



Horncastle and Tattershall/ Coningsby Canal Heritage (H.A.T.C.H)

Horncastle & Tattershall Canal

Feasibility Study

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EXECUTIVE SUMMARY

Purpose of Brief

Bullen Consultants was appointed by Horncastle and Tattershall Canal Heritage (HATCH) to investigate the technical requirements of restoring Horncastle and Tattershall Canal back to a fully operational canal. Several difficulties are faced with the restoration of the canal, as the canal has not been operational since the early 1900's.

The extent of the River Bain included in this study is from the Bain/ Waring confluence in Horncastle to the confluence of the River Witham and River Bain, south of Tattershall at Dogdyke. This study does not include the sections of canal into Horncastle up to the north and south basins.

This study has investigated these issues, which include water supply, flooding and environmental impacts, to determine if the restoration is technically feasible. A cost estimate of the restoration works was required to determine how much funding would be required to restore the canal.

Public Consultation

As part of the feasibility study a preliminary consultation was undertaken with local residents/landowners as well as with relevant organisations, such as the Environment Agency. This consultation process was to gauge people's opinion of the scheme to determine whether they were in favour or against the restoration of the canal.

From the consultations undertaken the majority of responses were in favour for the restoration however, there were some reservations regarding the scheme and these are listed below.

- ***Environmental Impacts*** – Concerns were raised over the affect the restoration would have on the ecology of the area and the pollution from boats.
- ***Flooding Issues*** – The risk of flooding in the area of the River Bain should not be increased with the restoration of the canal.
- ***Construction/ Maintenance of the Canal*** – Disruption to the local residents during the restoration works and the affects it will have on land drainage.
- ***Financial Concerns*** – Comments were received regarding who will finance the scheme and would it be an on-going cost for the Local Authority.

The majority of these concerns have been addressed within the feasibility report with the exception of the financial comments, as this was not part of the brief.

Water Resources

Water resources have been investigated in three main sections, these are the existing water requirements, predicted demand for water for navigation, and how to supply this water to the canal.

The existing water requirements include the abstractions from the canal and the recent Catchment Abstraction Management Strategy (CAMS) that had been undertaken by the Environment Agency for the Witham catchment. The compensation water required for the Old River Bain channel was also considered as part of the existing demand for water.

The water demand for navigation was determined by estimating the number of boat trips on the canal to calculate the number of lock operations and the leakage rate. The predicted number of boat trips was estimated by investigating the surrounding canal infrastructure and the number of boats that currently used the River Witham. Future improvements to the canal infrastructure, such as the extension of the Kyme Eau navigation and the new Fen Waterway Link, were taken into consideration. It was calculated that it would take approximately one day to travel from Dogdyke to Horncastle so the navigation would make a weekend trip. Future growth of the canal traffic has been taken into consideration and has been assumed to be in the region of 2% over the next ten years.

Taking all these factors into consideration, the estimated number of boat trips on Horncastle and Tattershall Canal is 2000 trips per annum. This figure is dependant on the Fenland Link being constructed, as this will open up Lincolnshire's waterways to a wider canal network.

It was assumed that one lock full of water would be used for each trip along the canal, irrespective of the length of the canal travelled. From this it was estimated that the number of lockages used per year would be 1429 and this equates to 404,646m³. The leakage of the canal was estimated by using the nationally accepted figure of 1.75Ml/km/wk. However the leakage figure was rationalised as it was thought that it was excessive for the parts of the canal that had been specifically constructed as a canal and lined with puddle clay. Therefore it was decided to use half the figure for leakage so the overall total required for leakage is 644,000m³ per year. Hence the total water demand for navigation is just over 1 million m³ of water.

The water demand for the navigation equates to 50 litres per second (l/s) and the recorded flow from gauging stations at Horncastle, Fulsby and Coningsby were analysed to determine periods of low flow. It was decided to keep the canal operational until a 20 year low event occurred when the canal would have to be closed. From the gauged data it was determined that the flow had fallen below 50l/s for 8 weeks during 20 years of record. This gave the length of time water had to be supplied from storage.

There are two options available for keeping the canal operational up to a 20 year low flow, these are storage of the whole volume required for an 8 week period or store a smaller amount and back pump the flow back to the top of the system.

Flood Control

Major flood events that have affected Horncastle and the surrounding villages on the River Bain have occurred in 1920, 1960 and 1981. Horncastle currently floods at less than a 1 in 10 year return period event (10% annual probability) and Kirkby-on-Bain and Haltham flood at about the 1 in 10 year return period. Coningsby and Tattershall are more at risk from the River Witham flooding than the River Bain and it is estimated that these villages could be affected by flooding between a 1 in 25 years and 1 in 50 year return period event (between a 4% and 2% annual probability).

A flood alleviation scheme has been proposed for Horncastle to alleviate flooding up to the 1 in 100 year return period event (1% annual probability). This involves the construction of flood storage reservoirs upstream of Horncastle on both the River Bain and the River Waring. At present there are no known plans to implement a scheme for the villages of Kirkby-on-Bain and Haltham.

If the canal is restored then the risk of flooding to the surrounding properties and land should not be increased. The flood flows should be able to flow down the canal in a similar way as they do in the existing situation. Three main options have been identified that would allow the conveyance of flood flows down the canal. A bywash channel around the lock structure was identified as the most appropriate solution as it would allow the canal to be operational all year round and take into account the possibility of summer flooding. There should not be an increase in the risk to safety to boaters with a bywash during a flood event unlike the overtopping of the lock gates option. This risk to safety could be minimised by using flood warning devices, offline moorings for boats, or fenders in front of the by-wash weirs to stop boats being washed over the weirs.

Restoration

The canal was spilt into four sections and these are:

- Confluence with the River Witham to Coningsby Lock
- Coningsby Lock to Kirkby-on-Bain
- Kirkby-on-Bain to Haltham Lock
- Haltham Lock to Horncastle

The confluence with the River Witham to Coningsby Lock section is the area with the most difficulties. It has been identified that one of the original routes of the canal, called Gibson's Cut, could not be restored due to developments since the canal's closure. These include a culvert underneath the A153 (Sleaford Road), which would need to be replaced with a bridge and the A153 road would need to be realigned.

The route from Dogdyke is currently the main channel of the River Bain from Coningsby to the confluence. However there are some issues with this route with regard to navigation and three options have been identified. The main difficulties with this section are the reduction in headroom at Butts Bridge and Tattershall Gauging Station. Three options have been identified but only two resolve all the difficulties associated with this section. The two main options are:

- Option A - Deepening the channel and underpinning the bridges,
- Option B - Raising Butts Bridge with dredging of the channel bed.

The third option is the same as the second option (of raising Butts Bridge) but does not include for the bridge raising and accepts a lower headroom requirement. All the options have major implications on the local residents and the ecology of the canal.

Between Coningsby Lock and Kirkby-on-Bain the restoration of the canal generally consists of refurbishment of the locks and remedial works to the banks and channel bed. There are two locks within this section that require refurbishment; these are Tumby Lock and Fulsby Lock both of which need various amounts of restoration. Dredging is required throughout the length of this section to remove the build up of silt that has accumulated since the canal's closure. Linings of the canal may also be required but the extent is unknown without further investigations.

The next section of the canal consists of the area between Kirkby-on-Bain and Haltham Lock. At Kirkby-on-Bain the original alignment of the canal has been long since filled in so the route that the river takes at present is down an old mill race. It is not feasible to reinstate the original canal cut as a house has been recently constructed near the original alignment. For this section it is proposed to construct a new canal cut with a new lock to take the canal slightly further away from the village but within walking distance. The exact position of the new cut has not been decided as further investigations are required, especially into the ground conditions and landowner agreements. Haltham Lock has been highly modified and there are very few original features that still remain. The lock structure requires refurbishment and the concrete footbridge needs to be raised, as it does not have the required headroom.

Within the section between Haltham and Horncastle there are five locks that require refurbishment works, each with varying degrees of remaining traditional features. As well as the lock refurbishment, the canal's bed will require dredging and there is the possibility that it may require lining to reduce seepage.

A storage area has been proposed to the south of Horncastle to keep the canal operational during an exceptionally dry summer. The water would be stored over the winter months and used during the summer if required.

Winding holes and mooring site have been considered within the restoration works. The winding holes have been placed so that visitors have various options on the length of their voyage up or down the canal. Overnight mooring should be provided near the villages or places of interest. Off line mooring is preferred, as this would give the boats some protection if a flood event occurred on the canal.

The existing access to the canal has been investigated and there are several areas where improvements can be made. These include extending the tow path to cover the whole length of the canal and providing the possibility of circular walks to nearby villages, such as Woodhall Spa. The Disability Discrimination Act (DDA) should be taken into account when looking to improve the existing access as well as when providing new footpaths/ cycleways.

It is suggested that the construction and restoration works of the canal are phased to minimise the disruption to local residents. Before the canal is opened several safety issues also need to be considered, such as the safety of boaters during a flood event.

Environmental Issues

Restoring the canal and subsequent recreational activities associated with the canal will have an impact on the existing natural and human environment. Restoration will result in impacts both during restoration and operation of the canal. Hence an Environmental Impact Assessment (EIA) is required to determine the impacts of the restoration and propose mitigation measures. A Scoping Report has been produced as the first stage of an EIA and provided information on key features and outlined the proposals for the canal. This document facilitated the consultation process with relevant organisations and individuals.

General mitigation measures for the ecology of the area are given in broad terms as survey work is required to determine the exact extents of the species present and then specific mitigation measures can be formulated. For example if water voles are located along the foreshore banks then these would be trapped and translocated and substantial habitat restoration and improvements could be made to encourage the establishment of the water voles.

As well as ecology the EIA would include the existing landscape, public use and human access, water resources and archaeology and cultural history. If there were any negative impacts caused due to the restoration of the canal then these would be highlighted for mitigation during construction and operational use of the canal.

Cost

The cost of the proposed options for restoration was calculated using the geometry information gathered about the canal and the rates were generally obtained from the Civil Engineering Standard Method of Measurement 3 (CESMM3) Price Database 1999/2000. These rates were then adjusted to January 2005 prices by using the Retail Price Index (RPI). Rates not taken from CESMM3 were taken from relevant manufacturers or from similar project and have been adjusted for RPI where applicable. Below is a summary of the cost calculated for the restoration of Horncastle and Tattershall Canal

Location	Cost (£)
<i>Dogdyke to Coningsby</i>	
Deepening of channel	3,611,000
Raising bridges	3,846,000
Reduced headroom	2,676,000
<i>Coningsby to Horncastle</i>	
Refurbishment of eight locks	5,034,000
Kirkby-on-Bain canal cut	1,371,000
Dredging	1,565,000
<i>Water Supply Options</i>	
Storage area only	2,193,000
Pumping station and storage area	1,936,000
<i>Others</i>	
Land acquisition	104,000
Total: raising bridges option and excluding lining)	14.6 million
Total: raising bridges option plus 50% of lining costs	20.1 million
Total: raising bridges option plus 100% of lining costs	25.6 million

The Way Forward

From this feasibility study it has been determined that the restoration of Horncastle and Tattershall Canal is practically feasible in terms of engineering works however it will cost between £20.1 million and £25.6 million. The next stage is to consider the legal and financial aspects of the scheme, such as who would maintain the navigation once it has been restored and to allow a comprehensive funding package to be negotiated. Once these issues have been resolved then detailed design can commence along with several detailed surveys of the site, including ground investigations and structural surveys of lock structures.

As mentioned previously the construction of the canal should be phased to reduce the impact on local residents and the environment. It is proposed that the restoration should start from Dogdyke to Coningsby and then work up to Horncastle in stages.

1.0 INTRODUCTION

Background

- 1.1. Horncastle and Tattershall Canal was originally constructed in the latter part of the 18th Century as a vital transportation link for the people of Horncastle and its surrounding area to the rest of the country. It was the beginning of the industrial revolution that was sweeping Britain. There were major changes in the way that the land was farmed and an increase in trade for commodities such as coal. However, Horncastle and that area of Lincolnshire was isolated from the rest of country as the road network was very poor.
- 1.2. Once the canal was opened, trade thrived and Horncastle grew in prosperity. However the life of the canal was short lived as by the middle of the 19th Century the railways came to Horncastle and aided in the demise of the canal.
- 1.3. Even though the railway has long since gone, the canal still remains but, at present it is not navigable, as all the locks have been changed into weirs. The canal mostly follows the River Bain channel. The original alignment of the River Bain, where it is separate from the canal, is used for land drainage and is known as the Old River Bain. It is the aim of the Horncastle and Tattershall Canal Heritage (HATCH) Trust to restore the canal back to a fully operational canal. Instead of the canal being a vital transportation link it would be a tourist attraction and encourage a greater number of visitors to Horncastle and the surrounding villages.

Outline of Report

- 1.4. Bullen Consultants have been commissioned by HATCH to undertake a feasibility study into the validity of restoration of Horncastle and Tattershall Canal. One of the main concerns of converting the watercourse back to a canal is whether there is enough water available to support the navigation. An initial investigation into the water demand has been undertaken as part of this study to determine if the canal could be restored. A cost estimate of restoring the canal has also been completed to help determine if the scheme would be viable. As well as the engineering aspects of the restoration, other issues have been included, such as including other recreational activities such as cycling and walking as part of the scheme. The report is split into the following sections.
 2. History of the Canal
 3. Geological Desk Study
 4. Geometry of the Navigation
 5. Existing Water Requirements
 6. Water Demand
 7. Water Supply
 8. Flood Control
 9. Public Consultation
 10. Restoration Requirements

- 11. Access and Footpaths
- 12. Ecological Requirements
- 13. Cost of Restoration
- 14. Conclusions

1.5. It should be noted that throughout this feasibility study the Construction Design and Management (CDM) Regulations 1994 have not been taken into account. Any design proposals in this report have not been subjected to risk assessment, which must be carried out during the detailed design stage. Any detailed design decisions need to be assessed as to the risk involved, not only during construction but also through the whole life of the canal.

Acknowledgements

1.6. A full list of the organisations and private individuals that have donated money to this feasibility study or who have provided information are acknowledged in Appendix A of this report. However, certain organisations have helped with the production of the feasibility study so we would like to thank the following for their support

H.A.T.C.H



**Lincolnshire
County
Council**

**LINCOLNSHIRE
COUNTY COUNCIL**

**Inland
Waterways
Association**



**East Lindsey
District
Council**



**Environment
Agency
Anglian Region**



**ENVIRONMENT
AGENCY**

2.0 HISTORY OF THE CANAL

Why Build a Canal?

- 2.1. The growth and prosperity of Horncastle was limited by the lack of sufficient transport links and inefficient communication links with the rest of the country. Distribution of goods, such as corn and wool, to larger markets was difficult, as the roads were impassable for many months of the year. This meant that the import of coal, salt and iron to the area was also difficult due to the poor condition of the roads. As farm production increased, farmers not only needed an outlet for their products but also a means of getting fertilizers, such as bone meal, to their land in large quantities.
- 2.2. An additional problem was that the surrounding land was low lying and prone to flooding from the River Bain. Therefore, a canal connecting Horncastle to the River Witham was an obvious solution to the transportation and communication links, as well as to the flooding issues.
- 2.3. The River Bain flows into the River Witham, which has been navigable since the Grand Sluice was opened in 1766 making the river non-tidal upstream of Boston.

Construction & Operation of the Canal

- 2.4. Sir Joseph Banks (1744 – 1820) was a keen supporter of the navigation and had strong local interest as well as influence nationally. It was his continued support that saw the canal through to completion.
- 2.5. An unofficial committee was formed and a local solicitor was asked to arrange the drafting of a Parliamentary Bill. The draft Bill was ready for consultation by March 1792 and was approved and presented to Parliament. It became law in June 1792 and authorised the formation of the Horncastle Navigation Company. Part of the Bill covered the purchase of the Tattershall canal that had been constructed on land leased to them. The Act of Parliament made the lease null and void but stated that the landowner should be recompensed for the loss of the lease.
- 2.6. The appointed Engineer, William Jessop, proposed two options. The first proposal consisted of a completely new canal cut across country from Horncastle to Kirkstead at an estimated cost of £12,544. The second proposal was to deepen the bed of the River Bain and widen and straighten it where necessary to Tattershall and then on to Dogdyke at a cost of £12,233. One problem with the first proposal was the fact that approximately 22 new bridges were required for the new canal cut at a cost of £1,650. Maintenance of the bridges would be the responsibility of the Navigation Company. It was decided to use the second proposal of canalising the existing watercourse, as this was the preference of the Engineer.

- 2.7. Construction commenced in 1793 and during the early years there were frequent changes in Engineer/ Overseer, which lead to poor workmanship and failures of locks. Due to the poor workmanship progress was slow and the Navigation Company started to experience severe financial problems. Hence, the canal was completed up to Dalderby in 1797 so that tolls could be charged to recoup some money.
- 2.8. The committee, on the advice of Sir Joseph Banks, asked John Rennie (a well known consulting engineer) to advise on the completion of the canal. He recommended a new canal cut from Dalderby to the west of the River Bain as the existing river was too winding. Also parts of the existing canal were in need of repair so it was becoming urgent to finish the canal. The company obtained a further Act in 1800 to raise the money required to finish the canal.
- 2.9. The canal, 11 miles in length with a fall of 84 ft was completed in 1802 at a total cost of £45,000. A public holiday was called in the 17th September 1802 so that people in Horncastle could celebrate the completion of the canal. The canal prospered and made a profit up to the 1850's. Horncastle became a thriving market town with a population expanding and new businesses developing. As well as the cargo barges there were steam packets carrying passengers to Lincoln and Boston on a regular basis.

