there are 12,600 active visitors every year to publicly accessible greenspaces in Luton Borough, which is equivalent to 428 Quality Adjusted Life Years (QALY). This delivers an annual value of £6.4 million, and a present value of £238 million (Table 3).

The total area of land in **agricultural production** in Luton Borough is c.150 ha (Table 3). This is predominantly arable land (134 ha) located around the fringes of the town, with small amounts of improved and rough grassland. The annual value of agricultural production in Luton Borough is c. £10,000, when all costs and subsidies (including the Basic Payment Scheme) are excluded, with a present value (over 50 years) of £263,000.

We have also looked at the woodland asset from a **timber and woodfuel** production perspective. This does not mean that the woodland is necessarily being harvested for these purposes, rather it is another way of exploring the value of woodland in the region. If the woodlands in Luton were to be manged for timber and woodfuel production, they would be able to produce approximately 1,200 m^3 per year under

their current management and averaged over a full woodland production cycle (Table 3). This has an annual value of £20,000, and a present value of £509,000 (Table 3).

In total, the value of the benefits delivered by the natural capital assets that we quantified across Luton Borough is £27.2 million annually, with a present value of £810 million over 50 years.

4.1 Sensitivity analysis

A sensitivity analysis examined the low, central and high estimates of all the benefits we valued (Table 4). This demonstrates the overall sensitivity of the natural capital values. The overall natural capital value ranges from a present value (over 50 years) of £478.7 million under the lowest benefits estimates up to just below £2 billion under the highest benefits estimates. This large difference highlights the challenges of placing a monetary value on some services. A key point, however, is that even under the low benefit estimate, the natural capital assets of the region will deliver a substantial benefit worth at least £16.9 million annually, which is £478.7 million in present value terms.

Table 4 Sensitivity analysis showing low, central and high estimates of the benefits provided by the natural capital assets of Luton Borough.

Ecosystem service	Annual values (2020) (£)			Present value (over 50 years) (£M)		
	Low	Central	High	Low	Central	High
Air quality regulation	0.72M	3.41M	10.5M	26.5	126	388
Carbon sequestration	45,000	90,000	135,000	2.50	5.25	8.00
GHG emissions from agriculture	-15,000	-29,000	-44,000	-0.816	-1.71	-2.60
Recreation	13.0M	17.32M	21.6M	331	450	552
Physical health	3.21M	6.42M	25.7M	119	237	950
Agricultural production	-2,000	10,000	54,000	-0.054	0.263	1.39
Timber/woodfuel production	15,000	20,000	25,000	0.382	0.509	0.636
Total value:	**17.0M**	**27.2M**	**58.0M**	**479**	**810**	**1,900**

NB. Figures shown to 3 significant figures. Any discrepancies due to rounding.

This analysis shows the high levels of uncertainty inherent in valuing ecosystem service benefits. Valuation of ecosystem services should be seen as appropriate at indicating the approximate magnitude of benefits, but not their exact values. It has allowed the comparison of values for a broad suite of services to be compared across Luton Borough. It also demonstrates the range of benefits that the natural environment can provide. However, these results need to be interpreted with care, and in the knowledge that whilst the highest quality and most readily available data and methods were used, there are limitations and assumptions that need to be borne in mind.

Work is progressing rapidly on the calculation of physical and monetary flows of ecosystem services from natural capital assets, but it remains a developing area. A number of ecosystem services remain difficult to quantify and value. Some are highly location specific, for example water flow and impact on downstream flood risk. This can be quantified and valued by running detailed hydrological and flood risk modelling, but it is difficult to generalise. Others, such as water quality can be modelled, but are very

difficult to value, while there are additional cultural services, such as aesthetic experiences, cultural heritage, spiritual experience and sense of place that are difficult to even quantify. It should, therefore, be borne in mind that the valuations presented in this section place values on several key benefits, but these are necessarily incomplete.

Table 5 Summary of uncertainties in the calculation of physical flows and monetary values of each natural capital benefit, and an overall assessment of confidence, using a red, amber, green (RAG) rating.

Natural capital benefits	Assessment of uncertainties	RAG rating
Air quality regulation	Biophysical estimates based on averages for broadleaved and coniferous trees and grassland. Valuation follows ONS guidance.	
Carbon sequestration	Well studied, standardised carbon lookup tables available. Valuation uses UK Government non-traded carbon price.	
Agricultural emissions	Receiving increasing attention as part of climate change accounting. Valuation uses UK Government non-traded carbon price.	
Recreation	Welfare values from a welfare function model from the ORVal tool. This is a good model and based on a travel cost method, but it is nonetheless a model.	
Physical health	The most uncertain of the services measured. High uncertainty over who would make frequent and active visits to the green spaces and the monetary value of these benefits. There is also a potential here for double counting with the amenity service.	
Agricultural production	Based on extensive data collected by Defra annually and market prices.	
Timber production	Well studied over many years as part of forestry management. Valuation uses market prices.	

For the services that have been included here, a range of assumptions have been made, and these are outlined when describing the methodology (see Technical Appendix in the main Bedfordshire report). In addition, a summary of the main uncertainties is provided for each service in Table 5 (above), along with a RAG rating highlighting the overall confidence in each estimate. For most ecosystem services these assumptions are minimal, as established production functions exist linking natural capital to ecosystem service production, and levels of production to monetary value. For some services, despite fast developing research in relevant areas, broad assumptions have to be made because these links are not clear. This is particularly the case for physical health, and this estimate should, therefore, be used with care.

5. Accessible natural greenspace

5.1. Introduction

We assessed access to natural greenspace within Luton Borough using Natural England's Accessible Natural Greenspace Standards (ANGSt). These standards stipulate that everyone should have an accessible natural greenspace:

- Of at least 2 ha in size, no more than 300 m from home.
- At least one accessible 20 ha site within 2 km of home.
- One accessible 100 ha site within 5 km of home.
- One accessible 500 ha site within 10 km of home.

Please see the main Bedfordshire report for more information on accessible natural greenspace and how they were determined.

5.2. Accessible natural greenspace in Bedfordshire

Figure 21 displays the accessible natural greenspace within Luton Borough, as well in the wider Bedfordshire area. The amount of accessible natural greenspace within Luton Borough equates to an area of 555 ha. The largest accessible natural greenspace site within Luton Borough was 100 ha. Figure 22 displays the buffers used during the ANGSt analysis. Overall, 67.60% of Luton Borough residents live within 300m of accessible natural greenspace ≥ 2 hectares in size (see Table 6). However, 100% of Luton Borough residents live within 2 km of accessible natural greenspace ≥ 20 hectares in size and within 5 km of accessible natural greenspace ≥ 100 hectares in size. There are no accessible greenspace sites ≥ 500 hectares in size within 10 km of Luton Borough residents. There are no Luton Borough residents who fall outside of the ANGSt criteria. Note that areas that failed the ANGSt criteria for living within 300m of accessible natural greenspace ≥ 2 ha in size tended to be slightly more deprived (mean IMD score of 26.9) than areas that passed (IMD of 23.6). This may relate to the town centre where deprivation is slightly higher than average and greenspace provision is less good.

Table 6 The number and percentage of residents within Luton Borough passing or failing each of Accessible Natural Greenspace Standards (ANGSt). Also shown are the mean IMD scores for those areas within Luton Borough that pass or fail of Accessible Natural Greenspace Standards (ANGSt). Higher IMD scores are indicative of higher levels of deprivation.

ANGSt	No Residents		% Residents		Mean IMD score	
	Pass	Fail	Pass	Fail	Pass	Fail
Within 300m of ≥ 2 ha site	132,273	63,404	67.6	32.4	23.6	26.9
Within 2km of ≥ 20 ha site	195,677	0	100	0	24.6	na
Within 5km of ≥ 100 ha site	195,677	0	100	0	24.6	na
Meets at least one access to greenspace standard	195,677	0	100	0	24.6	na

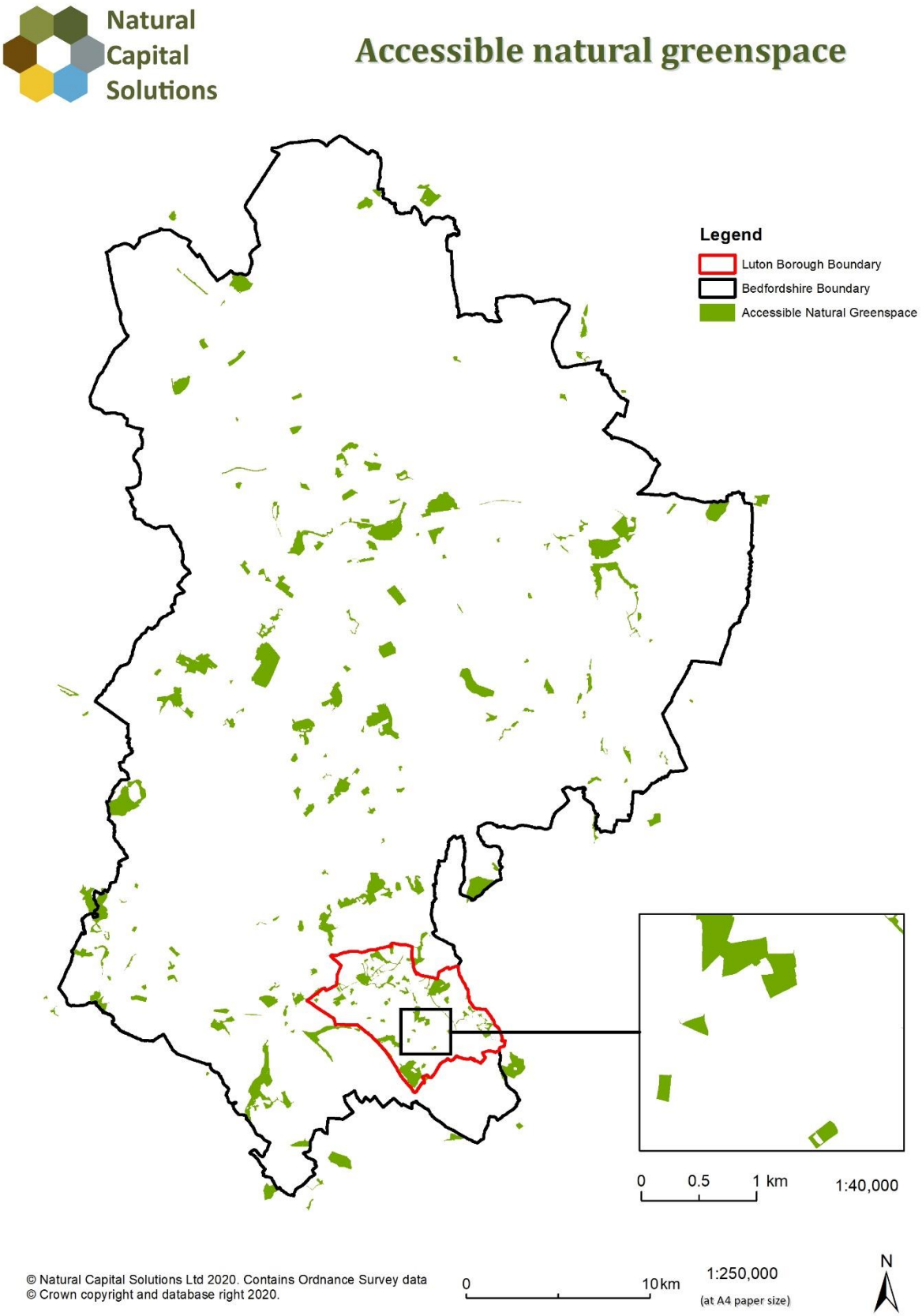

Figure 21 Accessible natural greenspace within and just outside Luton Borough and across the wider Bedfordshire area.

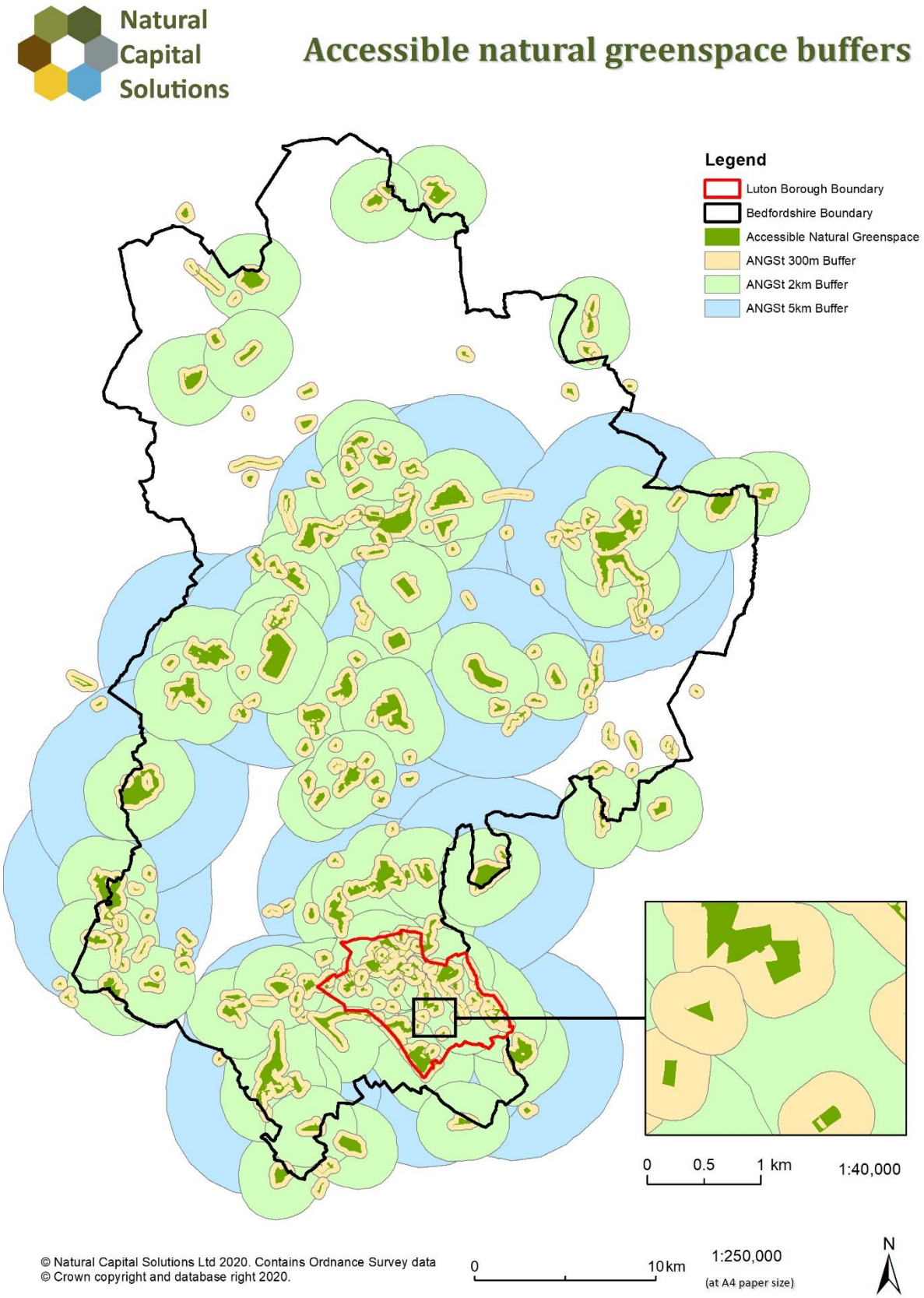

Figure 22 The buffers used during ANGSt analysis

6. Habitat opportunity mapping

6.1 Introduction

Habitat opportunity mapping is a Geographic Information System (GIS) based approach used to identify potential areas for the expansion of key habitats. It aims to identify possible locations where new habitat can be created that will be able to deliver particular benefits, whilst taking constraints (such as existing land uses or historic sites) into account. Opportunity mapping constraints are displayed in Figure 23 below and cover a significant amount of Luton Borough. In this project, opportunities for new habitats across a range of different benefits have been mapped. This has included mapping opportunities for the following:

1) To enhance biodiversity
2) To reduce surface runoff
3) To reduce soil erosion and improve water quality
4) To ameliorate air pollution
5) To reduce noise pollution
6) To regulate local climate (reduce urban heat)
7) To increase access to natural greenspace

6.2 Opportunity mapping for biodiversity enhancement

The importance of landscape-scale conservation and ecological networks has become increasingly recognised over recent years. Many wildlife sites have become isolated in a landscape of unsuitable habitats and efforts are now being directed towards linking existing habitat patches and increasing connectivity. Species are more likely to survive in larger habitat networks, are able to move and colonise new sites, and are more resilient to climate change and other detrimental impacts.

Habitat opportunity mapping to enhance biodiversity follows this ethos by using ecological networks to identify potential areas for new habitats. Identified areas will be ecologically connected to existing habitats, thereby expanding the size of the existing network, increasing connectivity and resilience, and potentially increasing the ecological quality of the new site. It was performed for three key habitat groupings, incorporating the main semi-natural habitats found in Bedfordshire. The broad habitats and their constituent types are shown in the table below:

Broad habitat	Specific habitats included
Semi-natural grassland	Acid, neutral, calcareous, rough and semi-improved grasslands
Wet grassland & wetlands	Marshy grassland, floodplain grazing marsh, lowland fen and swamp (reedbed)
Woodland	Broadleaved and mixed woodland types (excludes coniferous woodland, parkland or individual trees)

Biodiversity opportunity mapping followed a four-step process and was based on the approach developed by Catchpole (2006)[8] and Watts et al. (2010)[9]. Full methodological details are provided in the main Bedfordshire report. Note that opportunity areas for the three broad habitats often overlap, and no attempt has been made to ascertain the most suitable habitat at a particular location.

6.2.1 Results

The results are illustrated here for semi-natural grassland habitats, with the broadleaved and mixed woodland, and wet grassland and wetland maps following in Annex 1. The permeability of the landscape for typical semi-natural grassland species is shown on Figure 24. Darker areas are more permeable, meaning that typical species are expected to travel further across these habitats and hence will be less of a barrier to movement. For all three broad habitat types, buildings and infrastructure are significant barriers to movement, but away from the town centre, gardens and greenspaces help to make urban areas more permeable. Arable fields are also significant barriers to movement outside the urban area.

