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ENVIRONMENT AGENCY

Fens Waterways Link

Supporting Report 3: Engineering

FINAL

Notice

Document History

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GLOSSARY OF TERMS

Term	*Meaning / Definition*
SSSI	Sites Special Scientific Interest
EA	Environment Agency
IDB	Internal Drainage Board

1 Executive Summary

The purpose of this supporting report is to consider the best way to link four main river systems to create navigation between;

Earith and Ely (on the River Great Ouse System);

Ramsey (on the Middle Level System);

Peterborough (on the River Nene System);

Spalding (on the River Welland System) and;

Boston (on the River Witham System).

It is possible to create a **Southern Circular** route linking Ely, Earith, Chatteris, March and Denver with Peterborough. From Peterborough, a **Northern Linear** route can be created to Spalding and then to Boston.

This report represents a first assessment and many of the elements, to make the routes happen, will be dependent on integrating with proposals for developments around the proposed waterway and renovations to flood defence.

The previous work by Bullen Consultants was reviewed and also a number of new routes were considered. Many were rejected, either because of technical impossibility, or because they were too expensive. These have not been detailed in this report because it is important to consider the feasible routes and to add more detail.

The main emphasis has changed, from the findings of the Bullens reports, to attempting to find routes which will avoid tidal navigation. Therefore an aqueduct structure has been introduced on the Southern Route to link Well Creek with the Ely-Ouse system. Similarly at Spalding the feasibility of moving the tidal barrier downstream to Vernatts Drain outfall has been evaluated. The advantages being the creation of 4.5 km of non-tidal waterway and a link into the River Glen.

Whilst there was no wish to discard any of the previous work undertaken, the opportunity has been taken to re-visit and update the work, and to move forward on the routes suggested.

It is estimated that the creation of a navigable “Circular” Southern route linking Earith with Chatteris together with a link through to the River Nene system, will require investment of approximately **£40.8 million**.

The creation of a navigable Northern Route, linking Peterborough with Boston, will require investment of approximately **£91.9 million**.

2 Introduction

This supporting report considers the engineering feasibility of linking the various rivers in the Fenland Waterway network to provide a through route from Ely to Boston. It builds upon previous work undertaken by Bullen Consultants and examines a number of modifications to the routes. The links fall naturally into a circular **Southern Route** linking the towns of Earith, Peterborough, Chatteris, March and Ely, and a linear **Northern Route** linking Peterborough with Boston. Both routes are shown in diagrammatic form in the box below. The routes interlink at Peterborough.

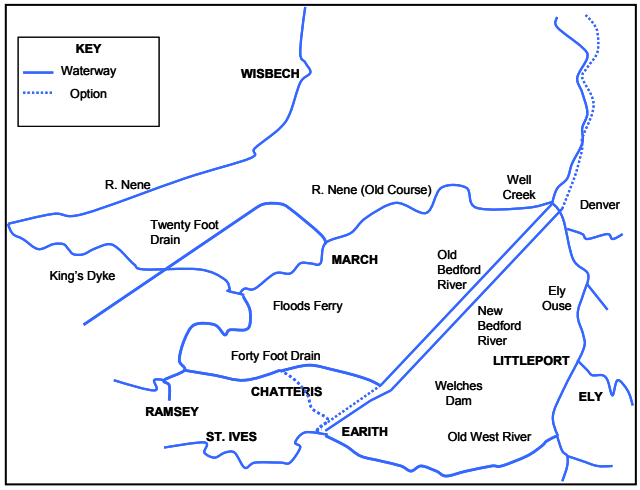


Diagram of Southern Route

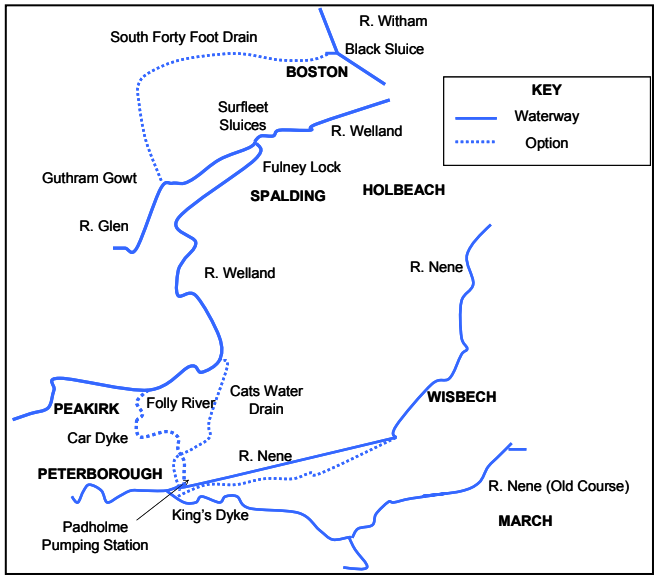
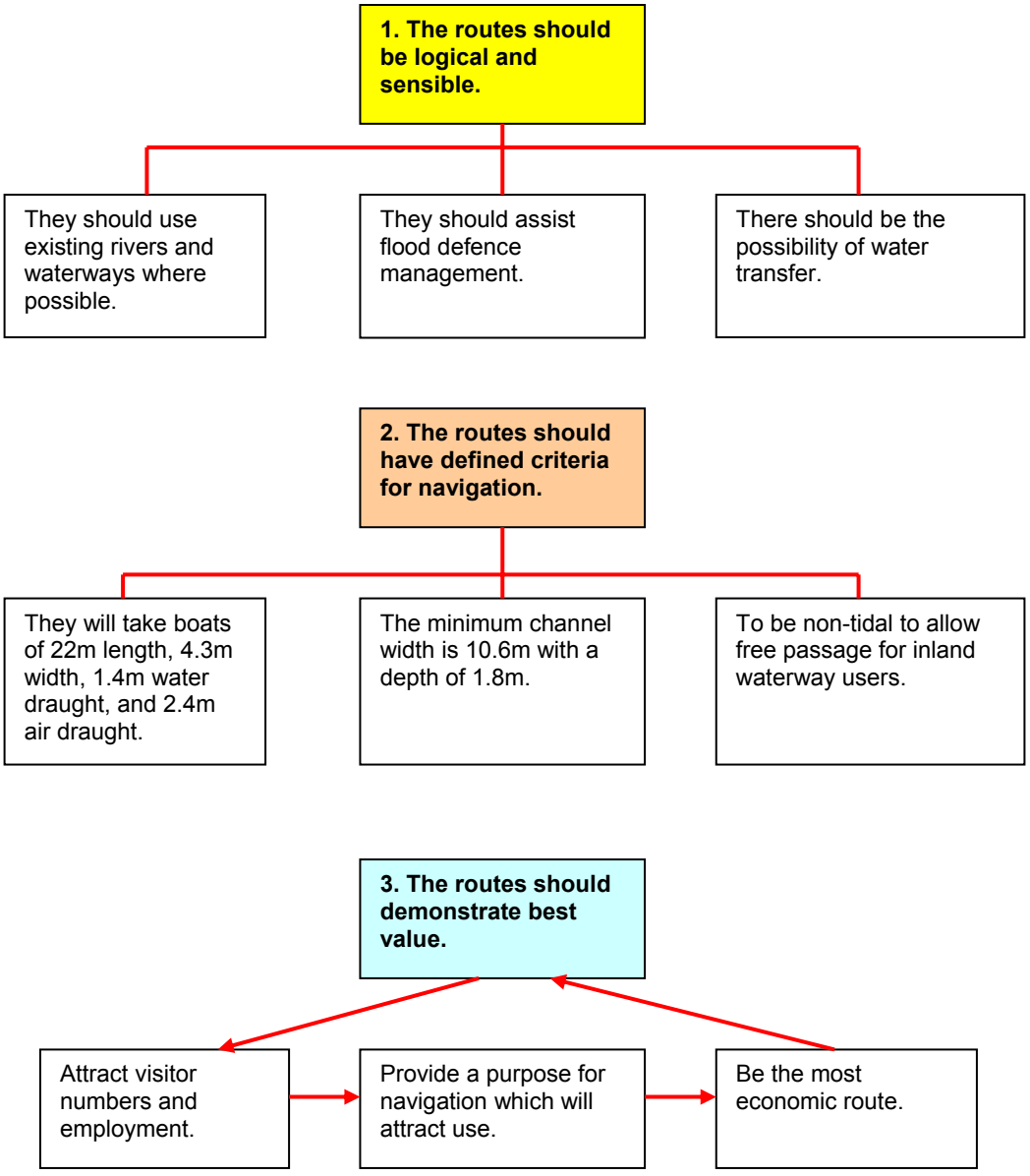


