



ANNEX A1.1

Abstraction Site Selection

This document has been written in line with the requirements of the RAPID gate two guidance and to comply with the regulatory process pursuant to Severn Trent Water's and Affinity Water's statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, Severn Trent Water and Affinity Water will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.



Affinity Water Limited

GRAND UNION CANAL

Annex A1.1 Gate 2 Position Paper – Abstraction
Site Selection





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Selection

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Annex A1.1 Gate 2 Position Paper – Abstraction Site
Selection

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EXECUTIVE SUMMARY

The supply deficit in Affinity Water Limited (AWL) Central Region will arise from a combination of abstraction licence reductions agreed to help preserve the regional water environment and additional demand from forecast increased population. The deficits are forecast to be most significant in the northern part of the Central Region, to the north and northwest of London.



The Grand Union Canal (GUC) Strategic Resource Option (SRO) is proposed to take benefit from a potential discharge of treated effluent from Severn Trent Water's (STWL) Minworth Wastewater Treatment Works (WwTW) into the GUC, and to transfer the additional resource using Canal & River Trust (the Trust's) assets.

Nine options were considered for the abstraction, treatment, and injection of transferred flow into the AWL network at Gate 1. Following appraisal, four options were taken forward for further consideration at Gate 2.

This position paper summarises the process of further investigation of the four candidate sites (Leighton Buzzard, Tring, Hemel Hempstead, and Grove), along with the associated options for connecting them to the existing AWL distribution system, to determine the preferred option for detailed assessment.

The detailed assessment of the preferred option is covered in a separate report (Annex A1 Concept Design Report - dated October 2022).

The preferred option taken forward is an abstraction and treatment works at Leighton Buzzard with a transfer of potable water from this site to the existing AWL water storage site at Chaul End for further distribution.

1 INTRODUCTION

1.1 BACKGROUND

This position paper relates to the selection and appraisal of potential sites for the abstraction, treatment, and injection into supply of additional water resources supplied from the Grand Union Canal (GUC) Strategic Resource Option (SRO).

The GUC SRO is one of the potential options that may be used alone, or in combination with other SROs, to resolve the forecast supply deficit facing AWL over the medium to long term; and involves conveying water from Minworth Wastewater Treatment Works (WwTW) near Birmingham to the AWL supply area, utilising the GUC. The preferred route selection for the GUC is discussed in the 'Grand Union Canal - Gate 2 Position Paper, Route Selection, ref Annex A1.2, October 2022'¹.

Nine site options were considered for the abstraction, treatment, and injection of additional water resources into the AWL network at Gate 1. These nine options were appraised using a process documented in Grand Union Canal Gate 1 Report. The appraisal was based on selecting a series of sites against a few high-level criteria including proximity to existing high-capacity transmission mains in AWL's system, strategic benefit of the water in terms of being capable of simple direction into an area of predicted shortfall, availability of sufficient space for the works, proximity to flood plain, potential for conflict with areas reserved for HS2. The potential sites were then screened against strategic value, geological constraints, environmental and planning constraints, and a ranking of the sites carried out based solely on constraints and risks.

The sites were then further assessed against headline costs and carbon budgets to allow further testing of the preferred sites to confirm that the selection was not markedly affected by these high-level assessments.

Following appraisal, it was recommended in the 'Gate 1 Report'² that the following four options should be taken forward for further consideration at Gate 2:

- Hemel Hempstead (Option 2)
- The Grove (Option 3)
- Tring (Option 4), and
- Leighton Buzzard (Option 5)

These sites are described in further detail below.

The Gate 1 review also determined that the preferred point for AWL to manage the distribution of water into supply is from their existing site at Chaul End.

¹ Document Reference: Annex A1.2 Gate 2 Position Paper – Route Selection , October 2022

² Document Reference: Grand Union Canal (GUC) Gate 1 Report

Although the conclusion of the Gate 1 report was that the Leighton Buzzard site had more advantages than the other sites the differentiation was not so significant that the site was an automatic choice. For example:

- There was only a 1% difference in estimated OPEX cost between Leighton Buzzard and Tring and only a 17% difference in their CAPEX costs. There was a similar but slightly higher difference between Leighton Buzzard and Hemel Hempstead costs. At Gate 2, further assessment, to verify the assumptions and risks used to generate costs and therefore the lead site, was required.
- The site assessment aim at Gate 1 was to reduce the number of sites down to a manageable number for discussion with and gain feedback from key stakeholders. Following this feedback the candidate sites would require re-assessment to confirm ranking.
- The Gate 1 assessment process looked at several key constraints (e.g. geological, environmental, carbon, system connectivity etc.). The assessment of these constraints was based on a standard layout for abstraction, treatment, and pipeline structures. However, at Gate 2 these assumptions would need review to see if alternatives would change the site ranking.

The purpose of this position paper is to take the candidate sites from the Gate 1 appraisal (Leighton Buzzard, Tring, Hemel Hempstead, and Grove) and confirm the ranking before undertaking more detailed assessment only on the preferred site.

The selection process undertaken to assess the transfer routes is considered in a separate document. (Ref Annex A1.2Gate 2 Position Paper – Route Selection)

The position paper has the following structure:

- Section 2: Abstraction Site and Route Option Selection Approach
- Section 3: Abstraction Site Comparison
- Section 4: Abstraction Transfer Route Comparison
- Section 5: Summary

1.2 OPTIONS SUMMARY

For this position paper, the following five options (4 options and one sub-option) have been considered for the new abstraction sites and connections into the existing AWL network:

- Leighton Buzzard to Chaul End Water Supply Reservoir (WSR).
- Leighton Buzzard to Boxted WSR and then Chaul End WSR.
- Tring to Boxted WSR and then Chaul End WSR.
- North-west of Hemel Hempstead to Boxted WSR and then Chaul End WSR.
- The Grove to Abbot Langley WSR.

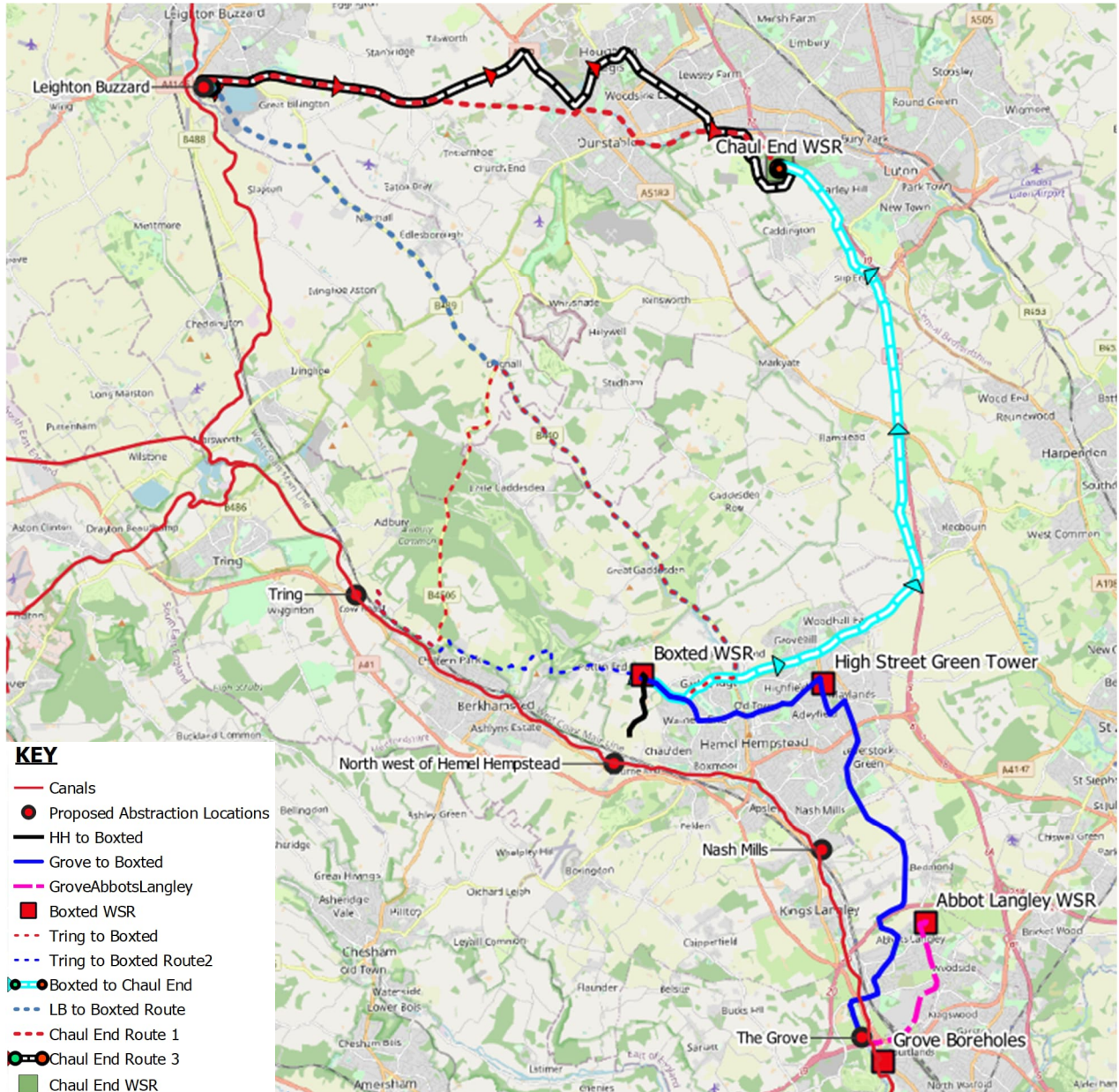


Figure 1-1 – Layout showing locations of Gate 2 proposed abstraction locations, AWL Water Supply Reservoirs and indicative alignment of transfer routes



The appraisal and selection of the short list of abstraction sites which has been described in this paper is described in the Gate 1 Report.

A summary of the components that make up these options is provided in Table 1-1. Further details with regards to the description of the options can be found in subsequent sections.

Table 1-1 – Abstraction Site and Transfer routes – Summary

Option components		Leighton Buzzard to Chaul End WSR Southern and Northern Routes	Leighton Buzzard to Chaul End WSR (via Boxted)	Tring to Chaul End WSR (via Boxted) Southern and Northern Routes	Hemel Hempstead to Chaul End WSR (via Boxted)	The Grove to Abbots Langley WSR and on to Chaul End
Abstraction sites	Leighton Buzzard	Red	Red	Red	Blue	Blue
	Tring	Blue	Blue	Blue	Red	Blue
	North West of Hemel Hempstead	Blue	Blue	Blue	Red	Blue
	The Grove	Blue	Blue	Blue	Blue	Red
Transfer Route Components	Chaul End Route 1 (Southern)	Red	Blue	Blue	Blue	Blue
	Chaul End Route 3 (Northern)	Blue	Red	Blue	Blue	Blue
	Chaul End – Boxted	Blue	Blue	Red	Blue	Blue
	Tring – Boxted Route 1 (Northern)	Blue	Blue	Blue	Red	Blue
	Tring – Boxted Route 2 (Southern)	Blue	Blue	Blue	Blue	Red
	Hemel Hempstead - Boxted	Blue	Blue	Blue	Blue	Red
	Boxted – Chaul End	Blue	Blue	Red	Red	Red

Option components		Leighton Buzzard to Chaul End WSR Southern and Northern Routes	Leighton Buzzard to Chaul End WSR (via Boxted)	Tring to Chaul End WSR (via Boxted) Southern and Northern Routes	Hemel Hempstead to Chaul End WSR (via Boxted)	The Grove to Abbots Langley WSR and on to Chaul End
	Grove – Abbots Langley					
WSR	Chaul End					
	Abbots Langley					

1.3 DESCRIPTION OF OPTION: LEIGHTON BUZZARD TO CHAUL END WATER SUPPLY RESERVOIR

Leighton Buzzard Abstraction Site

The potential site for the Leighton Buzzard abstraction (X: 49[REDACTED], Y: 22[REDACTED]) is located to the south of the A416 adjacent the active quarry (Gravebury Quarry) and the River Ouzel. The Grand Union Canal is located to the other side of the river, to the west, from the proposed location. Road access can be obtained via the existing roundabout access to the quarry. The abstracted water will pass via the raw water storage reservoir to the treatment works and then on towards the AWL distribution system.

The connection from the Canal to this area will require the installation of a pipe under the River Ouzel. See Figure 1-2

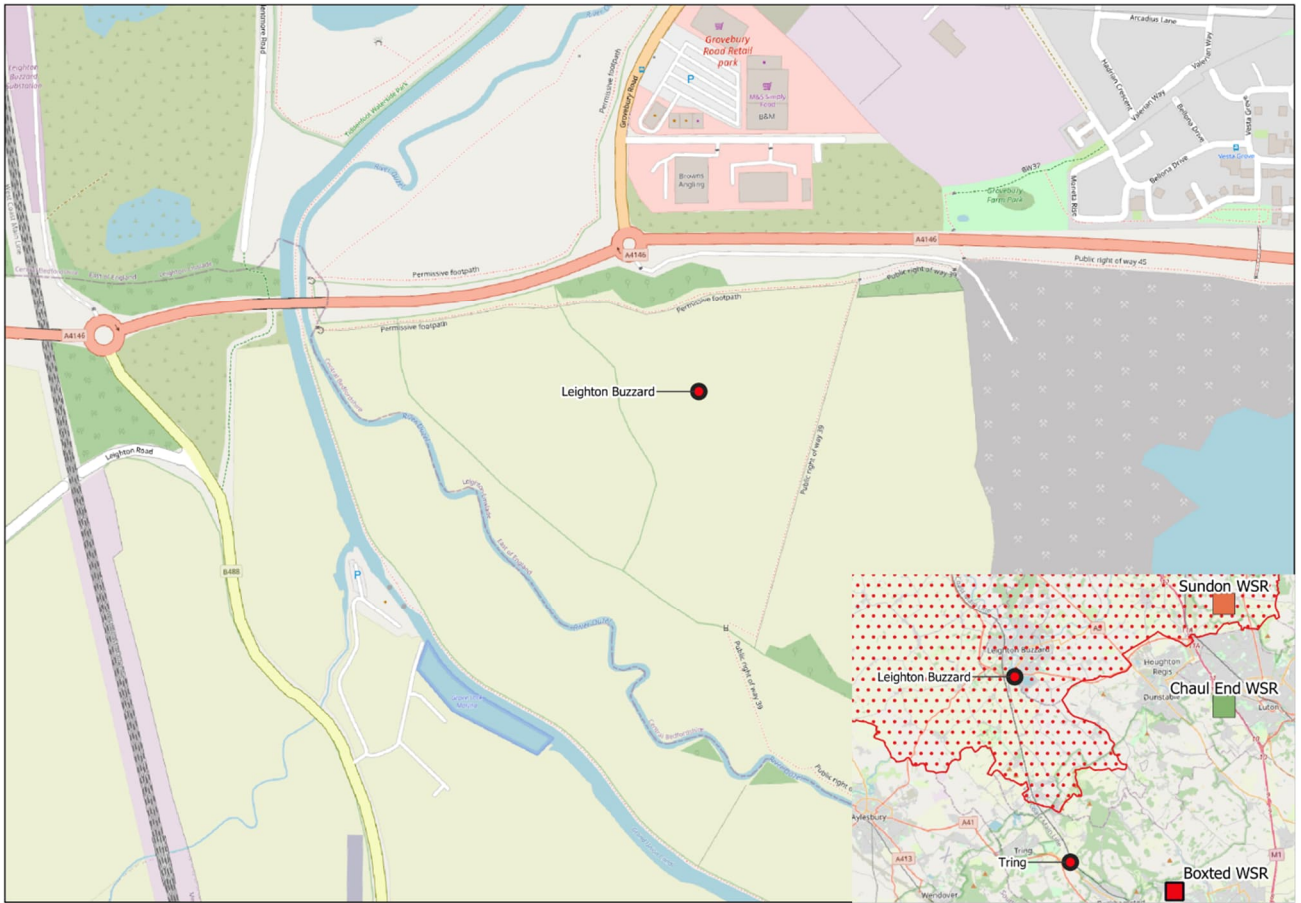


Figure 1-2 - Site location map showing the location of the potential site near Leighton Buzzard

Pipeline route from Leighton Buzzard to Chaul End Water Supply Reservoir

The nearest reservoir to this location is Chaul End Water Supply Reservoir (WSR), located approximately 14.5km east of the proposed site (requires 18.8km rising main), with a level difference of around 90-100m from the Leighton Buzzard site to Chaul End. AWL have confirmed their assessment that Chaul End WSR will be the most useful site from which to manage water into supply. This finding has come from AWL’s Connect 2050 strategy study which examines the supply demand balance at a network demand level up to 2050 and considers the best options to meet the forecast deficits.

Two potential routes were shortlisted, from five viable routes that were identified, between Leighton Buzzard and Chaul End WSR:

- Chaul End Route 1 (Southern route) – approximately 16km in length; and
- Chaul End Route 3 (Northern route) – approximately 20km in length.

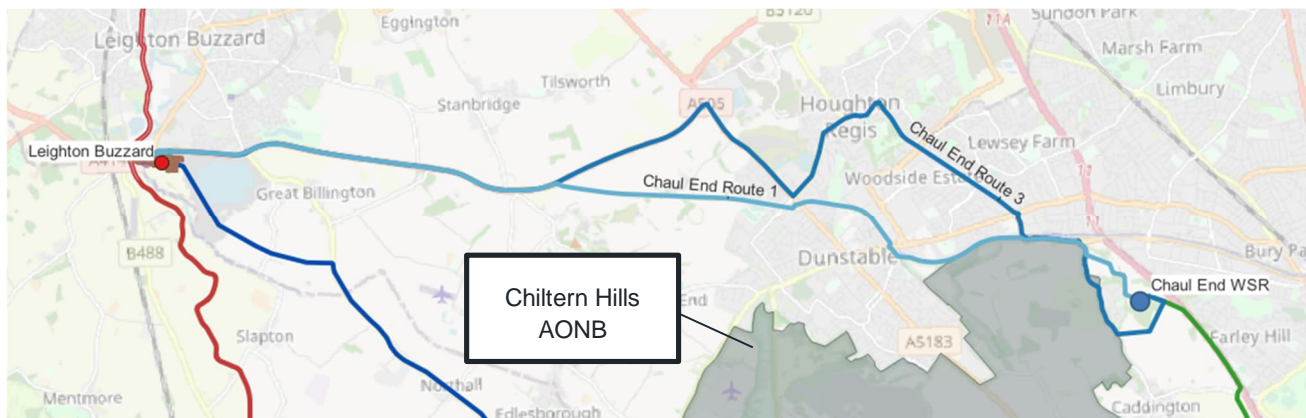


Figure 1-3 - Site location map showing the alignment of the two potential transfer routes between Leighton Buzzard and Chaul End WSR

The two routes share the same alignment along the A505 towards Houghton Regis for approximately the first 6km. The routes bifurcate where the Sustrans National Cycle Network Route (NCNR) 6 cycleway crosses the A505.