The habitat network map for semi-natural grassland is shown on Figure 25. Habitats that are ecologically connected are linked within a network shown in grey. White space between habitat patches indicate that the patches are not ecologically connected and dispersal between the patches is less likely to occur. There are relatively few patches of semi-natural grasslands across Luton Borough and these patches are disconnected (Figure 25). Broadleaved and mixed woodland habitat patches and networks are few and widely dispersed across the study area (Figure A2). Only a single wet grassland patch is present within Luton Borough (Figure A6).

Once constraints have been removed, the resulting maps show biodiversity opportunity areas. Figures 26 and 27 illustrates these for semi-natural grassland habitats, with the other habitats in Annex 1. Figure 26 shows the opportunity zones as buffers around existing sites, while Figure 27 highlights whole fields where habitats could be created, as these are a more meaningful management unit for conservation action. These maps indicate that the creation of semi-natural grassland is highly constrained within Luton Borough. Broadleaved and mixed woodland opportunities (Figure A4) are also highly constrained.

Please note that in many places the biodiversity opportunity maps overlap, hence a piece of land may have been identified as being potentially suitable for habitat creation for two, or even all three, different habitat types. This occurs where existing areas of the three habitat types are in close proximity to each other. This issue can be addressed by setting priorities for habitats to take forward in different locations (see Section 8.1).

[8] Catchpole, R.D.J. (2006). Planning for Biodiversity – opportunity mapping and habitat networks in practice: a technical guide. *English Nature Research Reports*, No 687

[9] Watts, K., Eycott, A.E., Handley, P., Ray, D., Humphrey, J.W. & Quine, C.P (2010). Targeting and evaluating biodiversity conservation action within fragmented landscapes: an approach based on generic focal species and least-cost networks. *Landscape Ecology,* 25: 1305–1318.

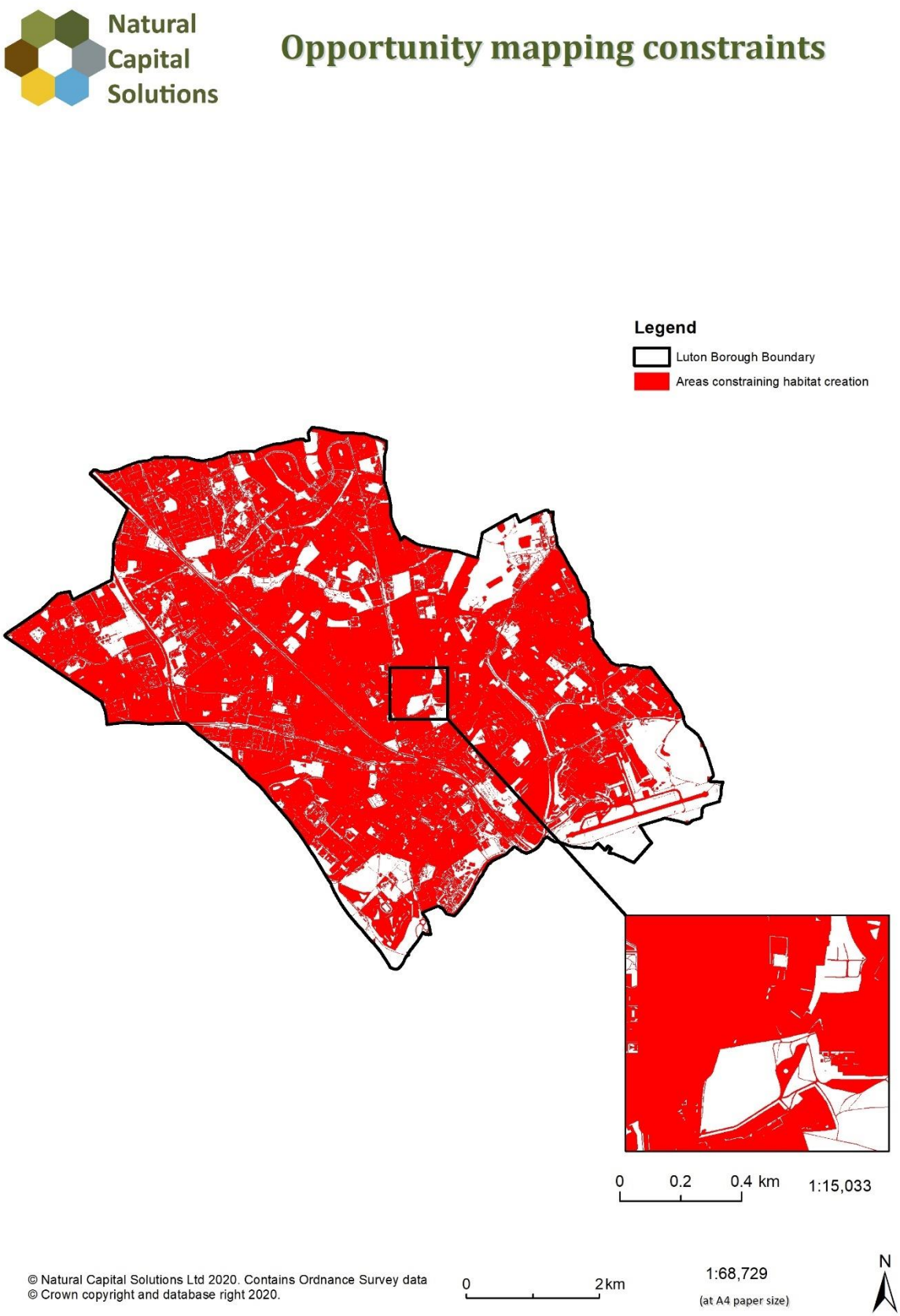

Figure 23 Key constraints taken into account during habitat opportunity mapping across Luton Borough.

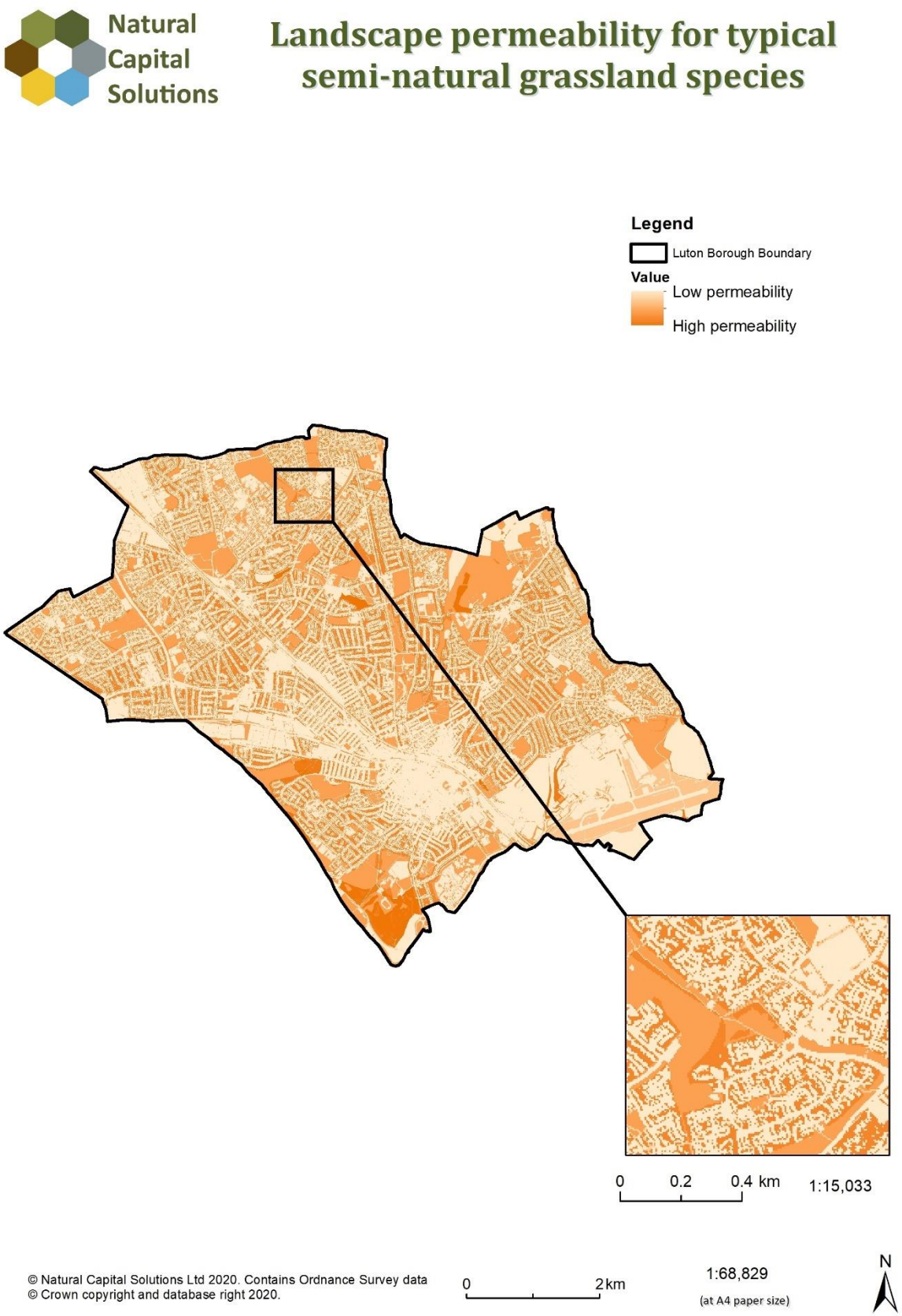

Figure 24 Landscape permeability for typical semi-natural grassland species across Luton Borough.

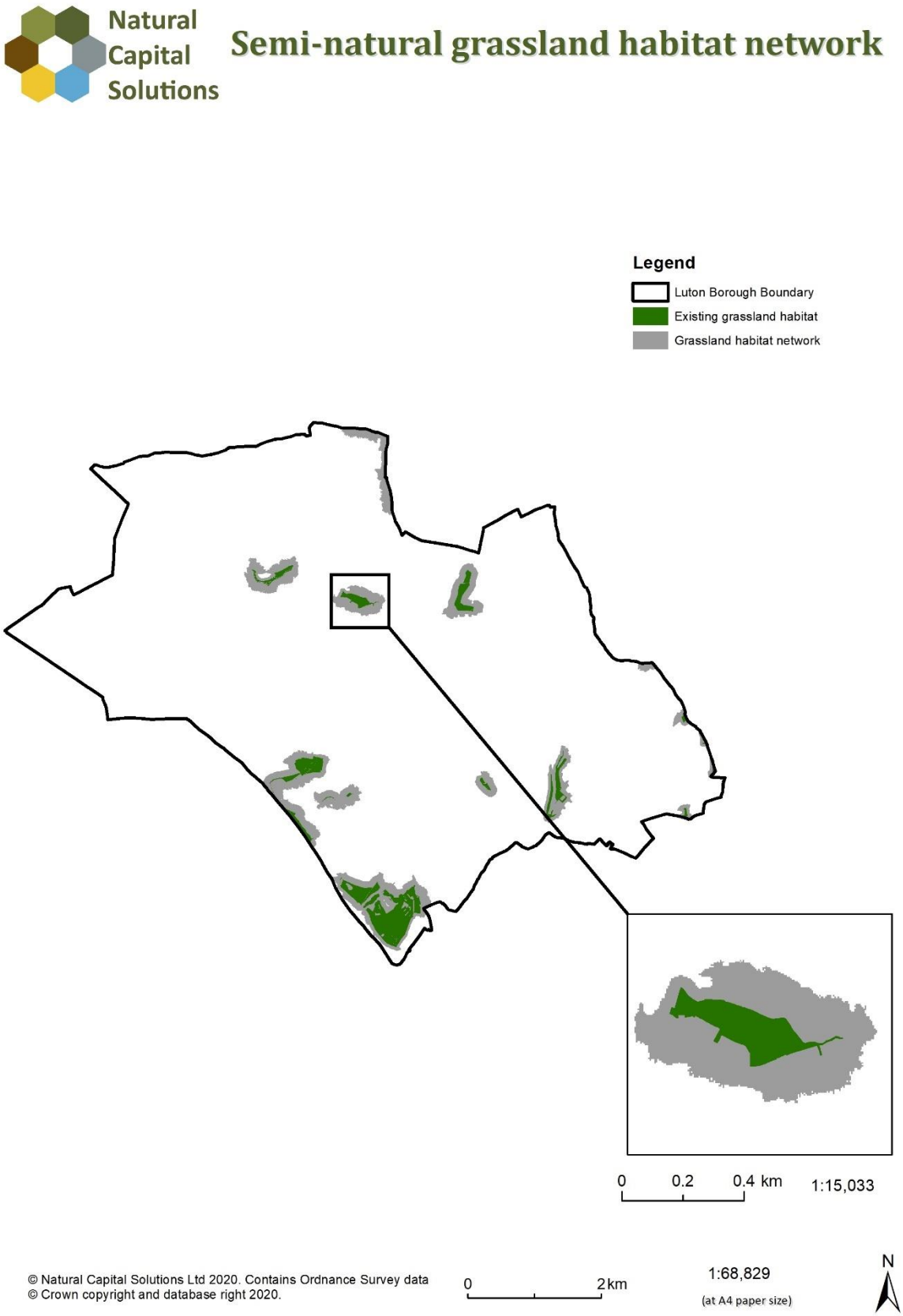

Figure 25 Habitat network for semi-natural grasslands across Luton Borough.

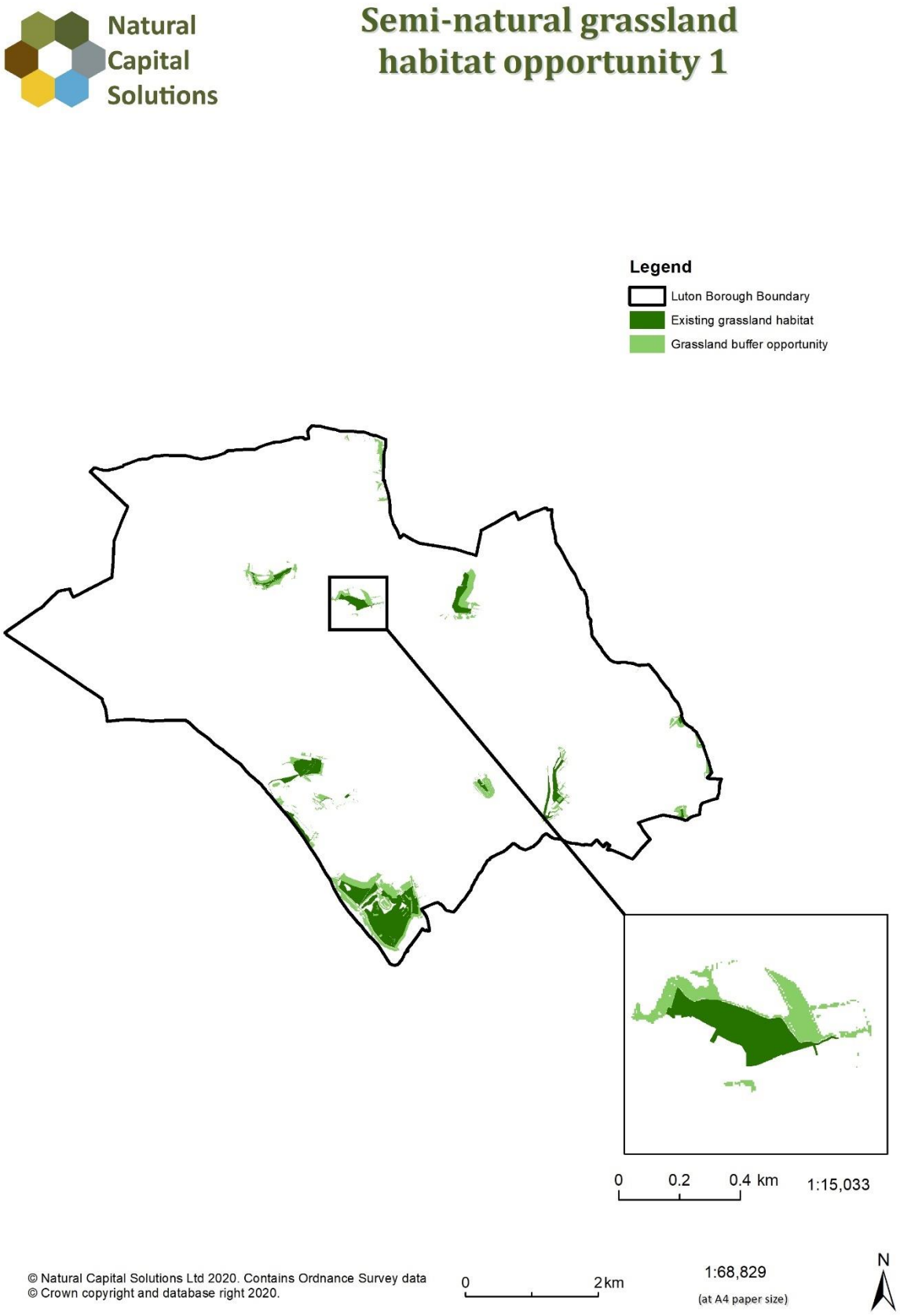

Figure 26 Buffer biodiversity opportunity areas for semi-natural grassland across Luton Borough.