Decline and Closure of the Navigation

- 2.10. During the 1850's the profits of the canal, and hence the dividends paid to shareholders, fell dramatically due the expansion of the railway network. A railway line was constructed between Lincoln and Boston and in the early 1850's the Navigation Company was paid tolls by the railway company as they had constructed a wharf at Dogdyke.
- 2.11. The Railway Company decided to construct a line between Kirkstead and Horncastle. The Navigation Company opposed the construction of the new line to no avail. The railway opened in 1854 but this was one of many problems that the Navigation Company was facing. There was friction between the Navigation Company and the Local Board of Health as the local residents in Horncastle used the canal basins as dumping grounds for dead animals and refuse.
- 2.12. The canal continued to be used to transport goods to and from Horncastle but only by a small number of vessels. Repairs and maintenance to the canal were carried out in the 1870's but funds were low and some of the repairs were unsatisfactory. Even though the canal offered a cheaper alternative to the railway to convey coal, the coal companies were not interested and so the canal closed in 1889 due to the lack of maintenance. However, the lower section of the canal was still in use in the early part of the 1900's for the transportation of coal to local businesses and householders.

3.0 GEOLOGICAL DESK STUDY

The Horncastle and Tattershall Canal Catchment Geology

- 3.1. The River Bain catchment, south of Horncastle, generally consists of alluvium deposits made up of silt and clay. River terrace deposits flank the alluvial deposits comprising sands and gravels. Along the central and southern regions of the canal the Glaciofluvial Sheet Deposits of sands and gravels are thought to be very close to the invert of the canal. The solid geology in the canal area consists of the various clays that are of Upper Jurassic age and they dip to the northeast. No faults were detected in the area from the geological map.
- 3.2. Aquifers are rocks that can store or transmit significant quantities of water. A minor aquifer is present in the lower section of the canal. The gravels and sands found in the lower section of the canal provide an important source of local groundwater. However, due to the development of the canal it has been assessed from monitoring data that the hydraulic continuity of the groundwater in the sands and gravels is poor. The amount of water available from this area can be variable as this reflects the changes in the thickness and the differences in grain sizes. This aquifer has been highlighted as part of the Witham Catchment Abstraction Management Strategy (CAMS)¹.

Evaluation

- 3.3. Horncastle and Tattershall Canal is currently partly silted, overgrown with weed and subject to flooding at certain points along its length. Earth embankments were raised along much of the disused canal for flood alleviation purposes during the 20th Century. It is proposed to restore the canal by returning the bed of the river channel back to what is thought to be its original level. Dredging will be used to remove the silt deposits that have accumulated since the canal's closure.
- 3.4. The current depth of the canal channel varies between 2.0 m and 3.5 m from top of embankment bank level to the channel's bed. The height of the embankments varies from ground level to at least 2m above ground level.
- 3.5. The current canal bed may be located within the alluvial and glacial till deposits, which have a low permeability therefore, it is unlikely to present a problem of seepage through the sides and base.
- 3.6. The geological map shows glacio-fluvial sands and gravels exposed at the surface on either side of the alluvial deposits, which flank the canal. This suggests that the current canal bed is within alluvial deposits, which are in turn underlain by glacio-fluvial sands and gravels. By excavating to a deeper level these high permeability glacio-fluvial deposits (sands and gravels) are likely to be exposed. If this scenario were to arise the water levels within the canal could drop due to seepage occurring

¹ Environment Agency, The Witham Catchment Abstraction Management Strategy, March 2004

during the dry season. During the wet season the seepage flow may reverse to become infiltration at the base of the canal bed and instability problems could arise. If this situation were to arise it would be necessary for the canal to be lined.

- 3.7. Stability of the section of the canal between Coningsby and Dogdyke where there is proposed deepening is dependent upon the proposed slope and groundwater conditions adjacent to the side slope. If the permeable sands and gravel deposits are exposed; the resultant increased water pressure at the dredged bed will alter the seepage conditions acting on the sides and base of the canal, which may create instability. Hence, a detailed site investigation is required to determine the stability of the banks and the leakage rate along the whole length of the canal.

4.0 GEOMETRY OF THE NAVIGATION

Introduction

- 4.1. There is limited information about the actual geometry of the canal as there are no drawings of the finished canal. Apart from the book “The Horncastle and Tattershall Canal by J. N. Clarke” there is little information about the original geometry of the canal. From our investigation into the geometry of the canal it is apparent that several aspects have been altered to suit the needs of society since the closure of the canal. For example the embankments of the canal have been raised to help contain the river when it is in flood. Therefore, it is difficult to determine the actual geometry of Horncastle Navigation when it was operational.
- 4.2. Three sources have been used to investigate the canal’s geometry both past and present, these are outlined below:
- Environment Agency (EA) survey used to generate the hydraulic model
 - 1950 survey undertaken by EA’s Predecessors²
 - 1834 survey (as detailed in J. N. Clarke’s book)

The survey information has been compared to determine the most appropriate geometry to use to restore the canal. This comparison for the rise of the canal only extends to Coningsby Lock, as there is more than one route to the River Witham.

Rise of Canal

- 4.3. Each survey investigated found differences in the rise at each lock as well as the total rise. Table 4.1 below highlights the rises from each of the survey’s investigated and Figure 4.1 shows the longitudinal profile of the watercourse.

Location	Rise of Canal (m)		
	1834 Survey	EA’s 1950 Survey	EA’s Model Survey
Thornton Lock	2.438	1.219	0.440
Lodge Hill Lock	2.286	2.039	2.382
Martin Lock	2.243	2.862	2.398
Dalderby Lock	2.310	1.137	0.850
Roughton Lock	2.310	2.134	2.214
Halham Lock	2.591	1.241	2.109
Kirkby-on-Bain	2.210	1.768	2.198
Fulsby Lock	2.643	1.890	2.661
Tumby Lock	2.210	1.570	1.618
Coningsby Lock	2.795	2.362	1.917
Total Rise	24.036	18.222	19.589

Table 4.1: Comparison of the Rise of the Canal (metres)

² Anglian Water, Lincoln Division – Rivers Department, River Bain (Horncastle and Tattershall Canal) Longitudinal Sections 4000m – 7000m, Sept 1983, Drawing No. 0703/N/41

- 4.4. As can be seen from Table 4.1, the 1834 survey has the highest total rise. The other two surveys have a total rise of approximately 5 to 6 m less than the 1834 survey. The differences in the rises could be attributed to the following factors:
- ***Siltation between the Locks*** – It was assumed that in 1834, when the canal was operational there would have been very little or no gradient between the locks. The rise at each locks added together is assumed to be the total rise. Since the canal's closure there would have been no maintenance to the channel so deposits of silt would have formed along the length of the canal. This would give a fall between each lock so only adding all rises, from either the EA's 1950 Survey or EA's Model Survey, omits the gradient which is part of the reason behind the fact that the latter surveys show a significantly lower rise than the 1834 survey. Also the relationship between the original sill level at each lock and the level of the weirs, which have replaced the locks, is unknown. Comparing the actual ground levels of the canal between Horncastle Lock and Coningsby Lock the rise of the canal is 22.2m in the model survey and 22.3m in the 1950 survey. Figure 4.1 implies that the canal has silted to a depth of about 1.8m at Wharf Lane.
 - ***Different alignment at Kirkby-on-Bain*** – The present river goes through Kirkby-on-Bain in the line of the old millrace, whereas the original canal alignment was to the east of this. The original canal alignment has been filled in and now forms part of a private property and farmland. This means that at Kirkby-on-Bain we are not comparing the same structure between the 1834 survey and the EA surveys conducted much later. It is not clear when the original canal cut was backfilled in favour of the millrace but it is assumed that this occurred not long after the canal closed.
 - ***Survey techniques*** – The differences between the 1950's survey and the model survey, which would have been completed in the late 1990's/ early 2000's, could be attributed to the survey techniques used and the accuracy of the survey.
- 4.5. It has been decided to use the 1834 survey for any design work relating to the restoration of the canal as this was undertaken whilst the canal was operational. However this survey has no relation to surveys undertaken in recent times, as it does not relate to OS ground levels. During the walkover survey undertaken in September 2004 it was noticed that Roughton Lock still had its original top sill so the 1834 survey data was positioned on the long section from this lock.
- 4.6. Between Coningsby Lock and Dogdyke it is thought that there must have been another lock as there is a fall of around 2.2m from the 1834 survey line and the confluence with the River Witham. However there was no survey of this lock undertaken in 1834. There was also a lock on Gibson's Cut, near the confluence with the River Witham, which was included in the 1834 survey, and had a rise of 2.235m

Beam (Width)

- 4.7. From the three surveys investigated, the 1834 survey is the only one that indicates the widths of the locks. The locks were measured to have a beam of 15', which equates to 4.572m.
- 4.8. As the width of the lock is around 4.6m, it has been assumed that if the maximum width of boat is 4.5m then a navigable width of the pound, between each lock should, ideally, allow two of the largest boats to pass with a little additional room. Therefore it has been assumed that the navigable width of the watercourse should be in the region of 10m. The cross sections of the channel from the hydraulic model indicate that the majority of the existing channel's base width is in the region of 10m or greater except for a section of canal near Martin Lock. The base width of the canal in the region of Marin Lock is around 6m instead of 10m. Instead of widening all this section of the canal, there is the possibility of providing passing places.

Pound Length

- 4.9. Figure 4.1 indicates the longitudinal profile of canal of all three surveys. The 1834 survey provides no information on the pound lengths. However the two EA surveys do give an indication of the distances between the locks and these were compared to the distances measured from the OS 1: 10,000 digital maps. Table 4.2 below compares the two EA surveys and the distances measured from the digital maps.

Location	Pound Lengths (m)		
	1950's Survey	Model Survey	OS Maps ^{1,2}
Thornton Lock			
	492	550	505
Lodge Hill Lock			
	1,317	1,300	1,327
Martin Lock			
	1,105	1,150	1,128
Dalderby Lock			
	1,216	1,000	1,206
Roughton Lock			
	1,538	1,550	1,545
Halham Lock			
	1,095	1,002	1,074
Kirkby-on-Bain			
	2,372	2,280	2,192
Fulsby Weir			
	1,638	1,800	1,708
Tumby Lock			
	1,005	1,050	1,020
Coningsby Lock			
Total Length	11,783	11,682	11,709

Notes:

- 1. The distances between the locks were measured down the centreline of the river on the OS maps.
- 2. The distance between the locks was measured on the OS map from the top gate of previous lock to the top gate of the next lock.

Table 4.2: Comparison of Pound Lengths

- 4.10. Table 4.2 indicates that there is over 100m difference in the total distances measured from the top lock to the bottom lock between the 1950's survey and the model survey. It also shows that the model survey is comparable to the distances measured from the OS maps. However, the individual distances between locks is inconsistent.
- 4.11. Even though the model pound lengths and the distances measured on the OS maps are similar it was decided to use the pounds from the OS map in the cost calculations.

Water Draft (Water depth)

- 4.12. It was decided to use the information from the 1834 survey, as this was undertaken when the canal had been in operation for more than 30 years. The 1834 survey indicates that the depth of water over the top and bottom sill is approximately 4ft, which equates to 1.2m.
- 4.13. If the depth of water over the sill of the lock is 1.2m, the water within the pounds should be slightly deeper. Hence, the water depth in the pounds will have been approximately 1.5m.

Air Draft

- 4.14. No information regarding the original Air Draft (headroom) allowance has been found. It has been assumed that the same boats that use the River Witham would also use the canal when it is restored. The headroom allowance on the Witham is 9ft 2 in, which is 2.8m so it is logical to assume that this is the minimum air draft that should be considered for the Horncastle and Tattershall Canal. Total clearance between riverbed and bridge soffit would be 4.3 m. This means that the boats that use the River Witham will not be prohibited from using the canal once it has been restored. To obtain the required air draft some of the bridges spanning the watercourse may require raising works as there is not sufficient headroom.
- 4.15. Consideration is been given to reducing the air draft on other navigations in the area, principally the upstream section of the Kyme Eau/ River Sleas extension. This could have implications on Horncastle and Tattershall Canal restoration scheme as the air draft requirements could be reduced to the same as the Kyme Eau Navigation. This could reduce the number of bridges that require raising works to obtain the same air draft as on the River Witham.

5.0 EXISTING WATER REQUIREMENTS

Introduction

- 5.1. At present there are many demands on the volume of water within the River Bain catchment. These include licensed abstractions generally for agricultural purposes and industry, and compensation flow into the Old River Bain. If the navigation was reopened there would be an additional demand on an already scarce water supply.

Existing Licensed Abstractions

- 5.2. In March 2004 the Environment Agency published literature on the Witham Catchment Abstraction Management Strategy (CAMS). This gives a holistic view of rainfall, hydrology, abstractions, compensation water and details the whole of the Witham catchment in relation to the number of abstraction licences, licensing strategy and future developments in the Witham area.
- 5.3. The River Bain is part of the Witham CAMS and was divided into two distinct soil type areas. These are the chalk and sandstone groundwater units from the river's source to Tattershall Gauging Station, and the Bain sands and gravels.
- 5.4. The chalk and sandstone groundwater unit includes the unconfined chalk and Spilsby Sandstone in the north of the Bain catchment, which is not part of the canal study. However, the report mentions that the canal is currently derelict as the current flows/levels are not sufficient to support any sort of navigation. In this reach of the river there are 40 abstraction licences, with the majority for industrial and commercial use and the remainder for spray irrigation/ general agriculture. The status described by the CAMS is that there is no water available. This status category means that there is no water available for further licensing at low summer flows but there may be water available at higher flows during winter months, with appropriate restrictions.
- 5.5. The Bain sands and gravels area (between Dogdyke and Kirkby-on-Bain) is where the sand and gravel is, or has been, extracted for aggregate use in the building industry. Once the gravel pits have been excavated these fill with water. Over time they have changed the landscape of the area, especially around Tattershall Thorpe. The gravel pits have become important habitats for wildlife and plants that are scarce in the area. There are 14 abstraction licences in this area mostly associated with the washing of sands and gravels with the remainder associated with the agricultural industry. The resource availability status is 'water available', which means water is available at high and low flows but restriction may apply.
- 5.6. In the area of interest (South of Horncastle to the Witham confluence) there are 22 abstractions by 17 landowners during the summer (April to October), 7 abstractions in the winter (January to March) and 3 abstractions all year round mainly from the sand and gravel companies. Figure 5.1 indicates the distribution of total monthly abstractions over the year.

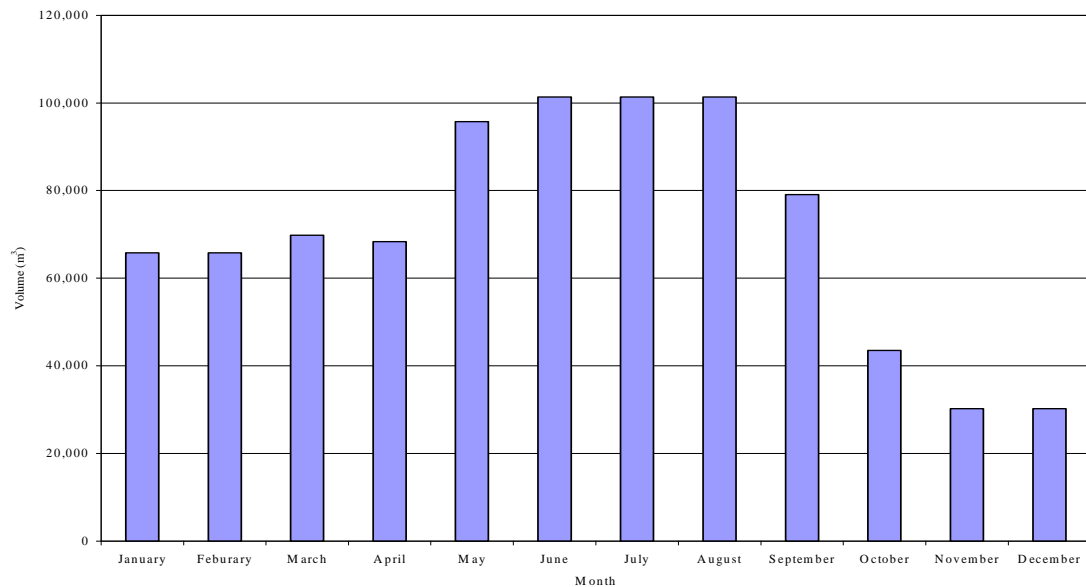


Figure 5.1: Monthly Abstraction Licences from River Bain (Horncastle to River Witham Confluence)

As can be seen from Figure 5.1 June to August is when the highest volume of water can be abstracted, depending on weather conditions.

Compensation Water into the Old River Bain

- 5.7. Parts of the Old River Bain were not used in the construction of the canal as the course of the river was too meandering. In these sections, new canal cuts were undertaken to straighten out the watercourse to ease the passage of boats. The Old River Bain river sections are now used for land drainage purposes and can be utilised to divert flow away from the main channel of the Bain during flooding. They are also a fairly important habitat and an amount of compensation water is required to maintain a minimum water level in the Old River Bain channels.

6.0 WATER DEMAND FOR NAVIGATION

General Methodology for Calculating Water Demand

- 6.1. The water demand for Horncastle and Tattershall Canal has been calculated by taking into account the predicted number of boat trips on the canal, the number of lock operations, and the leakage rate. Several consultations with relevant organisations were undertaken to determine nationally accepted figures for leakage and boat trips.