Chaul End Route 3 continues along the A505 and through the centre of Houghton Regis. Chaul End Route 1 avoids the town centre by following the greenway of Sustrans NCNR 6 and 606. They rejoin for approximately 750m, before taking different routes into Chaul End WSR.

Except for a very short length of Chaul End Route 3, the extent of the routes is outside the boundary of the Chiltern Hills AONB.

A high-level analysis of other potential routes has been carried out as part of an assessment of an alternative scoring methodology to provide support to the selection process. The outcome of this case study is summarised in a separate technical note (see Gate 1 Report) Description of Option: Leighton Buzzard to Chaul End Water Supply Reservoir, Via Boxted

Leg 1: Pipeline route from Leighton Buzzard to Boxted Water Supply Reservoir

An alternative to connecting directly to Chaul End WSR would be to connect to Boxted via a first leg of pipeline in the order of 23.5km in length, then transfer the water onto Chaul End WSR via a second leg of pipeline in the order of 20km in length. This option would allow additional flexibility to provide water to both Chaul End and Boxted and add some resilience to the system.

Only one variation of this option has been considered at Gate 2.

Except for the first few km at either end, the first leg of the route between Leighton Buzzard and Boxted generally runs up the valley between the Chiltern Hills, following the alignment of the B440 towards the south-east. It then loops towards the west, running through the residential area of Gadebridge before entering the Boxted WSR at Potten End.

Leg 2: Pipeline route from Boxted to Chaul End Water Supply Reservoir

As confirmed with AWL review of distribution strategy, distribution from Boxted south is straight forward but redirecting northwards in existing infrastructure to Chaul End has limitations. The existing infrastructure is already frequently fully loaded and is likely unable to accept any additional flow. Therefore, until confirmed by AWL modelling, it is assumed a new connection to increase the

transfer between to the two sites is required. The second leg of the pipeline to Chaul End WSR, follows the incoming pipeline route up until the A4146. The pipeline then crosses the River Gade, running along the B487 north-eastwards. The pipeline would then run on the eastern side of M1 in a north-westerly direction past the Pepperstock junction 10 to Chaul End WSR.

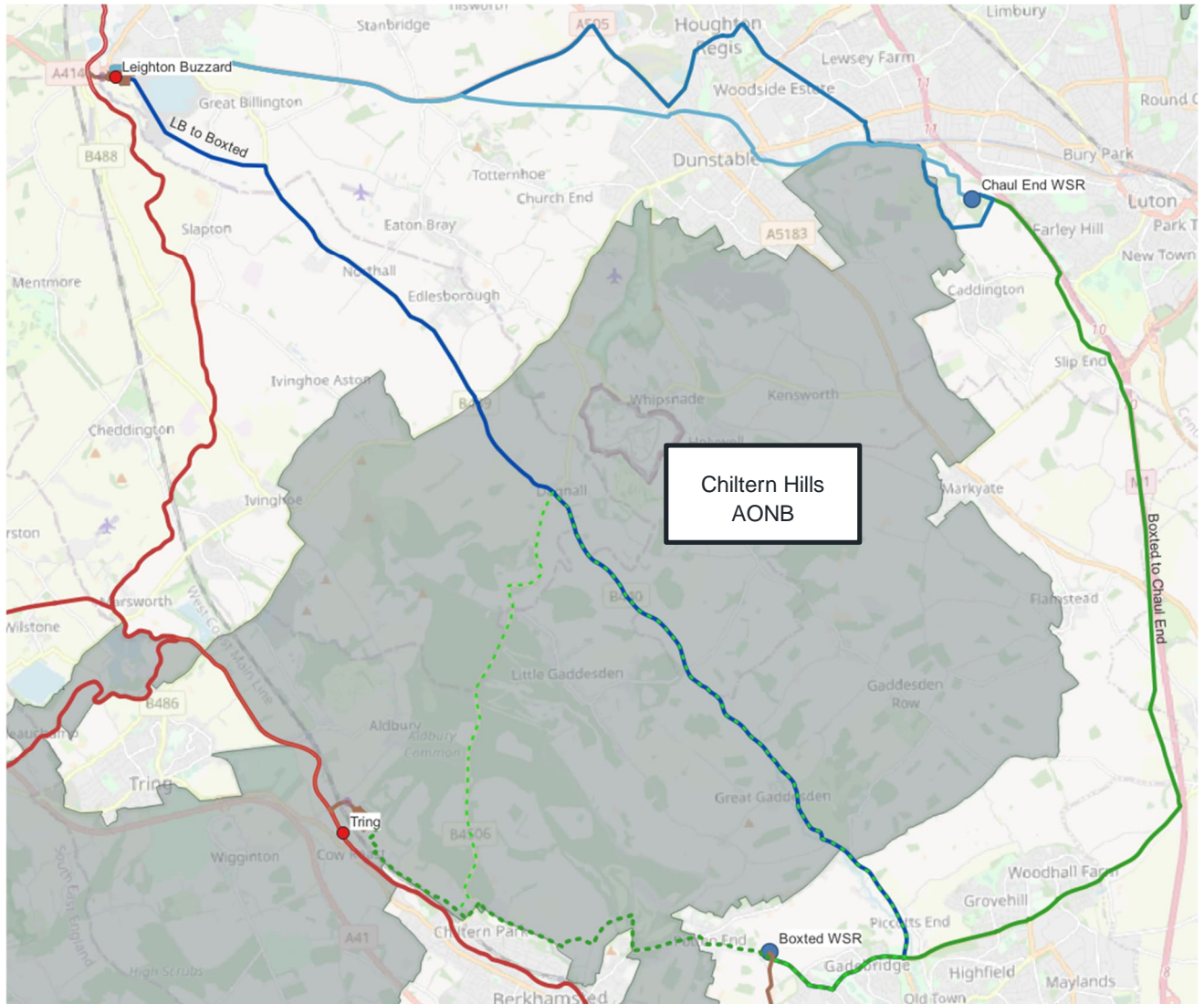


Figure 1-4 - Site location map showing the alignment of potential transfer route from Leighton Buzzard to Boxted WSR (leg 1) and then onto Chaul End WSR (leg 2)

1.4 DESCRIPTION OF OPTION: TRING TO CHAUL END WATER SUPPLY RESERVOIR VIA BOXTED WSR

Tring Abstraction Site

The potential site for the Tring abstraction (X:49█, Y:21█) is located north of Cow Roast Marina, and to the east of the West Coast Main Line. The Grand Union Canal is located to the other side of the railway from the proposed location. The abstracted water will pass via the raw water storage reservoir to the treatment works and then on towards the AWL distribution system.

Routing via Boxted provides a similar level of flexibility and system resilience as the Leighton Buzzard to Chaul End via Boxted option. The connection from the Canal to this area will require the installation of a pipe under the West Coast Main Line.

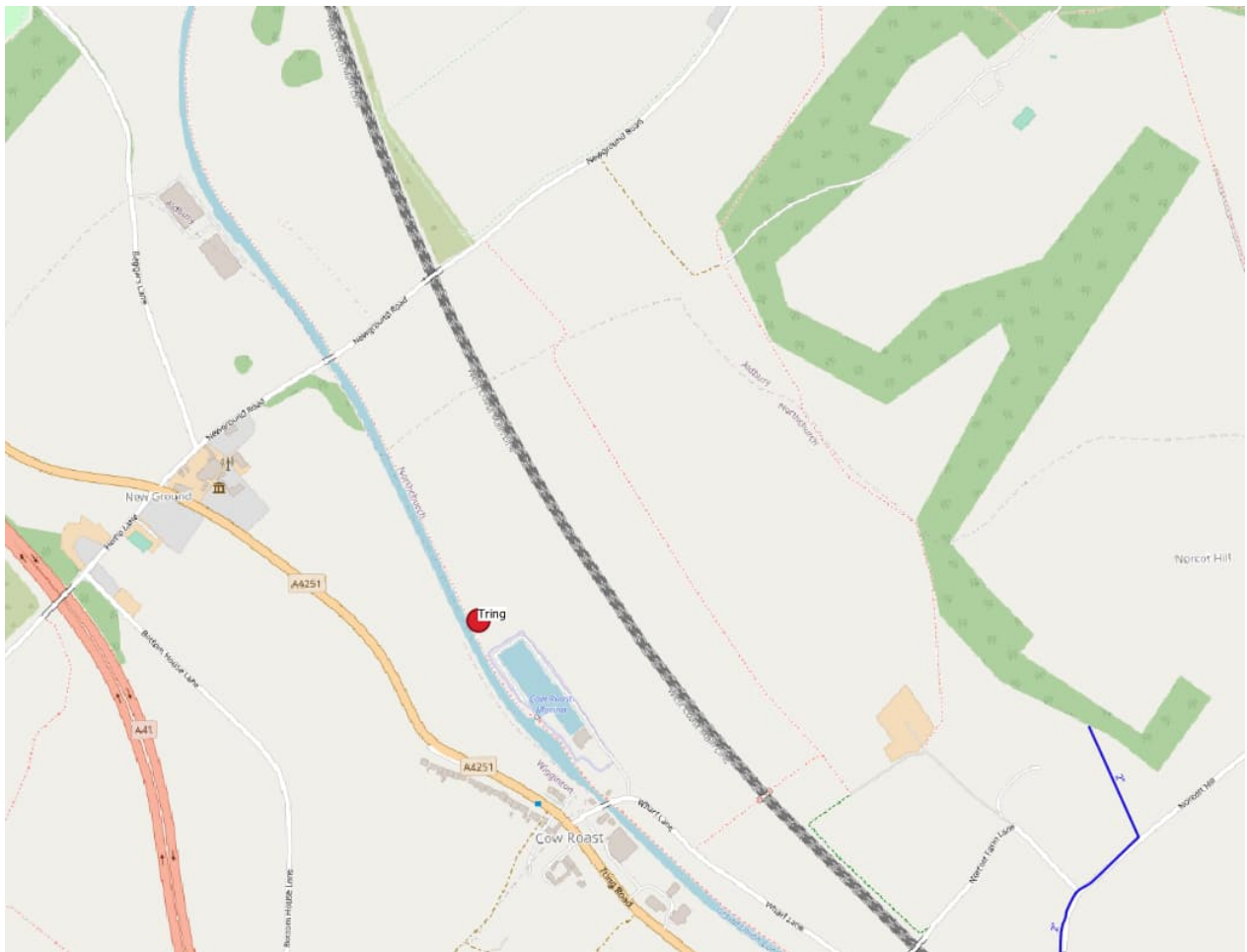


Figure 1-5 - Site location map showing the location of the potential site near Tring

Leg 1: Pipeline route from Tring to Boxted

The nearest reservoir to Tring is Boxted Reservoir, located approximately 7km east of the proposed site, with a level difference of around 30-40m from the Tring site to Boxted. The flow would then be transferred to Chaul End for network distribution.

Two potential routes have been identified between Tring, Boxted WSR and Chaul End WSR:

- Tring to Boxted Route 1 (Northern route). This route follows the BB4506 and B440 thereby minimising any disturbance in the Chilterns Hills AONB– approximate total length of 43km, including 20km length to Chaul End; and
- Tring to Boxted Route 2 (Southern route) cuts across the Chilterns Hills AONB. This is a more direct route but has greater risks (e.g. planning, permits, environmental assessments etc.) – approximate total length of 29km, including 20km length to Chaul End.

They both follow similar routes for approximately the first 2.5km parallel to the West Coast Mainline along the boundaries of agricultural land and parallel to existing wayleaves until they reach New Road (B4506). At this point they bifurcate.

The northern Route 1 doubles back on itself running to the northwest, following the B4506 along a section of the road that passes through several sites with environmental designations. It then joins with the alignment of the route from Leighton Buzzard to Boxted, which runs along the B440 towards the south-east. It then loops back to the west at the residential area of Gadebridge before entering the Boxted WSR at Potten End.

The southern Route 2 takes a more direct route, along the edge of the Chilterns Hills AONB, in an easterly direction. The route then diverts around the outside of Berkhamstead Hill, avoiding the cricket and golf club, before passing through Potten End then entering the Boxted WSR site.

As illustrated on Figure 1-6, both routes are located within the Chilterns Hills AONB for much of their length.

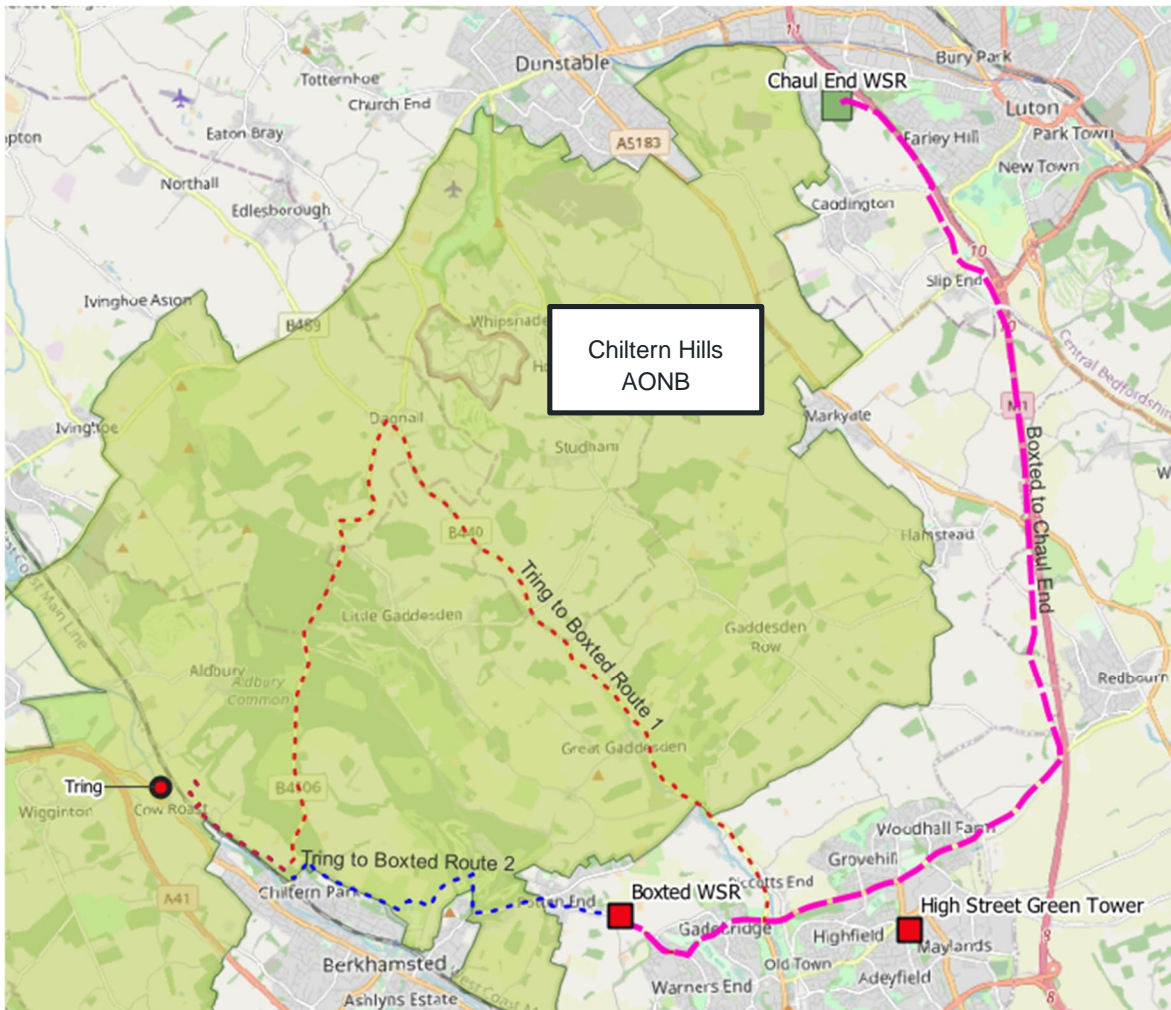


Figure 1-6 - Site location map showing the alignment of potential transfer route from Tring to Boxted WSR (leg 1) and then onto Chaul End WSR (leg 2)

Leg 2: Pipeline route from Boxted to Chaul End Water Supply Reservoir

The second leg of the pipeline to Chaul End WSR, is the same as that from Leighton Buzzard (see Description of Option: Leighton Buzzard to Chaul End Water Supply Reservoir, Via Boxted). The outgoing pipeline route initially leaves the site in a south easterly direction, then changing direction to pass through the area of Gadebridge. At the A4146 the pipeline crosses the River Gade, running

along the B487 north-eastwards. The pipeline would then run on the eastern side of M1 in a north-westerly direction past the Pepperstock junction 10 to Chaul End WSR.

1.5 DESCRIPTION OF OPTION: NORTH OF HEMEL HEMPSTEAD TO CHAUL END WATER SUPPLY RESERVOIR, VIA BOXTED WATER SUPPLY RESERVOIR

Hemel Hempstead Abstraction Site

The potential Hemel Hempstead site (X: 50[redacted], Y:20[redacted]) is located northwest of Hemel Hempstead. The canal runs through the centre of the town parallel to river Bulbourne. North of the potential site location there is open farmland, however, there is limited existing access available to the area. The abstracted water will pass via the raw water storage reservoir to the treatment works and then on towards the AWL distribution system.

The West Coast Main Line railway lies north of the Grand Union Canal in this location and the pipeline from to the potential site will need to cross the railway.

The potential site is located north of the West Coast Main Line and Grand Union Canal and slopes generally southwards towards the Canal.