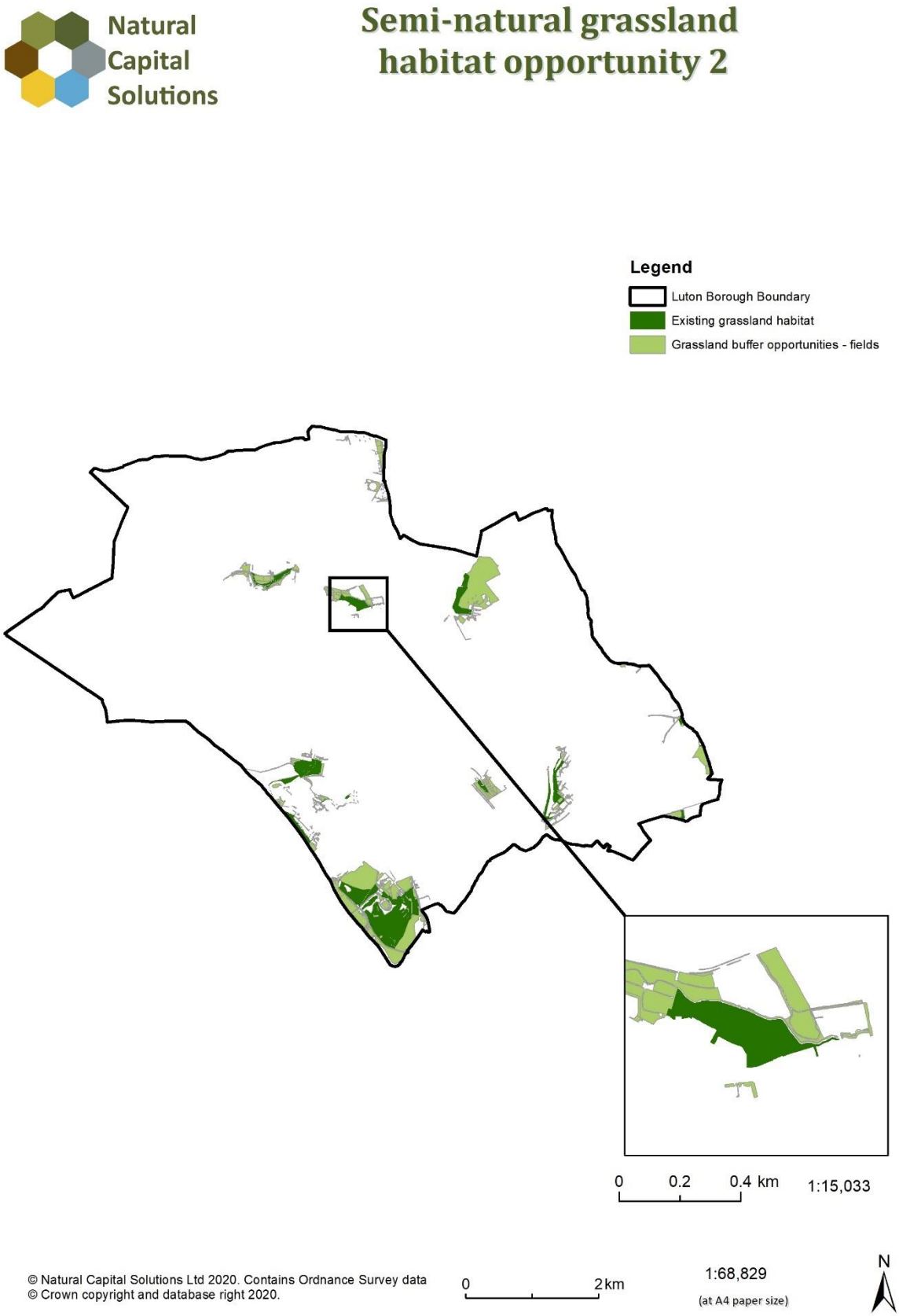

Figure 27 Field scale biodiversity opportunity areas for semi-natural grassland across Luton Borough.

6.3 Opportunity mapping to reduce surface runoff

There is growing interest in working with natural process to reduce downstream flood risk. These projects aim to "slow the flow", reduce surface water runoff and retain water away from the main river channels for as long as possible. The most likely approach to achieve this aim will involve planting woodland, although measures could also include woody debris dams and attenuation ponds in upstream areas. Opportunity mapping to reduce surface runoff was undertaken based on the water flow model described in Section 3.9 and highlights areas across the whole catchment where changing land-use would have the greatest impact on reducing runoff. Full methods for all opportunity mapping are provided in the accompanying Bedfordshire report.

6.3.1 Results

Once land use constraints were removed, several areas that are currently poor for surface water runoff remained and these where identified as opportunity areas on Figure 26. Opportunities are quite limited across much of Luton Borough, but do exist in a number of locations, with more apparent towards the south of the Borough. The opportunity areas have been displayed in relation to fields and plots of land in Figure 29.

Note that some of the worst areas for water flow regulation highlighted in Figure 15 relate to buildings and infrastructure, which were not assessed as part of this project, although could be suitable for the installation of green roofs and other types of retrofitted Sustainable Drainage Systems (SuDS).

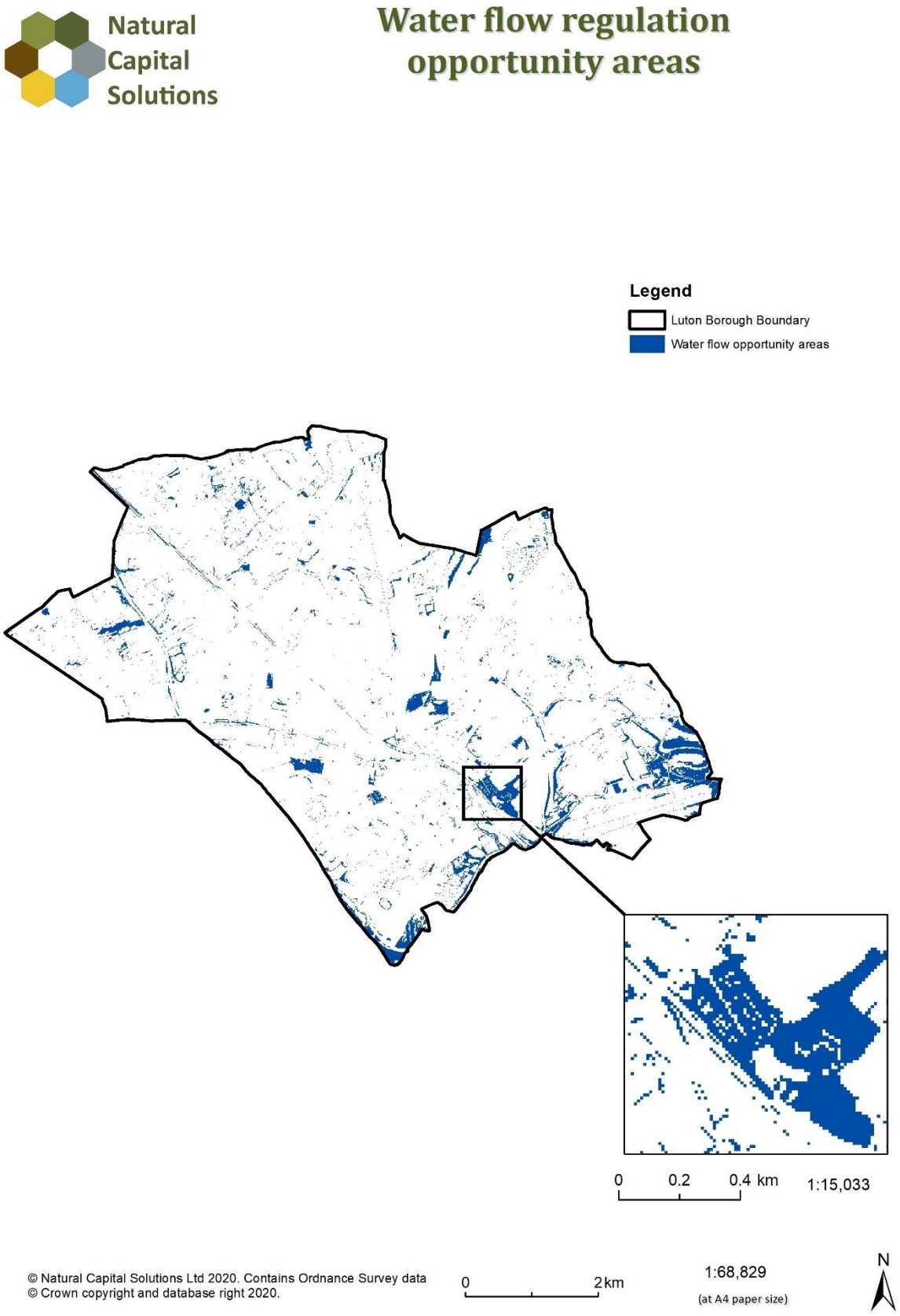

Figure 28 Water flow regulation opportunity areas across Luton Borough.

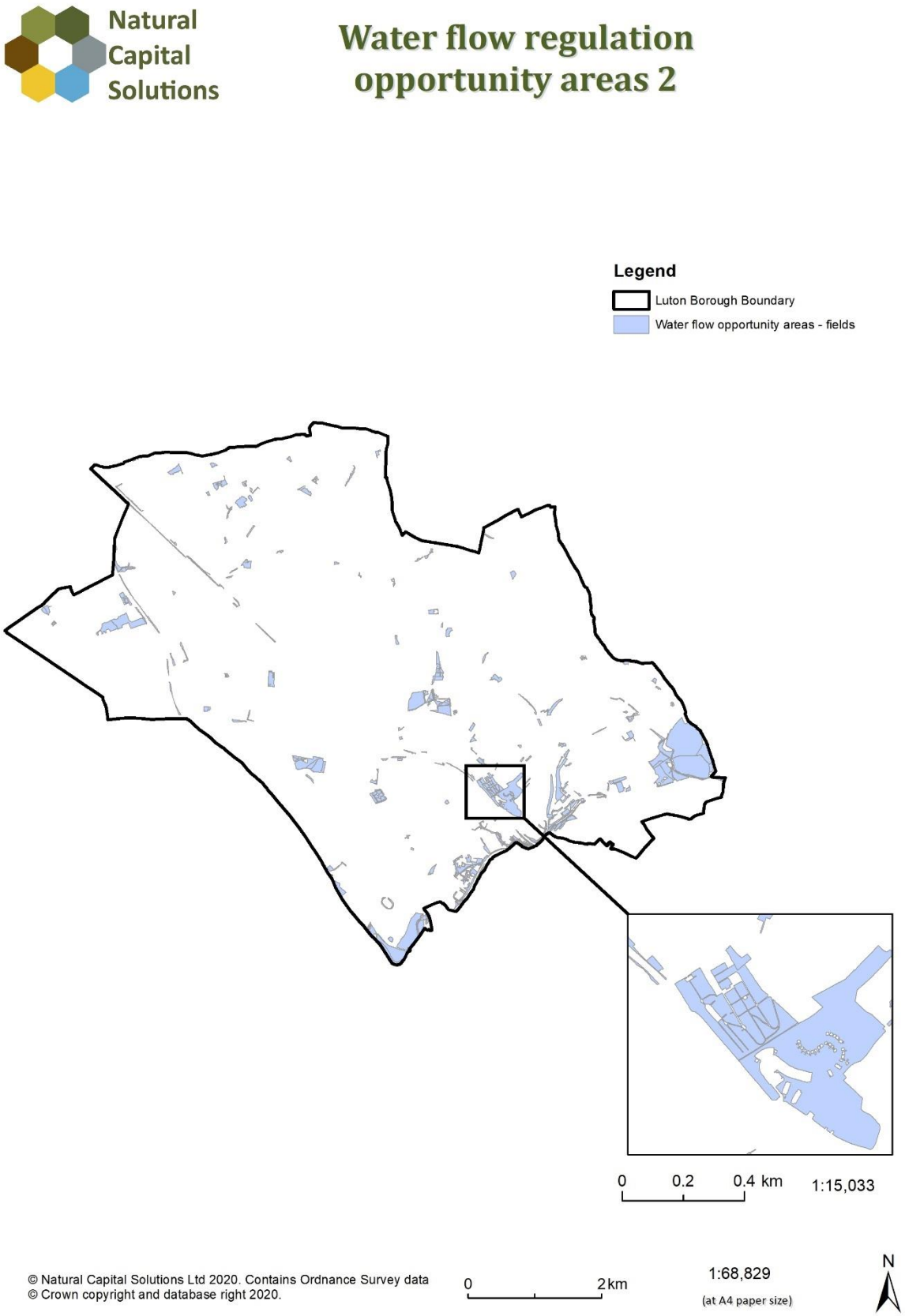

Figure 29 Field scale water flow regulation opportunity areas across Luton Borough.

6.4 Opportunity mapping to reduce soil erosion and improve water quality

Agricultural and urban diffuse pollution have a major impact on water quality in lowland areas in the UK. There is growing interest in catchment sensitive farming and working with natural processes to tackle this issue. These aim to reduce the amount of sediment and pollutants entering the watercourses in the first place by, for example, adjusting farming practices and planting riparian buffer strips. Opportunity mapping focussed on identifying areas at highest risk of sedimentation and soil erosion, based on catchment land use characteristics, distance to watercourse, slope length and land use erosion risk. It highlights areas across the whole catchment where changing land use would have the greatest impact on reducing soil erosion and hence improving water quality. Note that the focus is on sedimentation risk from agricultural diffuse pollution, and built-up areas (urban diffuse pollution) are not as well accounted for in the existing model, hence the findings for Luton only consider one aspect of water quality and other opportunities to tackle urban diffuse pollution will be present.

6.4.1 Results

Arable farmland scores particularly badly when mapping water quality regulation (Section 3.10) at both a coarse and a fine scale of assessment and these areas are, therefore, highlighted as the areas with greatest opportunity to reduce sediment loads and enhance water quality on the opportunity map (Figure 30). However, the number of these opportunity areas are few in Luton Borough due to the scarcity of arable land and inevitable occur on the periphery of the town. Distance to watercourses is another key factor in determining water quality regulation, hence locations close to the River Lea have also been highlighted. There are few watercourses in Luton Borough that have not been culverted, which also explains the limited water quality regulation opportunities.

Sediment loads, and therefore opportunity areas, can be variable across short distances as it is partly dependent upon slope and distance to water course, which change rapidly over short spaces, and is why many of the identified areas are linear stretches adjacent to watercourses. These areas would be ideal places to install riparian buffer strips, ideally of woodland, but any habitat offering year-round cover would help.

A map of whole fields where opportunities for reducing soil erosion and enhancing water quality would be most effective has been created (Figure 31). As noted, however, the areas that would be most effective for tackling water quality are often zones adjacent to watercourses, and changing land use in riparian buffer strips may be the most effective solution, rather than converting whole fields.

Comparing the opportunity maps for water flow (Figure 28) with water quality (Figure 30), reveals that there is little overlap between the two. The most effective locations for reducing surface water runoff tend to occur on slopes, many of which are in the south of the study area, whereas the most effective areas to enhance water quality are immediately adjacent to water courses and on arable fields. It is likely that habitat features created for one will still enhance the other, it is simply that the top 25% of target areas do not overlap in many locations. Woodland would be the most effective habitat to deliver these opportunities, although semi-natural grasslands, wet grasslands and wetlands would also deliver benefits.

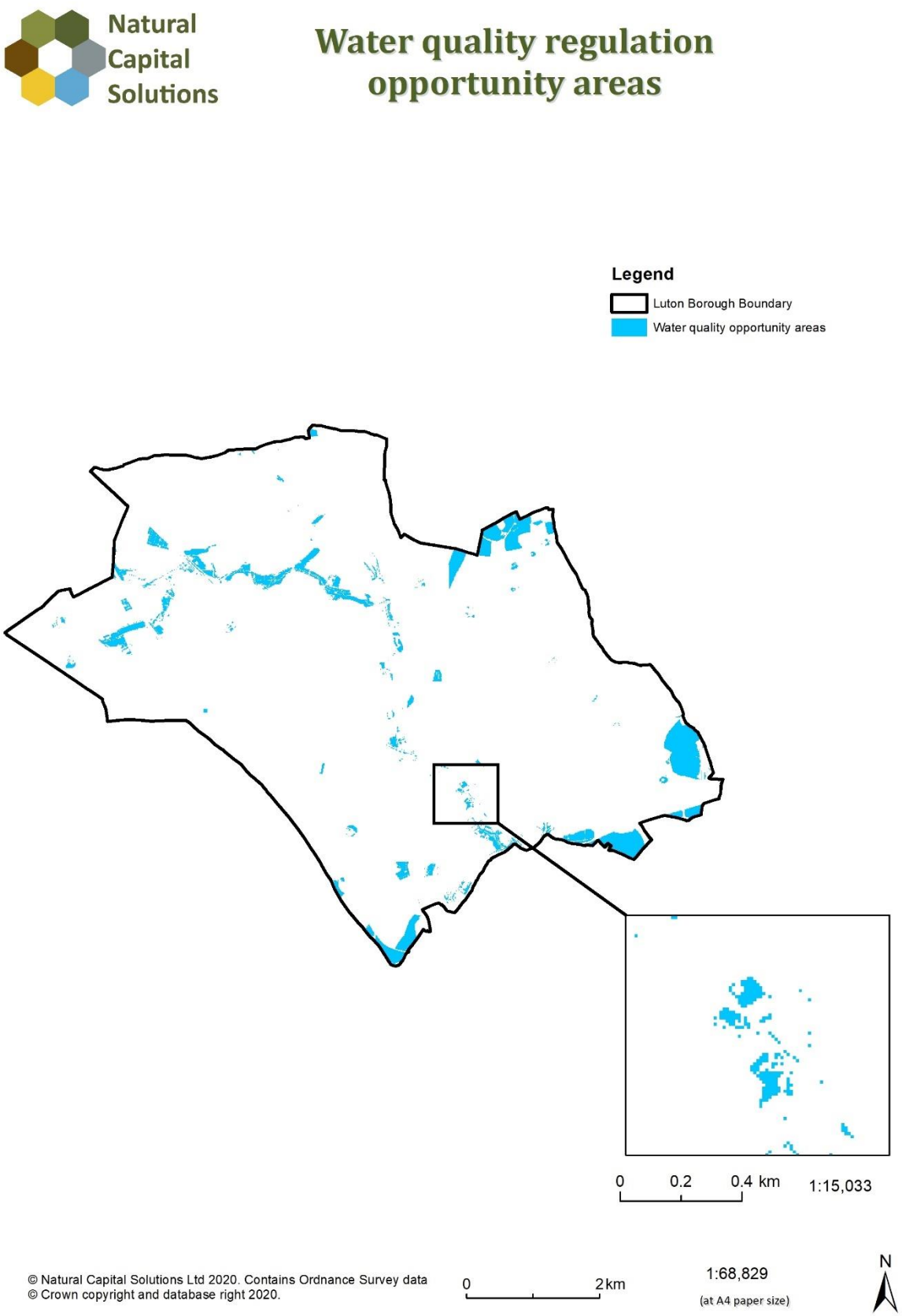

Figure 30 Water quality regulation opportunity areas across Luton Borough.