Estimation of Annual Trips

- 6.2. The predicted number of boat trips was calculated by firstly looking at the surrounding existing canal and waterway infrastructure. Figure 6.1 highlights the main watercourses in the vicinity of the canal and which watercourses are navigable. As can be seen from Figure 6.1 Horncastle and Tattershall Canal is an offshoot from the River Witham. The River Witham is navigable from Boston to Lincoln and then on to Fosdyke. Other nearby navigable watercourses are the Witham Navigable drains and the Kyme Eau. At present there is a feasibility study being undertaken on the Kyme Eau to increase the length of the navigation to Sleaford. Also under consideration at the present time is an important new waterway to link the Fens waterway network to the River Welland, River Nene and the River Great Ouse.
- 6.3. In general this part of the canal system is fairly quiet in comparison to other areas of the country. As a navigation the River Witham is almost a dead end with the sea connection via Grand Sluice at Boston being difficult to negotiate due to tides. Also most boats cannot pass Grand Sluice, as they are not sea going. However, if the new Fens Waterway Link Project goes ahead it would be a big boost to the boating economy in Lincolnshire. It would allow the Lincolnshire waterway network to be opened up to a much greater area, encouraging a greater number of visitors.
- 6.4. It was calculated that to go from one end of Horncastle and Tattershall Canal to the other, it would take approximately 8 hours (1 day), assuming the boats travel at 3mph and it takes 20 minutes per lock. This implies that a trip up and down the canal would take two days so could be an ideal weekend expedition.
- 6.5. British Waterways (BW) estimated that there are between 1,500 and 2,500 boat trips/movements on the River Witham per annum. It is assumed that approximately one quarter of the boats from the Witham would venture up Horncastle and Tattershall Canal. This equates to around 500 boat trips.
- 6.6. It is hoped that commercial interests would construct a marina on the canal to repair and/or accommodate boats that travel up the canal. It has been assumed that the marina would cater for 80 boats where half would make the full journey and the other half would just potter around the canal going no more than halfway in one day. It has also been assumed that each boat in the marina would make on average 9 trips every year; this is based on a national average. Calculations show that there would be an additional

720 trips per year for the boats making full traverses of the canal and a further 720 trips for the boats that just potter around part of the canal.

- 6.7. The growth in the canal industry over the last ten years has been 1% to 2% nationally and it is hoped that in the future the growth will rise to between 3% and 4% nationally. It is felt that the area around Horncastle and Tattershall Canal is not as popular with tourist as other parts of the canal network hence, it has been assumed that the future growth would only be 2%.
- 6.8. The total number of boat trips that has been included in the water demand calculation is 2000 trips. This figure includes the boats from the Witham, boats in the local marinas as well as the predicted future growth over the next 10 years. This figure is dependant on the Fenland Link being constructed. If this vital new link did not happen then it is reasonable to assume that the predicted number of boat trips would be halved. However, the calculation for the water demand has used the higher figure of 2000 boat trips to ensure that the canal would be operational even if the Fenland Link is constructed.

Water Requirements for Horncastle and Tattershall Canal

- 6.9. When a boat travels either the whole length of the canal or only half way it was assumed it will use one lock full of water. This has been used to calculate the volume of water required to operate the locks for the predicted boat usage over one year. Table 6.1 below outlines the volume of each lock on the canal.

Location	Volume (m ³)
Thornton Lock	253
Lodge Hill Lock	230
Martin Lock	226
Dalderby Lock	240
Roughton Lock	243
Halham Lock	261
Kirkby-on-Bain Lock	227
Fulsby Lock	269
Tumby Lock	227
Coningsby Lock	283

Table 6.1: Volume of water in each Lock

- 6.10. Table 6.1 highlights that the volume of water held within each lock ranges from 223m³ to 283m³. The largest lock volume of 283m³ was used to calculate the volume of water used to operate the locks in one year.
- 6.11. A nationally accepted boat to lock ratio is 1.4 boats to every lockage used. This is to allow for the locks being full or not as they are approached by a boat. No allowance is made for locks being used by more than one boat. This ratio can be altered by certain factors of the canal, such as how busy it is and whether the lock usage can be managed, as in a staircase of locks. From this ratio the lockage per annum for Horncastle and

Tattershall Canal is 1429 and therefore, the volume of water needed is $404,646\text{m}^3$ per annum, just for lock operation.

- 6.12. The other part of the water requirement is the allowance for leakage from the canal. It is expected that there will be a certain amount of water loss due to evaporation, seepage and leakage through gates and paddles. An accepted figure for leakage is 1.75Ml/km/wk (a national figure), this equates to $1,287,650\text{m}^3$ per annum over 14.15km of canal (south of Horncastle to Tattershall Gauging Station). The volume of water required to account for the leakage rate is just over three times greater than the amount of water required to operate the locks.
- 6.13. It was decided to consider a site specific figure for leakage. We know from J.N Clarke's work that the canal from Dalderby to Horncastle was lined with puddle clay, as it was a completely new canal cut. Other sections of the canal were new cuts, as the alignment of the Old River Bain runs parallel down sections of the canal. It has been estimated that approximately half the length would have been lined and hence, this would reduce the leakage rate. Without carrying out a detailed geotechnical analysis of the channel's leakage, and testing sections of the canal with the water level raised to navigation depth, there is no definitive answer to the amount to add in for the leakage allowance. It has been decided that it is reasonable to reduce the leakage rate by half so the leakage allowance for the canal will be in the region of $644,000\text{m}^3$.
- 6.14. By combining the leakage allowance and the lockage volume the total amount of water required to operate the canal would be $1,050,000\text{m}^3$ if 2000 boats use the canal in one year. If the canal is restored, July to September is the period that will be the busiest time and hence the greatest demand for water to support the navigation. Figure 6.2 below outlines the total water usage of the canal throughout the year (including lockage and leakage).

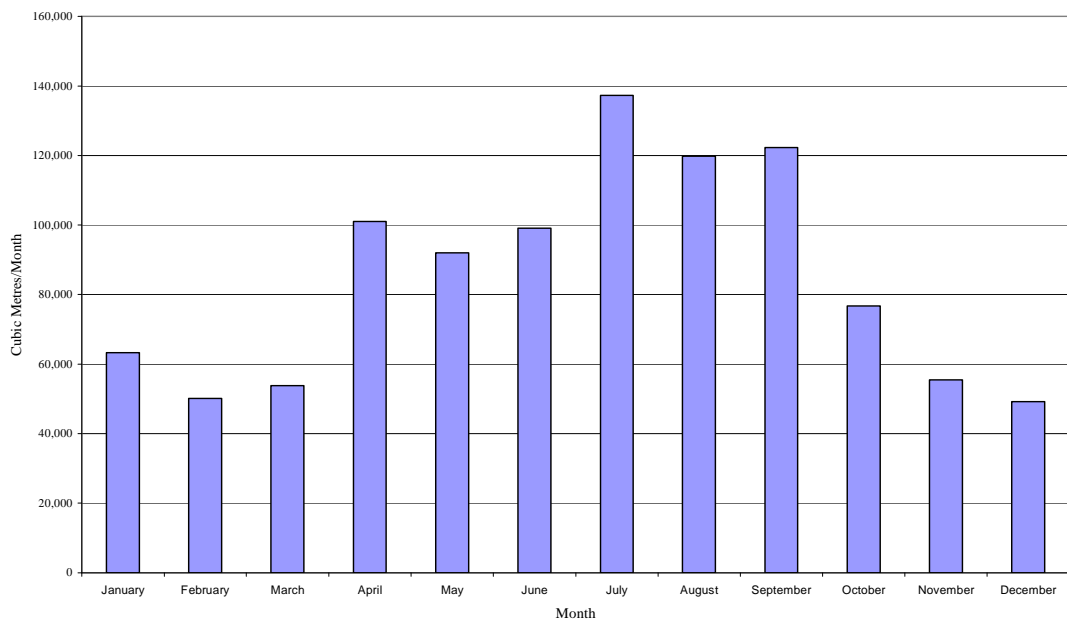


Figure 6.2: Water Usage for Canal Throughout the Year

- 6.15. Figure 6.2 highlights that the lowest usage of the canal occurs in February and December (winter time) and the highest usage occurs from July to September. There is a small peak in April due to the Easter Holidays. There are 19 weeks during winter when fewer than one boat trip per day is predicted.

7.0 WATER SUPPLY

- 7.1. The national annual rainfall for England and Wales is 897mm however, the annual average rainfall across the Witham catchment is only 600mm. This lack of rain has historically caused problems for the canal throughout its history, especially during the summer months. The existing pressures on the water supply are from abstraction licenses and compensation water into the Old River Bain. There is also the requirement to keep a minimum amount of water within the Old River Bain channel to support the ecology of the watercourse.
- 7.2. The calculations in Section 6 convert to a peak water demand for the canal of 50 litres per second (l/s) including losses. The 95-percentile flow is about 100 l/s according to gauge data from Tattershall and Fulsby. However, summer flows frequently fall below this value. It was decided in consultations with relevant organisations that to enable tourists and commercial operators of the canal to be reasonably sure of continuous use, a 20-year protection against failure of the above flow for a week was required.
- 7.3. Data from EA flow gauging stations at Victoria Mill (Horncastle), Fulsby and Tattershall was analysed to identify historic evidence of low flow. They contained continuously recorded flow data for 20, 40 and 20 years respectively.

Duration of Low Flows

- 7.4. The gauge data from Fulsby and Tattershall was interrogated to find all periods when the flow passing the gauges was less than 50 l/s for more than 7 days. These periods were then considered and it was found that from the 20 years of data from Tattershall there was a worst case of 8 weeks occurring between August and September 1991. There were also two long periods of flow less than 50 l/s in the 40 years of data from Fulsby of 6 weeks in 1976 and 5 weeks in August and September 1991.
- 7.5. The above suggested that a 20-year low event probably occurred in 1991 and a 40-year event may have occurred in 1976. The longer duration of low flow (3 extra weeks) at Tattershall was assumed to be due to abstraction down stream of Fulsby. This was considered reasonable considering the generally lower flows at Tattershall.

Option 1: Gravity fed Storage Volume

- 7.6. The longer duration of low flows at Tattershall was used to size a storage volume, given water demand over 8 weeks. Groups of 8 weeks of water usage were examined for a maximum volume, with 230,000 cubic metres being identified as the worst case of required storage volume.
- 7.7. It was also calculated that during the 1991 period of low summer flow when less than 50 l/s passed the Tattershall gauge, just under 90,000 m³ of water passed along the

watercourse at the gauge. This can be deducted from the proposed storage volume giving a revised storage of 140,000 m³.

- 7.8. Evaporation from a storage reservoir between April and the end of the drought was estimated using 2 and 3 mm/day, depending on the month. An area of reservoir from one suitable site was used to give evaporation losses of 52,000 m³. Leakage was assumed to be approximately 10%.
- 7.9. The total estimated volume for storage with allowances for evaporation and leakage was 230,000 m³.

Filling Storage Volume

- 7.10. A check was carried out to confirm if the proposed storage volume could be filled from flows passing Fulsby and Victoria Mill during the possible abstraction period from 1st January to 31st March. The flow data was examined by looking at cumulative flows for the above period for all years of data and finding the smallest value. This was approximately 5,000,000 m³ and 3,240,000 m³ respectively. March, the last month for abstraction, was also examined for Victoria Mill and found to have a minimum value of 630,000 m³
- 7.11. It was found that if the collection period was limited to March, the required volume for the storage area could be collected. However, the Environment Agency would have to be satisfied regarding abstraction licenses and compensation water.
- 7.12. Based on the above calculation the option to store water during the spring for use in the summer is feasible while giving 20-year protection against flow falling below 50 l/s for one week.

Option 2: Pumped Return of Canal Flow

Water Demand

- 7.13. The option of using a pump to return water that has flowed down the canal was considered. It was recognised from previous investigation that the flow could reduce to virtually zero in times of extreme drought. Again protection against the canal being inoperable for a week within a 20-year period was required for commercial reasons. It was considered that water for one days use could be re-circulated from a storage reservoir in weeks when there was less than 50 l/s flow in the canal. The lockage flow of 31 l/s for 1 day would have to be stored. However, each time the water flows down the canal losses of 19 l/s occur.
- 7.14. 31 l/s peak flow requirement for one day and losses of 19 l/s evaporation and leakage for 8 weeks were used to size storage for pumping from a downstream reservoir that could be filled early in the season. This would be required to provide 20-year protection against the canal becoming un-usable.

Water use over 8 weeks

- 7.15. Flow for 1 day with losses for 8 weeks gave a volume of 98,000 m³.
- 7.16. Evaporation losses from the surface of the reservoir were estimated to be 25,000 m³ in the same way as losses were calculated for the gravity storage option.
- 7.17. 10% of the stored volume was assumed would be lost through leakage through the base of the storage reservoir during the summer months. This was estimated as 12,000 m³ of the total volume above.

Total Storage Volume for Pumping Option

- 7.18. The total estimated volume required to ensure continuous use of the canal during all summers for 20 years was 135,000 m³. This includes lockage, losses along the canal, evaporation from the reservoir and leakage from the canal base.

Leakage Assumptions

- 7.19. The assumptions used above should be re-considered when more information is available from soil investigations when losses along the canal and through the reservoir base will be known. The location of the reservoir along with the type of underlying soil will be known. Also the possible need for a canal and/or reservoir lining will be assessed with appropriate leakage rates.

8.0 FLOOD CONTROL

Existing Flooding Situation

- 8.1. Major flood events have been recorded in Horncastle and the surrounding villages of Kirkby-on-Bain and Haltham in 1920, 1960 and 1981. The 1960's flood event washed away the original Butts Lane Bridge in Coningsby and a new one was built in its place in 1962. Since these flood events, further housing development has taken place, particularly in Haltham.
- 8.2. It has been assessed that the current standard of protection for Horncastle is less than a 1 in 10 years (10% annual probability) for the River Bain and less than 1 in 5 years (20% annual probability) for the River Waring. Current guidelines from the government show that the indicative standard of protection against fluvial flooding for an urban area is between 1 in 50 year and 1 in 200 year flood events³.
- 8.3. The existing standard of flood protection at the villages of Haltham and Kirkby-on-Bain has been assessed as being up to the 1 in 10 year event. The government indicative standard of protection against fluvial flooding for a semi-urban area is between 1 in 25 year and 1 in 100 year flood events³.
- 8.4. Coningsby and Tattershall were not included in the River Bain study as it was thought that the River Witham would dominate this section of the Bain. From the River Witham Strategy Study it has been determined that parts of Coningsby and Tattershall could be affected by flooding between a 1 in 25 year and 1 in 50 year flood event on the Witham.

Proposed Flood Alleviation Scheme

- 8.5. The flood alleviation scheme identified, through consultations with landowners and other relevant organisations, that the most appropriate solution to the flooding issues of Horncastle would be upstream flood storage areas.
- 8.6. It was recommended by the Environment Agency that Horncastle should be protected up to the 1 in 100 year flood event. This involved the construction of flood storage reservoirs on both the River Bain and the River Waring upstream of Horncastle. Minor improvement works were required in Horncastle to maximise the existing river channel and hence, minimise the volume required to store in the reservoirs. Table 8.1 (see overleaf) highlights the 1 in 100 year predicted peak water level in the existing situation and when the proposed flood alleviation scheme is in place.

³ defra, Flood and Coastal Defence Project Appraisal Guidance 3 – Economic Appraisal (FCDPAG3)

Location	100 Year Flood Event Peak Water Level (m AOD)	
	Existing Situation	With Proposed Flood Storage Area
Horncastle Town Centre	28.562	28.004
Halham	16.398	16.340
Kirkby-on-Bain	13.121	12.911
Coningsby	5.334	5.097

Table 8.1: 100 Year Flood Level, Existing Situation and Proposed Scheme

- 8.7. The study showed that the villages downstream of Horncastle would benefit from the storage areas. However, additional works would be required to meet the indicative standard for the villages. At present there are no known plans to implement a scheme that would directly affect the villages of Kirkby-on-Bain and Halham.

Flooding Once Canal is Restored

- 8.8. If the canal is restored to a fully operational navigation then the risk of flooding will be taken into consideration. Any works associated with the restoration of the canal should not increase the risk of flooding. Measures may be put in place to help reduce the flooding to certain areas of the canal system. Further investigations would be required during the detailed design stage.
- 8.9. The flood flows should be able to flow down the channel in a similar way, as they would do in the existing situation. There are three main options that would allow the conveyance of flood flows down the canal, these are:
- Opening the lock gates
 - Overtopping of the lock gates
 - Allowing the water to bypass the lock down the bywash.
- 8.10. Opening of the lock gates would allow the canal to act in a similar way as at present and hence, would have a limited impact on the flooding regime of the catchment. However, this would mean that the canal would need to be closed for the winter months, which would have a detrimental impact on the economic viability of the navigation. The employment opportunities at the marinas and other facilities associated with the canal would be seasonal rather than full time. If all the lock gates were opened then the navigation would need to be refilled to allow it to operate as a canal in the spring months. Refilling of the canal may take some time due to the general lack of water within the Bain catchment. Most importantly this option does not take into account flooding during the summer months.
- 8.11. Traditional gates are not designed for overtopping. Any new gates would need to be designed to withstand the force of the water that would be going over the top of them. This would alter the conveyance of the flood flows, as the water level would be higher. Also in times of flood, water would flow over the towpath and surrounding access

area. Debris gathering would need to be cleared. This option would allow the canal to remain operational during the winter months and allow for summer flooding.