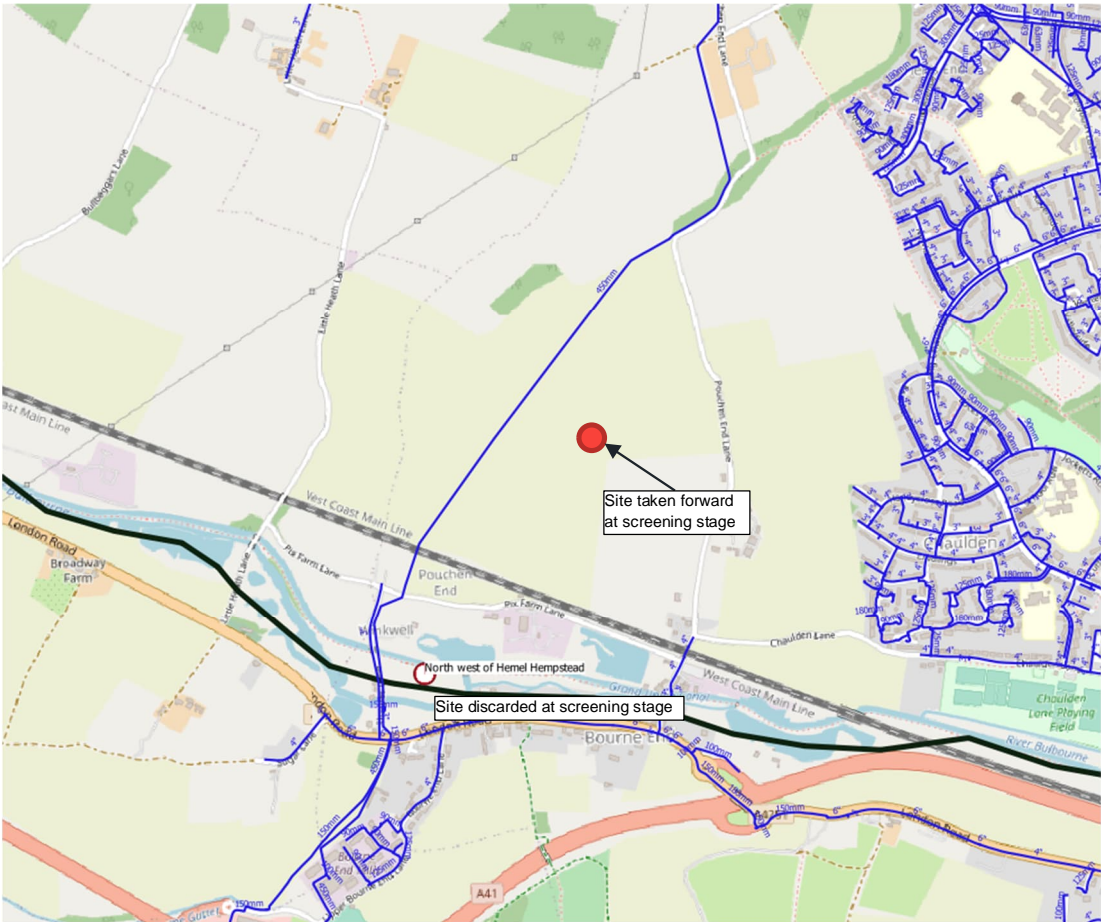


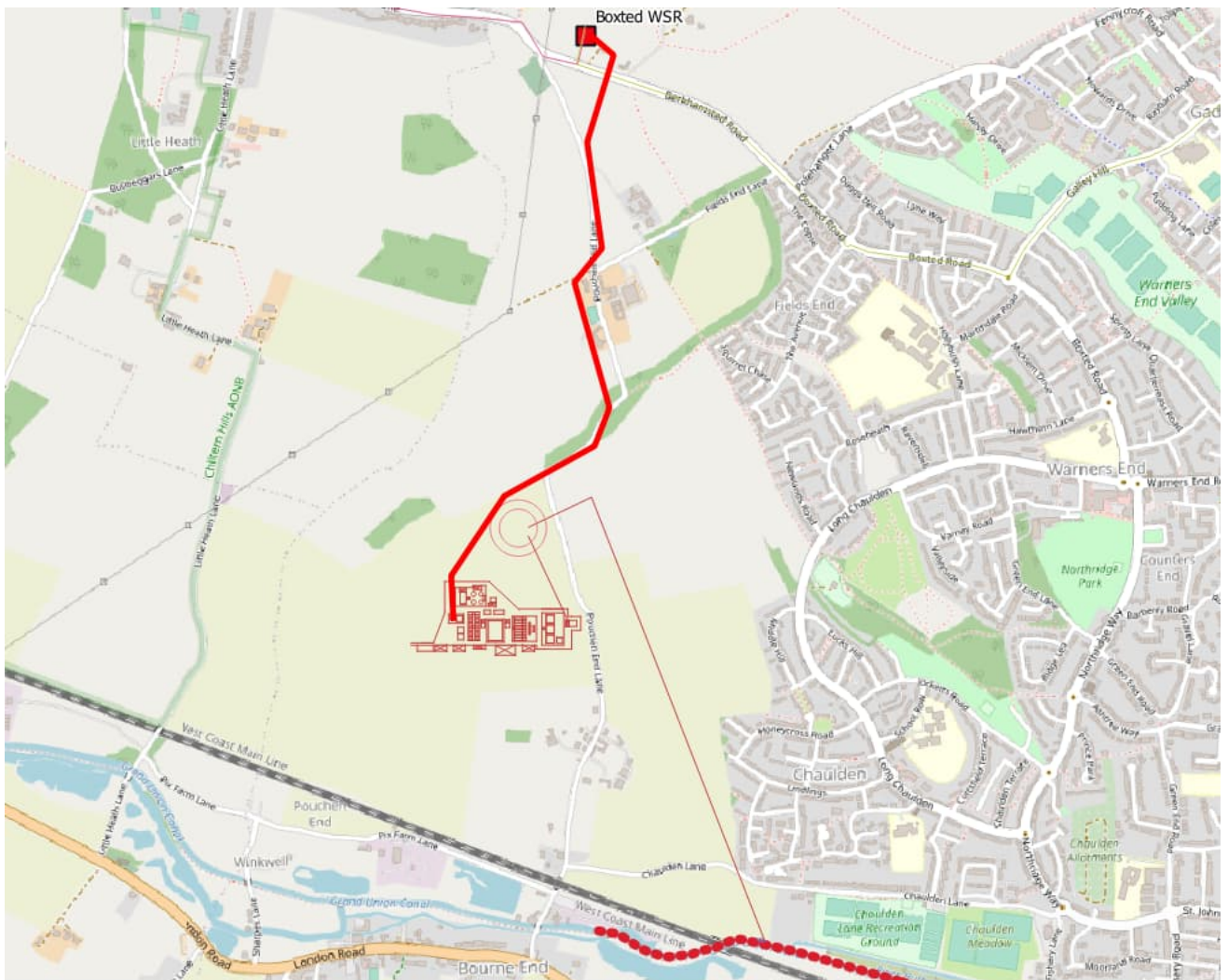
Figure 1-7 - Site location map showing the location of the potential site near Hemel Hempstead

Leg 1: Pipeline route from Hemel Hempstead to Boxted Water Supply Reservoir

The nearest existing reservoir is Boxted Reservoir, located approximately 2.5km away to the north of the potential treatment works site (). There are no major obstructions on the direct line from the potential site to Boxted, as the pipeline could be laid from the works across agricultural land on the edge of Chaulden avoiding the need to cross the railway. The flow would then be transferred to Chaul End for network distribution using the same route as described above.

The reservoir is located at elevation of between 30 to 50m higher than the proposed Hemel Hempstead site.

Figure 1-8 - Hemel Hempstead to Boxted Route



Leg 2: Pipeline route from Boxted to Chaul Water Supply Reservoir

The second leg of the pipeline to Chaul End WSR, is the same as that from Leighton Buzzard. The outgoing pipeline route initially leaves the site in a south easterly direction, then changing direction to pass through the area of Gadebridge. At the A4146 the pipeline crosses the River Gade, running along the B487 north-eastwards. The pipeline would then run on the eastern side of M1 in a north-westerly direction past the Pepperstock junction 10 to Chaul End WSR, see Figure 1-4

1.6 DESCRIPTION OF OPTION: THE GROVE - VIA ABBOTS LANGLEY WATER SUPPLY RESERVOIR TO BOXTED WSR AND CHAUL END WSR

The Grove Abstraction Site

The potential Grove site (X: 50 [redacted], Y: 19 [redacted]) is located to the west of Leavesden near the A411/A41 roundabout. The proposed site is located in greenfield land to the west of the Grand Union Canal and north of the M25 slip road. The abstracted water will pass via the raw water storage reservoir to the treatment works and then on towards the AWL distribution system.

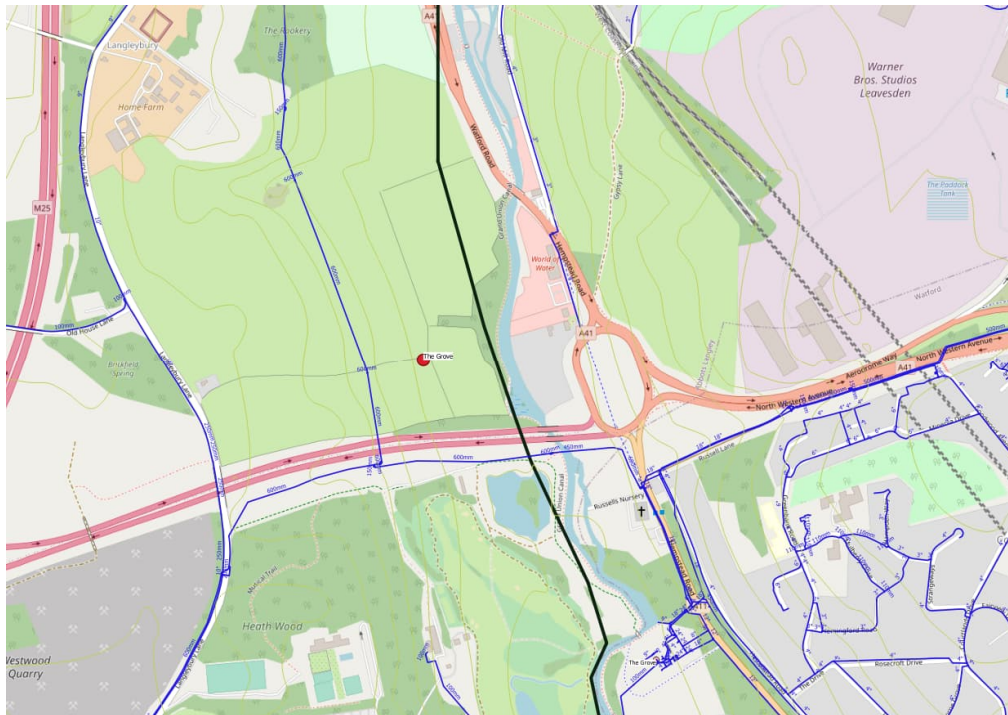


Figure 1-9 - Site location map showing the location of the potential site near The Grove.

Pipeline route from The Grove to Abbots Langley Water Supply Reservoir

The nearest existing reservoir which may be suitable in terms of connectivity is the Abbots Langley Reservoir located northeast of the site (approximately 5.3km away).

As shown on Figure 1-10 the potential route runs eastwards along the northern edge of the link road from M25 Chandlers Cross junction 19 towards the east. It then needs to cross the River Gade, the A41 interchange and the West Coast Main Line railway (a portion of which is tunnelled). It then passes through the areas of Leavesden and Abbots Langley, which are residential with some commercial property, before entering the Abbots Langley WSR site.

Any proposed direct route for this main would pass through an urban setting and crossing the West Coast Mainline Railway, the A41 and the Grand Union Canal. The reservoir is located at elevation of between 60 and 70m higher than the proposed The Grove site.



Figure 1-10 - Site location map showing the alignment of potential transfer route from The Grove to Abbot Langley WSR

As outlined in the screening report, there is limited benefit in assisting AWL demand areas in deficit from a local connection into the distribution system (other than freeing capacity at the Batchworth WTW). Therefore a transfer to Chaul End via Boxted will be required to allow comparison with the other site location options. However, there is no obvious route to Boxted other than to follow existing AWL pipeline routes from The Grove via the High Street Green water tower. This would require a new crossing of the canal, West Coast Mainline railway, M25, laying large pipes through congested Hemel Hempstead and would take the route within 500m of the Buncefield Oil Terminal.

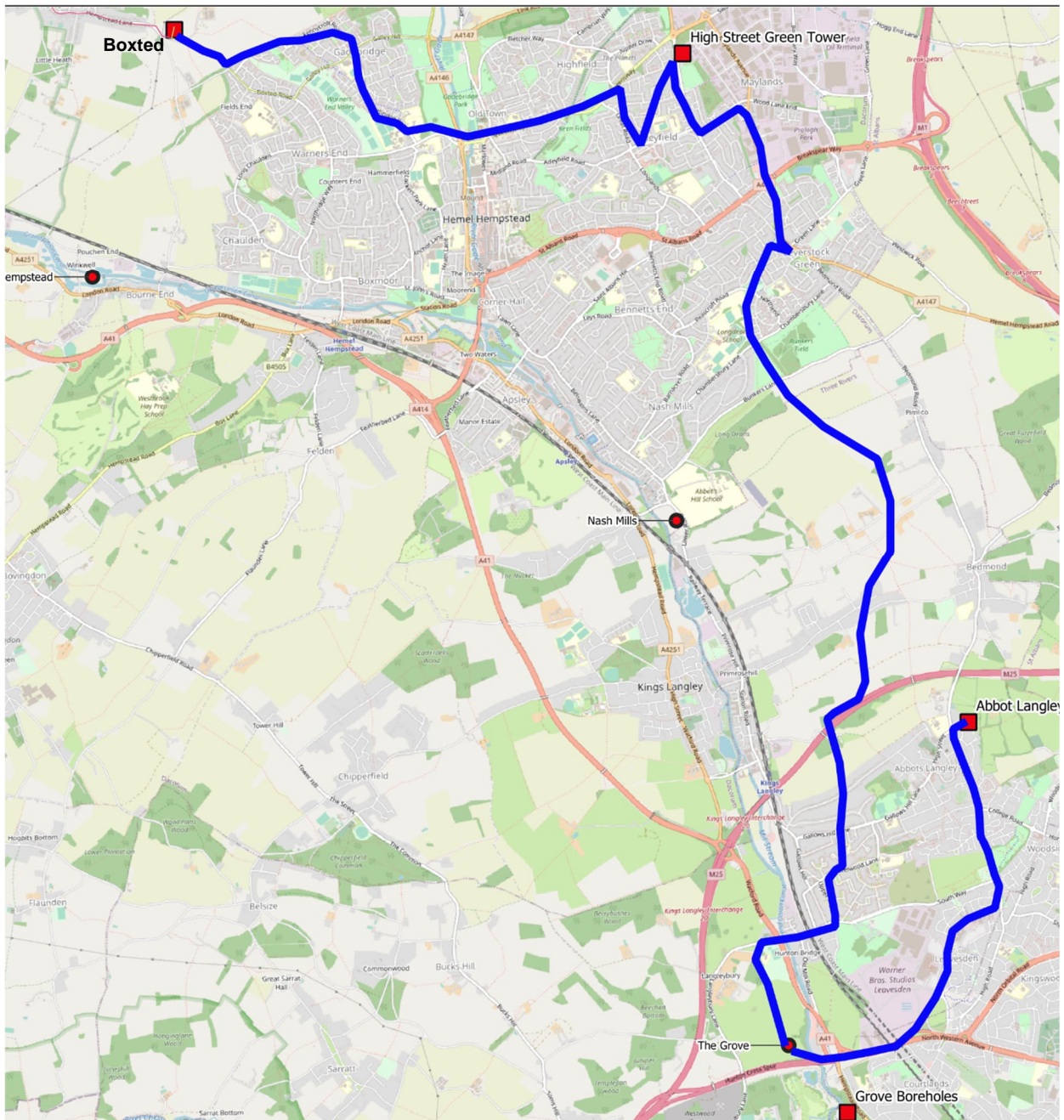


Figure 1-11 - The Grove connection proposal

2 ABSTRACTION SITE AND ROUTE OPTION COMPARISON APPROACH

2.1 FACTORS USED FOR COMPARISON

To ensure a consistent approach, the same factors have been used for assessment of, and comparison between, the abstraction sites and transfer routes. These include:

- Engineering and design
- Environmental impact
- Social impact
- Cost
- Value – wider benefits

A separate assessment has been carried out for each of the components that make up the options for the abstraction, transfer, and connection into the distribution network. These have then been compared cumulatively. How this has been approached is described in Section 2.2.

2.2 APPROACH TO COMPARISON OF OPTIONS

The comparative assessment has been largely qualitative and considers a breadth of factors that have been found to differentiate between the options, either during construction and/or operation. The approach taken to assess the factors is summarised in the sections below. The approach is to identify the best combination of treatment site location and connection to the distribution point at Chaul End. The priority is however to identify the most suitable location. Each site has multiple options for connection to the existing distribution system and each site could, if chosen, be adapted to meet this requirement. Therefore, although the site and connections are assessed as a whole system, the impact of transfer routes is more significant for costs and identifying potential risks and constraints in developing a particular site.

Quantitative assessment of costs and carbon has then been used to further assess preferences derived from the qualitative suitability assessment.

Abstraction Sites

The site comparison has been based on the candidate sites review described in the Gate 1 Report for sites at Leighton Buzzard, Tring, Hemel Hempstead, and The Grove.

- **Engineering and design** – All four options for abstraction sites are feasible. Similarly, all four options would equally be capable of adapting to meet future needs, such as supporting the digitisation of the network at a catchment level. Therefore, factors that might differentiate between them include those relating to site constraints (such as the space availability, planning requirements and geotechnical/ground conditions), the contribution of the site location to the hydraulic efficiency of the option (in relation to a comparison of the additional pumping requirements to bypass locks along the Grand Union Canal). Additionally, construction risks and constructability issues, as well as the relative resilience of the routes to climate change and the ability to accommodate mitigation measures were considered. No assessment with respect to the opportunities to reduce materials use has been made at this stage. Each site is based on a standard site layout and treatment process. Optimisation of treatment processes to meet

- receiving water quality parameters (monitoring ongoing by others, sufficient data not available for this stage of assessment) and hence the opportunity to reduce material will be investigated at the preferred option stage.
- **Environmental impact** – Factors that have been used to differentiate between the options include: the relative potential risk to sites with environmental and/or heritage designations; the relative embedded and operational carbon for each option; and flood risk. For this comparison, greenhouse gas (GHG) emission estimates for the 115Mld scenario have been used.
- **Social impact** – Social factors that might differentiate between the options include the impact and disruption to local communities, as well as impacts on users of the canal network and non-motorised users such as walkers, cyclists, and equestrians.
- **Cost** – A comparison between the relative estimated costs for the options has been used to differentiate between the abstraction site options. The cost estimates for the abstraction site options have been developed for both 58Mld and 115Mld scenarios. For this comparison the 115Mld costs have been used.
- **Value** – An initial review of opportunities to provide potential wider environmental and social benefits, that might differentiate between the options; considering how opportunities could align with national and regional policies and strategies.