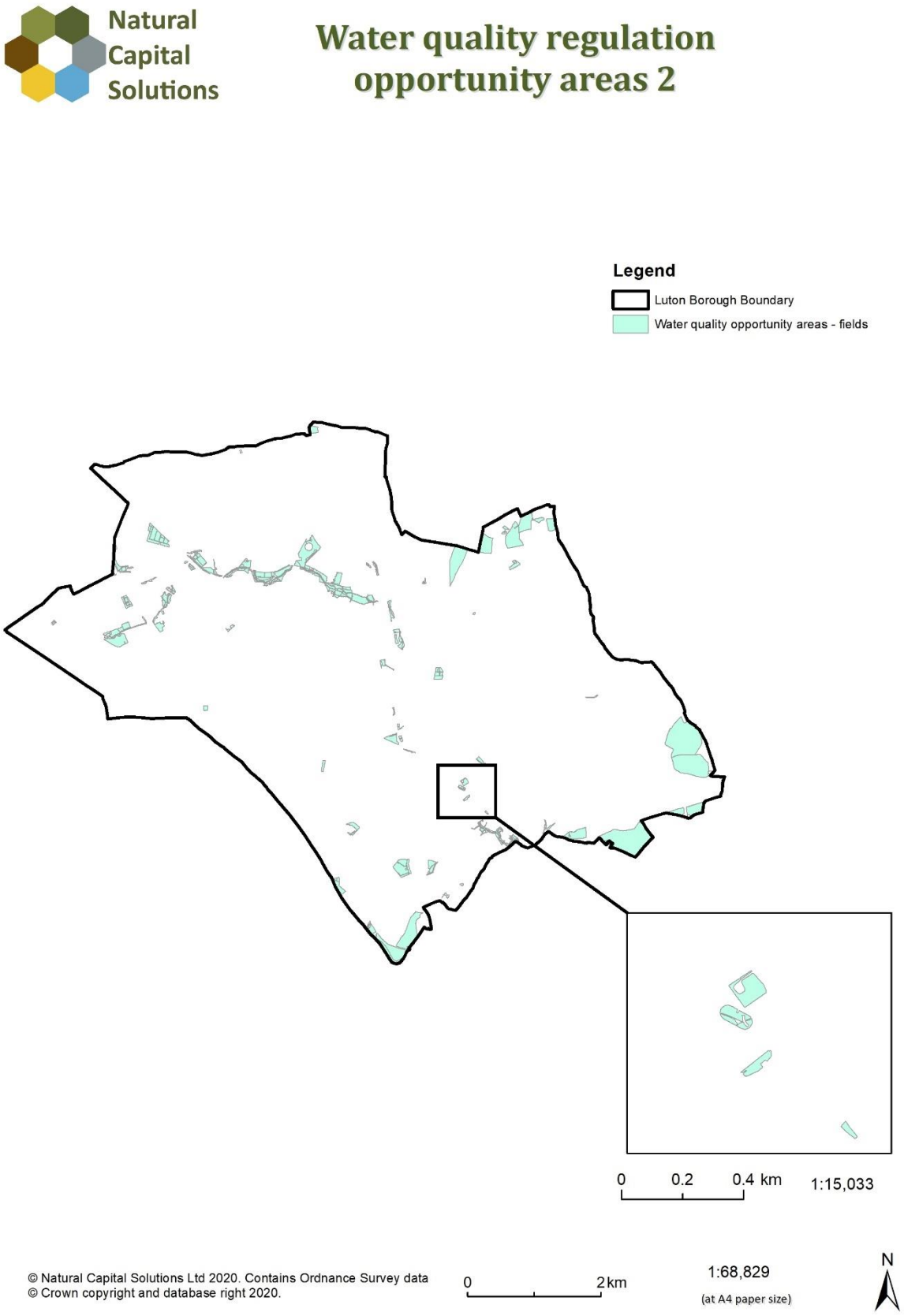

Figure 31 Field scale water quality regulation opportunity areas across Luton Borough.

6.5 Opportunity mapping to ameliorate air pollution

To map opportunities to use the natural environment to ameliorate air pollution, a slightly different approach was used compared to water flow and water quality. Air pollution is often highly localised, and vegetation is most effective at mitigating pollutants when planted close to pollution sources. Opportunities to ameliorate air pollution were therefore focussed around areas with greatest demand. As described in Section 3.4, demand is assumed to be highest in areas where there are likely to be high air pollution levels and where there are lots of people who could benefit from the air quality regulation service. The opportunity maps therefore highlight areas that currently have no trees, but where it would be most beneficial to plant them.

6.5.1 Results

As described previously, demand for air quality regulation (Figure 10) is highest in urban areas as these have both higher air pollution levels and higher populations that would benefit from better air quality, and also along the main road networks. Inevitably, when the focus on air quality regulation is in the major towns, large areas are constrained, where it would not be possible to plant trees or other green infrastructure. However, unconstrained areas do remain, and these were highlighted on the opportunity map (Figure 32). Opportunity areas along the main roads were also highlighted. Whole plots were also identified (Figure 33), although on this occasion this was similar to the previous map. These locations potentially provide the opportunity to plant trees that could trap air pollution in areas where there is the greatest need for this service. Note that this does not include pavements, where further opportunities may be present, if pavements are sufficiently wide.

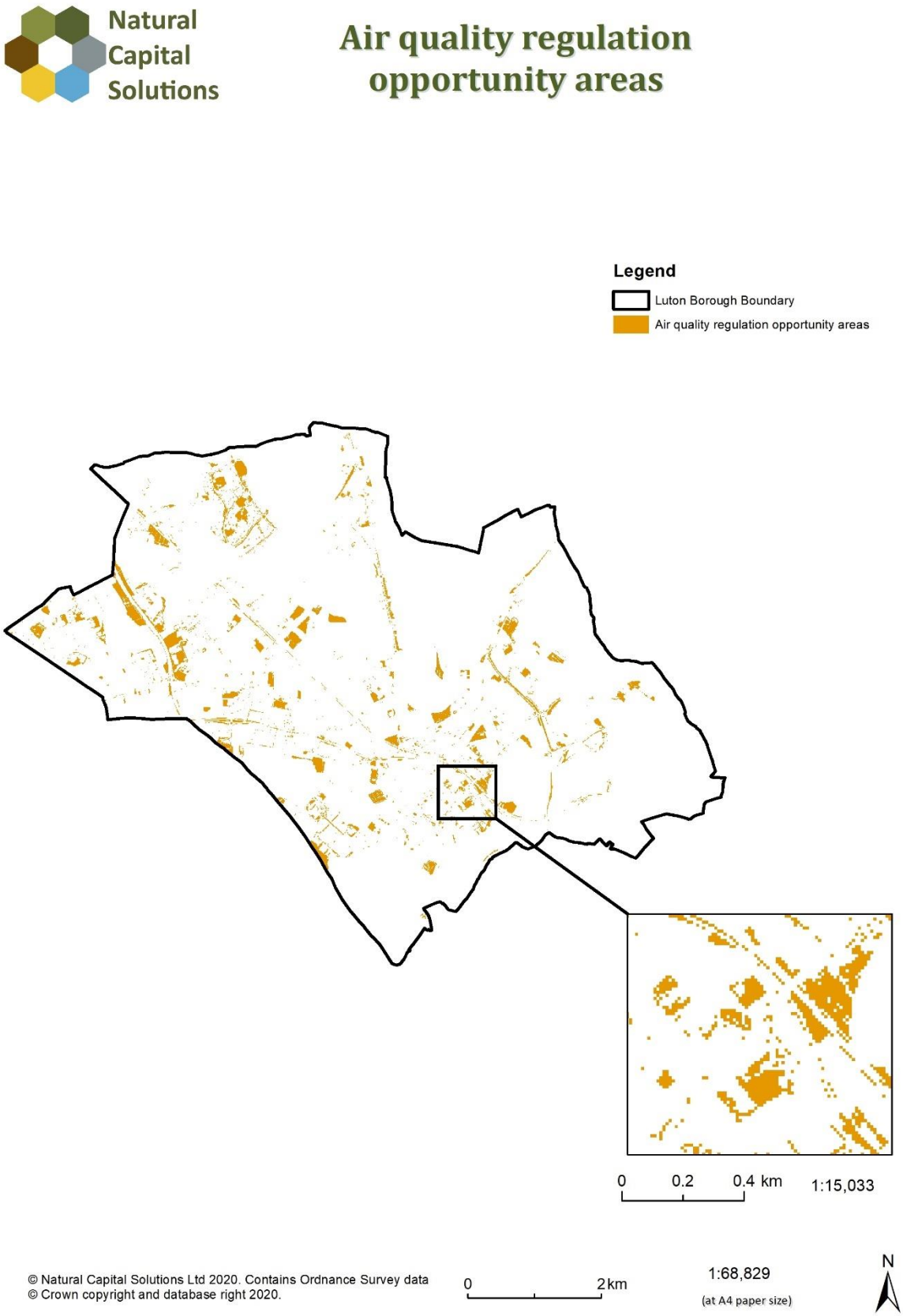

Figure 32 Air quality regulation opportunity areas across Luton Borough.

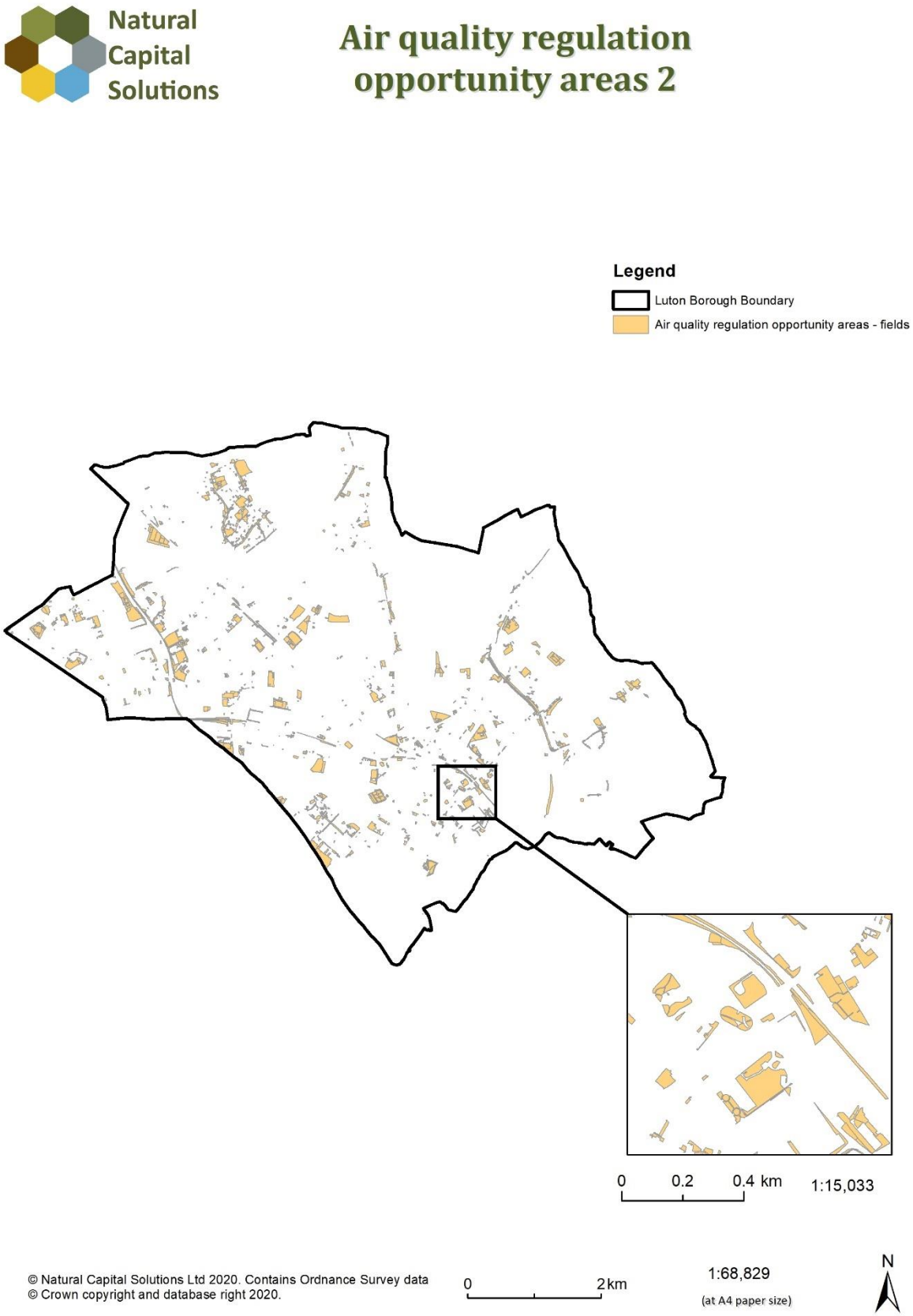

Figure 33 Field (plot) scale air quality regulation opportunity areas across Luton Borough.

6.6 Opportunity mapping to reduce noise pollution

Opportunities to reduce noise pollution were mapped in a very similar way to the air quality regulation opportunity mapping just described. This was focussed around areas with greatest demand for noise regulation, as described in Section 3.6. Dense plantings of trees and scrub are the habitat type that could potentially reduce noise pollution; the opportunity maps therefore highlight areas that currently have no trees, but where it would be most beneficial to plant them.

6.6.1 Results

Similarly to air quality regulation, demand for noise regulation (Figure 12) is highest in the main urban areas and adjacent to the road network, as these have both higher noise pollution levels and higher populations that would benefit from noise screening. Given the large number of constraints in urban areas, there are limited opportunities to reduce noise pollution across Luton Borough (Figure 34). Nevertheless, a number of opportunities are still present, especially on the western half of the town. Whole plots were also identified and shown in Figure 35. These locations potentially provide the opportunity to plant trees and scrub belts that could help to block and screen noise pollution.

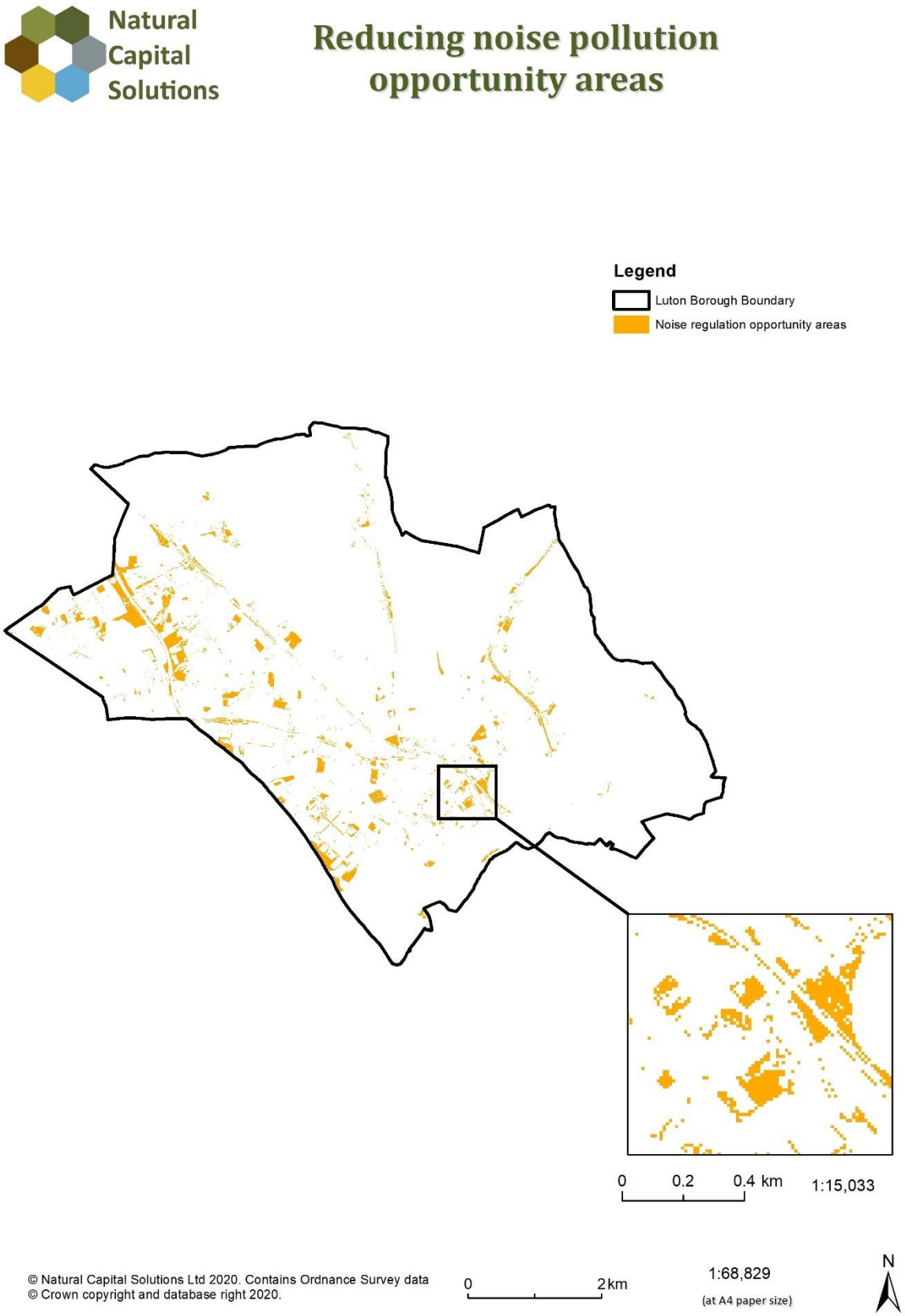

Figure 34 Noise regulation opportunity areas across Luton Borough.