- 8.12. The bywash could be oversized to allow the passage of flood flows around the locks. This would mean that the top lock gates and surrounding area would be the same height as the flood banks rather than approximately 300mm higher than the top water level of 1.2m from sill level. It is believed that the original banks of the navigation have been raised to contain flood flows and minimise the amount of land flooded at small order events. In effect the top gates would be larger than the traditional top gate, which will have a cost implication. The embankments of the canal could not be lowered back to the original level, as this would worsen the flooding situation of the catchment. The canal would not need to be emptied. This option would allow use of the canal all year. It is believed this option can be designed to operate without worsening the flood risk.
- 8.13. Since the canal banks are fairly high the bywash channel would not need to be too wide. A section of the River Bain hydraulic model was chosen to determine an approximate size of the bywash channel. Two lock locations were used as an example. These were Thornton Lock and Tumbly Lock. The existing flow conditions were used. The top lock gates were modelled as a sharp crested weir with it set to the same height as the embankments. This forced the water to go through the bywash channel.
- 8.14. The main criteria of the bywash channel and weir design were that water should not spill over the top gate and that it stayed in-bank in the bywash channel itself. This ensured that the flooding was not worsened by letting the water overtop out of the bywash channel. Also water levels should not rise higher above the banks of the canal than with the same event without the proposed gates or bywash. The estimated size of the bywash channel was modelled to be 3m wide by 3.5m deep with a weir 1.5m high from bed level and 10m long. This size of the bywash will be dependant on the position of the lock within the catchment. Larger weirs may be required the further downstream the catchment due to the additional tributaries entering the system.

9.0 PUBLIC CONSULTATION

Introduction

- 9.1. A public consultation has been undertaken as part of this feasibility study to gauge local residents/ landowners' opinion of the scheme. The public consultation also included relevant organisations, such as English Nature and the Environment Agency, to obtain their comments on the scheme. The consultations were undertaken between December 2004 and January 2005 and consisted of a scoping report⁴ (including the proposed engineering options and an environmental desk study), landowner questionnaire to landowners immediately adjacent to the canal and hand delivery of information to local residents next to the canal. All information gathered during the consultation period from landowners and relevant organisations was very much appreciated.

Public Consultation Outcome

- 9.2. Details of the responses to the consultation are given in Appendix B of this report and Table 9.1 below summarises whether they were for or against the restoration of the canal.

Support the Restoration	Total
Yes	11
Yes with Reservation	6
No	10
Needs Additional Details/ Comments Only	8
Total of Returned Consultations	35

Table 9.1: Results of Public Consultation

- 9.3. As can be seen from Table 9.1 the majority of responses were in favour of the restoration. The main reservation and comments made are listed below.
- **Environmental Impacts** – Several comments were received regarding the impact on ecology due to the construction of the canal, pollution from boats and increased noise levels. There were concerns raised about the increased number of tourists in the area and the affects this would have on the character of the area.
 - **Flooding Issues** – Concerns were raised regarding the flooding issues associated with the River Bain and it was highlighted that nothing should be done that would make the flooding situation worse. It was suggested the Horncastle Flood Scheme was of greater importance than the restoration of the canal. There were

⁴ Bullen Consultants Ltd, Horncastle and Tattershall/ Coningsby Canal Heritage Trust (HATCH), The Restoration of Horncastle and Tattershall Canal Feasibility Study, Environmental Scoping Report, Dec 2004, 104B058/RE02/A

also comments made on the safety of boaters and the possibility that they may be caught up in a flood event.

- **Construction/ Maintenance of Canal** – Some people who responded to the consultation were concerned over the disruption to local residents during the restoration of the canal. Other concerns raised were with respect to the affect on the local land drainage and safety and security issues with isolated houses.
- **Financial Implications** – Several comments were received regarding how the project was to be financed, and whether there would be on-going financial demands on the Local Authority. Some people thought the money would be better spent on other projects, such as the Horncastle Flood Alleviation Scheme or small-scale enhancements to the local area.

9.4. These concerns have been addressed in this feasibility study, with the exception of the financial implications. Further consultations will be undertaken during the detailed design phase and may comprise a public display, meetings with landowners with specific concerns/ information and in depth consultations with relevant organisations such as the Environment Agency.

10.0 RESTORATION REQUIREMENTS

Introduction

- 10.1. A walkover survey was completed in September 2004 to gauge the amount of engineering works required to restore the canal. From the information gathered during the surveys of the canal in its current state a cost estimate for restoration has been determined for the several options investigated. The cost of restoration is described in more detail in Section 12 of this report.
- 10.2. In general the engineering works will consist of reinstating the locks at the original locations and a new canal cut at Kirkby-on-Bain. Between Coningsby and the confluence with the River Witham there are several options to consider. Firstly there is the route that the new canal will use and secondly there is the difficulty with the amount of headroom required. The canal will be spilt into four sections, these are as follows:
- Confluence with the River Witham to Coningsby Lock
 - Coningsby Lock to Kirkby-on-Bain
 - Kirkby-on-Bain to Haltham Lock
 - Haltham Lock to Horncastle

Appendix C gives a detailed description of the engineering works required at each lock location.

Engineering Requirements

Confluence with the River Witham to Coningsby Options

- 10.3. Originally there were two connections to the River Witham, one was along Mill Drain and was called Gibson's Cut to the west, and the other was from Dogdyke to Tattershall from the south. At present the main route of the River Bain from Tattershall goes south to Dogdyke and Gibson's Cut is disused. Both options have been investigated to determine the most appropriate route to use for the canal.
- 10.4. At present we have limited information about Gibson's Cut. We do not have any information relating to the channel's current geometry or the lock structure. Due to the limited availability of information, a quantitative analysis of Gibson's Cut cannot be undertaken. Hence, a qualitative analysis has been undertaken to compare Gibson's Cut with the route from Dogdyke.
- 10.5. Gibson's Cut has many obstacles to overcome to reinstate this watercourse as a canal, these difficulties are listed overleaf:

- **Connection to the River Witham** – At present Gibson’s Cut is not connected to the River Witham as an embankment has been constructed across the end of the canal cut. To re-open this section of canal to the Witham, embankments would need to be removed with the approval of the Environment Agency. This would drastically alter the flood risk to this area of the Witham system.
 - **Refurbishment of Tattershall Lock** – One of the original locks is located on this arm of the canal. During the walkover surveys it was not possible to reach this lock to investigate its current state. It is believed that it is in much the same state as the majority of the other locks on the canal and hence, it would need reinstating.
 - **A153 (Sleaford Road) Bridge** – At present this road bridge consists of a 825mm diameter culvert going underneath the road to allow the passage of water. The draft (headroom) underneath the bridges to allow the passage of boats needs to be 4.3m from bed level to the soffit of the bridge. This means that a completely new bridge structure would be required in place of the culvert, which is 3.175m higher than the existing road. There would be difficulties in obtaining this new height and alignment as the bridge is situated near two bends in the road. There is no easy diversion route for the vehicles whilst this work is being carried out. Also the works would affect local residents as their driveways that lead up to the road would become steeper and the road would be higher. The front doors would be further below path level making an unpleasant outlook for the occupants.
 - **Leakage from the Channel** – No tests have been carried out on the leakage rate of this part of the canal. However, it was reported by a local resident that an experiment was carried out to see if the channel could be used for winter storage. Water was pumped into the old canal cut but was stopped after several days as severe leakage was observed.
- 10.6. The route from Dogdyke is currently being used as the main route from the River Witham to Coningsby. The main difficulty with this section of the Bain is the excessive weed growth and therefore, dredging is required. It is envisaged that only one of the bridges between Dogdyke and Tattershall Gauging Station requires raising works. The old railway bridge at Dogdyke is currently little used and reduces the headroom at the entrance of the canal. It is proposed that this bridge is replaced with a new footbridge that has a unique style, which could be associated with the canal.
- 10.7. The option of re-opening Gibson’s Cut is unfeasible due to all the known difficulties with this route. Not only is there an expensive bridge replacement there is also severe leakage problems. It is clear that the route from Dogdyke would be the most cost effective route to use if the canal was restored.
- 10.8. Between Coningsby Lock and Tattershall Gauging Station there is an issue with the reduction in air draft. Since the canal was closed, bridges across the watercourse have been constructed without taking the navigation into consideration. Consequently, the bridges do not have the required headroom to allow the passage of boats. The bridges that do not have the required headroom are Butts Bridge (A153), Wharf Lane Bridge, next to Coningsby Lock, and Coningsby Footbridge.
- 10.9. To overcome this reduction in headroom two options have been considered. One option involves raising the bridges and the other involves deepening the channel.

Figure 10.1 highlights the two options considered for the area between Coningsby Lock and Tattershall Gauging Station. A third option has been identified however, this does not fulfil the headroom requirements. Following is a description of the three options.

- **Option A: Deepening Channel** – This option involves renovating the canal with no lock between Dogdyke and Coningsby Lock. It requires dredging the channel from Coningsby Lock to Dogdyke and additional deepening of the riverbed and re-profiling of foreshore banks between Coningsby Lock and Tattershall Gauging Station. No lock would be required as the water level imposed from the River Witham means that the water depth would be in the region of 1.5m. It would involve re-profiling the banks, as dredging out over 2m would cause instabilities in the existing riverbanks. Dredging would also be required downstream of Tattershall Gauging Station to remove silt built up over the years to reduce the bed to its original level.

If the channel were deepened then all 3 bridge foundations would require stabilisation to make sure that the bridges are not affected by this reduction in the bed of the watercourse. It is assumed that underneath the bridges the width of the watercourse will be reduced to the same width of a lock, which is 4.572m. Instead of under-pinning the foundations with mass concrete, it is envisaged that a concrete channel would be constructed underneath the bridges. Since the channel would be reduced from around 20m wide to under 5m wide it is thought that this would have a limited impact on the foundations of the bridges. This concept has not been looked into in detail and further work is required to determine the exact works required to support the bridge foundations.

A new Gauging station will be required at Tattershall, however no lock would be required due to the amount of proposed dredging and water level imposed from the Witham.

Although alterations are not proposed to the bridge at Wharf Lane, this option introduces a completely new lock, approximately 15m upstream of the original lock. The bottom gates would then be far enough away from the bridge so that traditional lock gates could be used.

- **Option B: Raising Bridges** – Butts Lane Bridge is a crossing point for the A153 road, which is a major through road between Tattershall and Coningsby. This would need to be raised by approximately 0.72m (after dredging of the current bed level) to obtain the minimum air draft requirements.

When the bed has been dredged then the other two bridges (Wharf Lane Road Bridge and Coningsby Footbridge) would have the required headroom. However, Wharf Bridge is situated immediately downstream of the bottom lock gate recesses. Currently there is not enough room to install a traditional lock system of oak gates. Hence, there are several options to consider, which are: raising the bridge; moving the lock upstream away from the bridge to get the clearance for the lever of the oak lock gates; or installing a different type of lock gate such as a guillotine gate. Coningsby Lock will still need to be refurbished regardless of what happens to the bottom end of the lock.

As well as raising the bridge the channel will require some dredging works, previously mentioned, to return the bed level back to the original level. The dredging works would extend from Coningsby Lock to Dogdyke. A new lock is required downstream of Coningsby Lock and it is proposed to have a new canal cut around Tattershall Gauging Station. The new lock could be incorporated into this section. A lock is required to maintain water levels downstream of Coningsby Lock, as the water level from the Witham is not at a high enough level for navigation. The new lock would have a rise of approximately 1m. This would create a bypass round the gauging station so that the weir structure could be retained. However the way the water level is measured will need to be altered, as the majority of flow would be diverted through the new canal cut. The gauging station either needs to be replaced with a modern ultrasonic gauge or moved into the bywash to measure the flow of the canal. A counter to measure the number of lock openings may also be required to measure low flows in conjunction with the flood flows measured in the bywash.

- **Option C: Reduced Headroom** – This option is the same as Option B, however it does not include for bridge raising works at Butts Bridge. This would lead to a reduced total clearance of 3.3m and an air draft of 1.8m. The type of boats/ vessels that would be able to use the canal would be restricted due to this reduction in headroom. However, there would be less disruption to local residents and the bridge raising works could be completed at a later date if greater headroom is required.

10.10. Options A and B have been considered and they offer a solution to the problem of the reduced headroom whereas Option C investigates the possibility of a reduction in the headroom requirements. Cost estimates to determine the most cost effective options are provided in Section 13 of this report. Just considering the engineering work on site with regard to Option B there would be a greater disruption to local residents if the raising of Butts Lane Bridge were undertaken. Not only would the traffic have to be diverted, individual driveways would need to be raised causing disruption to a large proportion of the population of Tattershall/ Coningsby. With Option A the channel deepening works would require the foreshore banks to be re-profiled and there may not be enough space between the river and the adjacent properties to carry out these works without using some form of retaining walls.

Coningsby to Kirkby-on-Bain

10.11. In the Coningsby to Kirkby-on-Bain section, the main engineering works required are the refurbishment of the locks and remedial works to the banks and channel bed. There is also the possibility that the canal may require lining once the dredging has been carried out and the water level is kept at a constant 1.5m above bed level.

10.12. In this reach of the canal there are only two locks, Tumby Lock and Fulsby Lock. Appendix C gives a detailed description of the works required to refurbish the locks but a brief outline is given below:

- **Tumby Lock** – This lock has many original features but is in bad state of repair as practically no works have been undertaken at this location for some time. Part of the lock wall on the east bank has been eroded away and several bricks in other parts of the lock have been weathered, as can be seen in Photograph 10.1 below.



Photograph 10.1: Erosion of Tumby Lock Wall on East Side

The top section of the lock has been rebuilt in concrete and has a concrete beam spanning the watercourse. During the walkover survey it was unclear if the top sill remained and if the bottom sill was still intact.

To restore the lock, the top section would need to be rebuilt to include the recesses for the top lock gates and the concrete beam spanning the channel would need to be removed. The lock walls would need to be stabilised and rebuilt in the areas where they have been eroded away. Lock gates would need to be installed and other items associated with the operation of the lock. A bywash would also be required to convey excess water down the canal, especially during times of flooding.

- **Fulsby Lock** – Fulsby lock has been significantly modified since the canal became derelict. There is little remaining of the lock as can be seen from Photograph 10.2 overleaf.



Photograph 10.2: Fulsby Lock's Present Condition

As can be seen from Photograph 10.2 there are three weirs so it was difficult to determine which if any was the original lock sill. One other important fact is that there is no evidence of the downstream section of the lock. The walls have been altered so that they are the same length as the weirs. A concrete footbridge spans the watercourse and there is an important EA gauging station upstream that records both level and flow. This gauge has telemetry and is used for flood warning in Coningsby/ Tattershall.

To reinstate this lock the weirs would need to be demolished and replaced with a top sill. The lock walls would need to be lengthened so that all locks can take the same size of boats. A bywash would be required to convey additional water around the lock, especially during times of flooding. Also the gauging station either needs to be replaced with a modern ultrasonic gauge or moved into the bywash to measure the flow of the canal. A counter to measure the number of lock openings may also be required to measure low flows in conjunction with the flood flows measured in the bywash.

- 10.13. Between the locks the channel requires various depths of dredging with the maximum depth of 1.34m immediately downstream of Tumbly Lock. With the dredging there is the possibility of increasing the leakage rate of the canal so channel lining may be required. The embankments are in fairly good condition but there may be a few areas that require remedial works, such as areas used for cattle watering holes. Consultations with landowners are required to discuss the position and extent of watering holes.

Kirkby-on-Bain to Haltham

- 10.14. The area between the south end of Kirkby-on-Bain and Haltham Lock has numerous difficulties, the most important of which is that it is at risk from flooding.
- 10.15. The original alignment of the canal has been filled in and the channel that remains is the old millrace. A house has been recently constructed to the west of the millrace and part of the property's garden is on the old line of the canal. Photograph 10.3 below highlights the old lock position with half of it being in the garden of the property.



Photograph 10.3: Position of Kirkby-on-Bain Weir (Only Top Stones Visible)

- 10.16. It is not feasible to restore this section of the canal as it would mean that the property would be immediately surrounded by water on both the east and west side. The old millrace was never designed to take boats so there would be major alteration works to the existing weir and access bridge for the property.
- 10.17. It was decided that a completely new canal cut should be considered to take the canal slightly away from the village of Kirkby-on-Bain. The new canal would be in walking distance of the village but far enough away so that the new property owner does not feel surrounded by water. It is envisaged that the canal cut would leave the existing channel downstream of Red Mill Bridge and rejoin the existing channel at the corner immediately downstream of Kirkby-on-Bain, near Brickyard Farm. A new lock would also be required on the new canal cut.
- 10.18. The exact alignment of the new canal cut has not been determined. The line on Figure 10.2 is only an indication of the proposed route. Further investigations into the ground conditions in the area would be required to determine the most appropriate route for the new canal cut

- 10.19. The new channel would help with the flooding situation of Kirkby-on-Bain, as there would be extra storage volume and capacity to convey the flood flows. It is assumed compensation water would be required for the millrace. The majority of the water could be diverted down the canal cut instead of through the village during flooding to reduce the risk of flooding to the residents of the village. Further investigations are required to determine the full extent of the effects on the flooding regime of adding in this new channel around Kirkby-on-Bain.
- 10.20. Witham Third Internal Drainage Board (IDB), after consultation, has expressed concern that the proposed new cut near Kirkby intersects Church Drain. The millrace is on embankment so a new cut may also be above existing ground level & would cut off Church drain. They also expressed concern that following water levels being raised, seepage on to adjacent land may be a problem affecting land drainage. The exact alignment of the new canal cut has not been determined until ground investigations have been carried out in this area. Further consultations with the IDB will be carried out to determine the affects of the canal cut on the land drainage and to propose any mitigation measures required.
- 10.21. There is also the possibility that a storage area could be provided adjacent to the proposed canal cut. This would help to store vital water to keep the canal operational during times of drought. Pumping of some of the water back to the start of the canal would be required. Any pump would be screened to ensure that noise pollution was kept to a minimum and that it blended in with the natural surroundings.
- 10.22. Red Mill Bridge seems to be the only original road bridge remaining as it is a brick arch bridge. With the required dredging works there will be adequate headroom underneath the bridge. Remedial works may be required to the bridge foundations if the dredging is deep.
- 10.23. Haltham Lock has been highly modified. There are very few original features remaining from when the structure operated as a lock. There are two weirs at this location and it was not clear during the walkover survey where the original sill level was situated. At the downstream end of the lock there is a flap valve on the right bank and erosion protection in the form of concrete sandbags. It seemed that the original brickwork may be clad in concrete but further investigations into this are required at a later date.
- 10.24. To reinstate Haltham Lock back to a working state, the upstream and downstream lock gate recesses and sills would need to be reinstated before the lock gates are put in place. The concrete footbridge over the lock does not have the required headroom so would need replacing. Remedial works to the lock walls would be required and something may need to be done about the flapped outfall as it may fall within the lock.