Diagram of Northern Route

The guiding principles in considering the routes are;



2.1 The Report Layout

The report is laid out in two main sections. Part 1 is a description of both the Southern and Northern Routes which contains the information recorded on the walkover surveys and observations. The modifications and options are considered and a preferred route described.

Part 2 contains the schedule of engineering works required and leads onto the estimate of costs.

Detailed maps of the route are contained in Part 2 Appendix A. The routes are lengthy, and to assist in interpretation, each route has been divided into geographic sub-sections and reference in the text is made to these sub-sections. A key map is provided at the beginning of Appendix A

The detailed sheets of the estimated cost build up are given in Part 2, Appendix B.

2.1.1 Southern Route

The Southern Route is sub–divided into five geographical sections. These are;

- Chatteris to Earith;
- Earith to Ely;
- Ely to Upwell;
- Floods Ferry to Stanground Lock;
- Upwell to Chatteris.

2.1.2 Northern Route

The Northern Route stretches from the River Nene, just south of Peterborough, as far as the River Witham in Boston. The Northern Route is sub-divided into two geographical sections. They are:

- Peterborough to Spalding;
- Spalding to Boston.

PART 1

Route Description and Observations

3 The Description of the Routes: Southern Route

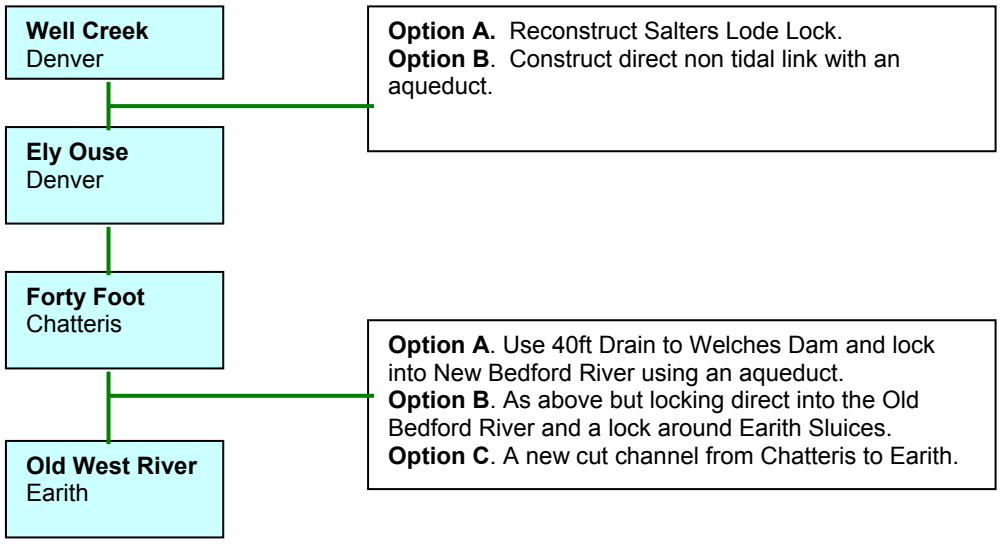
3.1 The Southern Route

The following watercourses along the proposed route can be utilised as navigable waterways:

- Old West River
- Ely Ouse
- Well Creek
- River Nene (Old Course)
- Kings Dyke
- Forty Foot Drain (Vermuyden's Drain)
- Twenty Foot Drain / Cranbrook Drain
- Old Bedford River
- New Bedford River

There are three options along this route which have been considered in detail, all use the Old West River, the Ely Ouse, Well Creek, River Nene (Old Course). All options require a direct link between Well Creek and The Ely Ouse River. This is a proposed aqueduct and staircase lock structure near Denver Sluice, which will carry the navigation over the New Bedford Flood Channel. This avoids the present tidal link between Salters Lode and Denver Sluice. All options will require the construction of a new lock at Earith Sluices.

The options in the table below are concerned with linking the Old Course of the Nene at Peterborough to Erith. The purpose is to provide a circular navigation route in the south, with a link into the northern system.