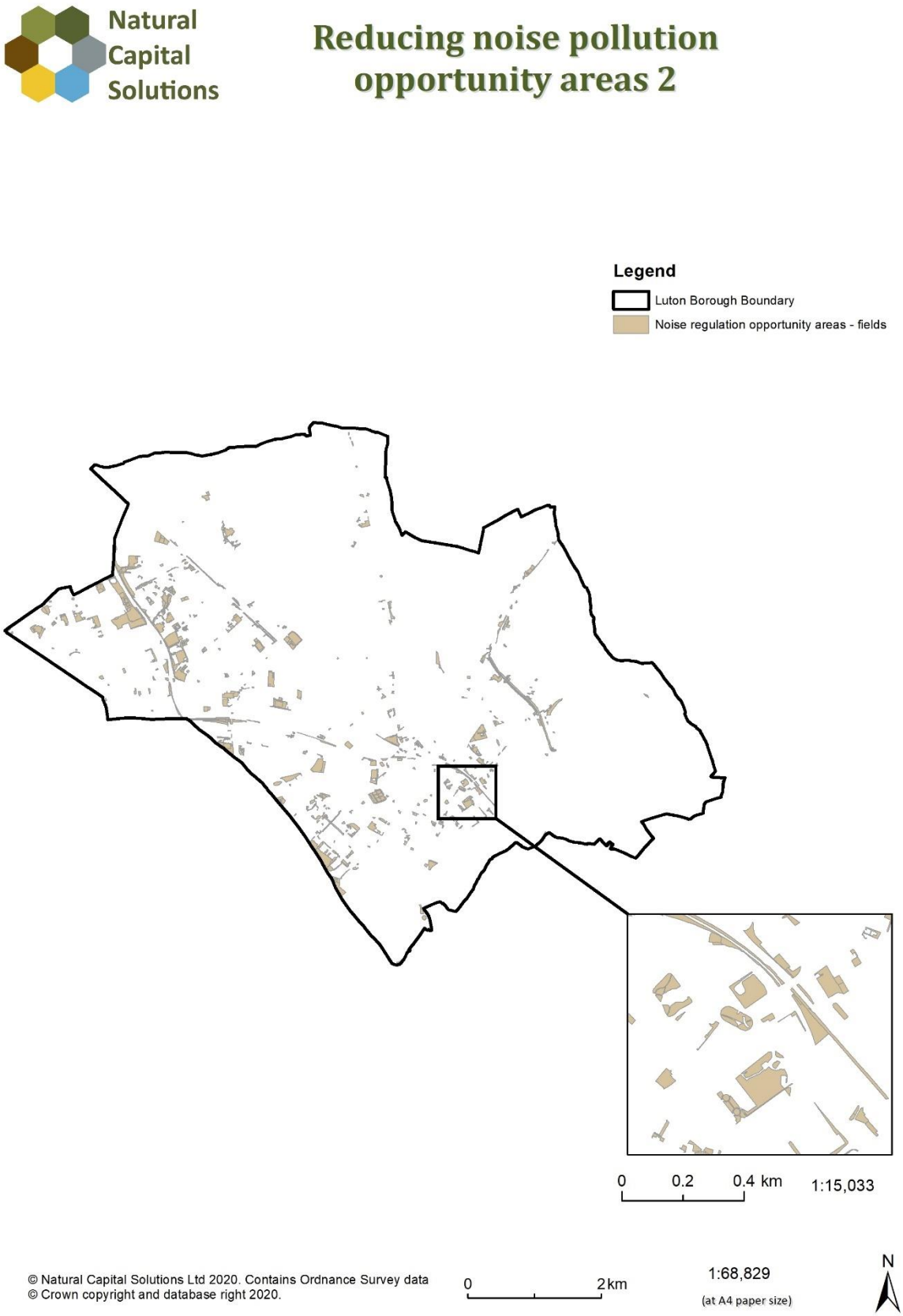

Figure 35 Field (plot) scale noise regulation opportunity areas across Luton Borough.

6.7 Opportunity mapping to regulate local climate (reduce urban heat)

Opportunities to regulate local climate were mapped using the same approach as for air quality regulation and noise regulation. This therefore, focuses on areas of highest demand, where there is currently low capacity. Using the natural environment to regulate local climate can best be achieved by either plating trees / woodland, or creating waterbodies such as ponds and lakes. The larger the area of habitat created, the greater the effect that it will have on urban temperatures, although even individual trees will have a small positive impact.

6.7.1 Results

Demand for local climate regulation (Figure 14) is highest in urban areas and the size of the urban heat island effect increase with size of urban area and amount of sealed surface. Luton is therefore likely to have the largest urban heat island effect in Bedfordshire and hence the greatest need for its regulation. As with air pollution regulation and noise regulation, there are limited opportunities to regulate local climate across Luton Borough (Figure 36), but opportunities do exist, scattered throughout the Borough. As for the other services, whole plots were also identified and shown in Figure 37. These locations potentially provide the opportunity to plant trees and woodland or to create water features that could help to reduce the urban heat island effect.

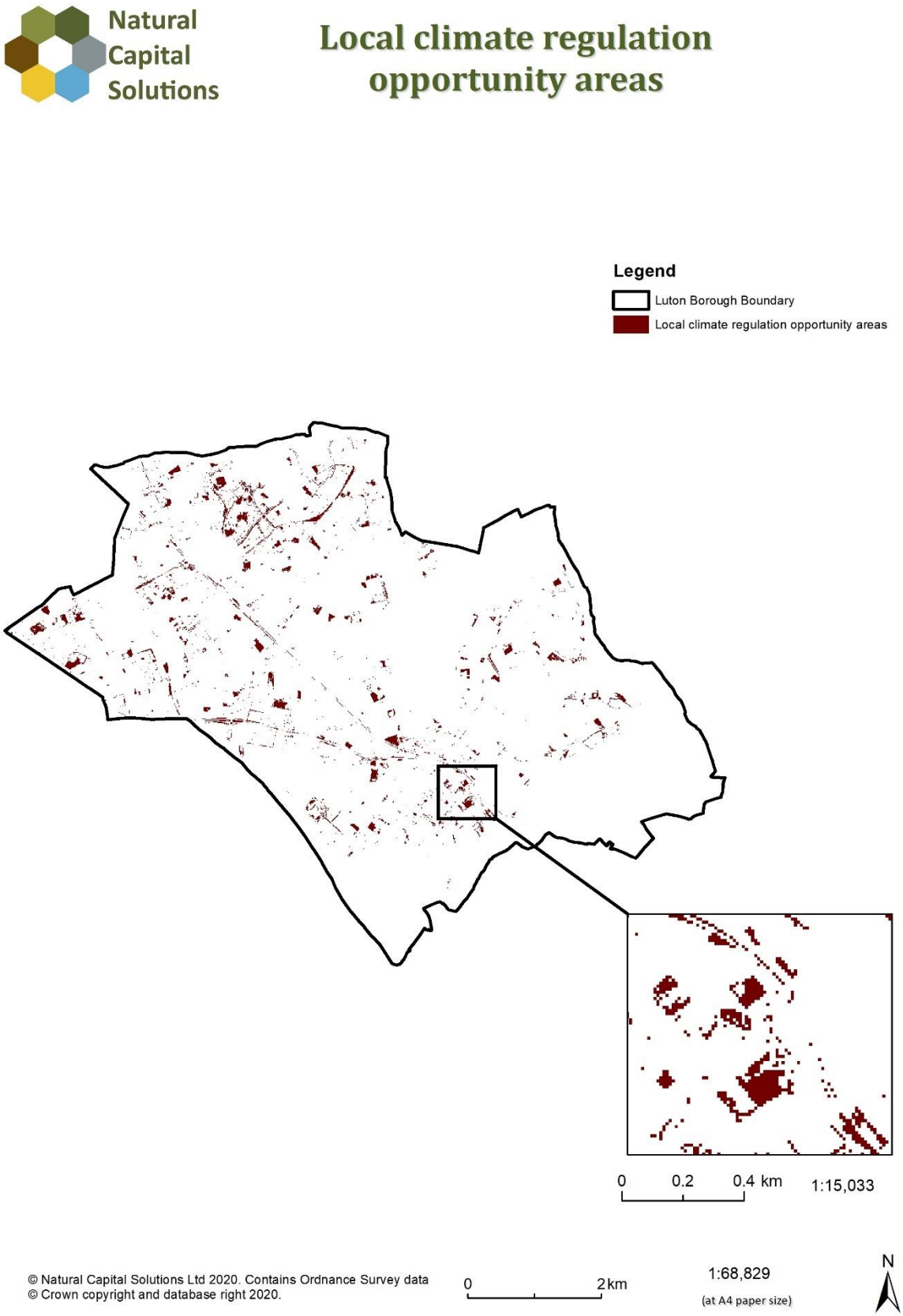

Figure 36 Local climate regulation opportunity areas across Luton Borough.

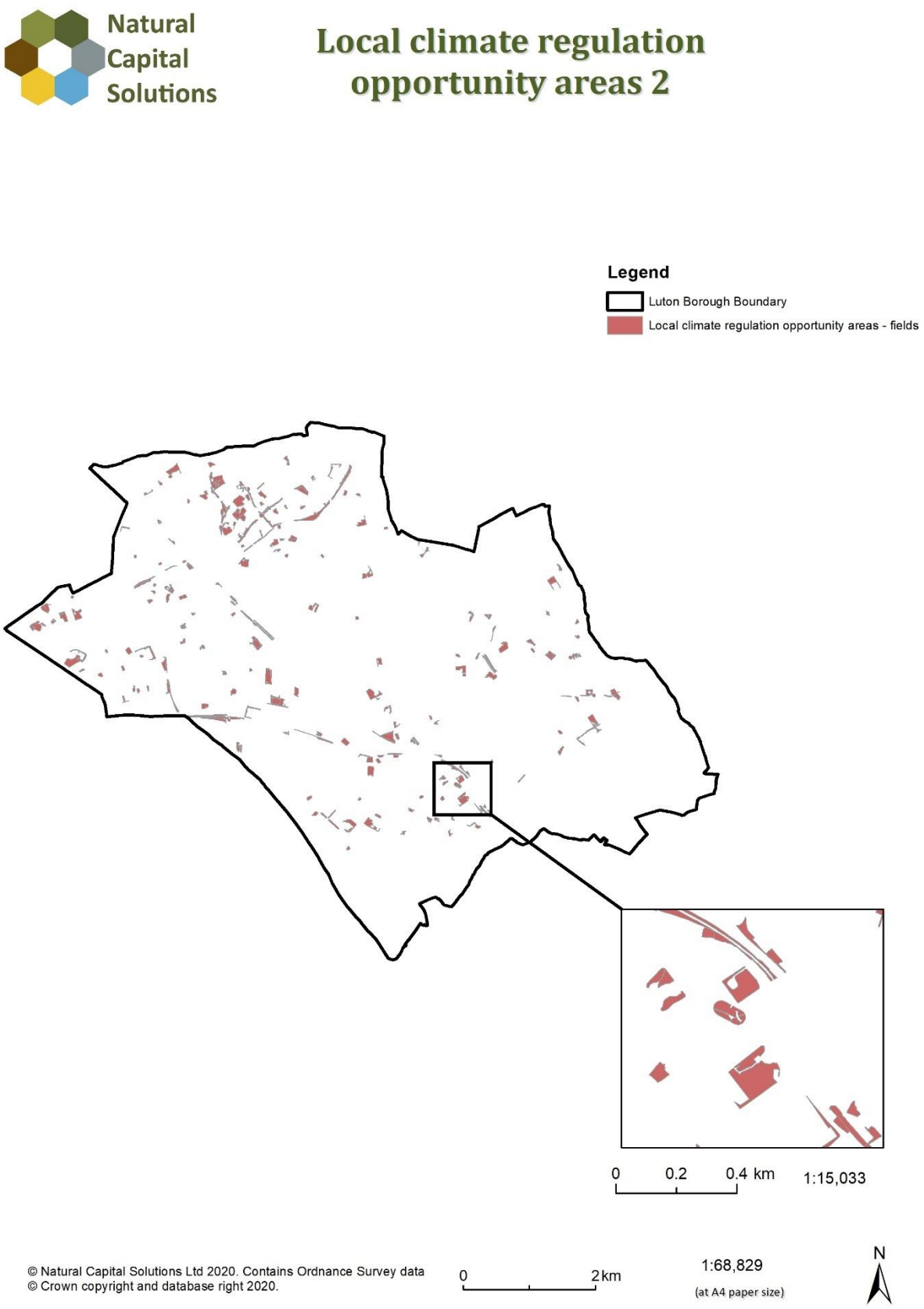

Figure 37 Field (plot) scale local climate regulation opportunity areas across Luton Borough.

6.8 Opportunity mapping to enhance recreation in the natural environment

There are many benefits of enhancing public access to natural greenspaces and the key features that maximise benefits are proximity to where people live and the naturalness of the habitats. Here, opportunities to provide accessible natural greenspace were mapped, based on creating new habitats at new sites, based purely on demand.

6.8.1 Results

Demand for accessible natural greenspace was described in Section 3.14 and is strongly focussed around urban areas. Therefore, it is perhaps unsurprising that most of Luton has strong demand for this service, but (lack of) constraints dictate where opportunities are identified (Figures 38 & 39). Opportunities are limited, but some areas have, nevertheless, been identified. Note, however, that no consideration of land ownership or other local site factors have been taken into account in this study.

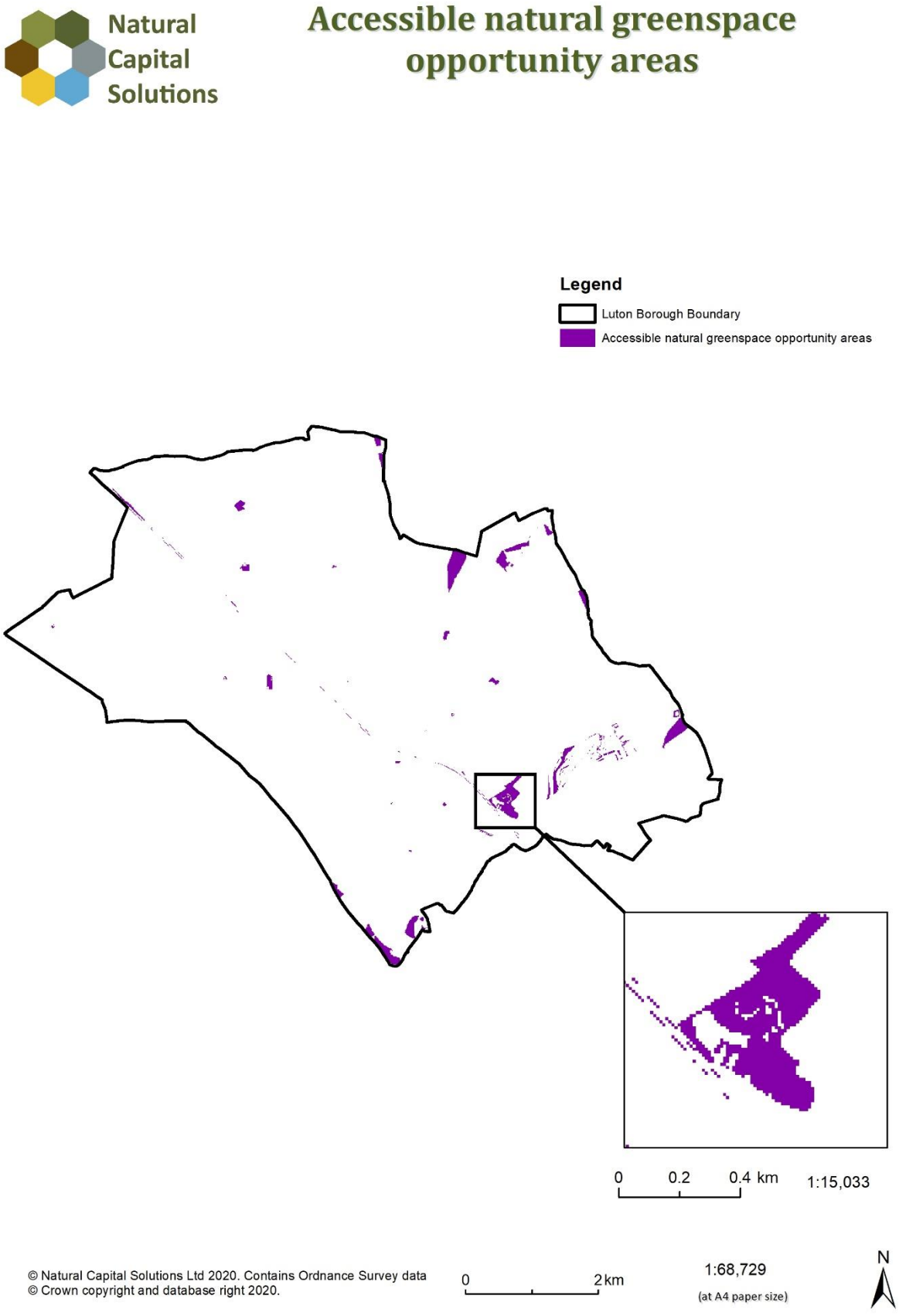

Figure 38 Accessible natural greenspace opportunity areas across Luton Borough.