Abstraction Transfer Routes

The transfer route comparison has been based on a desk study utilising GIS.

- **Engineering and design** – All five potable water transfer route options are feasible. Therefore, factors that might differentiate between them include those relating to the potential to minimise materials use (measured by length which is assumed to correlate to construction volumes), hydraulic efficiency of the routes (measured by a comparison of the relative head differences), construction risks and constructability issues, as well as the relative resilience of the routes to climate change and the ability to accommodate mitigation measures. Other issues considered include, whether the route crosses significant infrastructure, such as railways, or conflicts with other major water assets.
- **Environmental impact** – Factors that have been used to differentiate between the options include: the relative potential risk to sites with environmental and/or heritage designations; the relative embedded and operational carbon for each option (which is measured by relative length and change in elevation); and flood risk.
- **Social impact** – Social factors that might differentiate between the options include the impact and disruption to local communities, as well as impacts on users of the canal network and non-motorised users such as walkers, cyclists, and equestrians.
- **Cost** – A comparison between the relative estimated costs for the options has been used to differentiate between the routes. It is anticipated that the full cost benefit analysis will be undertaken at Gate 3.
- **Value** – An initial review of opportunities to provide potential wider environmental and social benefits, that might differentiate between the options; considering how opportunities could align with national and regional policies and strategies.

Sites for connection to distribution network.

The primary differentiator between the options in relation to the connection site, is whether the route links directly to the preferred connection point to the AWL distribution network.



It is understood that following discussions held with Affinity Water, the option of releasing water at Chaul End WSR will provide the best strategic value overall. The preference for Chaul End is based on the current level of development of AWL's Connect 2050 which examines the supply demand balance at a network demand level up to 2050 and considers the best options to meet the forecast deficits. If the final issue of Connect 2050 alters this finding a review may be needed of the route options assessment.

3 ABSTRACTION SITE COMPARISON

3.1 ENGINEERING AND DESIGN

All four abstraction site options were subject to the same engineering and design assumptions, as described in the Gate 1 Report.

SITE CONSTRAINTS

As part of the site screening reported in the aforementioned ‘Site Appraisal’ Report, factors affecting the site constraints were considered, including (not exclusively) the available open space and any ground conditions from publicly available sources that might constitute a restriction to construction. When reviewing the availability of the open space, typical features considered included the intake structure, storage, and treatment of the flows.

A summary of the site constraints for the four sites is provided below.

Table 3-1 – Abstraction site constraints

Abstraction site	Potential issues associated with insufficient open space?	Potential planning issues?	Ground conditions that might constitute a restriction?
Leighton Buzzard	Sufficient agricultural space to allow construction.	Site located in green belt.	In area of previous sand and gravel quarry. Site survey required to confirm previous remediation quality and potential need for piling.
Tring	Constrained site, that may be limited by key environmental and heritage designations.	Site located in green belt.	Underlying Chalk bedrock. A Foundation Risk Assessment will be required to prevent creating preferential pathways for contamination into the Chalk aquifer.
North of Hemel Hempstead	Sufficient agricultural space to allow construction.	Site located in green belt. Falls within area that is designated as having archaeological significance ³ .	Underlying Chalk bedrock. A Foundation Risk Assessment will be required to prevent creating preferential pathways for contamination into the Chalk aquifer.

³ Note: The transfer pipeline and Hemel Hempstead site is located within an area (DAC_57) that is designated in the Dacorum 2017 Adoption Local Plan as an area of archaeological significance. [site-allocations-map-book---adopted-12-july-2017.pdf \(dacorum.gov.uk\)](https://www.dacorum.gov.uk/sites/default/files/2017-07-12/site-allocations-map-book---adopted-12-july-2017.pdf)

Abstraction site	Potential issues associated with insufficient open space?	Potential planning issues?	Ground conditions that might constitute a restriction?
The Grove	Sufficient agricultural space to allow construction.	Site located in green belt on the boundary of land that is identified in the Three Rivers Development Plan ⁴ .	Underlying Chalk bedrock. A Foundation Risk Assessment will be required to prevent creating preferential pathways for contamination into the Chalk aquifer.

Based on the assessment described in the Gate 1 Site Appraisal Report and a review of the local development plans, the preferred option in terms of the above site constraints is Leighton Buzzard. There are no space constraints, fewer planning constraints and its not within the Chalk bedrock aquifer zone.

ADDITIONAL WORKS REQUIRED ALONG THE GRAND UNION CANAL

Transferring flow from Minworth to the abstraction sites is covered by a separate report (Grand Union Canal – Annex A1.2 Gate 2 Position Paper, Route Selection, August 2022). However, all routes considered converge at Braunston approximately 68km upstream of Leighton Buzzard. Leighton Buzzard is the furthest north site considered. All the works north of Leighton Buzzard are common to all abstraction locations.

From Leighton Buzzard, the GUC starts rising towards the south-east. To pass flow further along the canal, it would be necessary to bypass the locks up to Tring utilising a series of new pumping stations and pipelines. From Tring, the canal descends through the locks as it flows towards Hemel Hempstead and The Grove.

Use of the canal south of Tring therefore has some operational and capital cost effects. In addition, the potential for mixing a new water quality with the canal water south of Tring adds a risk to water quality management that the Environment Agency has expressed concern about. The canal south of Tring is very interconnected with local high quality chalk streams and even though transfer of Minworth water over the Tring summit would not be a likely or frequent event this risk might be better avoided as it would alter the current operating regime.

⁴ The Grove site is located at the edge of the Langleybury development area. See [Site Allocations Development Plan Document \(threerivers.gov.uk\)](#)

Table 3-2 – Comparison of additional canal transfer works for each site

Abstraction site	Pumped bypass	Gravity bypass	Comments
Leighton Buzzard	0	0	Site located furthest north.
Leighton Buzzard - Tring	10	0	A series of 18 locks raise the canal approximately 38m to Tring.
Tring - North of Hemel Hempstead	10	15	Between the Tring and the Grove sites the canal descends 60m down the Chiltern Hills via a series of 30 number individual locks. This section is also highly interconnected with local chalk streams.
Hemel Hempstead - The Grove	10	24	

As illustrated in the table above, the most energy efficient option would be to abstract the flow at Leighton Buzzard as additional pumping is required to transfer flows up to Tring Summit. From Tring onwards, the options perform similarly from a pumped hydraulic perspective. However, increasing amounts of capital works would be required for the options to provide gravity bypasses at the locks and any other constrictions that might be identified along the route of the canal.

CONSTRUCTION RISKS AND OPPORTUNITIES

The relative construction risks, constructability issues and opportunities for the four options have not been assessed in detail at this stage. A high-level review during the initial site selection process for the original nine sites was however undertaken and identified the following:

- Leighton Buzzard – no significant constraints identified
- Tring – Tring presents some constraints in terms of the Main Western Rail Line and the Grand Union Canal itself, potentially requiring upgrades to the crossing of these two obstacles for the construction works.
- North of Hemel Hempstead – site access for construction and operation will be difficult and will potentially require the upgrading of the existing Pouchen End Lane to avoid disruptions to local residents in Chaulden.
- The Grove – a new access will be required off Langleybury Lane. There is also the added complication of pumping back up the canal route to reach Boxted.

The Leighton Buzzard site appears to have the fewest constraints.

RESILIENCE

The outlet structures and a section of the abstraction pipelines at Leighton Buzzard, Hemel Hempstead and The Grove are located within flood zone 2 and/or 3. This could affect the performance of the abstraction during a relevant flood event (e.g. flooding of abstraction pumping station etc.).

Similarly, the abstraction performance could be affected in case of a pollution incident on the canal (e.g. flood waters flushing pollution into intake etc.).

Raw water storage for five days of peak transfer flow has been incorporated in the layout for all four sites. This will provide an equivalent level of operational resilience for all options, enabling the treatment site to operate in the event of emergencies. The volume of storage to be provided, for

operational use and for management of possible abstraction licence limitations is under investigation as part of the wider SRO resilience and operational review.

The storage and treatment sites for all four options are situated outside of flood zones 2 and 3, providing resilience against flood risk and there is thus no preferred site under this criterion.

3.2 ENVIRONMENTAL IMPACT

ENVIRONMENTAL RISKS

Geographical Information System (GIS) mapping has been used to identify and compare the relative potential environmental impact of the four options on environmental and heritage sites within a 1km buffer.

The comparison concentrated on sites with statutory and non-statutory environmental and heritage designations, using spatial data available under Open Government Licence⁵, including:

Sites with International Designations

- World Heritage Sites
- Ramsar England: A Ramsar site is the land listed as a Wetland of International Importance under the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the Ramsar Convention) 1973.

Sites with European Statutory Designations

- Special Protection Area: A Special Protection Area (SPA) is the land classified under Directive 79/409 on the Conservation of Wild Birds.
- Special Areas of Conservation: A Special Area of Conservation (SAC) is the land designated under Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora.

Sites with National Statutory Designations

- Scheduled Monuments: Scheduled monuments are nationally important monuments and sites. The aim of scheduling is to preserve sites and monuments as far as possible in the form in which they have come down to us today. They are legally protected through the Ancient Monuments and Archaeological Areas Act 1979.
- Listed buildings: Listing marks and celebrates a building's special architectural and historic interest and brings it under the consideration of the planning system, so that it can be protected for future generations.
- Sites of Special Scientific Interest: A Site of Special Scientific Interest (SSSI) is the land notified as an SSSI under the Wildlife and Countryside Act 1981, as amended.
- Areas of Outstanding Natural Beauty (AONB): Areas of Outstanding Natural Beauty (AONB) are designated areas where protection is afforded to protect and manage the areas for visitors and local residents.

⁵ [Search Results - data.gov.uk](#)

- National Nature Reserves England: A National Nature Reserve (NNR) is the land declared under the National Parks and Access to the Countryside Act 1949 or Wildlife and Countryside Act 1981 as amended.
- Locations of ponds surveyed as part of the Natural England 2013 Great Crested Newt Evidence Enhancement Project (Crested Newt Pond Surveys & Great Crested Newt Class Survey)

Other Local Designations

- Historic Parks and Gardens
- Local Nature Reserves
- Country Parks England
- Ancient Woodland England
- National Trails England.

The designated sites that were identified as being located within the 1km buffer, split into the different types of designations, are summarised in Table 3-3. Further details of these sites can be found in the Annex A1.1 Abstraction Site Selection Report.

Table 3-3 – Summary of Environmental Risk within 1km of Abstraction Site Locations

Designation	Leighton Buzzard	Tring ⁶	Hemel Hempstead ⁷	The Grove
International	0	0	0	0
European	0	1 SAC	0	0
National	5 Grade II listed buildings	1 SSSI 2 scheduled monuments, 3 Grade II listed buildings Chilterns AONB	1 SSSI 15 Grade II listed buildings, 1 conservation area, potential to impact on listed setting. 1 AONB	2 SSSI 4 Grade II*, 16 Grade II listed buildings, 1 conservation, potential to impact on listed setting.
Other	Priority habitat Water bodies Noise receptors	Ancient woodland Priority habitat Water bodies	Ancient woodland Water bodies 1 Noise Important Area (NIA) Noise receptors	4 other sites, including ancient woodland. Priority habitat Water bodies

⁶ Note: Tring site is immediately outside an area (DAC_23) that is designated in the Dacorum 2017 Adoption Local Plan as an area of archaeological significance. [site-allocations-map-book---adopted-12-july-2017.pdf](https://www.dacorum.gov.uk/sites/default/files/2017-07/site-allocations-map-book---adopted-12-july-2017.pdf) ([dacorum.gov.uk](https://www.dacorum.gov.uk))

⁷ Note: The transfer pipeline and Hemel Hempstead site is located within an area (DAC_57) that is designated in the Dacorum 2017 Adoption Local Plan as an area of archaeological significance. [site-allocations-map-book---adopted-12-july-2017.pdf](https://www.dacorum.gov.uk/sites/default/files/2017-07/site-allocations-map-book---adopted-12-july-2017.pdf) ([dacorum.gov.uk](https://www.dacorum.gov.uk))

Designation	Leighton Buzzard	Tring ⁶	Hemel Hempstead ⁷	The Grove
	Public Rights of Way (PROWs) and Cycle Route	Chiltern Landscape Character Area PROWs	PROW	3 NIAs Noise receptors PROWs

Although it is unlikely that all the designated sites identified in

Table 3-3 would be affected by the options, the abstraction site location that has the least risk overall from the perspective of environmental impact on such sites is Leighton Buzzard.

CARBON ASSESSMENT

A preliminary carbon assessment has been undertaken using the Bionova Oneclick LCA software and drawing on additional carbon emissions factors from SimaPro, using quantities (Gate 1 Report) which have been estimated for the following typical features:

- Earthworks
- Stainless steel (pumps, screens, and fencing)
- Iron pipes, Steel pipes and HDPE Plastic pipes
- Steel reinforcing bar (within concrete)
- Pre-cast and in-situ concrete
- Low temperature asphalt
- Aggregate
- Copper
- Electricity
- Treatment chemicals

A revised carbon assessment was produced for each of the sites, utilising a hotspot analysis to improve the design with the aim of reducing carbon emissions. The carbon accounting includes embodied greenhouse gas (GHG) emissions for construction and operational stages, plus operational stage energy related GHG emissions (tCO_{2e}).

The revised carbon accounting is presented in Table 3-4 below, for each of the sites. The operational stage assessment has covered chemical usage and electricity usage for each scheme over its 80-year operational life.

Table 3-4 – Revised Carbon Assessment Comparison for Abstraction Sites - Total lifetime GHG emissions (tCO₂e)

Feature	Leighton Buzzard Total lifetime GHG emissions (tCO₂e)	Tring Total lifetime GHG emissions (tCO₂e)	The Grove Total lifetime GHG emissions (tCO₂e)	Hemel Hempstead Total lifetime GHG emissions (tCO₂e)
Earth Works	972	970	968	968
Stainless Steel (pumps, screens, and fencing)	212,919	333,686	333,682	244,705
Iron Pipes	24,016	21,588	45,604	21,588
Rising main (HDPE)	0	7,031	0	2,956
Steel reinforcing bar (within concrete)	6,188	6,160	6,131	6,132
Concrete (pre-cast)	2,845	2,845	2,846	2,846
Concrete (in-situ)	27	27	22	29
Asphalt (low temperature)	145	145	145	393
Aggregate (Crushed Rock)	30	30	30	82
Copper	144,970	191,468	191,468	191,468
Electricity	178,385	182,020	253,318	204,108
Treatment Chemicals	854,737	854,737	854,737	854,737
Total	1,425,234	1,600,707	1,688,951	1,530,012

*See Gate 1 'Site Appraisal' Report for methodology and breakdown

The abstraction site location that, based on the carbon assessments carried out to date, is forecast to have the least total lifetime GHG emissions (tCO₂e) is Leighton Buzzard.

FLOOD RISK

As noted in **Section 3.1** the abstraction structures (e.g. pumping station, screening works etc.) and a section of the abstraction pipelines at Leighton Buzzard, Hemel Hempstead and The Grove are

located within flood zone 2 and/or 3. However, the raw water storage and treatment sites for all four options are situated outside of flood zones 2 and 3.

3.3 SOCIAL IMPACT

As defined by the International Association for Impact Assessment (IAIA), a “Social Impact Assessment includes the processes of analysing, monitoring, and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions...”

BASELINE SITUATION IN THE VICINITY OF THE POTENTIAL ABSTRACTION SITES

The English Indices of Multiple Deprivation (IMD2019) has been used to understand what the current (baseline) situation is in the vicinity of the abstraction sites. This index considers seven domains of deprivation in combination: Income; Employment; Education; Health; Crime; Barriers to Housing and Services; and Living Environment.

The relative levels of deprivation in the vicinity of the sites mapped by Lower layer Super Output Areas (LSOAs), can be seen on Figure 3-1 and Figure 3-2. Except for Leighton Buzzard, the abstraction sites are located in some of the least deprived areas in the country. LSOA neighbourhood data⁸ for the abstraction sites are summarised below. The areas are ranked from the most deprived (indicated by the areas with the lowest indices in dark blue) to the least deprived (indicated by the areas with the highest indices in pale green).⁹

⁸ [Indices of Deprivation 2015 and 2019 \(communities.gov.uk\)](https://www.communities.gov.uk/publications/communities/indices-deprivation-2015-and-2019)

⁹ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833959/loD2019_Infographic.pdf

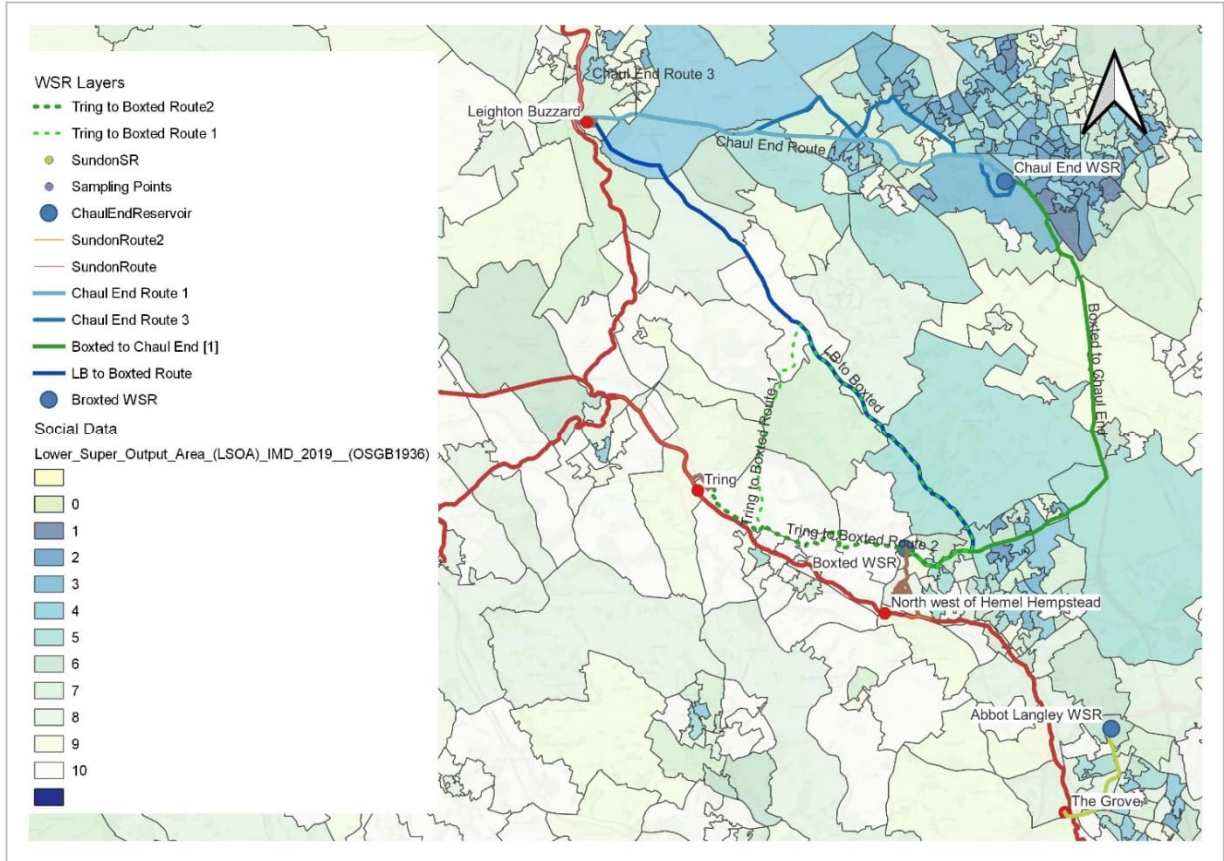


Figure 3-1 - Levels of relative deprivation in the vicinity of the abstraction site options at Leighton Buzzard, Tring, Hemel Hempstead, and The Grove