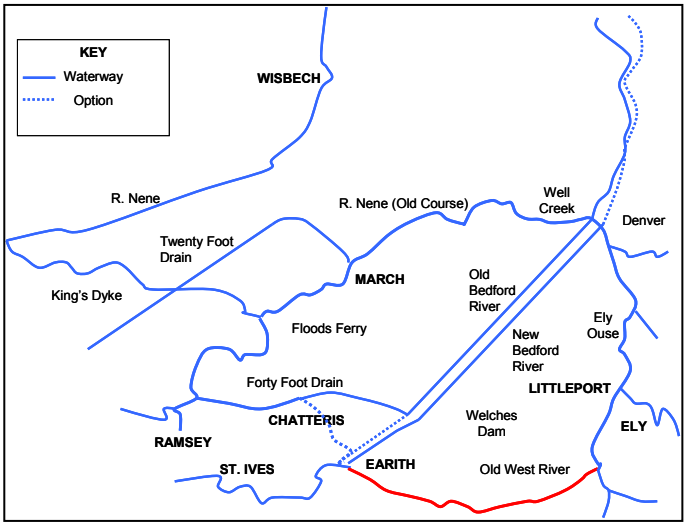


Link	Well Creek to the Ely-Ouse at Denver
Options	**Description of Route**
Option: A	Reconstruct Salters Lode Lock
Option: B	A new staircase and aqueduct structure to carry a link across from the Well Creek to the Ely Ouse River. This would also link into the Old Bedford River.

Link	Forty Foot Drain at Chatteris to Earith
Options	**Description of Route**
Option: A	Uses the Forty Foot Drain (Vermuyden's Drain) as navigation down as far as Welches Dam and from Welches Dam accessing the New Bedford River via an aqueduct structure before linking direct to Earith.
Option: B	Uses the Forty Foot Drain (Vermuyden's Drain) as navigation down as far as Welches Dam (as in Option A) and from the Welches Dam accessing the Old Bedford River via a lock structure before linking direct to Earith.
Option: C	Uses the Forty Foot Drain (Vermuyden's Drain) to its confluence with the Twenty Foot Drain west of Leonard Childs Bridge and from this point utilising the Fenton's Lode through Chatteris before accessing a newly constructed link between Chatteris and Earith via a short length of the Old Bedford River.

3.2 Old West River (River Ouse)

3.2.1 Description



The Old West River between Hermitage Lock at Earith, the Fish and Duck Inn and the marina near Stretham, is approximately 17.8km long. It has always been a problem to the Rivers Authority (now the Environment Agency (EA)) because although it is classified as a Main River, it serves a very small catchment area and has therefore received only a small grant to implement a land drainage improvement scheme. Historical data indicates that if it was not for the fact that boats have made passage through it since the war, it would probably be completely covered with weeds and reeds.

Some years ago, the Army dredged a considerable part of this section of the route as part of an exercise for learner drag line drivers, and although the finish they left was not to a high standard, the operation did result in a considerable benefit to navigation.

Hermitage Lock is the only navigation structure located along this reach of the Old West River. Approximately 3,900 craft pass through the lock each year. The lock is generally in good condition but navigation constraints exist during periods of low flow due to a lack of water depths. As a result , access into the lock can be restricted. Moorings along this stretch are located at Hermitage Marina, 20 Pence Marina, Stretham Engine, The Fish and Duck Marina and at Ely.

The main difficulties with the Old West River are that in places the channel can become narrow and the banks suffer badly from erosion due to the soft nature of the soils. Water levels can also become very shallow at certain times of the year during periods of low flows. This has two major effects on navigation. Firstly, the section of river between Hermitage Lock and the 20 Pence Marina can become very shallow and shoals often develop around the 20 Pence Bridge, leading to larger crafts becoming grounded. Secondly, low water levels at Hermitage Lock can restrict navigation into the lock.

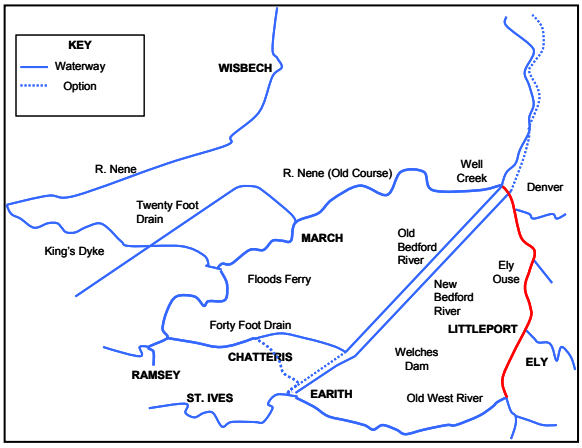
3.2.2 Observations

At the present time, approximately 3,900 craft pass through the Old West River each year. In its present condition this is not an ideal spot for river bank moorings as boats tend to considerably restrict the channel. The width of the channel and the poor bank conditions do not lend themselves well to increasing moorings on the Old West River. It would be better to allow small marinas to be developed, providing river moorings, rather than have the banks cluttered up with craft. There are currently mooring facilities at Stretham Bridge and the 20 Pence Marina, where the river broadens out, which could be further utilised as additional moorings.

With an increasing number of craft going through the Old West River, considerations will have to be given to the widening and deepening of the channel between Hermitage Lock and the Fish and Duck Inn. The width of channel will need to be increased to a minimum of 10.6 metres to allow easy passage of craft along this section of the route. In addition, the Hermitage Lock near Earith will have to be refurbished or replaced to accommodate increased boat traffic. The approach to Hermitage Lock will have to be made more accessible in order to provide efficient movement of craft through the lock.

3.3 Ely Ouse

3.3.1 Description



The Ely Ouse between Ely and Denver Sluice is approximately 21km long and has no significant navigation problems or constraints until it terminates at Denver Sluice. The number of permanent moorings on this stretch of the river has hardly increased. The relatively new Marina at Ely is not at capacity, having at the moment 65 permanent moorings with 142 currently vacant. Anglian Water Authority has provided more temporary moorings, and together with the Quay at Ely, mooring is no great problem.

The channel width between Ely and Denver is relatively wide and provides adequate clearance for boats to navigate without restriction. The depth of the channel is also sufficient for navigation. The only navigation problem which exists is at the downstream approach to the Denver Sluice lock which accesses the tidal section of the Great Ouse. The approach to the lock can experience siltation problems.