Haltham Lock to Horncastle

- 10.25. Between Haltham and Horncastle there are five locks and one road bridge between Thornton Lock and Lodge Hill Lock. The locks have varying degrees of traditional features remaining ranging from quoins (where the gates were hinged) and gate recesses through to no recognisable traditional features. The locks between Haltham and Horncastle, which are constructed of stone blocks, are as follows.

- Roughton Lock
- Dalderby Lock
- Martin Lock
- Lodge Hill Lock
- Thornton Lock

The following is a brief description of the each lock's present condition and the works required to reinstate it as a working lock. A detailed list of all the items required for each lock is given in Appendix C of this report.

- 10.26. Roughton Lock has been dramatically altered since the closure of the canal, as the lower part of the lock is no longer present. The upper section of the lock has been altered, as there are no signs of gate recesses, and it has a concrete footbridge that spans the watercourse. The one remaining feature of the lock was that the top sill was still intact as is shown in Photograph 10.4 below.



Photograph 10.4: Top Sill of Roughton Lock

- 10.27. To reinstate this structure as a lock, several items need to be rectified, including the overall length of the lock and the lack of headroom under the footbridge. The majority of this structure will need to be rebuilt in order for it to operate as lock. In the upper section, the lock gates and their recesses are required and the footbridge needs replacing. At the downstream section the lock walls need extending so the distance between the lock gates is 23m long. A bywash around the lock to allow the conveyance of flows round the lock is also required.

- 10.28. The next lock upstream is Dalderby Lock; this structure has very few original features remaining. The east wall of the lock downstream of the rise to the end of the lock seems to be intact as there is a gate recess present and it is constructed of stone. However, there is a service pipe that goes directly through the original gate recess, spanning the canal. The west wall of the lock has had the gate recess filled in and downstream of the footbridge the wall changes from stone to brickwork. The upstream section of the lock has been completely rebuilt, as there are no visible remains of the lock gate recesses. Scour protection works have been undertaken as additional weirs have been introduced in this lock. It is noted that the middle weir is curved in a similar way to that at Roughton Lock, so it may be the original sill.
- 10.29. To restore Dalderby Lock the upstream section would need to be rebuilt with the concrete beam spanning the watercourse removed and gate recesses made in the stonework. Downstream of the rise, remedial works to the existing walls would be required with the construction of the gate recesses. The service pipe through the bottom lock gate recesses would need to be moved, as it restricts the headroom and hinders the gate operation.
- 10.30. The next lock upstream is Martin Lock, near the old sewerage farm. Again, this lock has been significantly modified as only the upstream section of the lock remains; the downstream walls have been removed. The upstream walls have been modified, as there are no gate recesses present in the stonework.
- 10.31. The lock will need the downstream walls to be raised as part of the refurbishment works. As well as the walls, all the gate recesses and gates need to be reinstated and a bywash should be provided around the lock.
- 10.32. The penultimate lock is Lodge Hill, near Thornton Lodge Farm. This structure has a few traditional features but has been significantly altered. There are three weirs present and it was unclear from the walkover survey which one was the original sill. The lock has had the addition of a sluice gate that is operated from the sides via a spindle in the centre of the channel that is attached to the gate. The gate can be raised or lowered depending on the amount of water coming down the river.
- 10.33. The lock will require some major alterations to return the structure back to a working lock. The top section may need to be rebuilt as the sluice structure is to be removed and gate recesses are required. The exact sill level needs to be determined and the other weirs need to be removed. At the downstream end of the lock the sill and gates are required.
- 10.34. The last lock before Horncastle is called Thornton Lock and is situated to the north of Thornton Road Bridge. This is a very interesting structure as there are many original features that still remain. At present there is a tilting gate attached to the upstream end so it is not clear whether the top sill is present. There were at least two out of the four quoins remaining in the stonework and there were markings in the top stone for the straps that used to attach the lock gates. Photograph 10.5 shows an example of the quoins at Thornton Lock.



Photograph 10.5: Example of the Quoins at Thornton Lock

- 10.35. To refurbish this lock the tilting gate and associated machinery would need to be removed. Two gate recesses are remaining on the west bank however new ones are required on the east bank. A bywash is required around the lock to convey flood flows around the structure instead of over the lock gates.
- 10.36. As well as the locks there are two bridges to take into consideration, these are Thornton Road Bridge and a footbridge upstream of Haltham Lock. With the amount of dredging required, these bridges do not require any raising works but their foundations may need stabilising.
- 10.37. As mentioned above, dredging work are required along this reach of the canal, with the maximum depth of nearly 2m in one isolated area, with the average being around 0.8m. No dredging works are required upstream of Thornton Lock as it has been assumed that no alterations have been made to this sill

Storage Areas

- 10.38. As detailed in Section 6 of this report a storage area is required in order to keep the canal operational during the summer months when water is scarce. The most appropriate location of the storage area is at the start of the canal, immediately south of

Horncastle. It is envisaged that the storage area would be able to store up to 250,000m³ of water during the winter to be used if necessary during the summer.

- 10.39. The size of the proposed storage area would come under the Reservoir Act 1975, as it has a volume greater than 25,000m³. The Act requires that a Panel Engineer, who is a specialist engineer who are qualified and experienced in reservoir safety, be appointed to oversee the safe construction, operation and maintenance of reservoirs. This will need to be taken into consideration during the detailed design stage.
- 10.40. Detailed design of the storage area has not been undertaken but the area indicated on Figure 10.2 has been assessed to ensure that the amount of water required to be stored, can be stored in this area.
- 10.41. A marina would be required in the Horncastle area to give the boats that travel up the canal a place to moor for the evening. It is envisaged that this would be a private venture and has not been included in the cost estimate calculations.

Winding Holes And Moorings

- 10.42. Winding holes are to be provided in three places along the canal, these are: below Coningsby Lock, at the beginning of the new canal cut at Kirkby-on-Bain and at the entrance to the marina at Horncastle. The positions of the winding holes are highlighted on Figure 10.2. The position of these winding holes is strategically placed to give visitors many options on the length of their voyage up/ down the canal. The channel where the winding holes are to be located need to be widened to allow the maximum boat dimension to be able to turn round. Environmental features should be taken into consideration when choosing the sites so they do not clash with any protected sites on the canal.
- 10.43. Overnight moorings should be provided around the villages or places of interest, such as the Battle of Britain Memorial Flight site. This would encourage visitors to investigate the local amenities of the villages and towns that border the canal. The suggested position of the overnight/ temporary mooring sites are marked on Figures 10.1 and 10.2 of this report. It is envisaged that off-line moorings would be provided, as these would give protection to boats in case there was a flood event occurring on the canal.

Construction Phase of Canal Restoration

- 10.44. It is suggested that the restoration works are phased to minimise disruption to local residents and the environment. The exact phasing of the construction works should be determined at detailed design stage. It is thought that the section between Dogdyke and Coningsby Lock would be completed first to allow boats up to the Tattershall/ Coningsby area. Then a section, possibly up to Kirkby-on-Bain could be completed and then the final phase from Kirkby-on-Bain to Horncastle. A storage reservoir or pumping system may be required in the Kirkby-on-Bain area to supply water to the canal before the canal is extended to Horncastle.

Operation and Maintenance of the Canal

- 10.45. The canal's operation and maintenance will be taken on by the organisation that adopts the watercourse. At this stage in the process it has not been decided who will take over the running of the canal once restored and this should be agreed in the next stage of the works.
- 10.46. Several safety issues should be considered before the canal is opened to the public. These include making sure that the boats are secure when flood events are predicted on the Bain, and public safety around the locks. Also there are the safety issues regarding the local residents due to the increase in the number of tourists in the area. Procedures and advice on the use of the canal would be need to be published by the organisation that takes on the maintenance and operation of the canal with regard to any safety issues.

11.0 ACCESS AND FOOTPATHS

Existing Access to the Canal

11.1. At present only certain parts of the canal are accessible to the general public via public rights of way. The original towpath no longer exists and a good proportion of the canal can only be reached by private land. Following is a list of all the current public access points to the canal. Figures 10.1 and 10.2 highlight the existing public access along the canal

- Sustrans Route No. 1 (part of the National Cycle Network) runs perpendicular to the entrance of the canal at Dogdyke.
- Public footpath from Dogdyke to Coningsby starts on the east bank at the marina to approximately 500m upstream, which aligns with the centreline of RAF Coningsby's main runway. Here the footpath changes over to the west bank (footbridge is currently missing) and continues to Tattershall Gauging Station. The footpath then crosses over the footbridge to the east bank as far as Butts Bridge. The final section crosses over Butts Bridge to the west

Currently under investigation with Lincolnshire County Council Highways Department is an option to declassify the section of footpath on the east bank between the marina at Dogdyke and RAF Coningsby runway. A new section of footpath would be required to continue the footpath on the west bank to the old railway bridge to gain access to the marina. Consultations with the relevant landowners over compensation for this new footpath route are still ongoing. The current route of the footpath is shown on Figure 10.1.

- Public bridleway across Fulsby Lock from the A153 to the sand and gravel pits.
 - Public footpath from Toft Hill along the east side of Kirkby-on-Bain, with a loop to Haltham. This path also extends up to Roughton and crosses the canal over a footbridge between Roughton Lock and Haltham Lock.
 - Bridleway crosses canal at Dalderby Lock,
 - Viking Way (long distance path from Barton-on-Humber to Oakham) joins the canal to the south of Martin Lock and extends into Horncastle.
- 11.2. As can be seen from the above list and Figures 10.1 and 10.2, the section of canal between Coningsby and Kirkby-on-Bain, as well as the section between Roughton and Martin Lock is inaccessible to the general public. If the canal is restored, there is an opportunity to increase public access to the canal and to the surrounding long distance footpaths and cycleways. This could be done by the addition of gates and improving the grass surface of the existing canal banks.

Future Planned Developments

- 11.3. At present it is known that the County Council is planning to open a new long distance footpath along the River Witham, called the Witham Way. It is believed that this footpath is to run adjacent to the Witham and pass the bottom end of the canal at Dogdyke over the existing railway bridge. The old railway bridge will need to be replaced to allow the passage of boats up the canal. It is possible to link the new footpath to a circular route to Tattershall/ Coningsby by leaving the Witham at Gibson's Cut (Mill Drain) and walk into Tattershall, past the castle. The loop could then return to the Witham Way down the side of the canal from Tattershall to Dogdyke, as outlined above.
- 11.4. Apart from the Witham Way, there are no known planned developments in the near future.

Disability Discrimination Act

- 11.5. The Disability Discrimination Act (DDA) 1995 is based on the principle that disabled people should not, for a reason related to their disability, be treated less favourably than others. Since October 2004 service providers will be expected to take reasonable steps to remove, alter or provide reasonable means of avoiding physical features that make it impossible or unreasonably difficult for a disabled person to make use of a service.
- 11.6. A code of practice for the Disability Discrimination Act elaborates upon the duties placed by the Act on those providing access to goods, facilities, services and premises. Although not a legal document it can be used as evidence in legal proceedings under the Act and so it is in the interest of the service provider to ensure that their practice, policy and procedures are wherever possible in accordance with the code.

Suggested Improvements to Access

- 11.7. Where possible the Disability Discrimination Act should be incorporated to allow access for wheel chair users. The main improvements for access to and from the canal are as follows:
- ***Towpath for the Canal*** - A towpath should be created alongside the canal, it can be on either side of the canal but could utilise the existing footpaths that run parallel to the watercourse. The path would need to be wide enough to allow wheel chairs and people to pass each other. If there are areas where the width is limited then passing places should be incorporated into the towpath. The towpath would also be designed for cycle access to Horncastle. The surface of the towpath should be fairly smooth and made of a hard surface to prevent rutting during wet periods. At present the issues regarding the fact that part of the original towpath no longer exists has been raised at the Lincolnshire Central Open Access Forum under the heading of lost footpaths.

- **Access Over the Locks** – It is envisaged that all ablebodied people would be able to cross every lock. A footbridge could be provided at every lock for the provision of wheelchair access, however this would create an additional seven bridges.
- **Access to Local Attractions** – Access paths from the canal could be created to give boaters the opportunity to visit local attractions. This would be ideal for places such as the Battle of Britain Memorial Flight Museum to the south of Coningsby and to Tattershall Castle.
- **Circular Walks from the Canal** – These could include loops from the Viking Way to Woodhall Spa and back to the canal near Kirkby-on-Bain. Another loop could be a branch from the Witham Way along the old canal cut at Gibson’s Cut to Tattershall/ Coningsby and back to the Witham via the canal.
- **Access to the Canal by Car/ Public Transport** – It is not envisaged that additional car parking would be required along the length of the canal. It is not the trust’s aim to promote car use. There are car parks present in the main towns of Horncastle, Coningsby and Tattershall and there are others near the canal i.e. near Thornton Lodge Farm. It is believed that there are plenty of car parks along the route of the canal to accommodate tourists visiting the area.

12.0 ENVIRONMENTAL REQUIREMENTS

Introduction

- 12.1. Information regarding Horncastle and Tattershall Canal and the Study Area has been obtained from desk based studies and a walkover of the full length of the proposed restoration area in order to describe the existing environment.
- 12.2. Restoring the canal and the subsequent recreational activities associated with the canal will have an impact on the existing natural and human environment. Restoration will result in impacts both during restoration and operation of the canal. Therefore prior to any canal restoration works it is necessary to assess these impacts. It has been determined that an Environmental Impact Assessment (EIA) is required to assess these impacts and an environmental scoping report⁵ has already been produced as the first stage of the EIA. This scoping report provided information on key features and outlines the proposals for the restoration of Horncastle and Tattershall Canal. It also facilitates consultation with interested organisations and individuals.
- 12.3. It is considered that the restoration works will result in a number of adverse impacts, which will require substantial mitigation to reduce or prevent them (see Appendix D – Environmental Mitigation Measures). The majority of these are short term impacts, however, the operation of the canal will also lead to a number of long-term adverse impacts, such as increased human intrusion and potential damage to banks as a result of wash from powered boats. The long-term impacts will be of a lower magnitude but will occur more frequently.
- 12.4. Beneficial impacts to the existing environment will also arise as a result of the restoration scheme, such as the chance to improve habitat for both protected and non-protected flora and fauna, closer monitoring of the canal water quality, a potential improvement to the scenic value of the landscape and an increase to the economy and amenity value of the area.
- 12.5. The following sections discuss impacts of the proposals on Ecology, Landscape, Public Use, Water Quality and Archaeology. Under each heading further surveys are suggested along with examples of possible mitigation measures (Appendix D).

Ecology

- 12.6. Horncastle and Tattershall Canal and the surrounding area provide suitable habitat for numerous protected species, which are likely to be adversely effected by the proposed scheme. These species include;
 - Water Vole and Otter.

⁵ Bullen Consultant Ltd. The Restoration of Horncastle and Tattershall Canal Feasibility Study, Environmental Scoping Report, LMS/ 104B058/ RE02/ A, December 2004

- Badger and Brown Hare.
 - Bats.
 - Great Crested Newt.
 - White-Clawed Crayfish and Spined Loach.
 - Compressed River Mussel and Witham Orb Mussel.
 - Schedule 1 listed breeding birds.
- 12.7. Eight Sites of Special Scientific Interest (SSSI) lie within 2km of the stretch of canal under consideration. There are also twenty-one recorded Sites of Nature Conservation within 1km of the canal. The nationally protected Lincolnshire Wolds Area of Outstanding Natural Beauty lies to the north of the Study Area. Central Lincolnshire Vale Character Area includes Horncastle and Tattershall Canal and covers proposed ideas for shaping the future, which include hedgerow re-instatement, new woodland on open clay farmland, wet grazing and washlands.
- 12.8. Potential adverse impacts to all of the above listed species and their habitats are probable as a result of the canal restoration. These are thought likely to occur throughout both the construction works and the operational works, such as short and long-term disturbance to the waterbank and loss of land due to channel widening and water storage areas. However, mitigation measures can be formulated during the EIA to help reduce the extent of the impacts. Positive impacts may also be included in EIA, such as habitat restoration and bankside planting schemes. Further ecological surveys for all of the above listed protected species will be required to be undertaken prior to the commencement of the restoration works.
- 12.9. It is suggested that further survey work for water vole, otter, badger, brown hare, bats, breeding birds and great crested newt will all be required in order to determine the presence/absence of these protected species. This will enable the exact location and extent of these species to be considered, thorough mitigation strategies advised and the Department for Environment, Food and Rural Affairs (defra) and English Nature regulations adhered to (refer to Appendix D – Environmental Mitigation Measures). Consequently, up to two years prior to the proposed works, appropriate ecological surveys should be carried out along the complete stretch of Horncastle and Tattershall Canal due for restoration.
- 12.10. Additionally, surveys for spined loach, white clawed crayfish, Witham orb mussel and compressed river mussel will be required in order to locate these species. If any of these species are present within the Study Area, mitigation measures will need to be devised.
- 12.11. It is suggested that a macrophyte and invertebrate survey is carried out to determine what aquatics/ invertebrates are present in the canal. This could help to provide greater insight into the quality of the canal water.
- 12.12. A Phase 1 Habitat Survey, in accordance with the ‘Handbook for Phase I Habitat Survey’ NCC (1990), along the complete stretch of canal should be performed prior to any works, to provide a framework for the site area and surrounding land.
- 12.13. It is suggested that the restoration works should be carried out in stages, with the canal being divided into sections, which are worked consecutively. This will help not only to dilute the operational impacts of the proposed scheme, but also allow different

organisms to be taken into account. For example, disturbance to nesting birds can be avoided by precluding scrub clearance between March and July. Additionally, it is better to work with aquatic plants when in flower rather than when died back in the winter, so that arrangements can be made to cordon off areas for their protection and so avoid the removal of rootstock during dredging in the winter. Staggering the timing of the works would also enable parts of the suitable water vole and otter habitat alongside the water channel to remain suitable for habitation at all times throughout the complete operation.