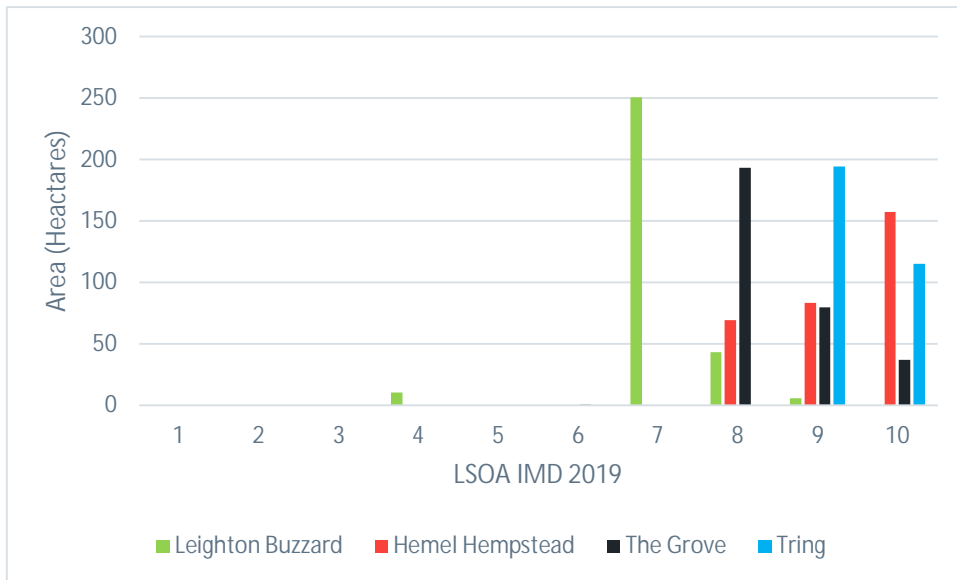


Figure 3-2 – Shows a comparison of the relative areas, located within 1km of the abstraction sites, within LSOA areas with highest levels of deprivation (1) to the lowest levels of deprivation (10)

Leighton Buzzard

The Leighton Buzzard abstraction site is sited within a 1km radius of Aylesbury Vale 007E and 009B, as shown in Figure 3-3, and Central Bedfordshire 019B, 022C, 024C and 024G.

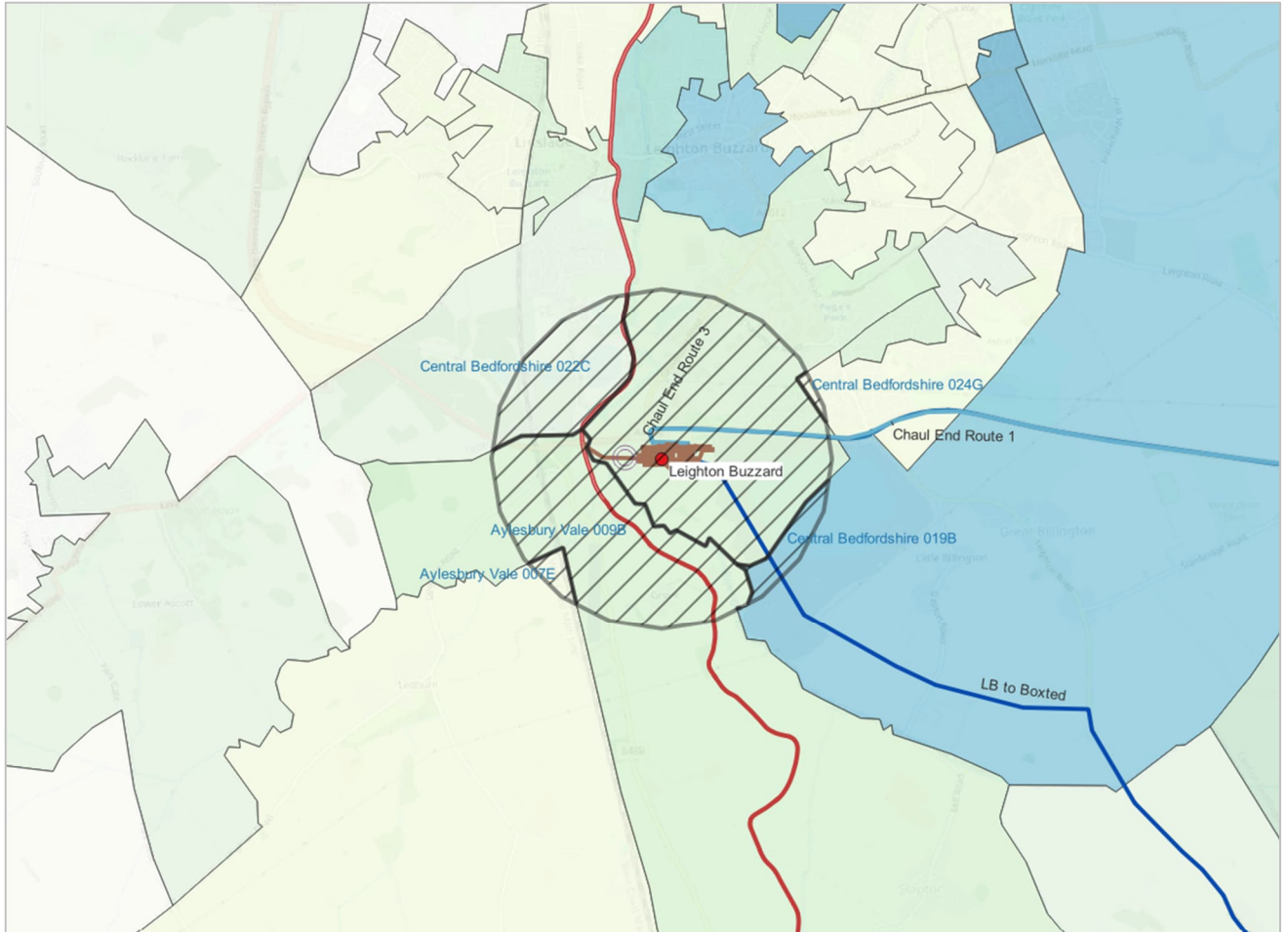


Figure 3-3 – Level of Deprivation within 1km of Leighton Buzzard Abstraction Site (Aylesbury Vale 007E and 009B, Central Bedfordshire 019B, 022C, 024C and 024G)

Of the LSOAs, Central Bedfordshire 019B is the most deprived with an overall Index of Multiple Deprivation of 4, meaning that it falls within the decile of 40% most deprived areas in the country. The other areas have overall Indices of Multiple Deprivation ranging from 7 to 9, meaning that they fall within the range of decile between 10% and 30% least deprived areas in the country.

Notwithstanding, all the neighbourhoods are affected by deprivation to some extent. As detailed in the following table, based on the 2019 Indices of Deprivation data the main issues encountered where areas fall within the top 40% of the worst affected LSOAs include: income deprivation; crime; barriers to housing and services; living environment deprivation; and income deprivation affecting children.

Table 3-5 – LSOAs within 1km of the Leighton Buzzard abstraction site

LSOA	Ward	Local Authority District	Overall Index of Multiple Deprivation (where 1 is most deprived)	Ranking out of 32844 LSOA in England (where 1 is the most deprived)	Examples of deprivation (top % most deprived neighbourhoods in the country)
Aylesbury Vale 007E	Wingrave	Aylesbury Vale	9	28058	Barriers to housing and services (20%), Living environment deprivation (40%).
Aylesbury Vale 009B	Wingrave	Aylesbury Vale	7	20349	Barriers to housing and services (10%), Living environment deprivation (50%), Income deprivation affecting children (50%).
Central Bedfordshire 019B	Eaton Bray	Central Bedfordshire	4	9973	Income (40%), employment (50%), Education, Skills, and training (40%), Crime (20%), Barriers to housing and services (10%), Living environment (30%), Income deprivation affecting children (10%).
Central Bedfordshire 022C	Linslade	Central Bedfordshire	8	25608	Crime (40% most deprived).
Central Bedfordshire 024C	Leighton Buzzard South	Central Bedfordshire	7	21226	Income (50%), Education, Skills, and training (50%), Barriers to housing and services (50%), Income deprivation affecting children (50%) and older people (50%).
Central Bedfordshire 024G	Leighton Buzzard South	Central Bedfordshire	9	30993	Education, Skills, and training (50%), Barriers to housing and services (30%),

Tring

The Tring abstraction site is sited within a 1km radius of Dacorum 004A and 006C.

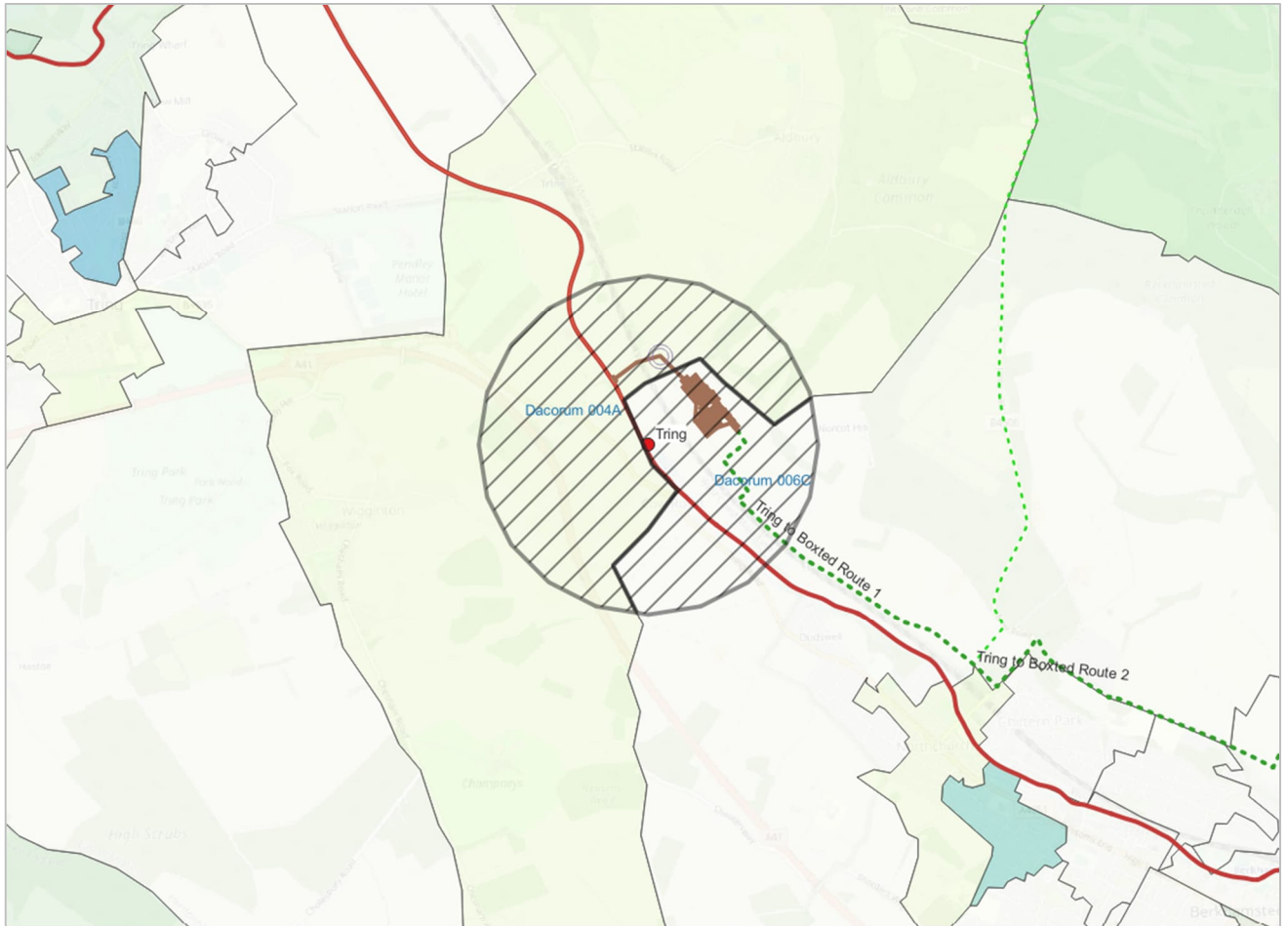


Figure 3-4 - Level of Deprivation within 1km of Tring Abstraction Site (Dacorum 004A and 006C)

These areas have an overall Index of Multiple Deprivation of 9 and 10, meaning that it falls within the decile of 20% and 10% least deprived areas in the country.

Notwithstanding, as detailed in the following table, both neighbourhoods are affected by deprivation in relation to barriers to housing and services. The LSOAs of Dacorum 004A and 006C fall within the top 20% and 40% most deprived neighbourhoods in the country for this domain.

Table 3-6 – LSOAs within 1km of Tring abstraction site

LSOA	Ward	Local Authority District	Overall Index of Multiple Deprivation (where 1 is most deprived)	Ranking out of 32844 LSOA in England (where 1 is the most deprived)	Examples of deprivation (top % most deprived neighbourhoods in the country)
Dacorum 004A	Aldbury	Dacorum	9	27646	Barriers to housing and services (20%).
Dacorum 006C	Wigginton	Dacorum	10	32844	Barriers to housing and services (50%).

Hemel Hempstead

The Hemel Hempstead abstraction site is located within a 1km radius of Dacorum 009B, 014C, 016A 021E and 021F.

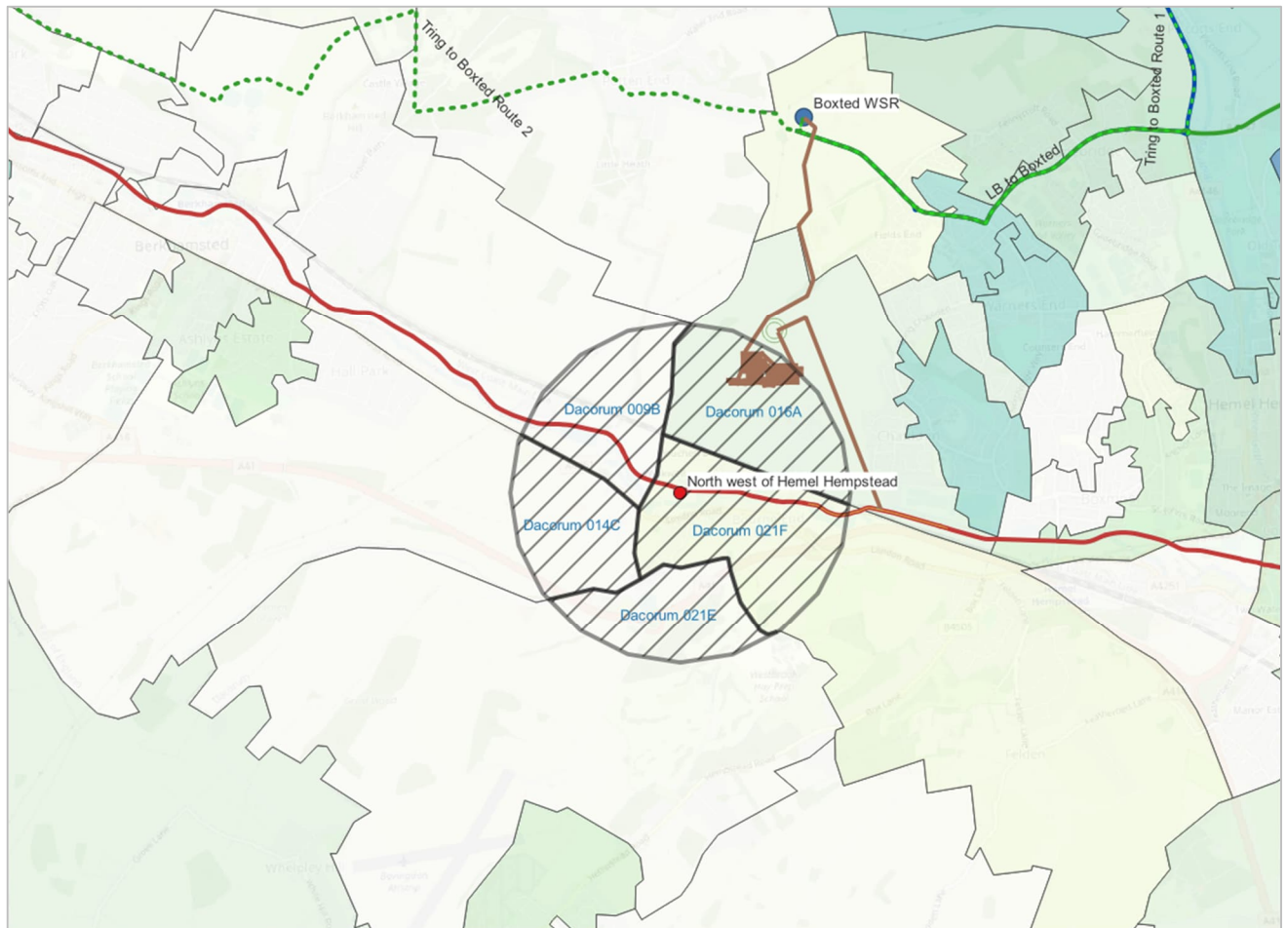


Figure 3-5 – Level of Deprivation within 1km of Hemel Hempstead Abstraction Site (Dacorum 009B, 014C, 016A 021E and 021F)

These areas have an overall Index of Multiple Deprivation ranging between 8 and 10, meaning they fall within the decile of 30% and 10% least deprived areas in the country.