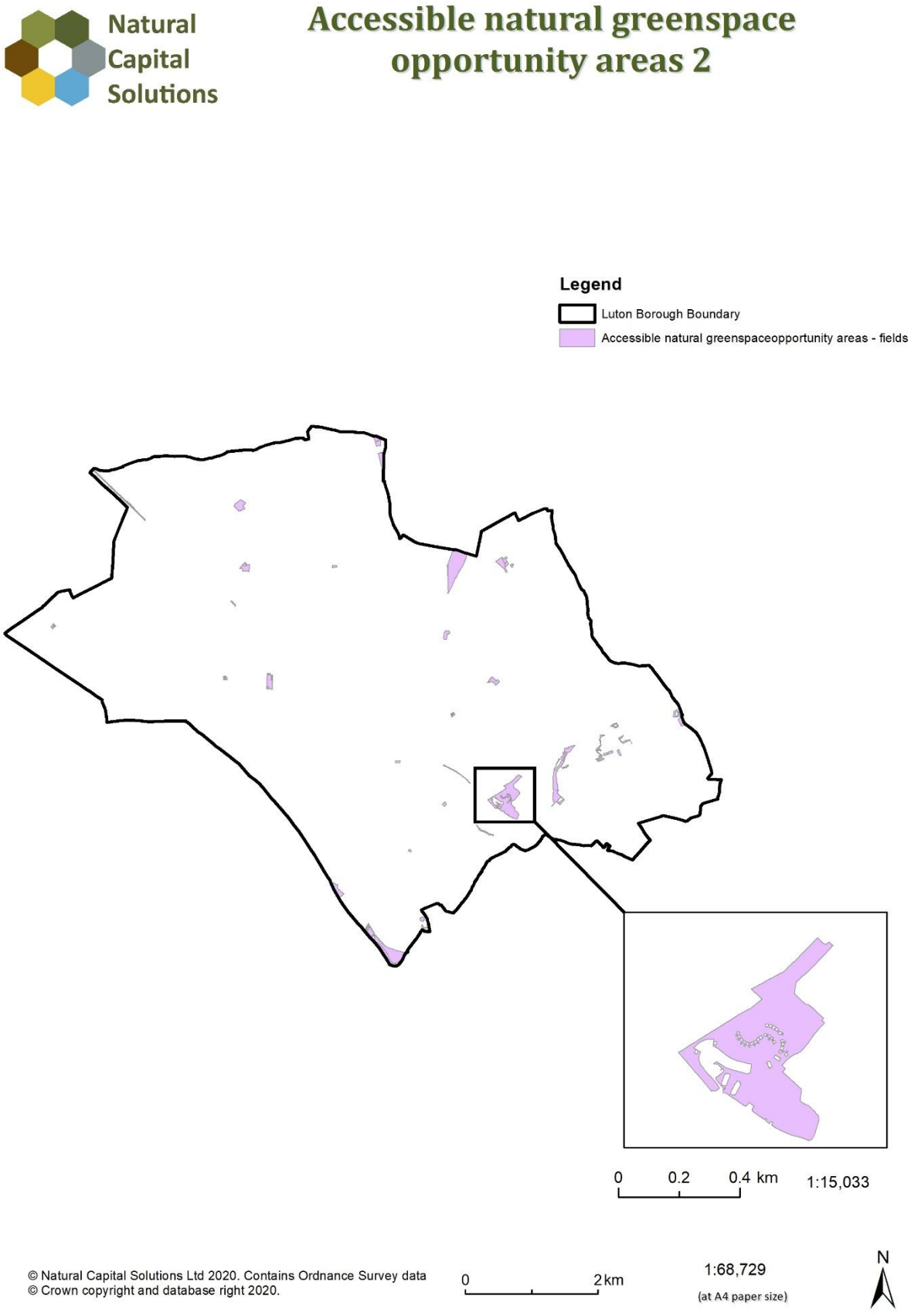

Figure 39 Field (plot) scale accessible natural greenspace opportunity areas across Luton Borough.

7. Combined opportunities for new habitats

In addition to mapping the individual opportunities presented in Sections 6, it is also possible to examine multiple opportunities, which are areas where new habitat can be created that provides opportunities to enhance more than one of the services mapped previously. This is assessed by overlaying each individual opportunity map already created to determine the degree of overlap, examining each of the main habitat types in turn. This is focussing on the top 25% of opportunity areas for each ecosystem service, so is only considering the higher levels of service provision. In reality, creating any new habitat for one ecosystem service is likely to provide benefits for other services, even if this does not fall within the top 25%. We have combined maps in two ways for each habitat:

1. Treating biodiversity opportunities and all ecosystem service opportunities equally, hence all opportunities are included in the final maps.
2. Restricting combined opportunities to areas that present a biodiversity opportunity. Hence opportunities are only included for areas that are ecologically connected to existing habitats. This follows the ethos of environmental net gain being focused on biodiversity net gain first, and then natural capital net gain as an additional feature.

It would also be possible to create maps with different weightings for different services. For example, if stakeholders considered water flow and access to nature as being the most important local priorities, then these opportunities could be given greater weighting. This has not been attempted here, but it would be possible to combine the maps in any way wanted.

7.1 Combined opportunities for new broadleaved and mixed woodland

Opportunities to deliver enhancement to water flow, water quality, air quality, noise, and local climate regulation (Sections 6.3-6.7), can all be best achieved through planting trees and woodland, and woodland is also one of the best habitats for creating high quality accessible natural greenspace (Section 6.8). Therefore, the opportunity maps for all of these services were overlain with the opportunity map for biodiversity enhancement through the creation of broadleaved and mixed woodland. Note that creating woodland habitats will also deliver benefits in the form of **carbon sequestration**. These have not been mapped separately as location is not especially important for carbon sequestration (although there will be some difference in the growth rate of trees in different places). Hence all of the locations identified in the maps below would also deliver this service.

The results are shown on Figure 40, which maps the existing areas of broadleaved and mixed woodland and an overlay of all the seven different opportunity areas, and on Figure 40 when constrained to areas that present biodiversity opportunities. The maps highlight the number of different opportunity areas that overlap (out of a maximum of seven) for each 10m by 10m pixel across the study area. The results show that while there are large areas that only offer one opportunity, there are many areas that offer multiple opportunities. Locations at the edges of the highly urbanised areas are most often highlighted due to the many constraints in the town centre, but some opportunities are also present in the urban core. If the aim of woodland creation was to maximise the delivery of as many ecosystem services as possible, then it is these locations that would deliver the greatest benefits to society.

When considering habitat creation for biodiversity as the primary driver (Figure 41), the number of locations is reduced still further, but there remain several where existing woodland is present nearby.

7.2 Combined opportunities for new semi-natural grassland

Creating semi-natural grassland will not be as effective at reducing water flow or enhancing water quality as planting woodland, but it is likely to be significantly better than arable and is likely to enhance the provision of these services. It will not, however, be very effective at ameliorating air pollution, reducing noise pollution, or regulating local climate (although better than sealed surfaces for each of these services). Hence combined opportunities were examined for four out of the seven services: water flow, water quality, accessible natural greenspace, and biodiversity enhancement, while air quality, noise, and local climate regulation were not included.

Combined opportunities for new semi-natural grasslands are even more restricted than they are for woodland (Figure 42). Similarly to woodland, there are several areas that support multiple opportunities. When opportunity areas are restricted to areas that deliver biodiversity benefits for this habitat (Figure 43), opportunity areas are further reduced.

7.3 Combined opportunities for new wet grassland and wetlands

Opportunities for new wet grassland and wetlands were mapped in the same way as for semi-natural grassland, except that all opportunities were restricted to areas within the indicative floodplain. Thus four out of the seven services were included, with air quality, noise, and local climate excluded. Wetland habitats can be effective at reducing water flow and enhancing water quality.

The location of opportunities for this habitat are severely limited across Luton Borough (Figure 44), due to the requirement for being located on the floodplain. These locations only offer the opportunity for a single service, generally either opportunities to enhance water quality or access to nature Due to the extremely limited number of existing wet grassland and wetland sites in Luton, none of the identified opportunity areas are ecologically connected to existing sites.

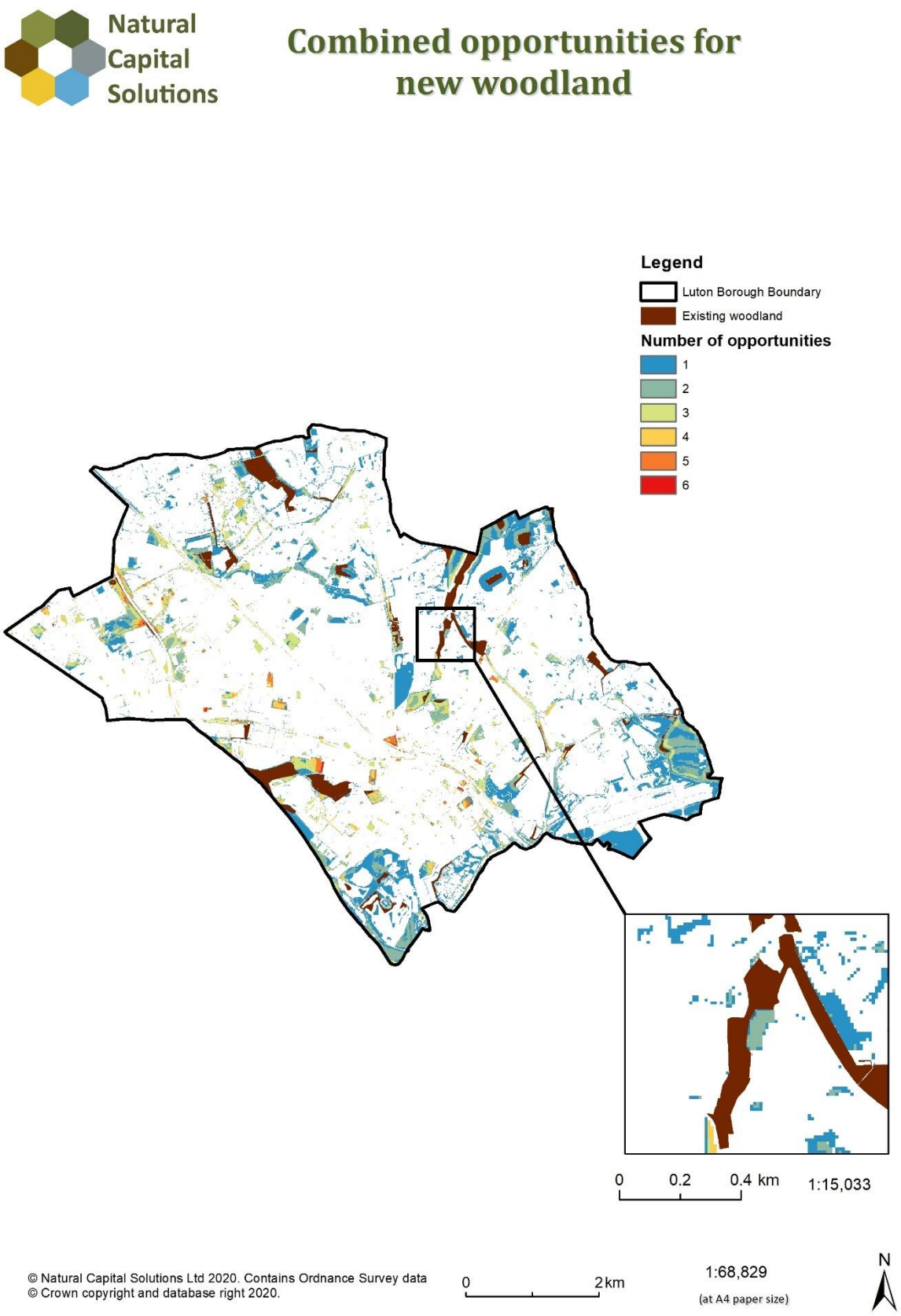

Figure 40 Existing broadleaved and mixed woodland, and combined opportunities for new woodland, across Luton Borough.

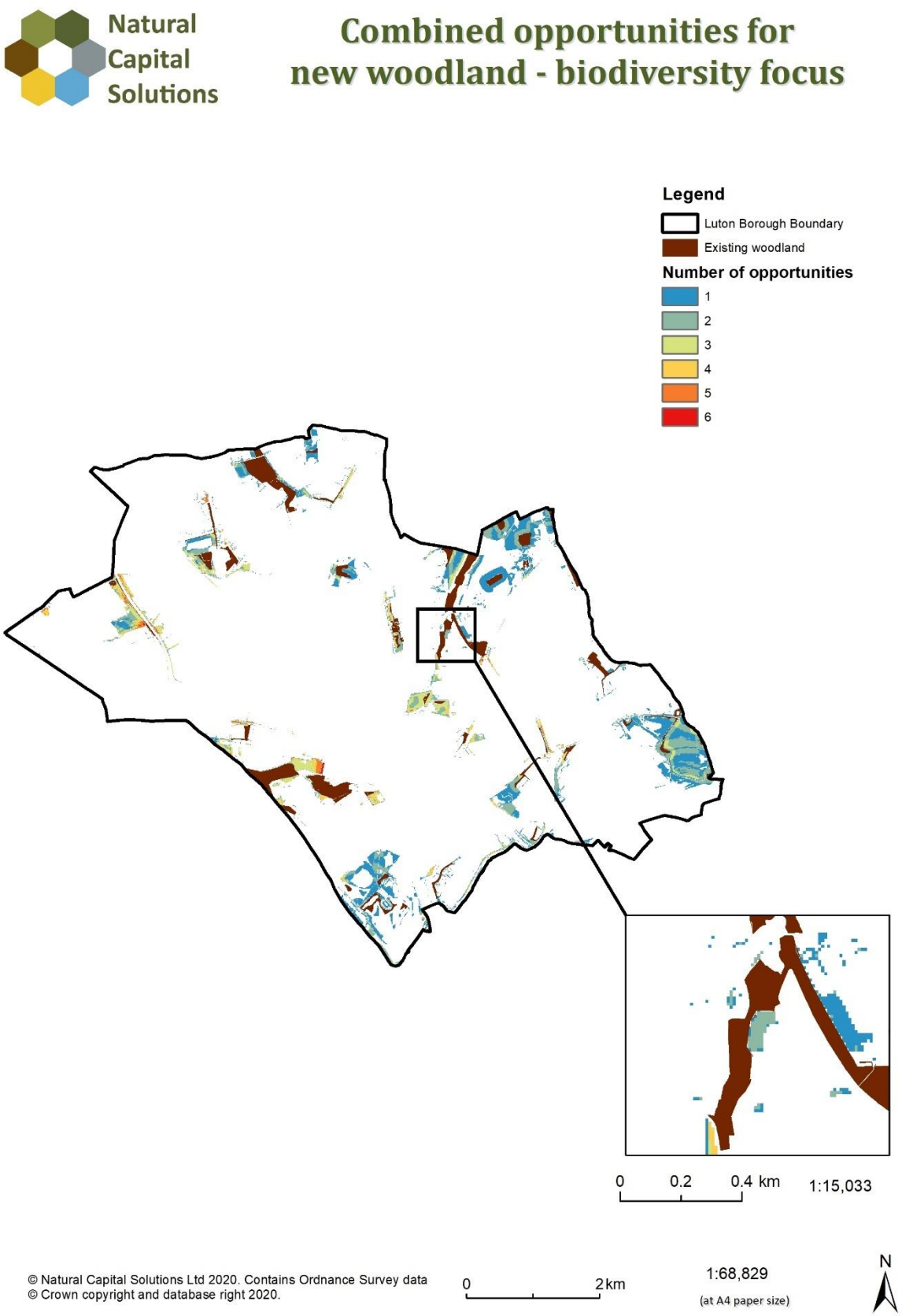

Figure 41 Combined opportunities for new woodland across Luton Borough, restricted to areas that are ecologically connected to existing woodlands.

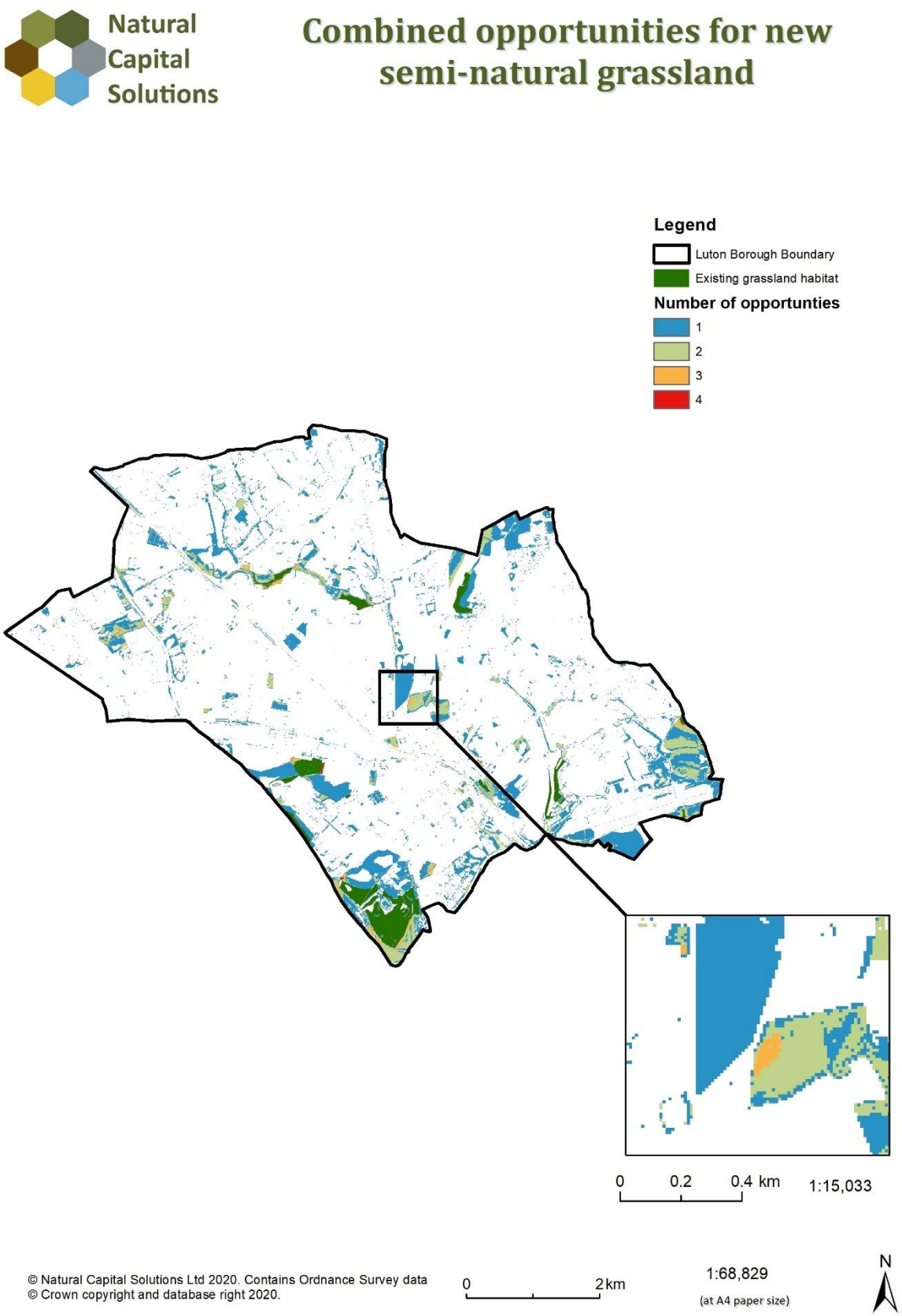

Figure 42 Existing semi-natural grasslands, and combined opportunities for new grasslands, across Luton Borough.