12.14. General mitigation measures relating to the ecology of watercourses will be essential regarding any planned works to areas where water vole and otter are present. These and further mitigation measures will be formulated during the EIA and facilitated by further survey work. These will include;

- Mitigation procedures to be applied directly to water vole include their exclusion from the work areas by trapping and translocation methods, as well as substantial habitat restoration to improve the habitat for water voles such as bankside re-profiling including creation of berms and planting schemes to encourage the establishment of species diverse banks and berms. Such measures will benefit all wildlife within the canal ecosystem not just water vole.
- Creation of buffer zones to provide habitat and refuge to species, which may endure disturbance as a result of the scheme.
- Consideration to species seasonal timings i.e. avoidance of vegetation clearance during bird breeding season (from late February through to August).
- Protection of designated SSSIs and SINCs (Sites of Importance for Nature Conservation) when any works are undertaken and precautionary measures carried out. It is important to realise also that actions taken outside protected areas have the potential to impact on the sensitive habitats and species of note.
- Monitoring of silt deposition rates as mitigation against an increase in algal growth.

12.15. Previous canal restoration schemes have brought to light valuable points to be taken into consideration regarding mitigation. The Montgomery Canal⁶ is a good example of this and it is suggested that this is referred to in the formulation of the EIA. Points raised regarding mitigation in the summary document include;

- The foundation of a body committed to safeguard the canal's wildlife interest and monitor changes and developments on an annual basis, and protecting the populations of the most sensitive species.
- Construction of new nature reserves with areas to provide additional areas of habitat.
- Provision of boat barriers and silt screens along some of the wider sections of the canal e.g. redundant winding holes to maintain some aquatic plants within the canal.
- Protecting plants living in the margins of the canal.

⁶ Montgomery Canal Partnership: 2004. *The Montgomery Canal. A sustainable restoration.* Summary document.

- Managing towpaths, hedges and dry land areas for other wildflowers and animals.
- Managing the navigational levels.
- Performing active measures to improve water quality.

Landscape

- 12.16. The landscape ranges from poorer quality worked sand and gravel pit areas to good quality attractive landscape, occasional woodlands but predominantly agricultural and rural areas.
- 12.17. The majority of the impacts to the landscape will occur via the construction works associated with the restoration. These include temporary loss of vegetation, possible channel widening at Coningsby and loss of and/or damage to surrounding land. There may be an improvement to the scenic value as a result of the restoration. As part of the suggested mitigation, a Landscape and Visual Impact Assessment Survey of the Study Area is suggested. This can be carried out in the EIA.

Public Use & Human Access

- 12.18. Public Rights of Way and private fishing clubs already exist along the canal but a large part of the canal is surrounded by privately owned farmland. (For further details regarding Public Access please refer to Section 11).
- 12.19. Adverse impacts associated with human use will predominantly arise during the restoration works i.e. construction impacts, such as temporary disturbance to public rights of way and increase in traffic levels. Mitigation can be formulated during the EIA and put in place to reduce the adverse impacts during the restoration of the canal, such measures include temporary footpath diversions that are well signed and interpretation boards to inform visitors to the area of the works being undertaken, the aims and the mitigation to protect the wildlife of the canal.

Water Resources & Quality

- 12.20. For full details on 'Water Resources & Quality' refer to Section 5.
- 12.21. The potential impacts to the water quality are associated with the operational impacts of the canal restoration, including an increase in water pollution entering the watercourse from boats using the canal and an associated decrease to the aquatic vegetation and associated invertebrates. These impacts may be mitigated by closer monitoring of the water quality, which could be performed through the suggested invertebrate and macrophyte surveys, to determine what aquatics are present in the canal to provide greater insight into the quality of the canal water.

Archaeology and Cultural Heritage

- 12.22. Consultation with the Lincolnshire Historic Environment Record and the National Monuments Record revealed information regarding 118 archaeological sites within 250m of the canal. Of these, six are Scheduled Ancient Monuments and 23 are Listed Buildings.
- 12.23. There are several known sites of prehistoric date within the study area. The earliest site around the canal dates to the Mesolithic (10,000 – 3500 BC) period, with Neolithic and Bronze Age sites also being present. Unusually, there seems to be a paucity of sites of Iron Age date. The number of sites of Roman date (43 AD – 450 AD) is due in part to the proximity of Horncastle, a Roman walled town.
- 12.24. There is an abundance of material from the medieval and later periods. A number of medieval structures survive, including churches and crosses, and several medieval villages are also recorded in the area. The sites of post-medieval date within the study area encompass buildings, industrial sites and sites related to transport. These include remains associated with the canal itself. Haltham and Fulsby Locks are recorded on the Historic Environment Record, although other locks also survive. These locks are not listed, but should be considered of regional importance.
- 12.25. Likely impacts of the proposed improvements will be caused by the storage areas, the new canal cutting, and the dredging of the canal. As well as impacts upon known archaeological sites, previously unrecorded sites may be discovered. Visual impacts on Listed Buildings are likely to occur during the work phase, but once the works are completed, it is likely that the improvements to the canal will enhance the setting of these, and other, buildings. Restoration of the locks along the canal will provide a beneficial impact to the canal as a whole, and to these historic structures.
- 12.26. In the first instance, a full desk-based archaeological assessment and walkover survey of the affected areas should be undertaken to further determine the impact of the proposals upon the cultural heritage of the area. This will also better inform the likelihood of discovery of previously unrecorded archaeological sites, and to assess the nature and survival of any historic structures associated with the canal. Sources to be consulted include archaeological databases, aerial photographs, historic maps, and other, relevant documentary sources.
- 12.27. This desk-based assessment will inform of the need for further mitigation, but it is likely that geophysical survey and trial trenching will be required within areas proposed for storage, as well as along the length of the proposed new cut, to aid in locating buried and previously unrecorded archaeological remains.
- 12.28. Archaeological mitigation is difficult to determine at this early stage, as the results of further surveys are required. However, it is likely that the locks will require recording, through photographs or drawings, and that any archaeological remains will need to be excavated to record them. Other areas may also require archaeological watching briefs, whereby ground works are monitored by an archaeologist, and any remains recorded.

13.0 COST OF RESTORATION

Introduction

- 13.1. The costing of the proposed options was undertaken by extracting quantities from the survey data used to produce the long section and cross sections of the existing canal. The majority of the rates were obtained from the Civil Engineering Standard Method of Measurement 3 (CESMM3) Price Database 1999/2000 (published by Thomas Telford) and adjusted to September 2004 prices by using the Retail Price Index (RPI). Rates for items not taken from CESMM3 Price Database were taken from relevant manufacturers or taken from similar projects and have been adjusted for RPI where applicable.
- 13.2. The costing is inclusive of an allowance for preliminary items, such as site set up costs, of 30% of the cost of the construction items. In addition, an allowance for contingency items for the unknowns of 20% of the construction and preliminary items is included. The costs exclude Value Added Tax (VAT), compensation for temporary land loss, utility diversion or protection costs, design fees, consultation expenses and operation and maintenance costs.
- 13.3. A risk register has been produced in Appendix E to determine the risk of the unknown items, such as a soil investigation, and assessment of the impact it will have on the overall cost of the project. This helps to quantify the contingencies for the project during the detailed design phase and construction phase.

Engineering Cost Estimates

Coningsby to Dogdyke

- 13.4. For this section of the canal, each option was considered and a cost estimate produced and a summary is outlined in Table 13.1 below.

Option	Cost (£)
Option A: Deepening Channel	3,610,620
Option B: Raising Bridges	3,845,556
Option C: Reduced Headroom	2,675,556

Table 13.1: Cost Estimate of Options for Section Between Coningsby and Dogdyke

- 13.5. As can be seen from Table 13.1 there is very little difference in the cost estimate produced for Options A and B considered for the canal between Coningsby and Dogdyke. The reduction in cost between Option B and Option C is just the removal of the bridge raising works. Several other factors, such as the effect on the local population of Coningsby/ Tattershall, will need to be considered to decide on the most

appropriate solution for this section of the canal. A breakdown of these costs is provided in Appendix C of this report.

Horncastle to Coningsby

- 13.6. Between Horncastle and Coningsby Lock the main components of the canal that require work are the lock structures, new canal cut at Kirkby-on-Bain and dredging to regain the headroom under the bridges. The costs of these items are listed in Table 13.2 below.

Item	Cost (£)
Refurbishment of eight locks from Horncastle Lock to Tumbly Lock with a new bywash structure	5,033,900
New canal cut around the village of Kirkby-on-Bain with a new lock structure and bywash channel	1,370,700
Dredging of the canal between Horncastle and Coningsby Lock to obtain the required headroom underneath the existing bridges	1,565,300
Total Cost	7,969,900

Table 13.2: Cost Estimate for Works Between Horncastle and Coningsby

- 13.7. As expected the most expensive section of this works is the refurbishment of the eight lock structures. Due to the lack of detailed survey data of each lock, it was assumed that each lock required the same amount of work. This cost estimate would be refined once detailed design of the scheme was undertaken.
- 13.8. Lining the canal to prevent seepage problems has also been considered. However, due to the lack of information on the areas prone to leakage it was decided that a cost estimate to line the whole canal should be included. The average cross sectional area of the canal was used in the calculation with a length of 16.5km. It has been estimated by using a geosynthetic clay layer with gabion mattresses on the top for protection the cost of lining the canal is in the region of £11,000,000.
- 13.9. As well as the in channel works there are the associated water supply structures required to ensure that there is a ready supply of water available, especially in the summer months. To ensure that there is a supply of water for the navigation during droughts in the summer months there are two options available. One is a large storage area with a volume of 250,000m³ and the other is a smaller storage area with a volume of 135,000m³ and a pumping station. Below in Table 13.3 is a summary of the cost of each option.

Option	Cost (£)
Large Storage Area – Volume approximately 250,000m ³	2,192,500
Pumping Station Option with a storage area of 135,000m ³	1,936,100

Table 13.3: Summary of Costs for Water Supply Options

- 13.10. As can be seen from Table 13.3 the pumping station option appears the slightly cheaper alternative. However, these costs are just the construction costs and it is envisaged that the pumping station option would have greater operational and

maintenance costs compared to just a storage area. The figures quoted in Table 13.3 do not account for the cost of land acquisition.

13.11. The majority of the restoration works will require no additional permanent land take except for the storage areas for the water supply and the new canal cuts at Kirkby-on-Bain and Tattershall. A cost estimate of the land acquisition has been calculated by assuming that the land to be acquired is of Grade 2 agricultural land standard and will cost in the region of £2,873 per acre. The cost of the total permanent land loss is in the region of £104,000.

13.12. To summarise, it will cost in the region of £12,000,000 for just the restoration of the canal with an additional £2,500,000 for the water supply and a possible cost of £11,000,000 if the whole canal requires lining. Also there is the cost of the land acquisition that is in the region of an additional £104,000. Therefore the total cost of the canal restoration to date is about £25.6 million (including lining the whole canal).

14.0 CONCLUSIONS

Summary

- 14.1. As part of this study to determine if it is feasible to restore the Horncastle and Tattershall Canal, several features have been investigated. These have included highlighting all the potential concerns and difficulties associated with restoration of the canal and then looking at the possible options for restoration. The main areas of concern are the water supply, flooding issues and the impact of the restoration on the environment and ecology. Options to overcome these difficulties have been identified and a cost estimate produced to determine an overall cost for the project.
- 14.2. From all the aspects investigated as part of this study it has been determined that the restoration of the Horncastle and Tattershall Canal is feasible. However several items or options suggested in this report still need to be investigated further. These include ways to mitigate the flooding situation and the preferred option between Dogdyke and Coningsby Lock. From the cost estimate produced to date the restoration will cost in the region of £25.6 million. This cost estimate will be refined in later stages of the design process.

The Way Forward

- 14.3. The way forward from this report is outlined in Appendix F of this report and it outlines the next steps in the process for the restoration of the canal to take place. More information is required to make progress to complete the reconstruction of the Horncastle and Tattershall Canal. These will include several surveys of the channel and existing lock structures as well as an in depth geotechnical investigation. The legal and financial aspects of the canal need to be investigated. This will determine who will operate and maintain the watercourse once it has been restored and the legal status of the original Act of Parliament for the navigation.

Appendix A

List of Acknowledgements



Appendix A – List of Acknowledgements

Lincolnshire Development Partnership



Lincolnshire County Council
Conservation and Healthy Communities Departments



East Lindsey District Council
Planning and Regeneration Department



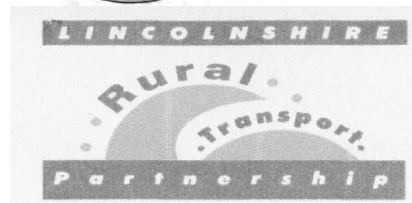
Inland Waterways Association
Lincolnshire Branch and National HQ



H.A.T.C.H (sub group of Coningsby and Tattershall with Thorpe Rural Challenge Association)



Lincolnshire Rural Transport Partnership



Horncastle Town Council



Coningsby & Tattershall Rural Challenge Association

Nelson Butler (Woodyard)

Cllr Bill Aron

Ben & Anne Bennett

David & Penny Carnell

Richard Hackford

Houldens Horncastle

Dr. Sandy Armour

Ashby Park

Woodlands Nursery

Elmhirst Lakes

Bob & Ann Wayne

Non Financial Contributors

Environment Agency
Anglian Region



**ENVIRONMENT
AGENCY**

British Waterways



British Waterways

Appendix B

Consultee Responses



Appendix B – Consultee Responses to Environmental Scoping Report & Landowner Questionnaire

Interested Party	Drainage Problems	Support the Restoration	Access to Locks	Storage Area	Additional Abstraction	Comments
Business	No	Yes	N/A	Yes	Yes	None
Landowner	Needs more detail	No	No	No	No	Concerned that the canal will not be interesting and that the financial implications are high.
Resident	N/A	Yes with reservation	N/A	N/A	N/A	Concerned about the environmental impact of the canal during construction but can see the benefits to the local community.
Business	N/A	No	N/A	N/A	N/A	Concerned about the impact on the environment.
Resident	N/A	Yes	N/A	N/A	N/A	Good opportunity to connect the facilities in Tattershall with the facilities in Horncastle.
Landowner	N/A	Yes with reservation				Historic information relating to the canal and in depth knowledge of the surrounding wildlife habitats. Concerns over changing the current ecosystems and affects opening the canal will have on his land. Suggests a museum of the canal and restore some of the Wharfs would be beneficial.

Interested Party	Drainage Problems	Support the Restoration	Access to Locks	Storage Area	Additional Abstraction	Comments
Resident	N/A	Yes with reservation	Yes	No	No	Agree with canal in principle but does not want canal within 5m of property.
Business	Needs more detail	Need more detail	No	No	No	Requires more detail but feels the flood alleviation scheme for Horncastle is more important.
Landowner	Needs more detail	Need more detail	No	No	No	Requires more detail but feels the flood alleviation scheme for Horncastle is more important.
Business	Needs more detail	Yes	Yes	No	No	Lock at the confluence with the Witham would make the marina usable for a better period.
Landowner	Foresee problems with drainage from land and reduced flood storage.	No	No	No	No	Reservations about the increased likelihood of flooding and the effect on the wildlife. Concerns over the pollution and affect on other tourists that visit the area.
Resident	N/A	?	N/A	N/A	N/A	Concerned that the canal will not have any financial demands on any local authority once operational and that the flooding issues are resolved.

Interested Party	Drainage Problems	Support the Restoration	Access to Locks	Storage Area	Additional Abstraction	Comments
Landowner	Not directly affected	Yes	N/A	Yes, possibly	No	None
Resident	N/A	No	N/A	N/A	N/A	Concerned over the affect on the local residents, the environmental impact, flooding and damage to historical sites.
Resident	Bain covers garden and patio when water level rises.	Yes	No	No	No	None
Business	No	Yes	Yes	Yes	Yes	Currently working with Lincolnshire Wildlife Trust to utilise exhausted mineral workings to extend scarce/ lost habitat.
Landowner	Yes, increase risk of flooding	No	No	No	No	Small benefit to tourism is outweighed by disruption to Coningsby. Concern over affect on wildlife
Relevant Organisation	Yes - see comments		N/A	N/A	N/A	Direct impacts on Drainage Board's infrastructure and deterioration of land drainage standard. Requires further information to decide if these affects could be mitigated.