3.3.2 Observations

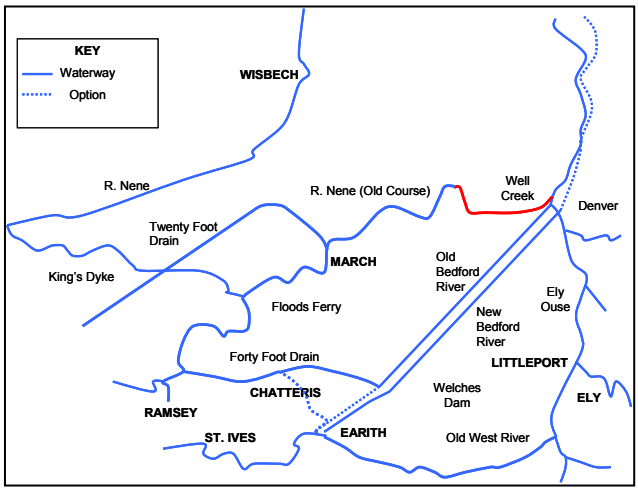
At the present time, approximately 1,000 craft pass through the Denver Lock each year. The lock is in good condition and provides access into the tidal section of the Great Ouse. Navigation of this tidal section of the Great Ouse is notoriously difficult due to strong currents and substantial siltation of the tail end of the Denver Lock. Water levels can also be extremely shallow. As a result, consideration will have to be given to dredging this section of the tidal side of the Denver Lock in order to deepen the channel. To allow passage of craft into Well Creek, boat users currently have to negotiate the tidal section of the Great Ouse. This situation is not ideal for long boat users as the strength of the tide can prove difficult. Navigation of this section is a major constraint. It has therefore been proposed that alternative ways of accessing the Well Creek be investigated.

One such option is to construct a landmark structure consisting of a series of three stair case locks along the Ten-mile bank, which will be linked to an aqueduct structure that will then divert boat traffic over the New Bedford River dropping down via a staircase lock into a new canal before finally into the Well Creek. This proposal will avoid the use of Salters Lode Lock and the tidal section of the Great Ouse for navigation.

The Denver complex has been identified as a target site for potential development opportunity. For example, the development of major leisure, land and water based visitor facilities including additional moorings, improvements to the existing sailing club, creation of public open space, construction of a visitor centre, boat trip facilities and environmental improvements to existing facilities.

3.4 Well Creek

3.4.1 Description



The Well Creek is approximately 11.3km in length and runs from Salters Lode Lock at the confluence of the Great Ouse, through the villages of Nordelph, Outwell and Upwell, and eventually terminates at Marmont Priory Lock where the Well Creek converges with the River Nene (Old Course).

The Well Creek, between Salters Lode Lock and Nordelph experiences siltation problems in certain locations. This makes the river shallow in places, resulting in navigation difficulties. Some sections of the Well Creek in Upwell and Outwell are also relatively shallow and require careful navigation. Dredging of these sections may be required to accommodate increased traffic in the future.

There are three main structures along the Well Creek:

- Salters Lode Lock which is situated at the confluence with the Tidal Great Ouse. This lock currently has an estimated 800 craft passing through it a year but is in a poor condition and is notoriously difficult to navigate from the Tidal Ouse. This is because of deterioration of the structure and its poor design. In addition, the lock can only be navigated for limited periods each side of high tide, meaning that only a certain number of boats can pass through the Salters Lode Lock per day.

- Mullicourt Aqueduct, along the Well Creek, allows transport of boats over the Middle Level Main drain and is situated between the villages of Nordelph and Outwell. Currently, the Mullicourt Aqueduct is in use but does have some renovation issues surrounding its future use, if traffic over it is going to be increased.

- The Marmont Priory Lock, situated at the confluence of the River Nene (old course) with the Well Creek. This lock is in good condition and has more than one thousand craft passing through it each year.

In addition to the main navigation structures discussed above, there are 15 bridges spanning the Well Creek along its length. The approximate head room of these bridges is 2.10 metres. There are also turning facilities at Salters Lode, Nordelph, Outwell Boat Basin and Marmont Priory Lock. Moorings and shop facilities can be found at Nordelph, Outwell and Upwell.

3.4.2 Observations

The main constraint along the Well Creek involves the difficulty of navigation into the Well Creek via Salters Lode Lock from the Great Ouse. It is recommended that the existing Salters Lock be substantially refurbished or replaced. Alternatively, navigation could be diverted from the Ely Ouse via an aqueduct structure thus avoiding the need for the Salters Lode Lock altogether.

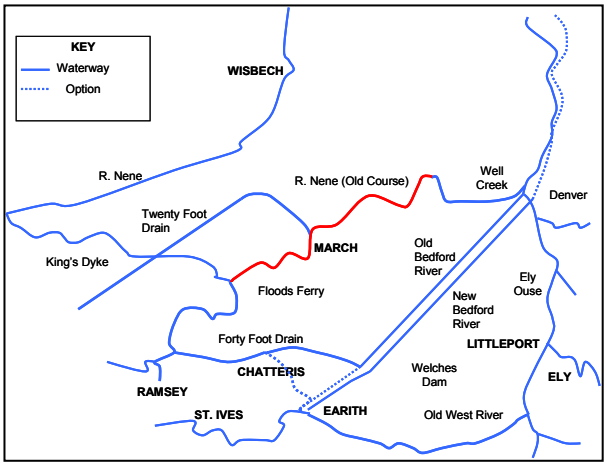
Other constraints identified along the Well Creek include some sections of the watercourse in Upwell and Outwell. Some of these sections are narrow and relatively shallow and currently require careful navigation, often requiring boat users to use the deepest part of the channel to avoid grounding. Consideration will have to be given to dredging sections of the Well Creek and increasing the channel width to accommodate increased boat numbers. Water levels can be further maintained by decreasing leakage from Marmont Priory Lock. Currently, leakage from the Marmont Priory Lock can rapidly lower water levels in the Well Creek, often requiring several days to restore satisfactory navigation levels. Consideration should be given to decreasing leakage through the lock doors and penstocks.

Finally there are a number of bridges that span the Well Creek which constrain navigation. Creek Farm Bridge, for example, currently has piers within the main channel that cause a restriction to navigation. This bridge will need replacing or redesigning to allow standard boat sizes to navigate the Well Creek. Head room of all the bridges will need to be increased to a minimum of 2.4 metres.