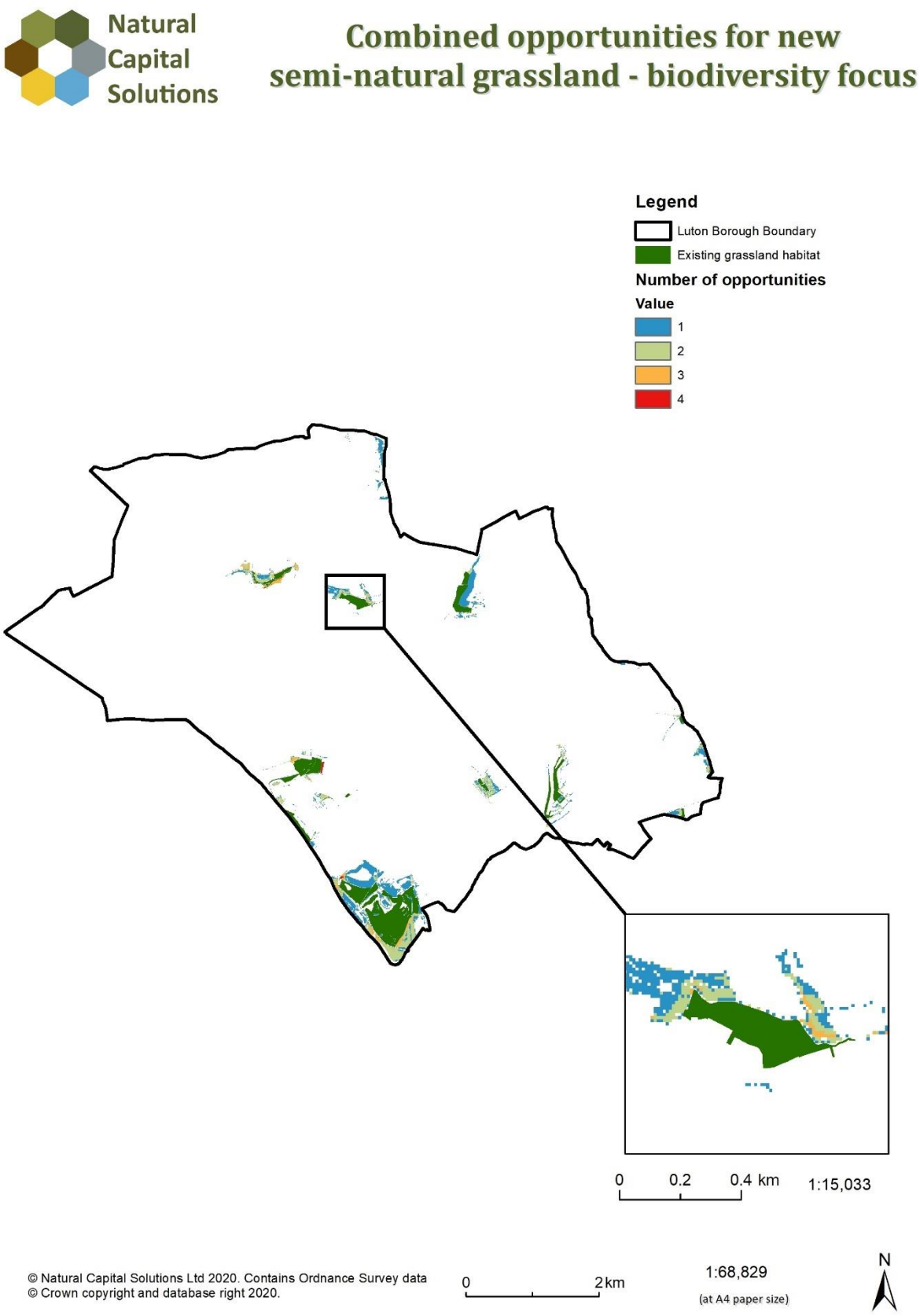

Figure 43 Combined opportunities for new semi-natural grasslands across Luton Borough, restricted to areas that are ecologically connected to existing grasslands.

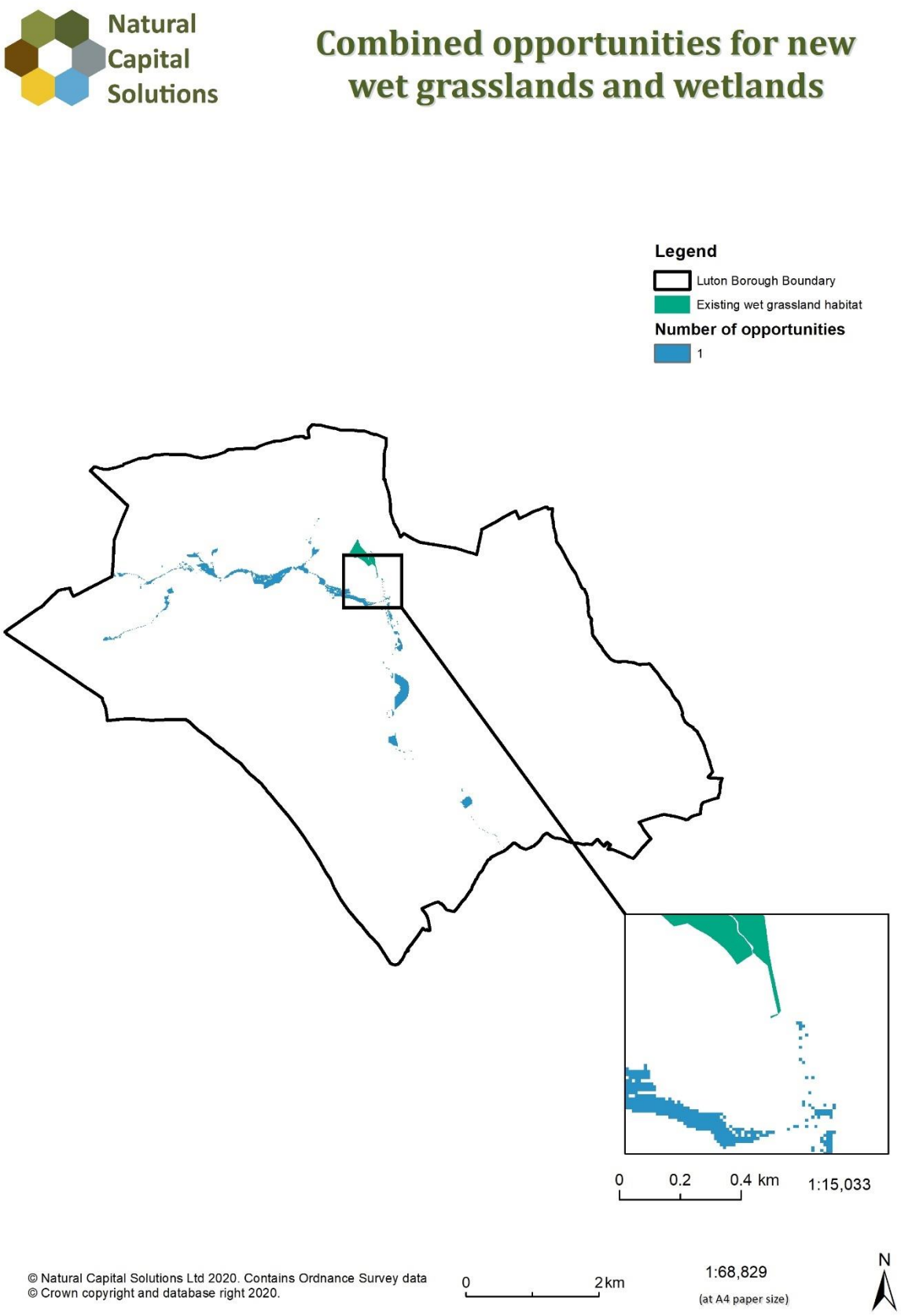

Figure 44 Existing wet grasslands and wetlands, and combined opportunities for new wetlands, across Luton Borough.

8. Conclusions

This project has produced a detailed habitat basemap using the best available data to assign Phase 1 habitat types to each plot of land and building across Luton Borough (and for the whole of Bedfordshire). It provides the most comprehensive and detailed coverage that is possible at this time and should have a wide range of applications. Luton Borough is dominated by built-up areas, infrastructure and gardens, taking up a combined 70.5% of the land area, but there are also extensive areas of amenity grassland (14.2%). Tree and woodland categories take up just 4.5% of the Borough.

The ecosystem service maps demonstrate the spatial pattern of provision of ten different ecosystem services, and the demand for four. The maps demonstrate that the woodland asset is important for high levels of provision of carbon storage, carbon sequestration, air quality, noise, local climate, and water flow regulation and timber/woodfuel production benefits. All accessible greenspaces are also important for access to nature and a range of other benefits for Luton's residents.

The demand maps of air quality, noise, local climate regulation and accessible nature show clearly the high demand for ecosystem service delivery across Luton Borough. Dense urban areas adjacent to the road network are hotspots for demand.

The monetary value of the benefits provided by natural capital are large, even in such an urbanised location: £27.2 million per annum across Luton Borough, representing an asset value (present value) of £810 million over 50 years. Benefits in terms of recreation, physical health, and air quality regulation are particularly large.

An assessment of Accessible Natural Greenspace Standards (ANGSt) has shown that Luton Borough has a reasonably good provision of greenspaces. All residents across the Borough live within 2km of a 20 ha site and within 5km of a 100 ha site. However, only 68% of people live within 300m of a small greenspace (at least 2ha in size) and communities that do not live close to a small greenspace tend to have higher levels of deprivation. There are no large greenspaces over 500 ha in size in the area. Creating new accessible greenspaces should therefore focus on creating small neighbourhood greenspaces, especially in the town centre and other more deprived areas.

Habitat opportunity maps have been created showing where new habitats could be created for biodiversity enhancement for three broad habitat types, as well as for six different ecosystem services. Note, however, that the maps have not been ground-truthed or checked against other data, and so individual locations will need to be assessed further before being taken forward. The maps should be considered as a resource to highlight potential locations for habitat creation or restoration projects, rather than as an end in themselves. The maps are best examined on a Geographic Information System, and GIS layers have been provided.

The opportunity maps for biodiversity highlight areas that are best located in terms of their connectivity with existing habitat patches and are, therefore, most appropriate from an ecological point of view. Enhancing connectivity and expanding habitat networks is a key priority for biodiversity conservation and climate change adaptation at present, and these maps can be used as the basis for creating nature recovery networks across the county. They also highlight areas where biodiversity offsetting should be focussed, under the new requirement to achieve biodiversity net gain for all new developments. Furthermore, the opportunity maps for ecosystem services highlight the best areas to create habitats to enhance the delivery of each ecosystem service in turn, based on where demand is high and capacity is currently low. These can be used to identify project locations to meet each particular need or can be

combined to show areas where new habitat can deliver multiple objectives. If combined with the biodiversity opportunity maps, they can be used in offsetting project to deliver additional benefits. Access to greenspace for people can be highly beneficial for physical and mental health and well-being and the monetary value of these benefits can be extremely high. Habitats for biodiversity and green infrastructure (GI) in general can also make important contributions to all the other ecosystem services mapped in this report. Semi-natural habitats are multi-functional, meaning that an investment focussing on one benefit (e.g. natural flood risk management), can deliver multiple additional benefits, hence offering excellent value for money.

8.1 Next steps

The maps and GIS layers produced for this project provide an extensive evidence base with a wide range of potential applications. The layers can also be combined in a wide variety of different ways, depending on the issue being addressed, the key priorities, and the location. Hence it would be possible to present the results in a number of different ways and there would be merit in producing different outputs for different audiences. There are a number of possible projects that could be developed to take this work forward. These include dissemination of results, mapping habitat quality, refining the most promising areas to take forward, and completion of a Natural Capital Investment Plan. These ideas are described in more detail in the main Bedfordshire report.

Annex 1: Additional biodiversity opportunity maps

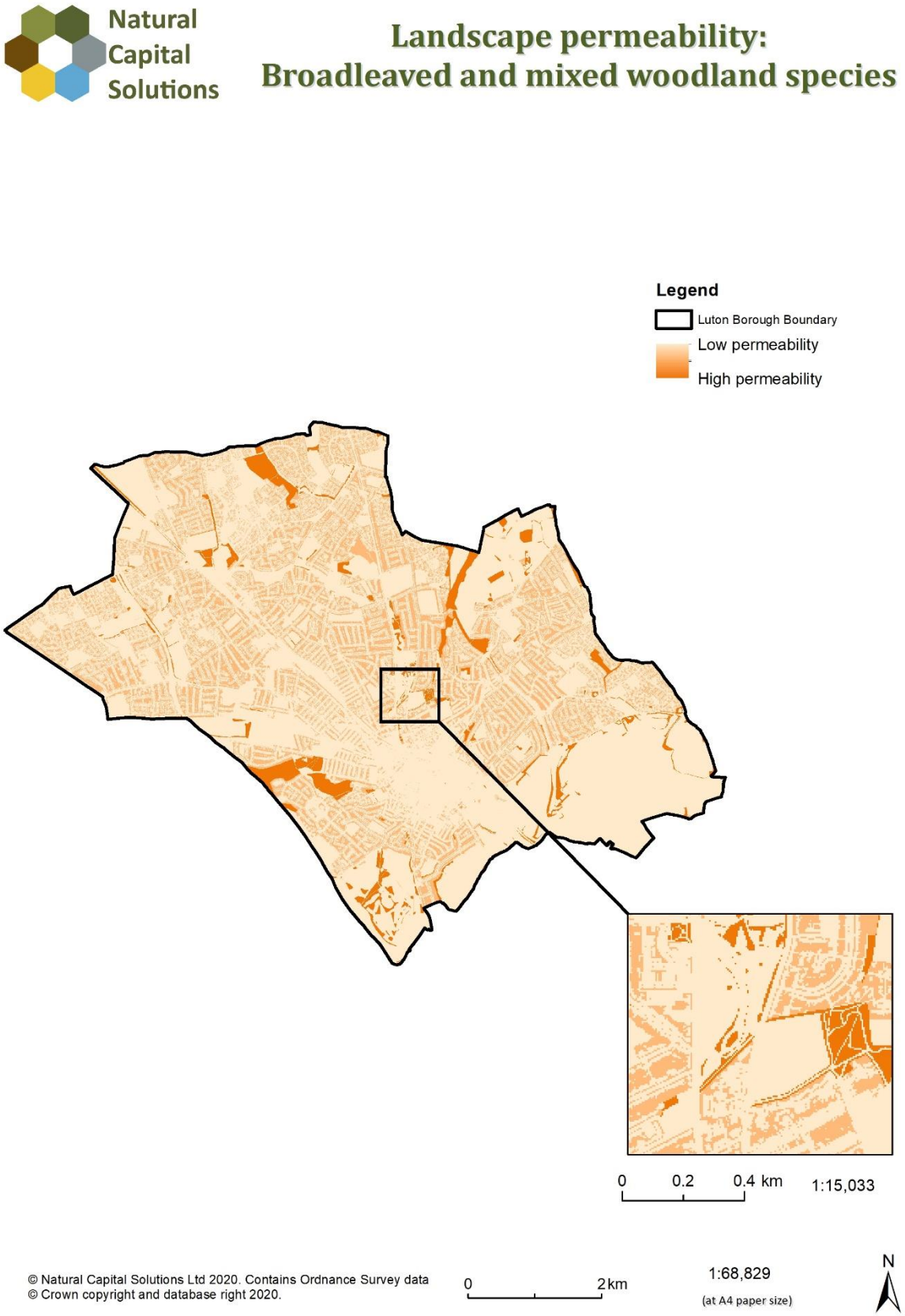

Figure A1 Landscape permeability for typical broadleaved and mixed woodland species across Luton Borough.