Notwithstanding, although notably Dacorum 014C has no domains within the top 50% most deprived, all the neighbourhoods are affected by deprivation to some extent. As detailed in the following table, based on the 2019 Indices of Deprivation data the main issues encountered where areas fall within the top 40% of the worst affected LSOAs relate to barriers to housing and services.

Table 3-7 – LSOAs within 1km of Hemel Hempstead abstraction site

LSOA	Ward	Local Authority District	Overall Index of Multiple Deprivation (where 1 is most deprived)	Ranking out 32844 LSOA in England (where 1 is the most deprived)	Examples of deprivation (top % most deprived neighbourhoods in the country)
Dacorum 009B	Berkhamstead East	Dacorum	10	32468	Barriers to housing and services (50%).
Dacorum 014C	Berkhamstead East	Dacorum	10	32619	No domains within LSOA within top 50%.
Dacorum 016A	Chaulden and Warners End	Dacorum	8	20014	Education, skills, and training (50%), Income deprivation affecting children (50%).
Dacorum 021E	Bovingdon, Flaunden and Chipperfield	Dacorum	10	29682	Barriers to housing and services (30%).
Dacorum 021F	Bovingdon, Flaunden and Chipperfield	Dacorum	9	28848	Barriers to housing and services (20%).

The Grove

The Grove abstraction site is sited within a 1km radius of Three Rivers 002D, 003C and 003D, and Watford 001D and 004D.

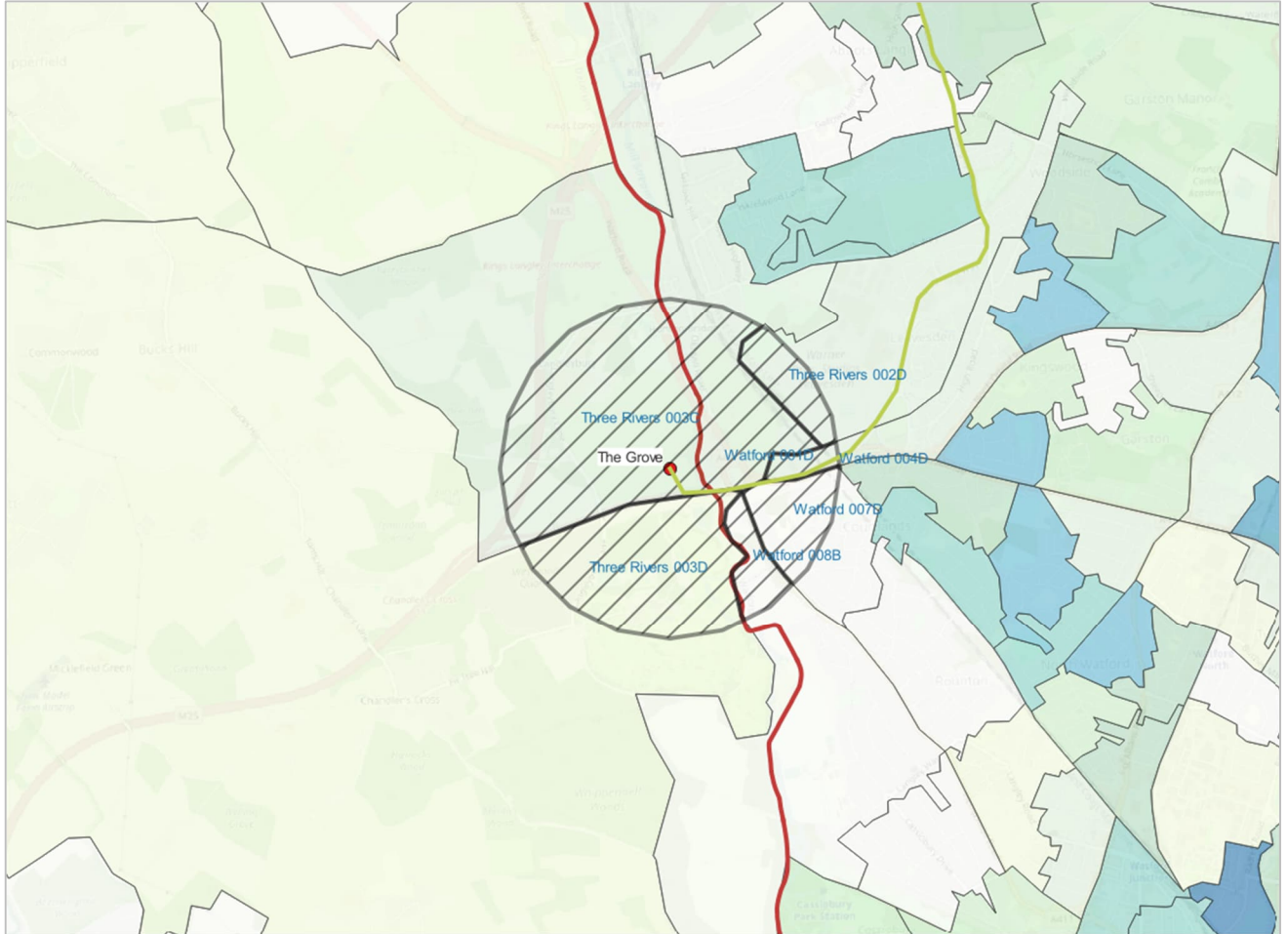


Figure 3-6 – Level of Deprivation within 1km of The Grove Abstraction Site (Three Rivers 002D, 003C and 003D, Watford 001D and 004D)

The most deprived of the areas (Watford 004D), has an overall Index of Multiple Deprivation of 6, meaning that it falls within the top 50% least deprived areas in the country. Whereas the other areas have overall Indices of Multiple Deprivation of 8 or 9, meaning that they fall within the decile of 30% or 20% least deprived areas in the country.

Notwithstanding, all the neighbourhoods are affected by deprivation to some extent. As detailed in the following table, based on the 2019 Indices of Deprivation data the main issues encountered where areas fall within the top 40% of the worst affected LSOAs include: crime; barriers to housing and services; and living environment deprivation.

Table 3-8 – LSOAs within 1km of The Grove abstraction site

LSOA	Ward	Local Authority District	Overall Index of Multiple Deprivation (where 1 is most deprived)	Ranking out of 32844 LSOA in England (where 1 is the most deprived)	Examples of deprivation (top % most deprived neighbourhoods in the country)
Three Rivers 002D	Leavesden	Three Rivers	8	23657	Barriers to housing and services (50%), Income deprivation affecting children (50%).
Three Rivers 003C	Gade Valley	Three Rivers	8	24950	Crime (40%), Barriers to housing and services (40%), Living environment (50%).
Three Rivers 003D	Chorleywood North and Sarratt	Three Rivers	9	28666	Barriers to housing and services (30%), Living environment (50%).
Watford 001D	Woodside	Watford	8	25842	Crime (50%).
Watford 004D	Woodside	Watford	6	19094	Crime (40%), Barriers to housing and services (30%), Living environment (30%), Income deprivation affecting children (50%) and older people (50%).

COMPARISON OF POTENTIAL SOCIAL IMPACT

The following social factors have been considered, when making a comparison of the four options. These are factors that are considered are most likely to differentiate between the sites and primarily relate to the potential impact and disruption to local communities, as well as users of the canal network and non-motorised users such as walkers, cyclists, and equestrians. It is recognised that most of these impacts are likely to occur during construction.

- People’s way of life on a day-to-day basis, including impacts affecting access to amenities, services, and employment. In particular, works could cause disruption when works are built. Additionally, the proposals could impact both active travel and vehicular routes.
- Community, including cohesion, character, and impact on services/amenities within the community.
- Environment – Including impacts related to the risk of pollution (such as noise, air, or water pollution) and/or loss of habitats. For comparison, it has been assumed that the environmental impact would be directly proportionate to the environmental risks identified in **Section 3.2**.

- Health and well-being – Including health related impacts, such as stress or the reduced likelihood of people exercising and enjoying the local environment, open spaces (such as the Canal, cycleways, bridleways, and footpaths). Works at all sites would inevitably affect access to the towpath running along the canal whilst construction works are carried out.
- Personal and property rights – for example loss of land ownership or third-party rights. It is assumed for the purpose of the comparison that, apart from private moorings, the greatest impact would be associated with the pipeline connecting the abstraction point to the site where the raw water will be treated as most of the land along the Canal route is owned by the Trust.

Social impacts such as those related to culture and political systems would be affected similarly by all the sites, and therefore would not be differentiating factors. Similarly impacts such as personal safety would be subject to mitigation.

Table 3-9 – Summary of potential social Impacts

Social factor	Leighton Buzzard	Tring	The Grove	Hemel Hempstead
People's way of life	The work will be undertaken on-line to the existing Canal or in agricultural land to the east.	The work will be undertaken on-line to the existing Canal or in agricultural land to the east.	The work will be undertaken on-line to the existing Canal or in agricultural land to the west.	Although the work will be undertaken on-line to the existing Canal or in agricultural land to the northwest, a section would be located close to a residential area of Chaulden.
Community	The transfer pipe would need to cross a traffic free cycle route that runs along the towpath in this location.	The transfer pipe would need to cross the towpath and would affect footpaths.	The transfer pipe would need to cross the towpath.	The transfer pipe would need to cross the towpath and minor roads.
Environment	This option has the least environmental risk.	This option has a higher environmental risk than Leighton Buzzard with an SAC and several SSSI and listed buildings.	This option has a higher environmental risk than Leighton Buzzard with several SSSI and listed buildings.	The site is located within an area that is identified in the Adopted Local Plan as an area of archaeological significance.
Health and well-being		There appear to be private moorings (possibly residential) on the opposite bank that would be affected by the construction works.		The residential properties overlooking the route, would be affected by the construction works.

Social factor	Leighton Buzzard	Tring	The Grove	Hemel Hempstead
Personal and property rights	The site is located in private land approximately 0.5km to the east of the canal.	The site is located in private land approximately 0.5km to the east of the canal. The transfer pipeline needs to cross the West Coast Mainline.		The treatment works site is located in private land approximately 1km to the northwest of the canal. Due to the total length of the transfer pipeline, required to transfer the flow to Boxted WSR (more than 2km), this option is likely to affect the greatest numbers of parties with freehold, leasehold ownership or third-party interests in the affected land.

Although in the short term the construction work associated with the treatment works and transfer infrastructure would provide employment opportunities, the long-term impacts at each site are limited and therefore not a differentiator at this stage. However, it can be seen from the above that the potential for negative impacts is greater at Tring and Hemel Hempstead.

3.4 COST

An indicative cost estimate has been produced for capital and operational expenditure using AWL cost curves, using prices and curves adjusted after PR19¹⁰. Where no information was available, the estimate was either based on costs from other projects or other sources such as SPONs.

The design costs in this report do not include the cost associated with the design of the canal upgrades (see separate report Annex A1.2 for transfer route costs and Annex A1 for summary of whole scheme costs). Instead, the costs only cover those associated with the canal abstraction, treatment, and network injection, which include the following typical features in addition to design costs (not exclusively).

The abstraction and treatment works were sized to accommodate the maximum flow of 115Mld flow and the costs in this section relate to these elements.

Capital costs related to Civil, Mechanical and Instrument Control and Automation (ICA):

- Canal abstraction including the canal intake and bankside storage.

¹⁰ Ofwat price review 2019 for AMP7

- Treatment including clarification, disinfection, facilities, GAC filters, ozonation, sludge treatment and ultrafiltration, power supply.
- Network connection costs.
- Other costs including land acquisition, planning applications, site investigation and landscaping.

Annual operational costs:

- Electricity.
- Chemicals / materials required for treatment.

Table 3-10 – Summary of Indicative Cost Estimate for Abstraction Sites

Type	Leighton Buzzard	Tring	The Grove	Hemel Hempstead
Capital expenditure	£135,503,525.00	£159,613,012.00	£180,117,340.00	£158,851,738.00
Annual operational expenditure	£9,728,910.63	£9,822,217.36	£11,596,330.25	£10,371,106.00

*Tring, The Grove and Hemel Hempstead would also incur additional costs associated with the additional canal transfer required (see Table 3-2).

The abstraction site location that, based on the indicative cost estimates produced to date, is forecast to have the lowest capital and annual operational cost is Leighton Buzzard.

3.5 VALUE - WIDER BENEFITS

An initial review has been undertaken to identify opportunities to provide potential wider benefits, that might differentiate between the sites and routes. This has included a review of relevant guidance and other documents to consider how these opportunities could align with national and regional policies and strategies.

Policy

The key relevant policy documents that cover the geographical extent of sites and routes include:

- Draft National Policy Statement for Water Resources Infrastructure (Nov 2018)
- Affinity Water, Water Resources Management Plan 2020-2080 (April 2020)
- UK Government Levelling-up policy:
 - ‘Build Back Better: our plan for growth’ (March 2021)
 - ‘Levelling up the United Kingdom’ white paper’ (February 2021)

The aim of the policy described in the white paper is to address geographical disparities, by means of a programme of change based on the following medium-term (2030) missions to boost productivity, pay, jobs and living standards; spread opportunities and improve public services; restore a sense of community, local pride and belonging; and empower local leaders and communities.

- Buckinghamshire Council ‘Corporate Plan’ 2020-2030



The Buckinghamshire Council plan outlines the Council's ambitions for Buckinghamshire. It details four key priorities for residents, employees, businesses, service users and councillors: strengthening our communities; improving our environment; protecting the vulnerable; and increasing prosperity.

- Hertfordshire County Council 'Corporate Plan' 2022-2025

The Hertfordshire County Council Corporate Plan 2022-2025 explains the vision to create a cleaner, greener, and healthier Hertfordshire. To achieve the vision, there are four priorities: A cleaner and greener environment, Healthy and fulfilling lives for our residents; Sustainable, responsible growth in our country; and Excellent council services for all.

Both the levelling up policy and the Local Authority corporate plans identify opportunities that might align with some of the wider benefits that could be delivered through this project.

Opportunities for wider benefits

Wider benefits considered include opportunities for environmental improvements (such as flood risk, biodiversity, and carbon sequestration) and social enhancements that could improve people's health, wellbeing and understanding of the natural environment. Leighton Buzzard site was used as a case study to identify the types of benefits that could be associated with the construction of a water treatment plant. However, many of the benefits identified in the case study, such as wetland creation and enhancements to footpaths/cycleways or the creation of renewable energy, could be replicated at the other sites but to a lesser scale.

Risks

Conversely, there is a risk that the proposals could increase deprivation locally. One of the key issues that could be affected is using land that has been allocated for housing (thus increasing the barriers to housing).

The sites at Leighton Buzzard, Tring and Hemel Hempstead are located^{11 12} outside areas identified for strategic housing and/or mixed-use allocations. Therefore, this would not act as a differentiator when comparing these options.

Whereas The Grove is in the immediate vicinity of an area that was identified in the Three Rivers District Council Site Allocations Development Plan¹³ as being appropriate for hotel/leisure development and/or continued agricultural use (Policy SA7). Hence there is a risk that siting the abstraction location at The Grove could have a detrimental impact on an existing issue in Three Rivers 003C with respect to 'barriers to housing and services'.

¹¹ For Leighton Buzzard, see interactive map on [My Central Bedfordshire - Central Bedfordshire Council](#) for Central Bedfordshire Adopted Local Plan.

¹² For Dacorum, see [site-allocations-map-book---adopted-12-july-2017.pdf \(dacorum.gov.uk\)](#)

¹³ The Grove site is located at the edge of the Langleybury development area. See [Site Allocations Development Plan Document \(threerivers.gov.uk\)](#) (2014)

3.6 ABSTRACTION SITE OPTION COMPARISON

The comparison of the abstraction sites has been based on qualitative assessment with use of quantitative data, where available, such as for cost and carbon estimates. The sites have been ranked from 1 (performs the best) to 4 (performs the worst). Where further assessment would be required to differentiate between the sites, they have been scored at the same level.

Table 3-11 – Summary of comparison of abstraction site locations

Factors	Leighton Buzzard	Tring	The Grove	Hemel Hempstead	Comments
Engineering design					
Site constraints	1	4	3	4	Tring is a constrained site, that may be limited by key environmental and heritage designations. The Grove is on the boundary of land that is identified in the Three Rivers Development Plan. Hemel Hempstead falls within a site that is designated as being of archaeological significance.
Works required on GUC	1	2	4	3	Ranked order: Increasing amount of work, as the flow is passed towards the south.
Construction risks and opportunities	1	4	2	3	High level assessment only undertaken.
Resilience	1	2	2	2	Similar for all sites however Leighton Buzzard has a higher potential to provide additional resilience
Environmental impact					
Environmental risk	1	2	2	2	Further assessment required to differentiate between Tring, The Grove and Hemel Hempstead.
Carbon	1	3	4	2	Ranked order.
Flood risk	2	1	2	2	Although storage/treatment would be located outside flood zones 2/3, with the exception of Tring the abstraction point lies within the flood zones.

Factors	Leighton Buzzard	Tring	The Grove	Hemel Hempstead	Comments
Social impact					
Social impact	1	2	1	3	It is anticipated that the option at Hemel Hempstead would have the greatest social impact on local communities.
Other factors					
Cost	1	2	4	3	Ranked order: Tring & Hemel Hempstead are very similar. Hemel Hempstead's estimated capital cost is marginally lower. However annual operational costs are higher.
Value – Wider Benefits	1	2	3	2	There is the greatest opportunity to provide a social and environmental benefit at Leighton Buzzard. The Grove is on the boundary of land that is identified in the Three Rivers Development Plan. Further assessment required to differentiate between the other sites.

4 ABSTRACTION TRANSFER ROUTE COMPARISON

4.1 ENGINEERING AND DESIGN

All the options were subject to the same engineering and design assumptions, as described in the Gate 1 Report.

SITE CONSTRAINTS

No detailed site-based assessment has been undertaken of the site constraints for the abstraction transfer routes. The current route assessment has been undertaken to assist in site selection. The preferred option report (see Annex A1) covers the preferred treatment works site to Chaul End Water Service Reservoir (WSR) transfer route assessment in more detail.

However, whilst developing the potential routes, several issues that might constitute a restriction to construction were considered. These included the availability of open construction routes, avoiding sites with environmental/heritage designations and potential clashes with existing AWL infrastructure. There is currently insufficient information to determine if engineering issues, such as ground conditions, are likely to be differentiators for the pipelines. However, the following generalisations can be made:

- Leighton Buzzard to Chaul End Routes 1 and 3 are mainly within area of mudstone and sandstone. Only the final section from around Dunstable to Chaul End is within a Chalk area.
- All routes from Tring, Hemel Hempstead and Grove are almost exclusively within Chalk area with only sections of the Grove route passing through areas of superficial sands and gravels.