The Well Creek has been identified as a possible target site for development. An example of potential development is the refurbishment of the village frontage, with a co-ordinated strategy, throughout and between the villages of Nordelph, Upwell and Outwell. Proposed schemes may involve enhancements to boating facilities and moorings. Potential for improvement includes landscape enhancement and face lifts to buildings and pubs, in conjunction with private sector buildings, and landscape enhancements to the main road immediately adjacent to the waterway.

3.5 River Nene (Old Course)

3.5.1 Description



The section of the River Nene (Old Course) between Marmont Priory Lock and the confluence with the Forty Foot Drain (Vermuyden's drain) is approximately 24.3km in length and passes through the town of March and the village of Benwick before converging with the Forty Foot Drain near Ramsey. Approximately 6.4km downstream from the town of March, the River Nene (Old Course) splits at Floods Ferry and joins the Whittlesey Dyke watercourse, which accesses King's Dyke before terminating at Stanground Lock. The Whittlesey Dyke / King's Dyke water courses are discussed in section 3.5.

The River Nene Old Course is currently a popular navigation route and the river is mostly wide and deep. The only exceptions to this are through March Town centre and immediately before the approach to Marmont Priory Lock. These sections require careful navigation. There are no navigation structures present along this stretch of the River Nene (Old Course). There are, however, 10 bridge crossings which span the width of the channel, all of which have ample headroom to facilitate boat passage. The only bridges that may cause concern are at Floods Ferry Bridge and Staffurth's Bridge, Whilst these bridges provide sufficient clearance, they do have structural faults giving rise to the need for replacement in the near future.

Moorings are provided at Floods Ferry Touring Park, March Town Quay. There is a Marina located just south of March at Fox's Boat Yard.

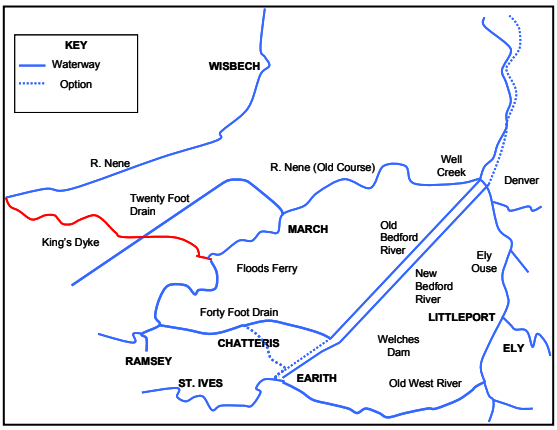
3.5.2 Observations

There are few navigational constraints along this section of the River Nene (Old Course). It is, however, recommended that the Floods Ferry Bridge and the Staffurth's Bridge should be replaced in the future owing to their structural faults.

There are a number of locations along the length of the River Nene (Old Course) which have been identified as target sites for opportunity. Opportunities include incorporating a range of environmental improvements to the Fox Boatyard, for example, improvements to linear moorings and significant river enhancements e.g. planting, and leisure related development and facilities. Town corridor enhancement through March is to include opportunities and proposals for boating facilities, face lifts to buildings and regeneration of the town centre to attract visitors and investment.

3.6 Whittlesey Dyke / King's Dyke

3.6.1 Description



The Whittlesey Dyke links with the River Nene (Old Course) at Floods Ferry and merges with the King's Dyke at Ashline Lock before finally continuing along the King's Dyke to Stanground Lock. The length of the combined watercourses is approximately 14.5 km long.

The Whittlesey Dyke is an existing navigation route with adequate channel size to accommodate boat access. The only navigation structure present is located at Ashline Lock near Whittlesey. This small unattended lock is in good condition but if not properly operated can lead to depletion of water levels within the King's Dyke through leakage. Considerable difficulty in restoring water levels can result if the penstock doors are not appropriately closed. There are 7 bridges which cross the Whittlesey Dyke, all of which have adequate head room to allow passage of boats. Moorings are provided and leisure facilities are available within the town of Whittlesey.

The King's Dyke between Ashline Lock and Stanground Lock, is more of a navigational problem. Water levels between the two locks are sometimes below navigation levels causing delays to boats entering Stanground Lock waiting for water levels to be adjusted to accommodate boats. Stanground Lock itself provides access into the River Nene and as a result doubles up as a sluice gate. Another major difficulty of the King's Dyke reach is the restricted width of the channel at Briggate Bend where the channel can be as narrow as 4.27m. There are also a number of sharp bends around Briggate which can pose difficult to navigation. Eight bridges span the King's Dyke, but all have ample headroom to accommodate free passage of crafts.

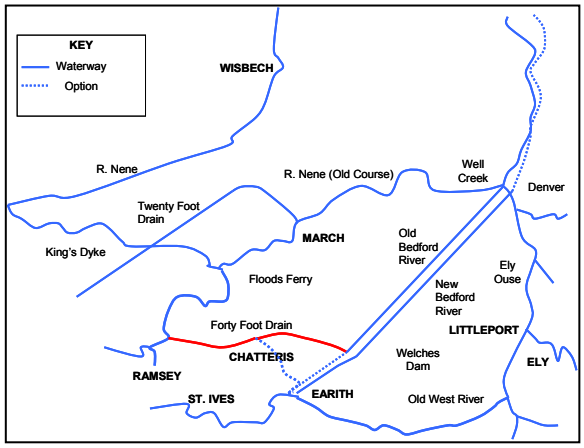
3.6.2 Observations

Channel improvements to Briggate Bend on the King's Dyke will need to be made to accommodate full-length craft. In order to maintain water levels within the King's Dyke, improvements to Ashline Lock could be made to prevent leakage. The channel may also need dredging to increase water depths.

There are a number of locations along the King's Dyke that have been identified as potential target sites for opportunity. For example, town corridor enhancements could be made to Whittlesey to incorporate waterside improvements. Opportunities exist for large scale waterside development and regeneration with a mixed use proposal including marina facilities at Whittlesey Brick Clay Pits.