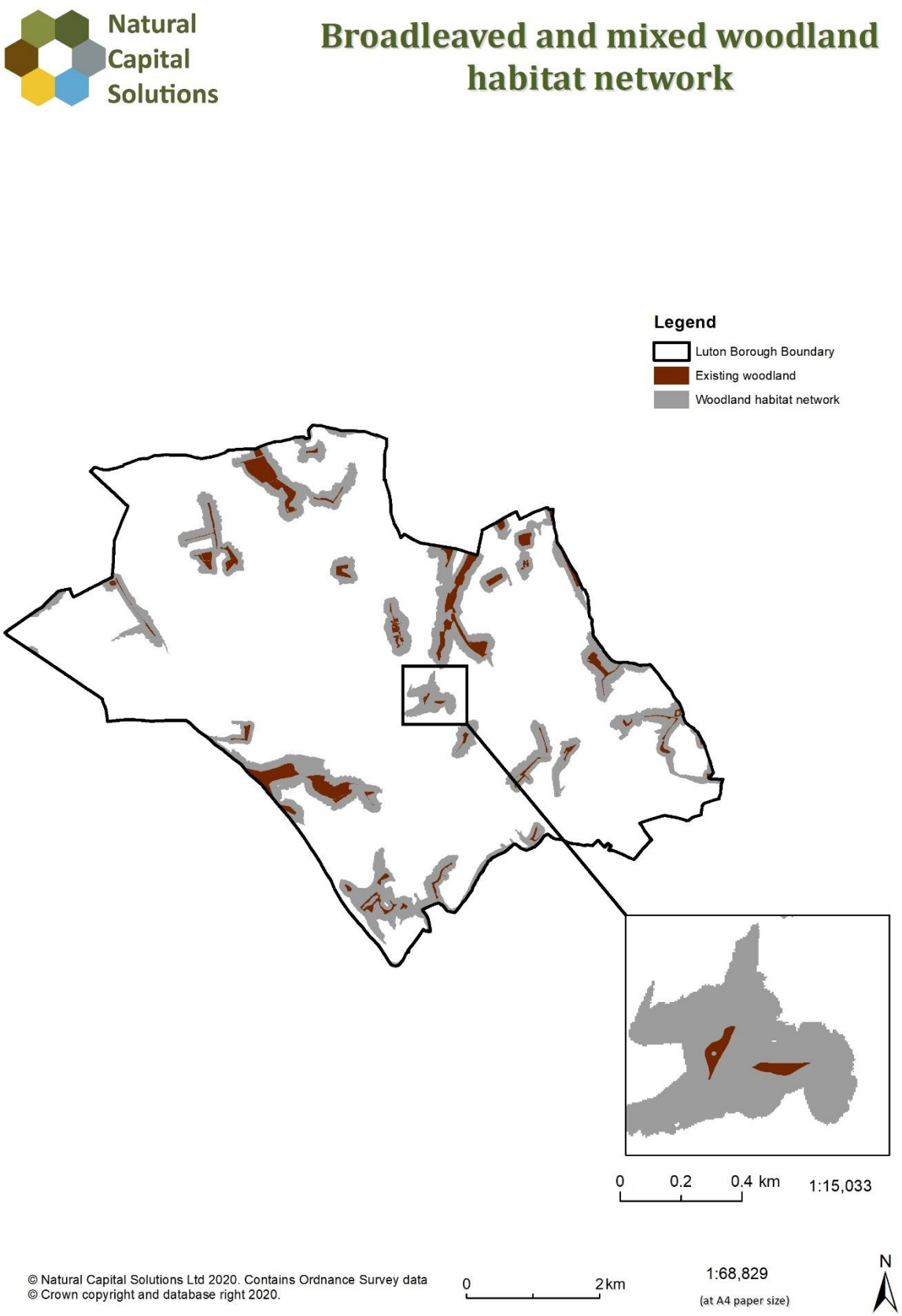

Figure A2 Habitat network for broadleaved and mixed woodlands across Luton Borough.

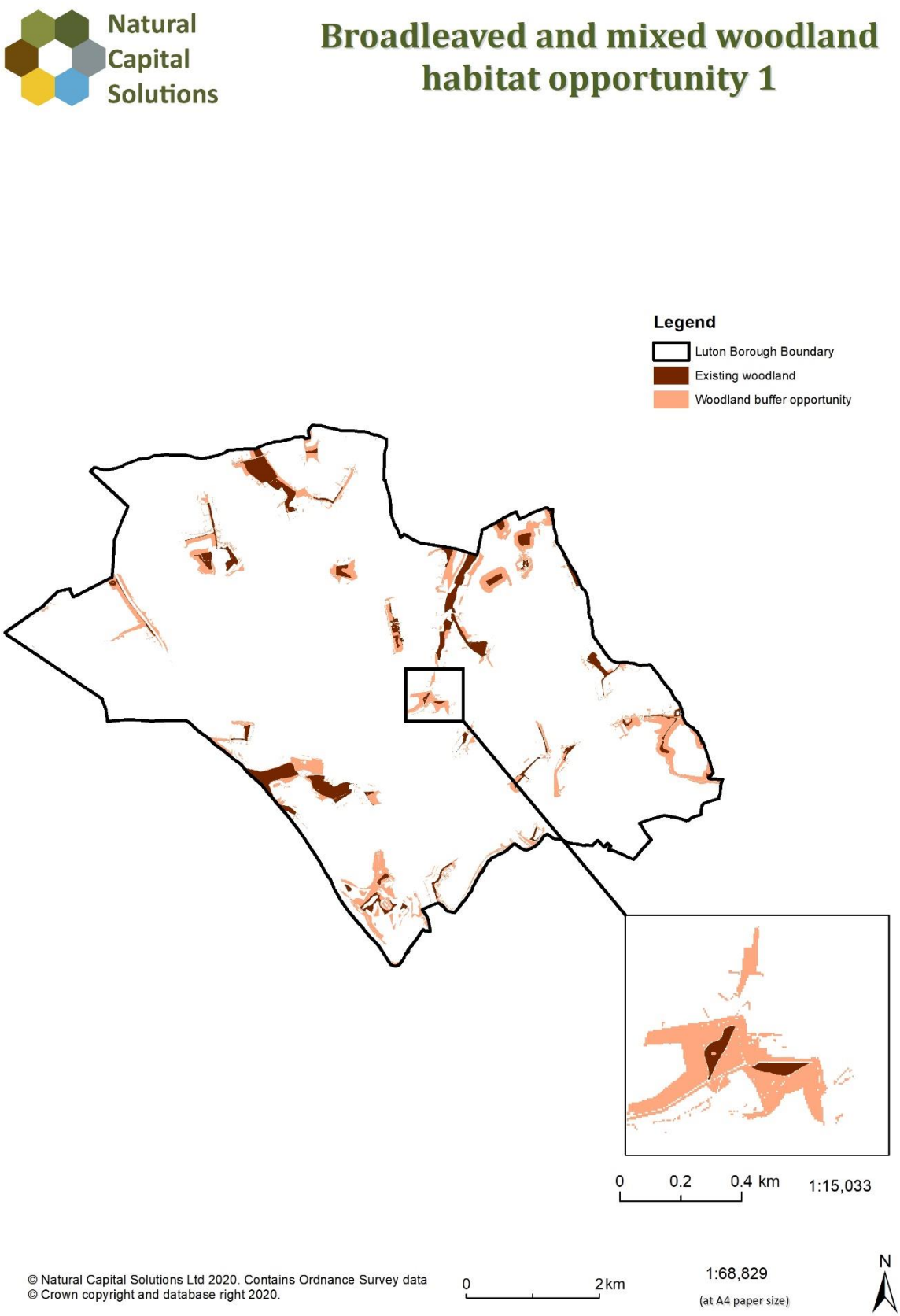

Figure A3 Buffer biodiversity opportunity areas for broadleaved and mixed woodlands across Luton Borough.

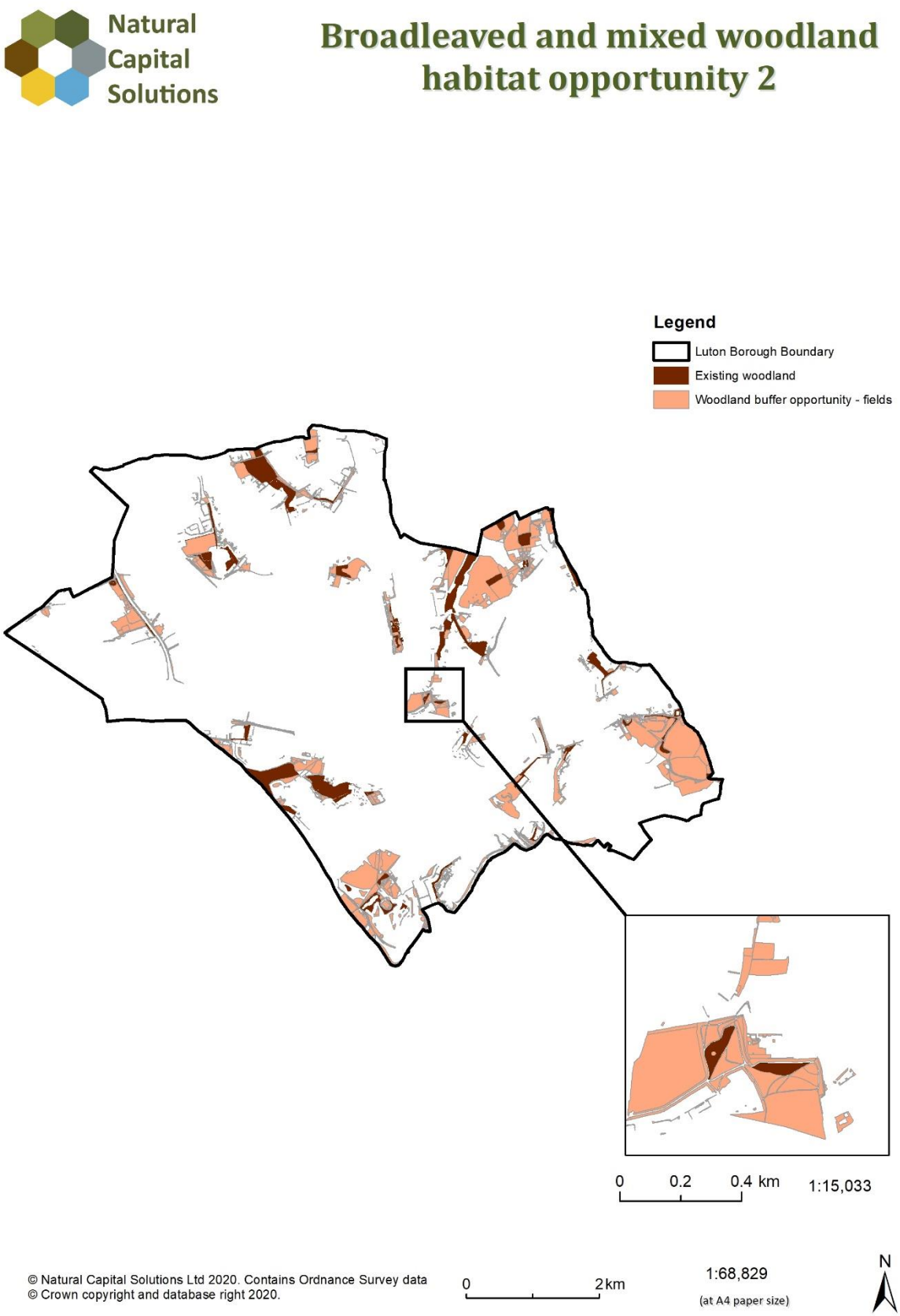

Figure A4 Field scale biodiversity opportunity areas for broadleaved and mixed woodlands across Luton Borough.

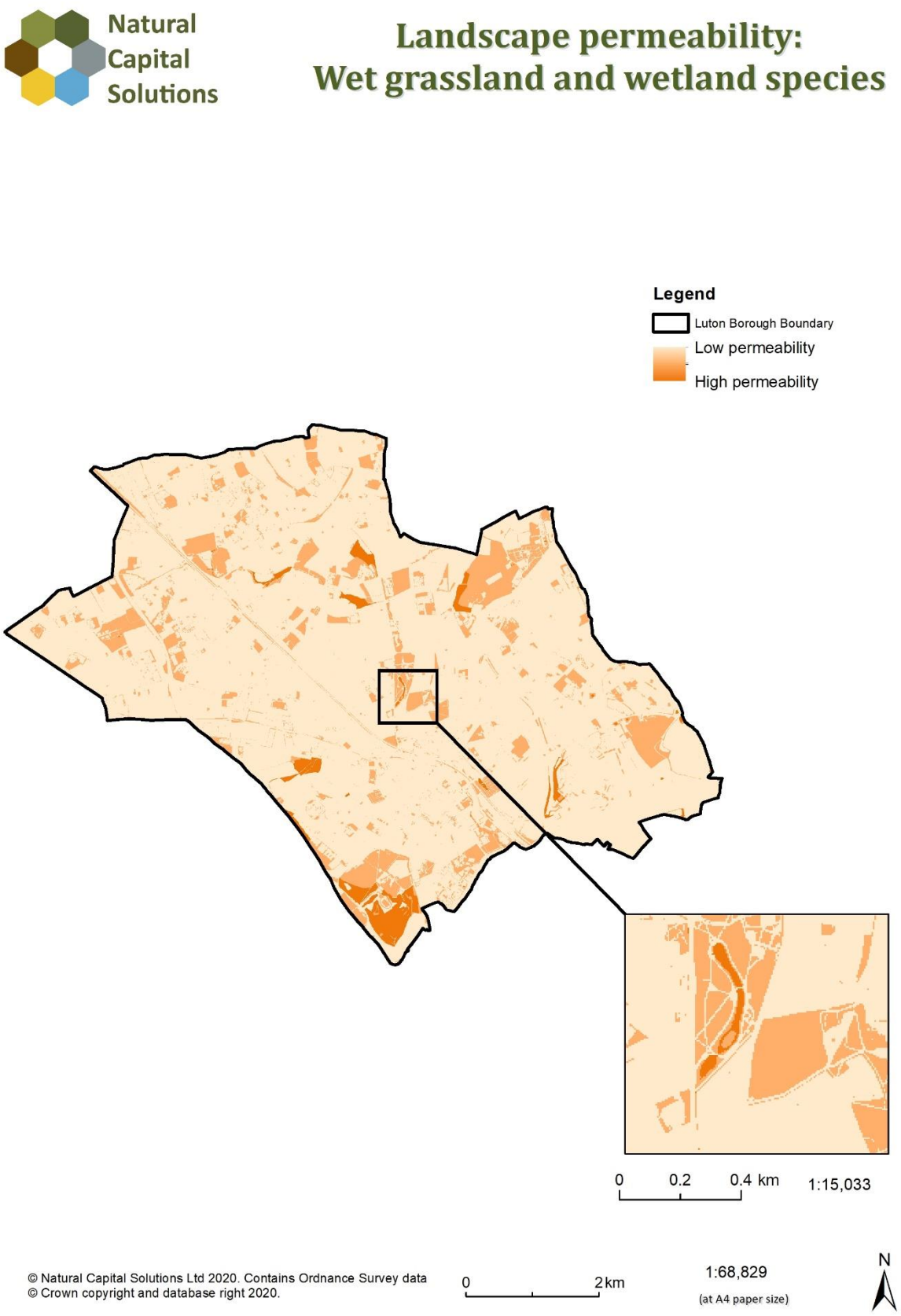

Figure A5 Landscape permeability for typical wet grassland and wetland species across Luton Borough.

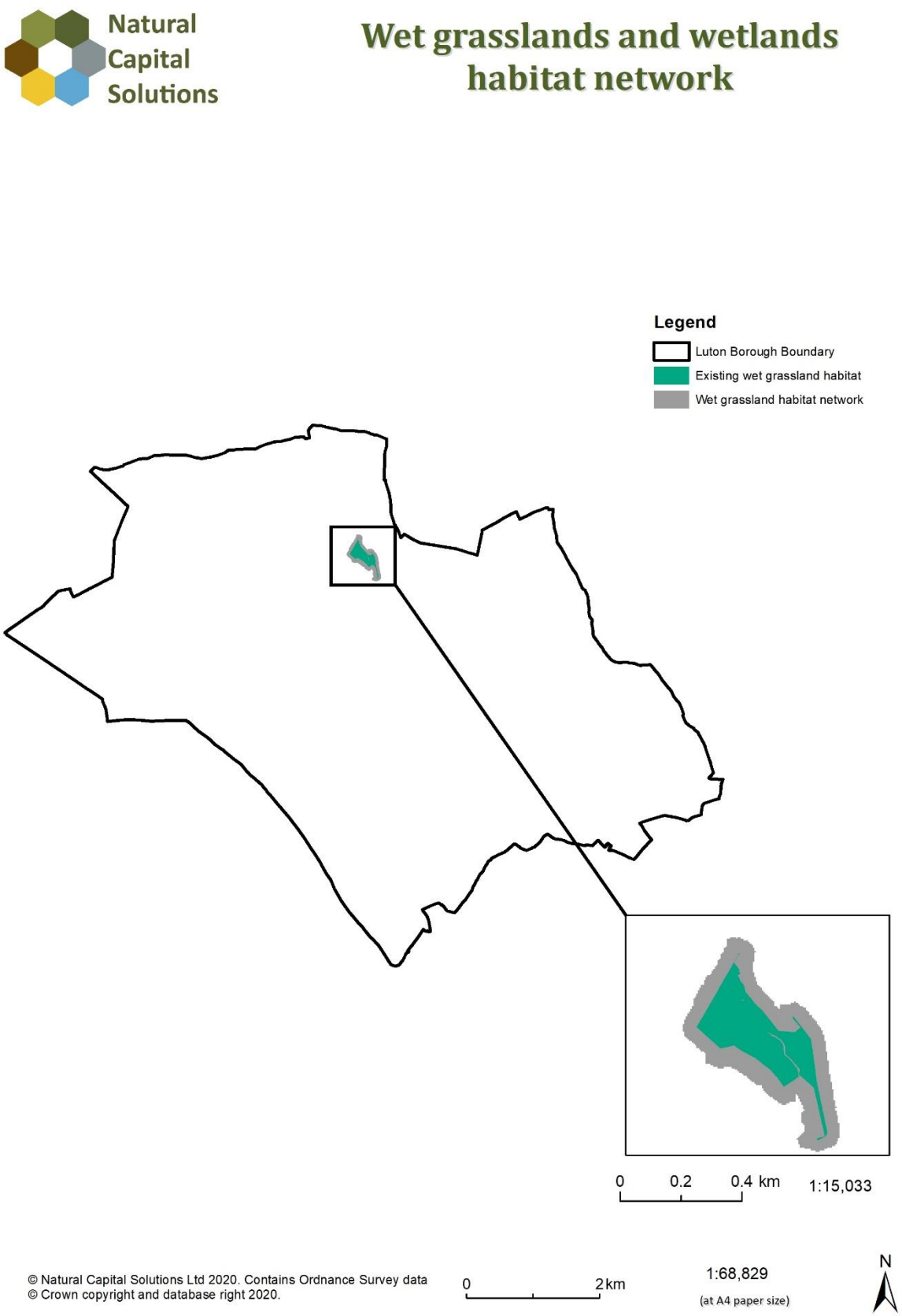

Figure A6 Habitat network for wet grassland and wetlands across Luton Borough.