A summary of the site constraints for the routes are provided below.

Table 4-1 – Abstraction transfer routes constraints

Route	Potential issues associated with insufficient open space?	Constraints due to environmental / heritage designations?	Potential for clashes with AWL infrastructure?
Leighton Buzzard – Chaul End Route 1	Follows part of Luton Dunstable Busway route.	Passes along short boundary (450m) of Blow's Down SSSI on the outskirts of Houghton Regis (HR).	Not identified
Leighton Buzzard – Chaul End Route 3	Constrained route through HR, due to likelihood of other utilities within the road space.	Listed buildings in HR either side of route. Passes along boundary of HR Marl Lakes SSSI	Passes Caddington WSR
Leighton Buzzard – Chaul End (Via Boxted)	Mainly farmland either side but a long diversion route for affected traffic.	Majority of route through Chilton AONB	Follows existing pipeline route via Friars Wash

Route	Potential issues associated with insufficient open space?	Constraints due to environmental / heritage designations?	Potential for clashes with AWL infrastructure?
Tring – Chaul End (Via Boxted Route 1)	Option crosses the West Coast Main Line railway. There is then open agricultural land for first 2.5km.	The route passes between designated sites that are located on either side of the road.	Follows existing pipeline route via Friars Wash.
Tring – Chaul End (Via Boxted Route 2)	Heavily wooded route with no verge to road in most places.	Passes multiple listed buildings and site of Roman building.	Crosses 12" main at Potten End. Follows existing pipeline route via Friars Wash
Hemel Hempstead – Chaul End (Via Boxted)	Option crosses A41 and the West Coast Main Line railway.	Site borders ancient woodland	Follows existing pipeline route via Friars Wash.
The Grove – Abbots Langley	Route crosses M25, A41, A414, the GUC and the West Coast Main Line railway	Passes multiple listed buildings	Follows the route of the Hunton to Boxted main passing and crossing multiple strategic assets

Based on the assessment described, the two preferred options in terms of site constraints are Leighton Buzzard to Chaul End Route 1 and Tring to Chaul End (Via Boxted Route 1).

CONSTRUCTION RISKS AND OPPORTUNITIES

The relative construction risks, constructability issues and opportunities for the options have been reviewed only at a high level for route comparison purposes at this stage. These can be summarised as follows:

- Leighton Buzzard – Chaul End Route 1
 - Advantages:
 - The route is wholly within the highway verge or greenway therefore limited numbers of landowners to consult.
 - Standard permits and constraints therefore straight forward and known planning costs
 - Lower risk of archaeological finds stopping work.
 - Avoids the town centre so lower risk of complaints and possible claims
 - Route partly along Luton to Dunstable guided bus route – there has been a long-standing plan to extend the route to Leighton Buzzard. This could be incorporated/collaborated with as part of the pipeline construction.
 - The most direct route to Chaul End WSR.

- Disadvantages:
 - The route is wholly within the highway or verge so daily production rates (i.e. metres of pipes laid per day) will be lower than through agricultural land.
 - Risk of utility strikes
 - Route partly along Luton to Dunstable guided bus route – although there are wide footpaths and verges the reinstatement costs may be higher than standard construction
- Leighton Buzzard – Chaul End Route 3
 - Advantages:
 - The route is wholly within the highway or verge therefore limited landowners to consult.
 - Standard permits and constraints therefore straightforward and known planning costs
 - Lower risk of archaeological finds stopping work.
 - Disadvantages:
 - The route is wholly within the highway or verge so daily production rates (i.e. metres of pipes laid per day) will be lower than through agricultural land.
 - Reputational (AWL) risks high with likely multiple complaints/claims for delay and loss of business
 - Risk of utility strikes
 - Limited space in Houghton Regis and Dunstable for site set up, storage areas etc.
- Leighton Buzzard – Chaul End (Via Boxted)
 - Advantages:
 - The route to Boxted is wholly within the highway or verge therefore limited landowners to consult.
 - The route to Chaul End mainly follows existing AWL assets so there is the option of using economies of scale to upgrade/replace assets at lower costs.
 - Lower risk of archaeological finds stopping work.
 - Disadvantages:
 - The route to Boxted is wholly within the highway or verge so daily production rates (i.e. metres of pipes laid per day) will be lower than through agricultural land.
 - The longest route – a busy link between Leighton Buzzard and Hemel Hempstead with limited diversion routes.
 - The route from Boxted is through agricultural land and alongside the M1 so access will be constrained.
 - Risk of utility strikes
- Tring – Chaul End (Via Boxted Route 1)
 - Advantages:
 - The route to Chaul End mainly follows existing AWL assets so there is the option of using economies of scale to upgrade/replace assets at lower costs.

- Disadvantages:
 - Although the route is within the highway it passes through multiple environmentally designated sites (e.g. SAC's, SSSI's, Roman settlements etc.) therefore planning will be more complicated than standard.
 - The route from Boxted is through agricultural land and alongside the M1 so access will be constrained.
 - The second longest route by only a few hundred metres – a busy link between Leighton Buzzard and Hemel Hempstead with limited diversion routes.
 - Risk of utility strikes
- Tring – Chaul End (Via Boxted Route 2)
 - Advantages:
 - The route to Chaul End mainly follows existing AWL assets so there is the option of using economies of scale to upgrade/replace assets at lower costs.
 - Disadvantages:
 - The route from Boxted is through agricultural land and alongside the M1 so access will be constrained.
 - Risk of utility strikes
- Hemel Hempstead – Chaul End (Via Boxted)
 - Advantages:
 - The route mainly follows existing AWL assets so there is the option of using economies of scale to upgrade/replace assets at lower costs.
 - Disadvantages:
 - The route from Boxted is through agricultural land and alongside the M1 so access will be constrained.
- The Grove – Abbots Langley
 - Advantages:
 - The route mainly follows existing AWL assets so there is the option of using economies of scale to upgrade/replace assets at lower costs.
 - Disadvantages:
 - The route is largely within the highway or verge so daily production rates (i.e. metres of pipes laid per day) will be lower than through agricultural land.
 - The route mainly follows existing infrastructure therefore constraints may be greater than other routes.
 - Multiple major crossings to negotiate.
 - A short section (700m) crosses the A41, the canal, River Gade and the mainline railway – this will be particularly challenging and costly
 - Risk of utility strikes

RESILIENCE

The main potential impacts on the resilience of the abstraction transfer pipeline are related to climate change and flood risk. The resilience of the outlet structures, treatment and associated infrastructure are considered in Section 3.1.

As all the pipeline routes cross main rivers and watercourses and are thus affected by flood risk to some extent, this is not considered to be a differentiating factor.

From a supply resilience perspective those routes which link to existing AWL storage assets will potentially allow more flexibility in system operation, leading to more supply resilience.

4.2 ENVIRONMENTAL IMPACT

ENVIRONMENTAL RISKS

GIS mapping has been used to identify and compare the relative potential environmental impact of the four options on environmental and heritage sites within a 1km buffer.

The comparison concentrated on sites with statutory and non-statutory environmental and heritage designations, using spatial data available under Open Government Licence¹⁴, including:

Sites with International Designations

- World Heritage Sites
- Ramsar England: A Ramsar site is the land listed as a Wetland of International Importance under the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the Ramsar Convention) 1973.

Sites with European Statutory Designations

- Special Protection Area: A Special Protection Area (SPA) is the land classified under Directive 79/409 on the Conservation of Wild Birds.
- Special Areas of Conservation: A Special Area of Conservation (SAC) is the land designated under Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora.

Sites with National Statutory Designations

- Scheduled Monuments: Scheduled monuments are nationally important monuments and sites. The aim of scheduling is to preserve sites and monuments as far as possible in the form in which they have come down to us today. They are legally protected through the Ancient Monuments and Archaeological Areas Act 1979.
- Listed buildings: Listing marks and celebrates a building's special architectural and historic interest and brings it under the consideration of the planning system, so that it can be protected for future generations.
- Sites of Special Scientific Interest: A Site of Special Scientific Interest (SSSI) is the land notified as an SSSI under the Wildlife and Countryside Act 1981, as amended.

¹⁴ [Search Results - data.gov.uk](#)

- Areas of Outstanding Natural Beauty (AONB): Areas of Outstanding Natural Beauty (AONB) are designated areas where protection is afforded to protect and manage the areas for visitors and local residents.
- National Nature Reserves England: A National Nature Reserve (NNR) is the land declared under the National Parks and Access to the Countryside Act 1949 or Wildlife and Countryside Act 1981 as amended.
- Locations of ponds surveyed as part of the Natural England 2013 Great Crested Newt Evidence Enhancement Project (Crested Newt Pond Surveys & Great Crested Newt Class Survey)

Other Local Designations

- Historic Parks and Gardens
- Local Nature Reserves
- Country Parks England
- Ancient Woodland England
- National Trails England.

The designated sites that were identified as being located within the 1km buffer, split into the different types of designations, are summarised in

Table 3-3. Further details of these sites can be found in the 'Site Appraisal' Report.

Table 4-2 – Summary of Environmental Risk for each of the Abstraction Site Transfer Routes

Designation	Leighton Buzzard – Chaul End Route 3	Leighton Buzzard – Chaul End Route 1	Leighton Buzzard – Chaul End (Via Boxted)	Tring – Chaul End (Via Boxted Route 1)	Tring – Chaul End (Via Boxted Route 2)	Hemel Hempstead – Chaul End (Via Boxted)	The Grove – Abbotts Langley
International	0	0	0	0	0	0	0
European	0	0	0	4	0	0	0
National	13+3+2 =18	7+5=12	72+16+39 =127	4+1+32+81+39 =157	19+8+39 =66	1+39 =40	3+129 +39 = 171
Other	0	0	1	1	1	1	1

Although it is unlikely that all the designated sites identified in

Table 3-3 would be affected by the options, the route that has the least risk overall from the perspective of environmental impact is Leighton Buzzard Chaul End Route 1.

CARBON ASSESSMENT

A preliminary carbon assessment has been undertaken for the routes.

GHG emissions for construction are summarised in the following table.

Table 4-3 – Summary of Carbon for each of the Abstraction Site Transfer Routes - Total lifetime GHG emissions (tCO₂e)

Leighton Buzzard – Chaul End Route 3	Leighton Buzzard – Chaul End Route 1	Leighton Buzzard – Chaul End (Via Boxted)	Tring – Chaul End (Via Boxted Route 1)	Tring – Chaul End (Via Boxted Route 2)	Hemel Hempstead – Chaul End (Via Boxted)	The Grove – Abbots Langley
33,764	27,597	74,551	74,090	49,753	37,149	63,975

The route that has the least risk overall from the perspective of Carbon impact is Leighton Buzzard Chaul End Route 1.

FLOOD RISK

It is not considered that flood risk would be a differentiator for the options for the abstraction transfer pipelines during operation. Any additional measures required for construction, for example to mitigate flotation, are considered within the costs section.

4.3 SOCIAL IMPACT

As defined by the International Association for Impact Assessment (IAIA), a “Social Impact Assessment includes the processes of analysing, monitoring, and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions...”

BASELINE SITUATION IN THE VICINITY OF THE ALTERNATIVE TRANSFER PIPELINE ROUTES

The English Indices of Multiple Deprivation (IMD2019) has been used to understand what the current (baseline) situation is in the vicinity of the alternative routes. This index considers seven domains of deprivation in combination: Income; Employment; Education; Health; Crime; Barriers to Housing and Services; and Living Environment.

The relative levels of deprivation in the vicinity of the routes, mapped by Lower layer Super Output Areas (LSOAs), can be seen on Figure 4-1 and Figure 4-2.

The areas are ranked from the most deprived (indicated by the areas with the lowest indices in dark blue) to the least deprived (indicated by the areas with the highest indices in pale green).¹⁵

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https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833959/loD2019_Infographic.pdf

Figure 4-1 - Levels of relative deprivation in the vicinity of the transfer routes connecting into the AWL network

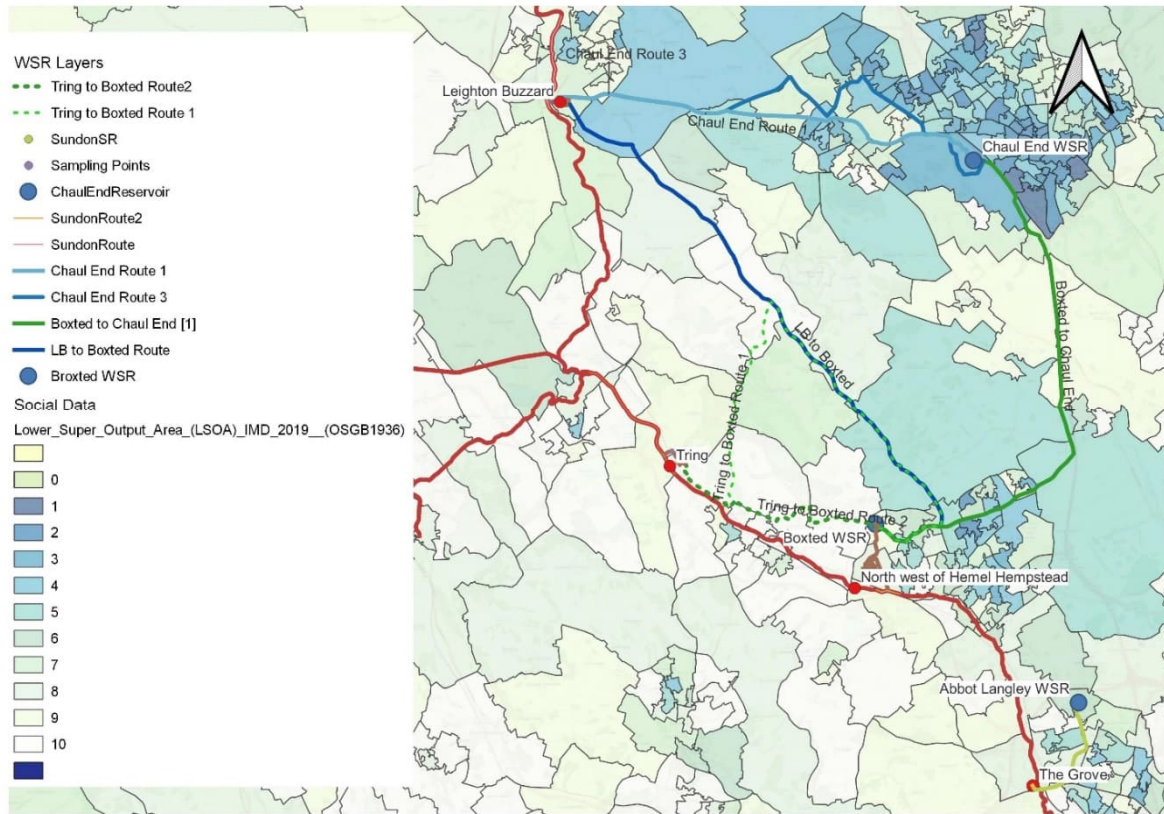
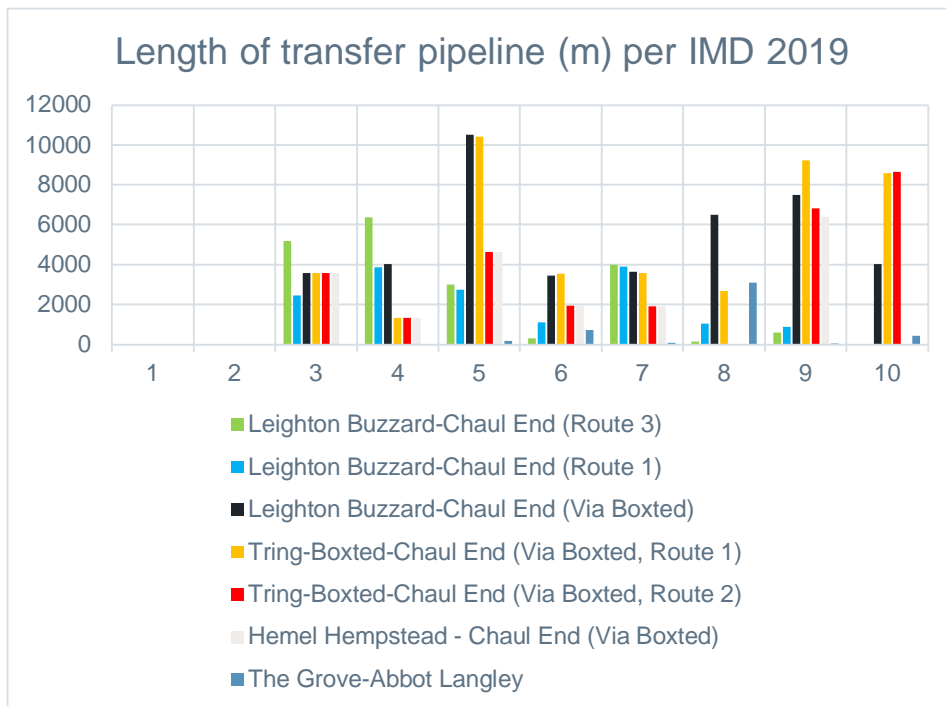


Figure 4-2 – Shows a comparison of the relative lengths of transfer pipeline within LSOA areas with highest levels of deprivation (1) to the lowest levels of deprivation (10)



All seven routes affect LSOAs that make up some of the most deprived areas in the country. LSOA neighbourhood data¹⁶ for those LSOAs directly affected by the pipeline routes, with Indices of Multiple Deprivation (IMD) of 3 and 4, are described in the following sections¹⁷. The LSOAs with an Indices of Multiple Deprivation of 3 and 4 are summarised in the following tables. Figure 4-3 and Figure 4-4 show the LSOAs with an IMD of 3 and 4 highlighted in yellow.

Additionally, as indicated by the LSOAs with the darkest blue, the pipelines pass in close vicinity of areas with IMD of 1 and 2. For example, the Boxted to Chaul End pipeline passes the LSOAs of Luton 020E and Luton 020A, within the Farley Ward. These are amongst the 10% most deprived neighbourhoods in the country and are affected by the full breadth of indices of deprivation related to income, employment, education, skills and training, health, crime, barriers to housing and services, living environment, income affecting children and older people.

It should be noted that the pipeline between The Grove and Abbots Langley does not affect any LSOAs between 3 and 4 and therefore this route has been excluded from the tables.