Interested Party	Drainage Problems	Support the Restoration	Access to Locks	Storage Area	Additional Abstraction	Comments
Relevant Organisation	N/A	Yes	N/A	N/A	N/A	The organisation supports the restoration as long as it restores and enhances landscape character.
Landowner	N/A	Yes with reservation	N/A	N/A	N/A	Concerned about the cost of the project and flooding.
Landowner	Yes if banks not maintained.	Yes with reservation	N/A	N/A	N/A	Live in isolated farm and have concerns over future safety and security.
Relevant Organisation	N/A	Yes	N/A			Pleased that many key ecological issues have been identified and these with their comments should be addressed.
Resident	N/A	Yes	N/A	N/A	N/A	Love to see the canal fully restored and operational with plenty of boats.
Resident	N/A	Need more detail	N/A	N/A	N/A	Has an open mind about the project but required specific detail on how the scheme would affect her property.

Interested Party	Drainage Problems	Support the Restoration	Access to Locks	Storage Area	Additional Abstraction	Comments
Resident	N/A	No	N/A	N/A	N/A	Concerned over the noise and pollution and who would use the canal as it is a dead end.
Relevant Organisation	N/A	No	N/A	N/A	N/A	No immediate benefits to the Parish with disruptions to local wildlife habitats. Loss of amenity around proposed storage area and keen to ensure that nothing is done that affects the flooding in the village.
Relevant Organisation	N/A	Yes with reservation	N/A	N/A	N/A	Support the proposal as long as the required mitigation measures are put in place.
Landowner	More potential for flooding of property	Need more detail	Possible	No	No	Recently moved to property and knows little about what is planned, needs more detail.
Landowner	No comment	No	No	No	No	They have sporting rights up to half the channel (used for fishing and shooting wildfowl) and river traffic would disrupt this. Extra noise and expensive as the canal is a dead end.
Landowner	Problems with seepage tank	No	No	No	No	Concerned over environmental issues and flooding. Also concerned that their views will not be considered and mitigation measures not carried out.

Interested Party	Drainage Problems	Support the Restoration	Access to Locks	Storage Area	Additional Abstraction	Comments
Landowner	Affect gravity culvert outlets	No	No	No	No	Should be stopped to save money for more worthwhile projects. Flooding builds up rapidly and concerned over boaters being caught up in a flood situation. River is self regulating and this would be disrupted with the introduction of locks. Conflict of interest
Landowner	Concerned over affect on fishing lake	Yes	Yes	Yes	No	Good thing for Kirkby-on-Bain.
Landowner	Confluence of Bain and Waring prone to flooding	Yes	N/A	No	No	Provide economic benefit to Horncastle as long as the environmental impact on the river system is not too great.
Relevant Organisation	N/A	No?	N/A	N/A	N/A	Concerned about the cost of the scheme both during construction and maintenance issues, environmental concerns and that it would be unbeneficial to Horncastle as it would not attract more tourist.
Landowner	Yes due to rise in river levels, affect approximately 40 acres.	No	Yes	Yes	Yes	Raising water levels could be beneficial if environmental scheme included wet land habitats

Appendix C

Engineering Works & Costings



Appendix C – Engineering Works & Costs

Dogdyke to Coningsby Lock

Description of Works	Cost	Comments
Option A		
Deepening channel between Coningsby Lock and Tattershall Weir, which will include re-profiling the banks of the river to accommodate the increased depth.	1,502,800	Price obtained using CESMM3
Dredging from Tattershall Weir to Dogdyke, average dredging depth = 0.8m	206,800	Assuming there is no contaminated material.
Underpinning of Butts Bridge, Wharf Lane Bridge and Coningsby Footbridge	124,200	Price obtained using CESMM3
New canal cut round Tattershall Weir (no lock required due to depth of dig)	114,700	Price obtained using CESMM3
Refurbishment of Coningsby Lock, lock position to be moved approximately 15m upstream of its current position due to position of Wharf Lane Bridge	366,000	Price obtained using CESMM3
Subtotal	2,314,500	
30% for Preliminaries	3,008,850	
20% for Contingencies	3,610,620	Final Construction Costs
Option B		
Raising of Butts Bridge by 0.72m	750,000	Approximate costing obtained from recent bridge cost estimates.
New canal cut, approximately 305m long and lock around Tattershall Weir area	444,100	Price obtained using CESMM3
Refurbishment of Coningsby Lock, lock position to be moved approximately 15m upstream of its current position due to position of Wharf Lane Bridge	366,000	Price obtained using CESMM3
Dredging of canal from the downstream end of Coningsby Lock to Dogdyke, average dredging depth = 0.98m	905,000	Assuming there is no contaminated material.
Subtotal	2,465,100	
30% for Preliminaries	3,204,630	
20% for Contingencies	3,845,556	Final Construction Costs
Option C		
New canal cut, approximately 305m long and lock around Tattershall Weir area	444,100	Price obtained using CESMM3
Refurbishment of Coningsby Lock, lock position to be moved approximately 15m upstream of its current position due to position of Wharf Lane Bridge	366,000	Price obtained using CESMM3
Dredging of canal from the downstream end of Coningsby Lock to Dogdyke, average dredging depth = 0.98m	905,000	Assuming there is no contaminated material.
Subtotal	1,715,100	
30% for Preliminaries	2,229,630	
20% for Contingencies	2,675,556	Final Construction Costs

Coningsby Lock to Horncastle

Description of Works	Cost (£)	Cost Plus Preliminaries & Contingencies (£)	Comments
Refurbishment of the eight locks between Horncastle Lock and Tumbly Lock inclusive. This involves the complete re-lining of the lock with concrete, replacement of the brickwork and masonry, new lock gates and the completely new construction of a new bywash structure around the lock to accommodate the flood flows.	3,226,840	5,033,900	Price obtained using CESMM3. Lock gates prices obtain from suppliers. 10% added on for ancillaries such as life buoys and ladders.
New canal cut around Kirkby-on-Bain to include a new lock structure and bywash.	878,650	1,370,700	Price obtained using CESMM3.
Dredging of the canal bed between Horncastle and Coningsby to return the bed level back to its original position when the canal was operational	1,003,353	1,565,300	Assuming there is no contaminated material.
Overall Total		7,969,900	

Other Costings:

Lining of the Canal Bed

This was determined by starting at first principles and working out the cost of the materials and then the labour and plant costs to make up a total cost to line the whole length of the canal. The lining would consist of a geosynthetic clay layer with a protective layer of gabion mattresses. Soil could be placed on the gabion mattresses to encourage plant growth and to disguise them. The total cost for lining 16.5km of canal with a water depth of 1.5m would be in the region of **£11,000,000**. Once surveys of the leakage rate at certain areas of the canal have been conducted then a more realistic estimate can be given.

Water Supply

Two options were considered for the supply of water to the canal during drought conditions, these are outlined below:

A 250,000m³ storage area to be constructed immediately downstream of Horncastle, this will consist of embankments constructed to reservoir standard to retain the required water. Total Cost (including preliminaries and contingencies) is in the region of £2,192,500

A 135,000m³ storage area with a pumping station to abstract flows and store some water required during a 20 year drought. Total Cost (including preliminaries and contingencies) is in the region of £1,936,100.

The pumping station and a storage area is the least expensive option when just looking at construction costs. However, there are greater running and maintenance costs with a pumping station than with just a storage area. It would be beneficial to investigate the whole life costing of the two options to obtain a fairer comparison between them.

Third Party Land Costs

It has been assumed that all the land that is required to build either a storage reservoir or a new canal cut is Grade 2 agricultural land. It has been assumed that the cost per acre is in the region of £2,500 (1998 prices), which equates to £6,178 per hectare. These rates have been adjusted using the RPI to obtain a cost relative to today's prices, which equates to £2,873 per acre. The following is a list of the land acquisition required and the total costs.

Location	Cost (£)
250,000 Storage Area, south of Horncastle	79,506
New canal cut round Kirkby-on-Bain	17,356
New canal cut round Tattershall Weir	6,474
Total Cost	103,336

Appendix D

Environmental Mitigation Measures



Appendix D – Environmental Mitigation Measures

A number of organisations have published guidelines, which should be referred to as detailed below:

- British Waterways have devised an environmental code of practice to help ensure that both environmental and heritage issues are fully considered before any work is carried out. It has also prepared a Biodiversity Action Plan in partnership with DETR, English Nature, the Countryside Council for Wales, local authorities and the voluntary sector.
- The Environment Agency *Code of Practice on Conservation, Access and Recreation*, which provides advice on measures to protect wildlife from harmful effects of bankside or navigation activities.

Consultation with local planning authorities and Department of Environment, Food & Rural Affairs (defra) will be required to be held to seek their in-confidence views on the loss of agricultural land, particularly regarding Countryside Stewardship Scheme (CSS) land.

All of the relevant national and international conservation regulations, local planning policies and initiatives regarding protected habitats and species will be taken into account and adhered to as required. These include;

- Habitats Directive 92/43/EEC translated into British Law under Statutory Instrument No. 2716 ‘The Conservation (National Habitats &c.) Regulations 1994.’
- Conservation of Wild Birds Directive (79/409/EEC).
- Wildlife and Countryside Act 1981 (as amended).
- Countryside Right of Way (CRoW) (2000).
- Badger Protection Act (1992).
- The Hedgerow Regulations (1997).
- Ancient Woodland Inventory.
- Grassland Inventory.
- Woodland Grant Schemes.
- Countryside Stewardship Scheme.
- Sites of Local Nature Conservation Importance (SNCI’s).
- Local Nature Reserve (LNR).
- The UK and Lincolnshire Biodiversity Action Plans (BAP).

- Local Environment Agency Plans (LEAP).
- Countryside Character Areas.
- RSPB Birds of Conservation Concern 2002-2007.

It is strongly suggested that the relevant scientific studies are promoted at the earliest possible stage so that a scheme can be produced that is acceptable to wildlife conservation interests.

If mitigation measures are addressed in both the restoration phase and during the subsequent operation of the restored waterway, there may be opportunities to enhance the wildlife conservation value.

Appendix E

Risk Register for Costings



Appendix E – Risk Register for Costings

Risk	Effect	Approximate Cost Implication (£)
Constant water levels in the River Witham of 1.5m Above Ordnance Datum (AOD) all year round.	This is a rise of 0.4m from the winter level of 1.1m AOD. It will reduce the headroom underneath the bridges between Coningsby Lock and Dogdyke. Deepening the channel would not lower water levels so this option would not be viable without some means of controlling the water level near the Witham/ Bain confluence	Cost of a new lock = £200,000 Cost of raising more bridges = £750,000
Material to be dredged contains contaminated materials.	Since there is no information available regarding the channel's bed material, it has been assumed that all dredged material does not contain contaminated materials. If the dredged material contained contaminants then the rate for dredging would increase from £18 per m ³ to £180 per m ³ .	Rate for contaminated material = £180/m ³ Cost increase of approx. £9,000,000
Leakage along the whole length of the canal.	Tests to determine areas of leakage are required to determine if the whole canal would need to be lined. Once exact locations have been determined the amount of lining can be reduced.	Assume only half canal requires a lining, reduction of £5,500,000
Climate change effect on weather patterns.	If climate change leads to drier summers then the canal may require a larger storage area than the one proposed. Also if climate change leads to wetter winters then flooding would become more frequent.	???
Future developments on the canal network in the area	It is unclear when the Slea Navigation is to be extended and if the Fenland Link is to be constructed. Both these development will have an impact on the number of predicted boats that would use the canal in the future.	???
Water storage calculation, is there enough storage to cover a 5% annual probability of a drought occurring.	If not enough water is stored to cover a 5% annual probability of a drought occurring then the canal would have to be closed more frequently or a restriction in place on the number of boats allowed to travel up the canal due to the lack of water. This will have an implication on the profitability of the canal.	Larger storage area, assume it needs to be doubled hence cost increase of approx £2,000,000

Risk	Effect	Approximate Cost Implication (£)
Headroom requirements	If the headroom requirement is reduced this would prevent a number of bridges having to be raised, resulting in a cost saving. However, by lowering the headroom this would restrict the size of boat that could use the canal and hence reduce its viability as the economic benefits would be reduced.	Reduction in costs as no bridge raising works required at Butts Bridge (assume minimum headroom is 3m). Cost reduction = £1,000,000
Existing ground conditions – bank stability	Once dredging has taken place further works may be required to stabilise the existing embankments. This has not been included in the current cost estimate as the material used to construct the embankments is unknown. It has been assumed that the embankments would remain stable once the dredging has taken place.	???
Source of clay material for embankments around proposed storage area	Conservative estimate used for importation of clay from a local source. If clay source is not local this rate is set to increase due to the increase in transportation costs. This would also have implications on the sustainability of the construction phase.	???
Buying of land for storage area and new canal cuts	Land prices may have increased significantly above the rate of inflation.	???

Appendix F

The Way Forward



Appendix F – The Way Forward

We recommend that the following stages are implemented to take the restoration of the project forward.

Stage 1: Feasibility Report

This study is this report, which investigated if there were any technical reason why the project could not go ahead. It carried out some public consultation and had extensive discussions with technical third parties.

Stage 2: Legal and Financial Study

This part of the project would include a cost benefit analysis of the project and investigate the legal position of restoring the navigation. It would investigate the possible organisations that would maintain the navigation when restored. This would allow a comprehensive funding package to be negotiated. It would also investigate sources of funding from private developers so that parts of the canal, such as the marina could be built in partnership with a housing developer for example.

Stage 3: Outline design of Phase 1

The commission would be to carry out the outline design for restoring the navigation to Coningsby. It would include:

- Detailed topographical survey to include the next pound and lock to establish the final geometry of the canal
- Detailed ground investigation to allow slope stability, allowable bearing pressures and leakage rates calculations.
- Consultations with professional partners such as the planning authorities, Environment Agency, Highways Authority, English Nature and others.
- Consultations with those directly affected by the scheme
- A wider public consultation including a public display
- A full Environmental Impact Assessment
- Outline design with sufficient detail to obtain planning permission and other statutory permissions. All options are to be considered in detail taking account of any changes in retained water level within the Witham and the detailed investigations undertaken as part of this commission.
- A detailed cost estimate for the construction of Phase 1.
- The gaining of all statutory permissions.
- The production of contract documents for the construction phase.

Stage 4: Construction of Phase 1

This could be let as a traditional contract with the design done under a separate commission or with a design and construct contract under one contract.

Stage 5 et al: Continuation to Kirkby-on-Bain

Once Phase 1 was complete, the restoration could continue using small construction firms and volunteer labour upstream to Kirkby-on-Bain. During this time the water resources issues would have to be addressed and the storage requirement determined. The position and size of the reservoir would have to be agreed and the statutory permissions obtained.

The new cut around Kirkby-on-Bain and the reservoir would be constructed by a contractor so that it would be completed relatively quickly minimising disruption to the local residents.

The navigation from Kirkby-on-Bain to Horncastle would be carried out with a mixture of small construction firms and volunteer labour.

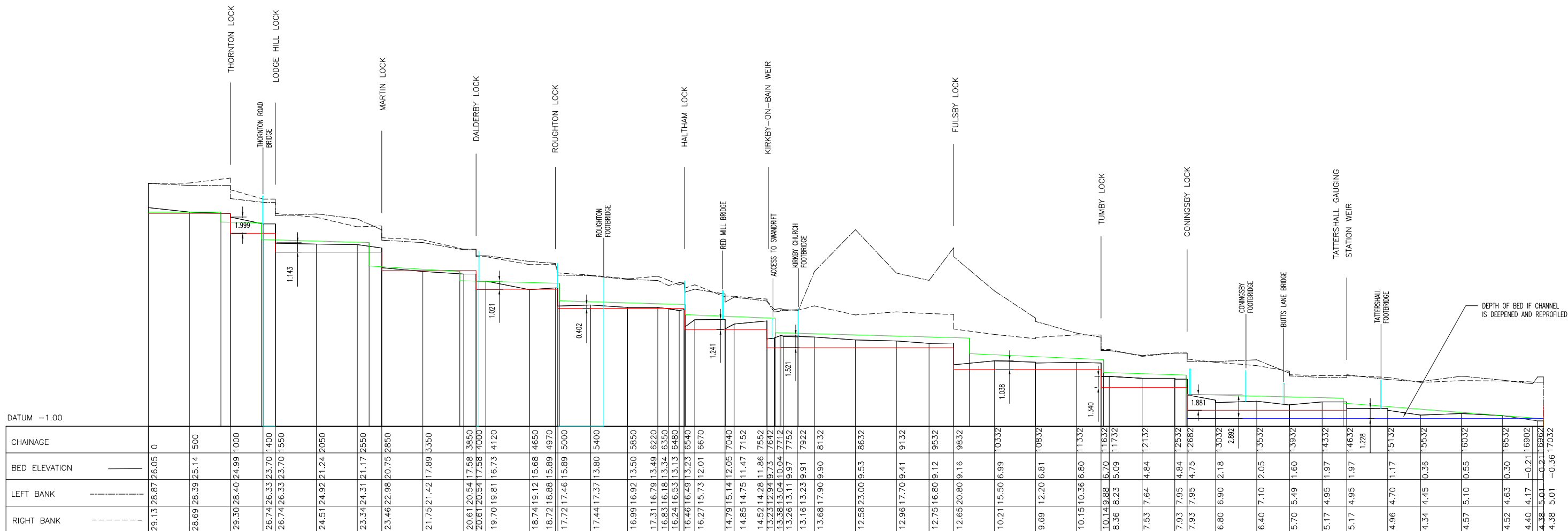
Stage 5 and the subsequent stages have not been detailed as they will depend on fund raising and the amounts raised.