3.7 Forty Foot Drain (Vermuyden's Drain)

3.7.1 Description



The Forty Foot Drain runs from Wells Bridge at the confluence with the River Nene (Old Course) to Welches Dam on the Old Bedford River. The length of this watercourse is approximately 15.3km. The Forty Foot Drain is currently used as a navigation channel, but it has restrictions during specified times of the year due to lack of water levels. There are two locks along the Forty Foot Drain at Horseway Lock and at Welches Dam. Both locks are small and can only be used on specific weekends throughout the year. There are 7 bridges which span the Forty Foot Drain one of which, "Low Bridge", is of insufficient height to facilitate larger boat passage. "Low Bridge" only has a clearance height of 1.7 metres.

The Forty Foot Drain converges with the Twenty Foot Drain (Fentons Lode) immediately before Leonard Childs Bridge. The Twenty Foot Drain provides access to Chatteris and is one of the options discussed in section 3.8.

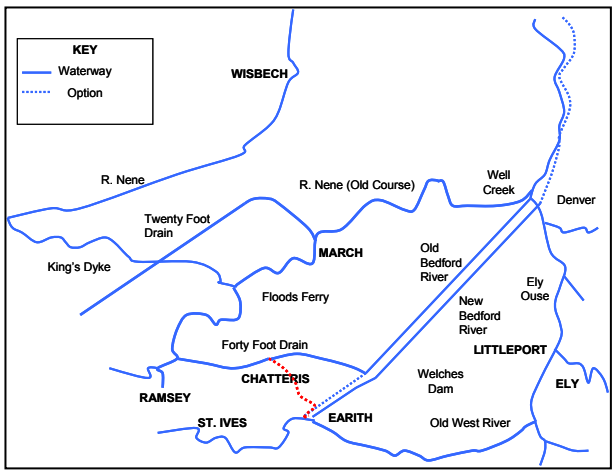
3.7.2 Observations

If the Forty Foot Drain is to be utilised as a permanent navigation channel, water levels will have to be made more constant so as to provide prolonged access to Welches Dam. Low Bridge will also need to be raised or replaced to allow a clearance of 2.4 metres. The channel itself will not require any works or widening as it is of sufficient size. The main difficulty which will have to be overcome if the navigation is to continue down to Earith will be accessing the New Bedford River from Welches Dam. Currently, navigation ends at Welches Dam and there is no method of transporting boats into the New Bedford River or the Old Bedford River. Two options have been formulated to overcome this problem:

- **Option A –**Construction of an aqueduct over the Ouse Washes to the New Bedford River , with access to Earith along the existing navigation of The New Bedford River.
- **Option B -** Construction of a lock accessing the Old Bedford River from Welches Dam with access to Earith using the currently unnavigable Old Bedford River to Earith Sluice with a new lock structure to lift craft past the Earith Sluice.

3.8 Option C: Twenty Foot Drain – Fentons Lode – New Build Channel (Cranbrook Drain)

3.8.1 Description



Option C is an option for linking the Forty Foot Drain discussed in section 3.6 with the Old Bedford River. This option utilises the Twenty Foot Drain, Fentons Lode and the Cranbrook Drain to link the navigable waterways of the Forty Foot Drain and the Old Bedford River, and would involve constructing a section of new waterway between Chatteris and Earith.

The Twenty Foot Drain meets with the Forty Foot Drain approximately 0.8km West of Leonard' Childs Bridge. The confluence is marked by a small weir structure with a foot bridge running over it. The Twenty-Foot Drain then runs for approximately 1.60km towards the town of Chatteris, it is at this point that the Twenty Foot Drain becomes the Fentons Lode. Once into Chatteris, the Fentons Lode is spanned by the Washway Industrial Park access bridge and the Washway Road Bridge. Immediately downstream from The Washway Road Bridge, the Fentons Lode channel is restricted by a weed screen structure which is situated within the channel, therefore preventing navigation from this point. The Fentons Lode then continues in a southerly direction to Seawards Farm and eventually to a point adjacent to High Fen pumping station where it is proposed that the new build section of the canal should begin. Up until this point, the Fentons Lode is wide enough to support navigation, although there may be problems with bank erosion.

The new build section of the canal could run from the Fenton Lode at Hill Fen pumping station into the Cranbrook Drain. This new build section will be approximately 1.9km long and will run to the East of the sand and gravel pits at Somersham Fore Fen before meeting the B1050 Road. The B1050 Road crossing marks the termination point of the new build section of the canal. Once beneath the road, the canal enters the Cranbrook Drain. The Cranbrook Drain then runs for approximately 1.9km before reaching the proposed site of entry into the Old Bedford River. The Cranbrook Drain is currently a drainage ditch which is both narrow and shallow. Its current condition will not facilitate navigation.

3.8.2 Observations

In order to provide navigation between the navigable Forty Foot Drain and The Old Bedford River a number of technical issues will have to be overcome. Firstly, the small weir structure at the confluence of the Twenty Foot Drain with the Forty Foot Drain will have to be removed so as to allow boats free passage. Once into the Twenty Foot Drain, boats will be able to travel towards the town of Chatteris freely.

Once into Chatteris, the Washway Industrial Site Access Bridge will need to be heightened to allow a 2.4 metres air draught. In addition, the presence of a weed screen structure situated within the channel causes a major restriction to navigation. At the current time, boats would be unable to pass this point. It is therefore necessary to either remove the obstruction or excavate a bypass channel

around the weed screen. The bypass channel option will require excavation of a canal section to provide a minimum navigation depth of 1.4 metres and would need a navigation width of 10.6 metres. An alternative is to bypass the industrial estate.

To allow the farmer access into Seward's Farm, a new bridge will need to be constructed. The small wooden bridge currently in place spans the Fentons Lode channel and would restrict boat passage. A new bridge structure is required and should provide 2.4 metres of air draught.

A new build section of canal linking the Fentons Lode with the Cranbrook Drain will need to be constructed. The approximate length of this canal section would be 1.9km and would need to be excavated to a depth of 1.4 metres, with a width of 10.6 metres. The B1050 Road which marks the end of the new build section will also require bridging to allow the canal to pass beneath it.

The Cranbrook Drain between the B1050 Road and the proposed point of confluence with the Old Bedford River is currently a small drainage ditch. In order for it to accommodate boat navigation the existing watercourse will need to be excavated to a navigable depth of 1.4 metres and a width of 10.6 metres. The approximate length of the Cranbrook Drain is 2,000 metres. In addition, two new access bridges will need to be constructed to replace existing access bridges which span the Cranbrook Drain at Ash Bridge.