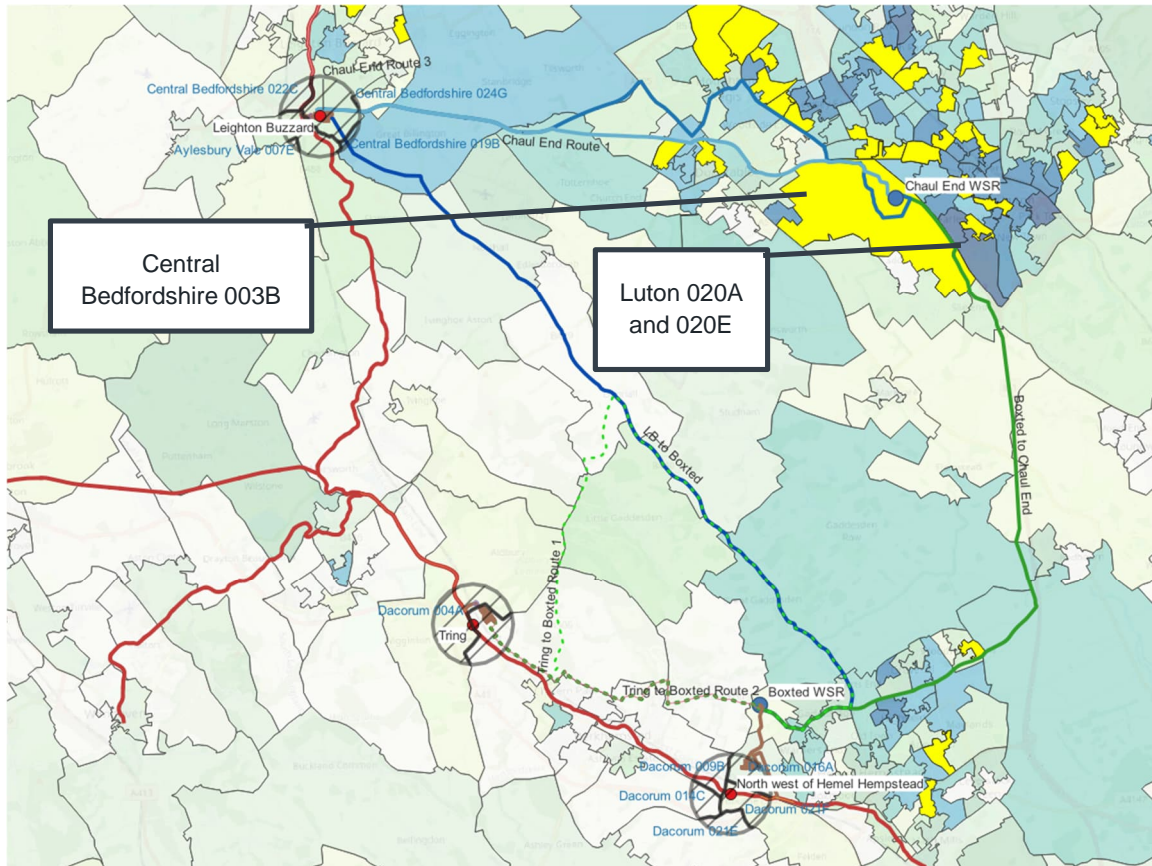


Figure 4-3 - Lower Super Output Areas (LSOA) with an Indices of Multiple Deprivation (IMD) of 3 (highlighted in yellow)

¹⁶ [Indices of Deprivation 2015 and 2019 \(communities.gov.uk\)](https://communities.gov.uk)

¹⁷ Note: None of the routes affect LSOAs with IMD of 1 or 2.

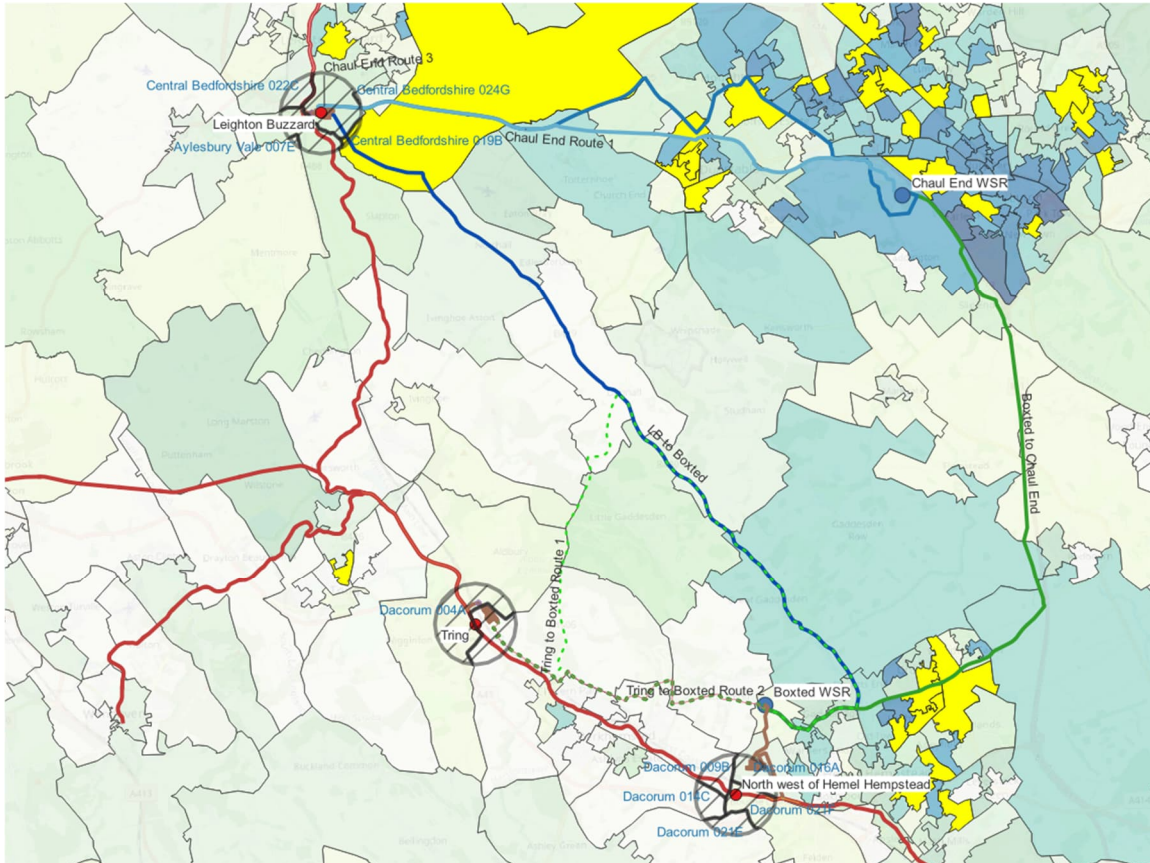


Figure 4-4 - Lower Super Output Areas (LSOAs) with an Indices of Multiple Deprivation (IMD) of 4 (highlighted in yellow)

The LSOA which would be affected by all the options is Central Bedfordshire 033B. This area is located within the Caddington ward and Central Bedfordshire local authority district. In 2019, it was ranked 8210 out of 32844 LSOAs in England, making it amongst the 30% most deprived neighbourhoods in the country. The most significant issues relate to crime and barriers to housing and services, for which it is one of the 10% most deprived areas in the country.

The other LSOAs listed in the tables are affected by the full breath of indices of deprivation related to income, employment, education, skills and training, health, crime, barriers to housing and services, living environment, income deprivation affecting children and older people.

Table 4-4 – Summary of LSOAs with an IMD of 3

LSOA	Leighton Buzzard – Chaul End Route 3	Leighton Buzzard – Chaul End Route 1	Leighton Buzzard – Chaul End (Via Boxted)	Tring – Chaul End (Via Boxted Route 1)	Tring – Chaul End (Via Boxted Route 2)	Hemel Hempstead – Chaul End (Via Boxted)
Luton 009B	✓					
Luton 009F	✓					
Central Bedfordshire 033B	✓	✓	✓	✓	✓	✓
Central Bedfordshire 026C	✓					
Central Bedfordshire 029C		✓				
Dacorum 005D			✓	✓	✓	✓

Table 4-5 – Summary of LSOAs with an IMD of 4

LSOA	Leighton Buzzard – Chaul End Route 3	Leighton Buzzard – Chaul End Route 1	Leighton Buzzard – Chaul End (Via Boxted)	Tring – Chaul End (Via Boxted Route 1)	Tring – Chaul End (Via Boxted Route 2)	Hemel Hempstead – Chaul End (Via Boxted)
Central Bedfordshire 026D	✓					
Central Bedfordshire 028F	✓	✓				
Central Bedfordshire 019B	✓	✓	✓			
Dacorum 013B			✓	✓	✓	✓
Dacorum 007A			✓	✓	✓	✓
Dacorum 007C			✓	✓	✓	✓
Dacorum 008B			✓	✓	✓	✓

COMPARISON OF POTENTIAL SOCIAL IMPACT

The following social factors have been considered when making a comparison of the options. These are factors that are considered are most likely to differentiate between the routes and primarily relate to the potential impact and disruption to local communities, as well as users of the canal network and non-motorised users such as walkers, cyclists, and equestrians. It is recognised that most of these impacts are likely to occur during construction.

- People’s way of life on a day-to-day basis, including impacts affecting access to amenities, services, and employment. In particular, works could cause disruption when the transfer pipelines are laid through built up areas. Additionally, the proposals could impact both active travel and vehicular routes.
- Community, including cohesion, character, and impact on services/amenities within the community.
- Environment – Including impacts related to the risk of pollution (such as noise, air, or water pollution) and/or loss of habitats. For this comparison, it has been assumed that the environmental impact would be directly proportionate to the environmental risks identified in Section 4.2.
- Health and well-being – Including health related impacts, such as stress or the reduced likelihood of people exercising and enjoying the local environment, open spaces (such as the Canal, cycleways, bridleways, and footpaths).
- Personal and property rights – for example loss of land ownership or third-party rights. It is assumed for the purpose of the comparison that, apart from private moorings, the greatest impact would be associated with the transfer pipeline as most of the land along the Canal route is owned by the Trust.

Social impacts such as those related to culture and political systems would be affected similarly by all the routes, and therefore would not be differentiating factors. Similarly impacts such as personal safety would be subject to mitigation.

Table 4-6 – Summary of potential social Impacts – Routes between Leighton Buzzard and Chaul End WSR

Social factor	Leighton Buzzard – Chaul End Route 3	Leighton Buzzard – Chaul End Route 1	Leighton Buzzard – Chaul End (Via Boxted)	Tring – Chaul End (Via Boxted Route 1)	Tring – Chaul End (Via Boxted Route 2)
People’s way of life	Construction could cause a major impact on access to services and amenities in the centre of Houghton Regis.	Option mitigates impact on Houghton Regis, by following NCNR 6 and 606. However, this would impact on users of the cycleways.	Option follows road B440 through the Chiltern Hills. Could cause minor disruption during construction.	Option follows B4506 before joining with B440. Could cause minor disruption during construction.	Option skirts around edge of Chiltern Park. Could cause a minor disruption during construction.

Social factor	Leighton Buzzard – Chaul End Route 3	Leighton Buzzard – Chaul End Route 1	Leighton Buzzard – Chaul End (Via Boxted)	Tring – Chaul End (Via Boxted Route 1)	Tring – Chaul End (Via Boxted Route 2)
Community	There would be significant disruption during construction.		There would be disruption to the community of Gadebridge during construction.		
Environment	A very short length of pipeline falls within the Chiltern Hills AONB.		Falls within the Chiltern Hills AONB.	Falls within the Chiltern Hills AONB. It runs between sites with environmental designations along the B4506.	Crosses through the edge of the Chiltern Hills AONB. Length designated as an urban wildlife corridor. ¹⁸ Potential archaeological interest.
Health and well-being	Even with traffic management, due to site constraints works could cause stress to residents and visitors.	During construction, the works could detrimentally impact on people's habits that promote health and well-being.		Route impacts on PROWs.	Route impacts on PROWs, other footways, and recreational facilities. Works could detrimentally impact on people's habits that promote health and well-being.
Personal and property rights	The route primarily follows highways. Therefore, limited impact.	Cycleway route ownership would need clarifying (E.g. whether owned by or under licence to Sustrans).		Option affects agricultural land and third-party wayleaves.	Option affects agricultural land, third-party wayleaves, and other private land.

All options have some impacts, but these are not considered to be a differentiator at this level of definition and further work may be needed at the next stage of development.

¹⁸ See Figure 3, [la4-master-plan-\(adopted-12-july-2017\).pdf \(dacorum.gov.uk\)](https://www.dacorum.gov.uk/media/14444/la4-master-plan-(adopted-12-july-2017).pdf)

4.4 COST

A detailed Civil Engineering Standard Method of Measurement Bill of Quantities (CESMM BoQ) cost estimate has not been produced for the comparison of transfer pipelines. It is anticipated that this would be produced only for the preferred option. Comparison has however been undertaken on the assumption that the costs would be proportionate to the relative length of pipeline and pump heads and therefore use the AWL cost curves for infrastructure (Unit Cost Trunk Renewals sheet provided by AWL).

A summary of the relative costs is provided in the table below.

Table 4-7 – Summary of Indicative Cost Estimate for Abstraction Transfer Pipelines

Type	Leighton Buzzard – Chaul End Route 3	Leighton Buzzard – Chaul End Route 1	Leighton Buzzard – Chaul End (Via Boxted)	Tring – Chaul End (Via Boxted Route 1)	Tring – Chaul End (Via Boxted Route 2)	Hemel Hempstead – Chaul End (Via Boxted)	The Grove – via Abbotts Langley
Length (m)	19545	15973	43156	42888	28801	19766	37033
Pump Head (m)	100	100	60	60	90	90	120
Capital expenditure (£M)	38.88	31.77	85.84	85.31	57.29	39.32	73.66
Annual operational expenditure (£M)	1.80	1.69	2.04	2.04	1.97	1.69	2.58

The abstraction site location that, based on the indicative cost estimates produced to date, is forecast to have the lowest capital and annual operational cost is Leighton Buzzard to Chaul End Route 1.

4.5 POTABLE WATER TRANSFER ROUTE OPTION COMPARISON

The comparison of the routes and sites has been based on quantitative data where available. The sites have been ranked from 1 (performs the best) to 4 (performs the worst). Where further assessment would be required to differentiate between the sites, they have been scored at the same level.

Table 4-8 – Summary of comparison of potable water transfer route locations

Option components	Leighton Buzzard – Chaul End Route 3	Leighton Buzzard – Chaul End Route 1	Leighton Buzzard – Chaul End (Via Boxted)	Tring – Chaul End (Via Boxted Route 1)	Tring – Chaul End (Via Boxted Route 2)	Hemel Hempstead – Chaul End (Via Boxted)	The Grove – via Abbotts Langley
Engineering Design							
Route Constraints	2	4	1	3	5	6	7
Construction Risks and Opportunities	2	2	3	4	1	1	7
Resilience (of supply)	6	6	2	2	2	2	1
Environmental impact							
Environmental risk	2	1	5	6	4	3	7
Carbon Cost	2	1	7	6	4	3	5
Flood Risk	3	3	3	3	3	3	3
Social Impact	3	3	3	3	3	3	3
Other factors							
Capex	2	1	6	7	4	3	5
Annual Opex	3	1	5	6	4	1	7

By inspection the preferred route is Leighton Buzzard to Chaul End Route 1.

If all the scores are simply summed this finding is confirmed. Removing the cost assessment scores or the scores where there are no differentiation (e.g. flood risk and social impact) confirms this selection as shown below:

	Leighton Buzzard – Chaul End Route 3	Leighton Buzzard – Chaul End Route 1	Leighton Buzzard – Chaul End (Via Boxted)	Tring – Chaul End (Via Boxted Route 1)	Tring – Chaul End (Via Boxted Route 2)	Hemel Hempstead – Chaul End (Via Boxted)	The Grove – via Abbotts Langley
All scores summed	25	22	35	40	30	25	45
Rank with all scores summed	2	1	5	6	4	2	7
Sum excluding cost score	23	21	29	33	26	22	40
Rank with no cost score	3	1	5	6	4	2	7
Sum excluding common scores	19	16	29	34	24	19	39
Sum excluding cost score	2	1	5	6	4	2	7

4.6 VALUE - WIDER BENEFITS

As noted in Section 3.5 above there is the opportunity for wider benefits. The benefits principally occur at the main abstraction and treatment works sites and these have been addressed above at high level. For the potable water transfer pipeline routes there may be benefits but these are not considered to be sufficiently differentiating, given the dispersed and uncertain nature that might accrue, on which to base a decision. For Gate 3 it would be worth wider engagement with statutory and non-statutory consultees to establish the sorts of benefits that might be cost effectively derived from the works.

5 SUMMARY

On cost (capital and operational) alone, the preferred site and potable water transfer route combination would be Leighton Buzzard with Route 1 to Chaul End. When all the additional advantages are also included then this combination is clearly the preferred option to take forward for more detailed assessment.

Tring is the next most advantageous site but pipeline routes into distribution at Chaul End are unfavourable. The routes are expensive and have high environmental risks.

Hemel Hempstead only has advantages over the other sites if there is a need to distribute water to Boxted and Chaul End. As the stated criteria was to distribute water eastwards from Chaul End, Hemel Hempstead did not meet these requirements.

Grove site and potential pipeline routes into the system have no advantages. The site also has major crossing and planning challenges.

NEXT STAGES

During the development work reported above several assumptions have been made and this leads to uncertainties in some of the detail. Some of the uncertainties are at a more strategic level than dealt with in this report; for example the utilisation patterns across the years are unknown as they will respond to the finally agreed programme of abstraction reductions and to the effects of climate change on water availability, as well as to any growth in population and their attitudes and behaviour in respect of water use. Increased utilisation will lead inevitably to higher opex (chemicals and energy), and this impact may affect long term decisions about power sources and the value of investing in renewables or in operational changes.

At a less strategic level there are also uncertainties relating to ground elevations and soil conditions for all elements of the proposed works and not just at the abstraction site and along the route of the potable water transfer main. A campaign of geotechnical and topographical survey is proposed in the Concept Design Report to resolve these issues for the next stage of design.

In addition, to date all the environmental assessment has been undertaken at desk level; a significant campaign of baseline survey will be required for the full range of potential impacts including water bodies, acoustics, visual impact, landscape quality, heritage, ecology. Finally whilst there has been limited engagement with statutory consultees there has been very little with non-statutory consultees and given the great distance over which the scheme will extend this will require some effort.



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