Figures

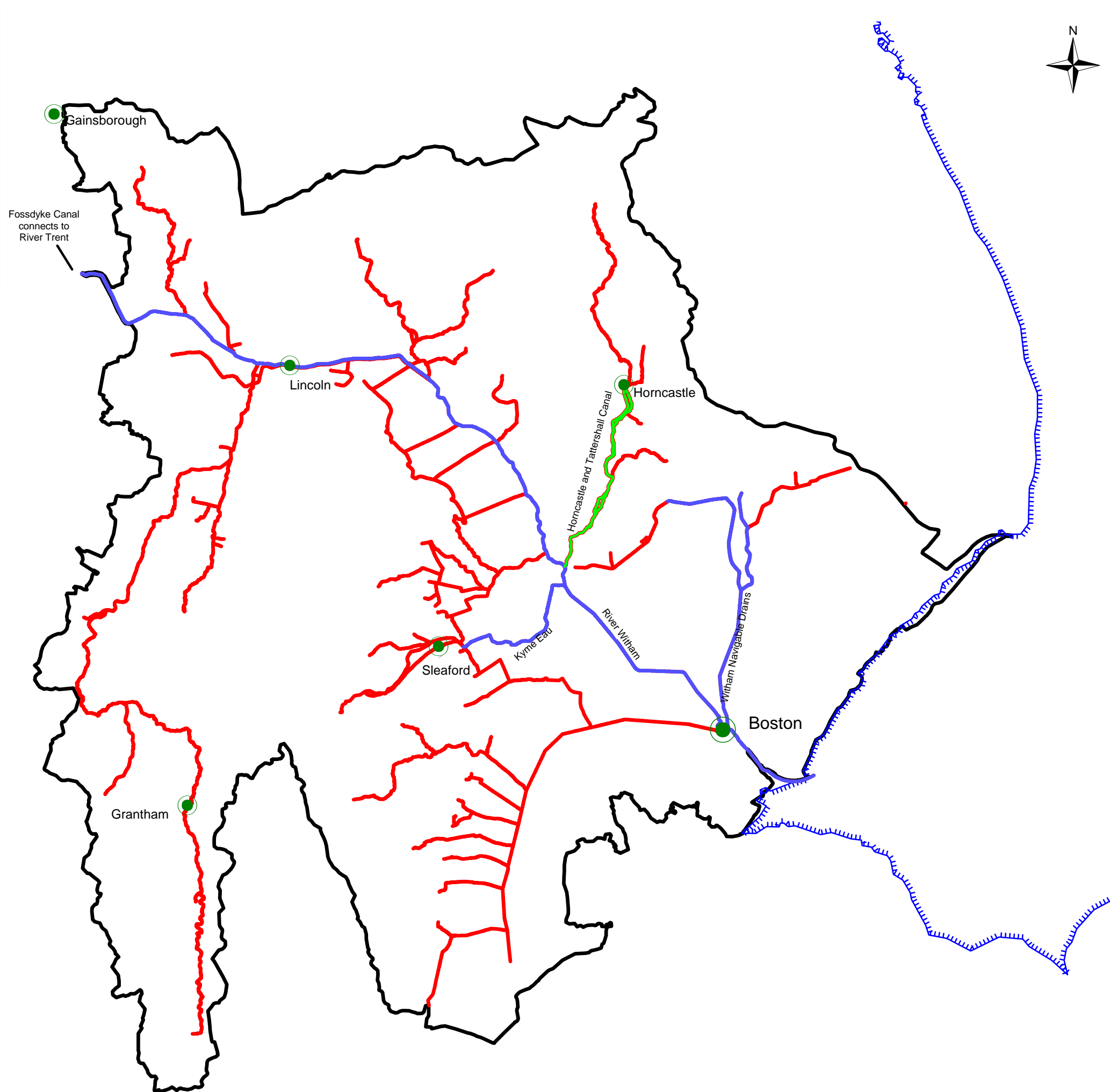
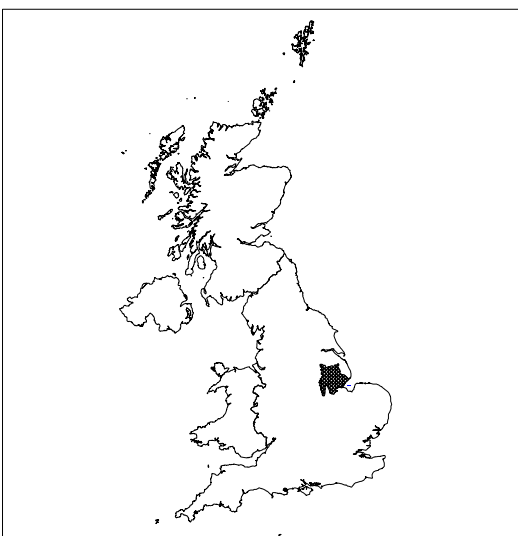


- NOTES:
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- KEY:
- 1834 SURVEY —
 - 1950 SURVEY —
 - MODEL SURVEY —



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<p>CLIENT HORNCastle AND TATTERSHALL CANAL HERITAGE TRUST</p> <p>PROJECT HORNCastle AND TATTERSHALL CANAL FEASIBILITY STUDY</p> <p>TITLE LONGITUDINAL SECTION</p>					
<p>11/12 Eldon Place, Bradford, BD1 3AZ. Tel. 01274 370410 Fax. 01274 734447 Email: bradford@bullen.co.uk</p>					
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DAC		N.T.S.		APR '05	
PROJECT NO.		FIGURE NO.		REVISION	
104B058		4.1			



LEGEND

- Cities / Towns
- Main River
- Existing Navigable Watercourses
- Proposed Canal Restoration
- Witham Catchment Boundary
- UK Outline

REV	AMENDMENT	DWN	CHKD	APPR	DATE

CLIENT
 HORNCASTLE & TATTERSHALL CANAL HERITAGE TRUST

PROJECT
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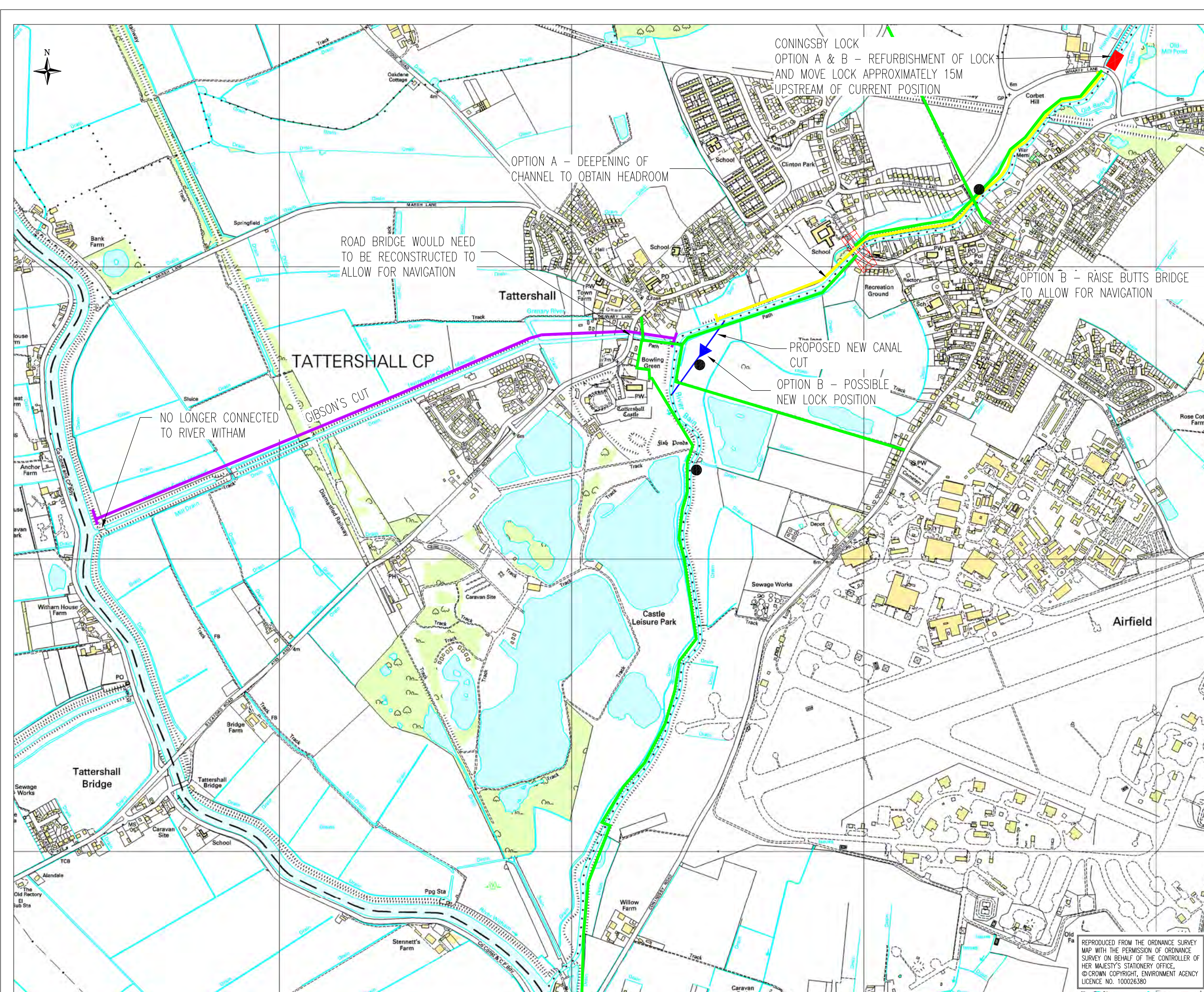
TITLE
 PLAN OF WATERCOURSES IN WITHAM CATCHMENT



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KEY:

-  OFF-LINE MOORING
-  EXISTING FOOTPATHS/ BRIDLEWAYS

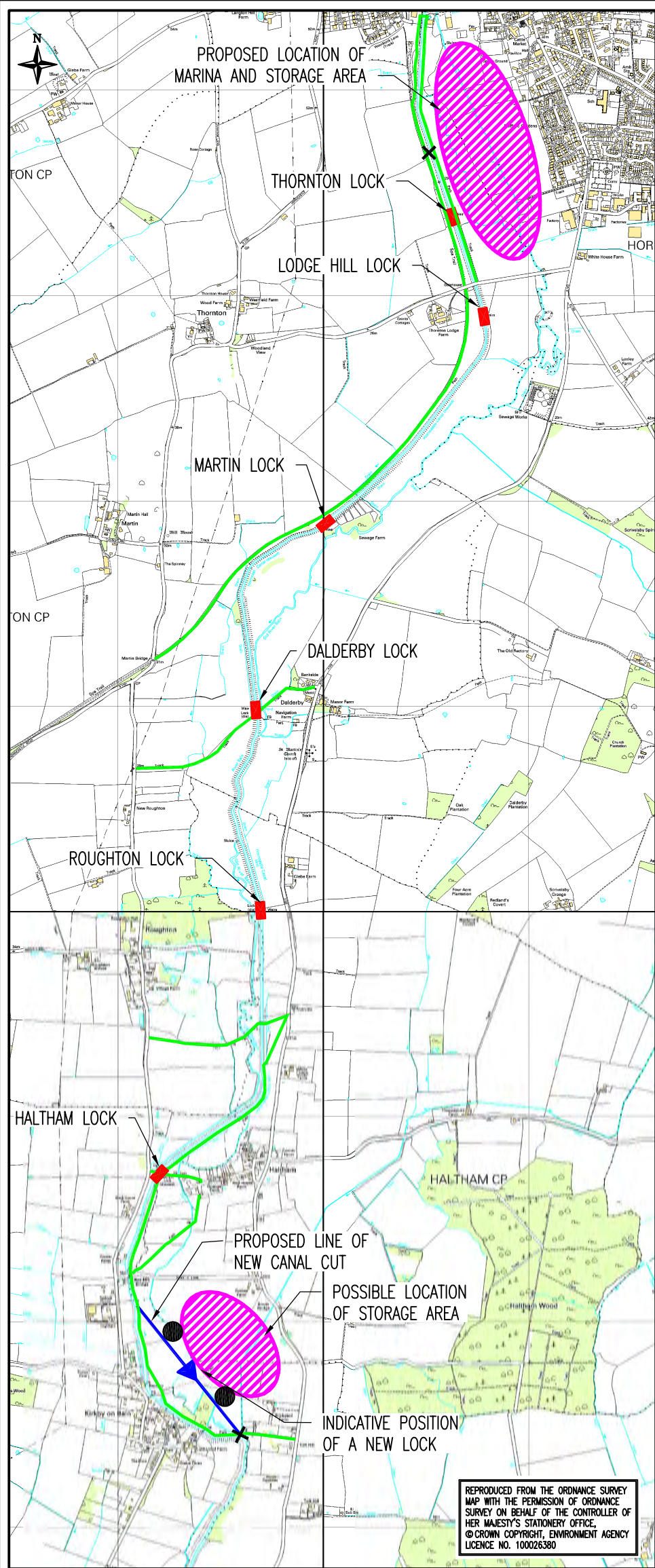
REV	AMENDMENT	DWN	CHKD	APPR	DATE
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PROJECT HORNCastle AND TATTERSHALL CANAL FEASIBILITY STUDY					
TITLE LOCATION OF PROPOSED ENGINEERING WORKS CONINGSBY TO THE RIVER WITHAM					



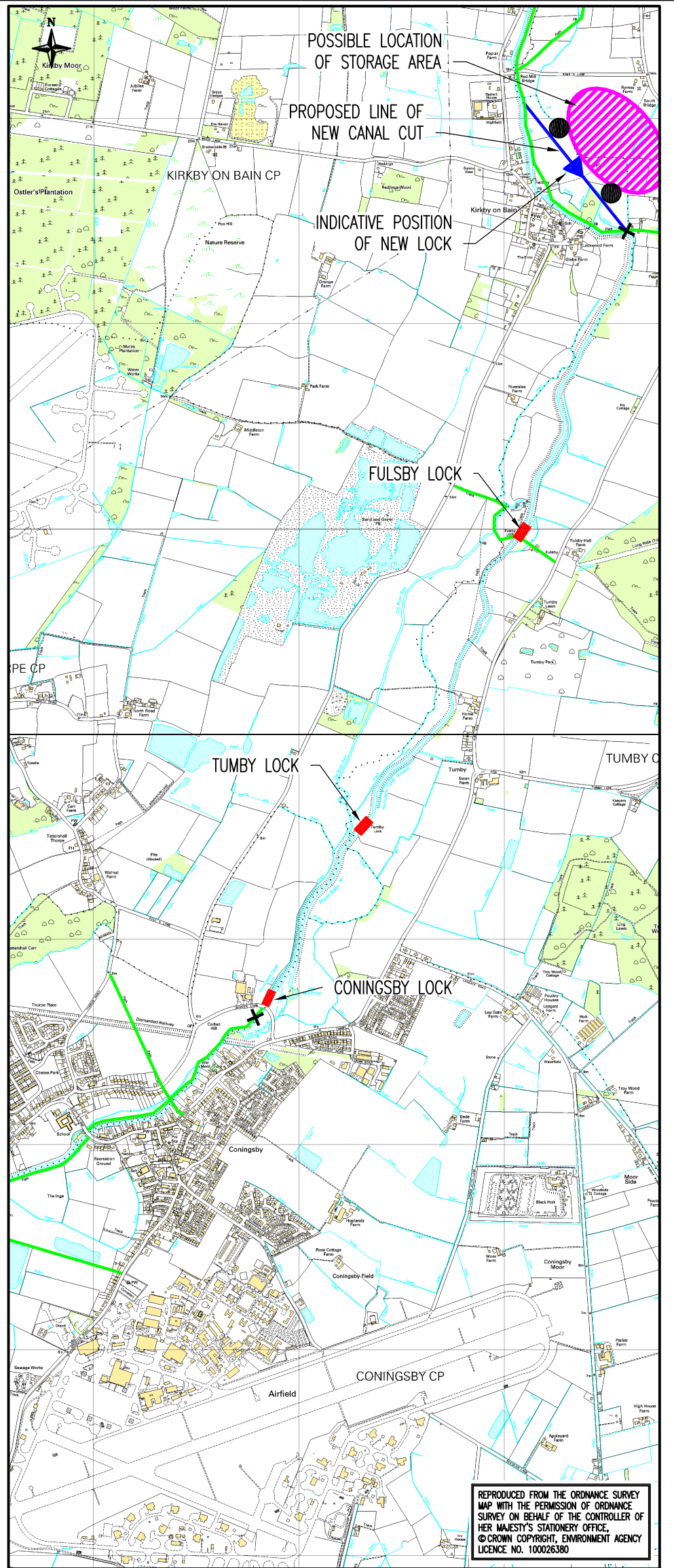
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PLAN OF ENGINEERING WORKS – HORNCASTLE TO KIRKBY ON BAIN



PLAN OF ENGINEERING WORKS – KIRKBY ON BAIN TO CONINGSBY

NOTES:

- DO NOT SCALE THIS DRAWING.
- ALL PROPOSED NEW CANAL WORKS ARE INDICATIVE ONLY.

KEY:

- REFURBISHMENT OF LOCK
- NEW CANAL CUT
- ▲ NEW LOCK
- ✘ WINDING HOLES
- STORAGE AREA/ MARINA
- OFF-LINE MOORING
- EXISTING FOOTPATHS/ BRIDLEWAYS

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PROJECT

HORNCASTLE AND TATTERSHALL
CANAL FEASIBILITY STUDY

TITLE

LOCATION OF PROPOSED ENGINEERING
WORKS HORNCASTLE TO CONINGSBY

CLIENT

HORNCASTLE AND TATTERSHALL
CANAL HERITAGE TRUST

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