Finally, to enable access from the Cranbrook Drain into the Old Bedford River a lock will need to be constructed to allow boats into the Old Bedford Navigation channel.

From the Old Bedford River, direct access to Earith can be gained and the Circular Route completed.

3.9 Southern Route

The Well Creek to Ely Ouse Link

Options	Option Status	Reasons
Option: A	**Rejected**	The reconstruction of Salters Lode would not remove the problem of limited tidal navigation, nor the siltation problems at the exit of the lock
Option: B	**Preferred Option**	Although this option is expensive it will enhance the circular navigation on the Southern Route.

The Chatteris to Earith Link

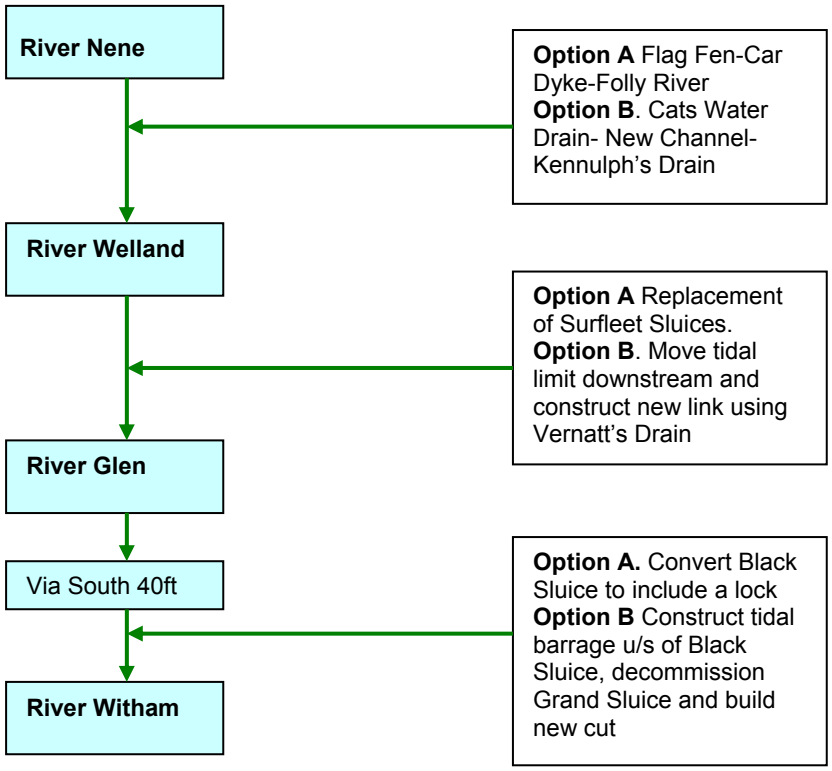
Options	Option Status	Reasons
Option: A	**Rejected**	The construction of an aqueduct to carry the navigation over the New Bedford River could affect the SSI and is more expensive than Option B.
Option: B	**Preferred Option**	The most cost effective route
Option: C	**Rejected**	**Landowner access for the new build portion of canal. Disturbance of Middle Level Commisioners operating regime. Probable instability of existing banks.**

4 The Description of the Routes: Northern Route

The following watercourses have been identified along the proposed route and can be utilised as navigable waterways:

- River Nene
- Cats Water Drain
- Car Dyke / Folly River
- River Welland
- River Glen
- South Forty Foot Drain
- River Witham

There are three important links to be achieved on this route, between



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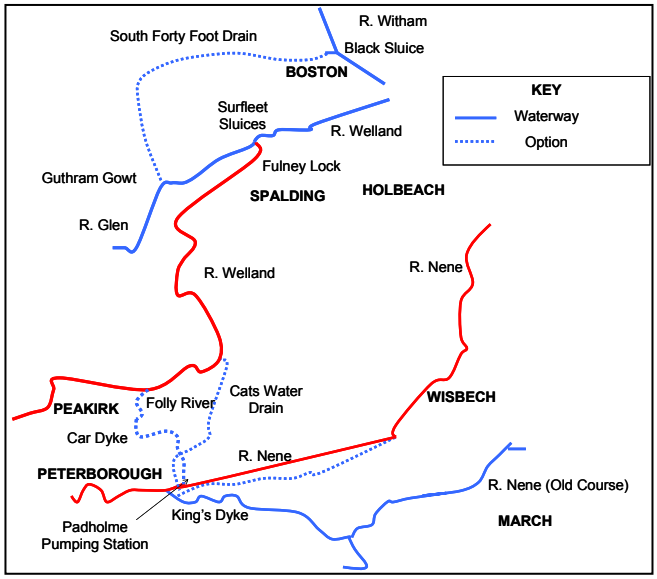
Description of the Options

Link	**R.Nene to R.Welland**
Options	**Description of Works**
Option A	**Car Dyke Option** Creation of a new build section of canal between Flag Fen and Car Dyke and then the restoration of the Car Dyke into a navigable waterway to provide access into the River Welland system at Peakirk Pumping Station.
Option B	**Cats Water Drain Option** Restoration of 10 kms of the Cats Water Drain into a navigable waterway from Flag Fen to Nene Terrace and then the creation of a new build canal link from Nene Terrace into the Kennulph's Drain. The restoration of the Kennulph's Drain into a navigable waterway will finally provide access into the River Welland at Postland Pumping Station.
Link	**R.Welland to R.Glen**
Options	**Description of Works**
Option: A	**Restoration of Surfleet Sluice** Construction of a Tidal Lock to replace the existing Surfleet sluices structure to enable navigation into the River Glen.
Option: B	**Vernatt's Drain Link** Construction of a Tidal Sluice with Lock upstream of Vernatt's Drain outfall and the creation of a link from the River Welland into the Vernatt's Drain and finally an additional link from the Vernatt's Drain into the River Glen at Surfleet Sea's End. *Note: Permission to use the Vernatt's Drain as a navigation must be gained from Welland and Deepings IDB before this option can be considered*
Link	**South 40 ft to R.Witham**
Options	**Description of Works**
Option: A	**Restoration of Black Sluice** Restoration of the existing Black Sluice into a Tidal Sea Lock to allow navigation from the South Forty Foot into the River Witham.
Option: B	**Boston Fluvial Link** Construction of a tidal barrage and lock upstream of the existing Black Sluice and the creation of a link to the west of Black Sluice to access the fluvial River Witham.

4.1 River Nene to Welland Link

4.1.1 Description



The River Nene from Stanground Lock provides access into the Northern Route from the Southern Route as discussed in section 3.4.

From Stanground Lock the Nene Navigation can be followed for approximately 2,000 metres upstream towards Peterborough before Padholme Pumping Station is visible on the left hand bank of the Nene. The River Nene is currently an established navigation channel and therefore provides no real constraints in accommodating water craft.

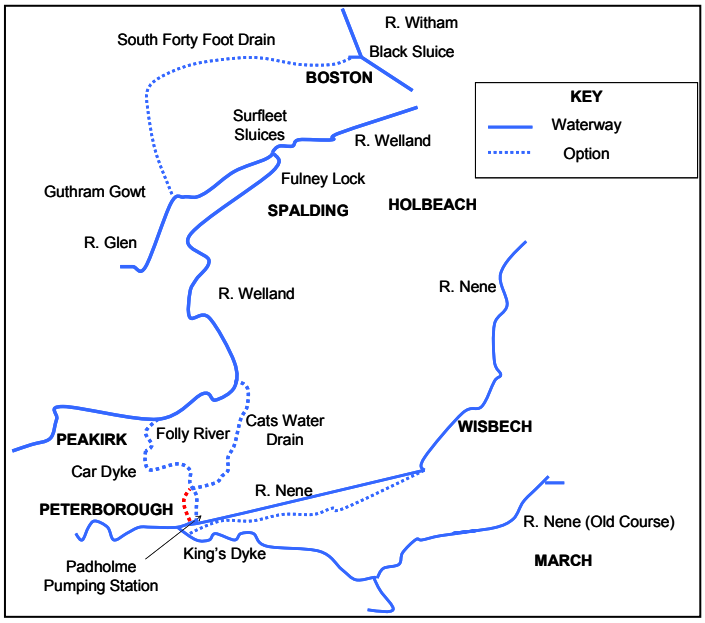
The Padholme Pumping Station marks the point at which a new build canal commences. A lock structure will need to be constructed at the current site of the existing pumping station to link the Nene with the proposed new canal section.

4.1.2 Recommendations

There are currently no restrictions along the River Nene. The only requirement of this section is the construction of a lock at Padholme Pumping Station. This will allow access from the Nene into a new build section discussed in section 4.2.

4.2 New Build Canal between Padholme Pumping Station and Cats Water Drain (this is common to both options

4.2.1 Description



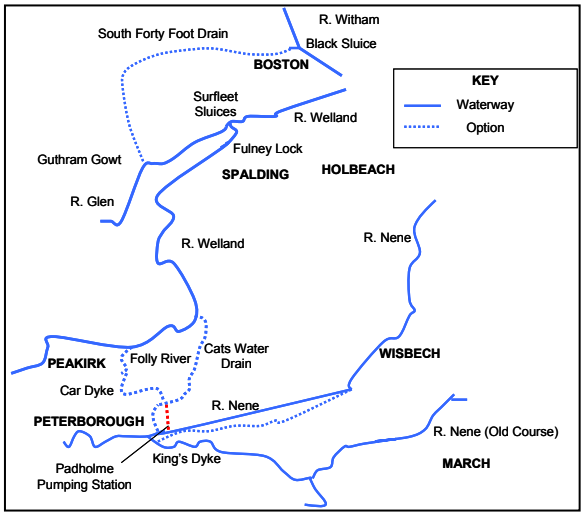
At present, there is a small drainage ditch between the Padholme Pumping Station and the Cats Water Drain. The distance between the two watercourses is approximately 500 metres. The existing drainage ditch flows through a series of farm fields and the Flag Fen Bronze Age Museum. The drain is approximately 2 metres in width and is relatively shallow. In its current condition the ditch could not support navigation and will therefore require extensive excavation to accommodate water craft.

4.2.2 Recommendations

To enable boats to access the drainage ditch, as discussed above, the existing ditch will have to be excavated along its total length (500m) to a navigable width and depth. It is recommended that the channel will need to be 10.6 metres in width with a depth of 1.8 metres to allow free passage of water craft.

4.3 Option A: New Build Canal between Flag Fen and Car Dyke

4.3.1 Description



Option A is one of two options being put forward. It involves constructing 2,500 metres of new canal linking the drainage ditch in section 4.2 with the Car Dyke situated just east of Peterborough. The Car Dyke is then able to link into the River Welland, via the Folly River.

This new section of canal would begin at Flag Fen just south of Storey Bar Road and will run in a North West direction below Storey Bar Road, towards Oxney Ho. Here, it will cross Gull Road and eventually join the Car Dyke on the North side of the A47 Road. The course of the canal will mean that it will have to cross Storey Bar Road, Gull Road and the A47 Road.

The new build canal section will need to be excavated to a depth of 1.8 metres and to a width of 10.6 metres to allow boats to navigate the channel. The approximate length of this watercourse is 2,500 metres.

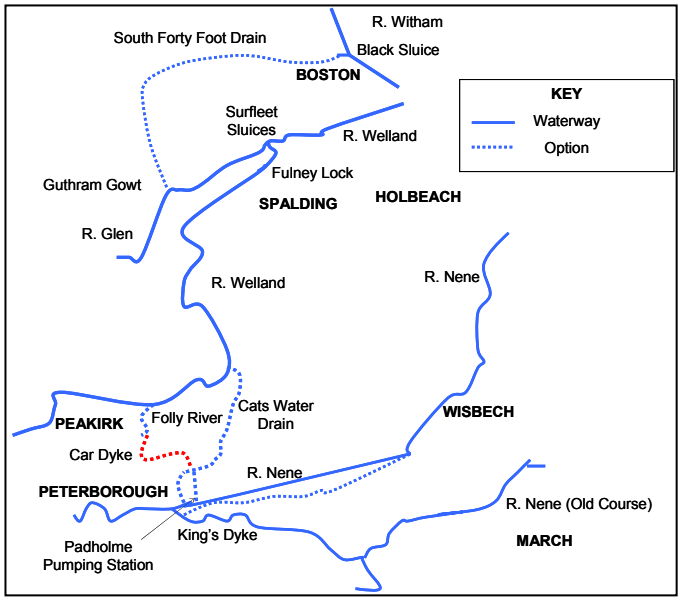
4.3.2 Recommendations

If Option A is to be adopted, a number of constraints will have to be overcome. Firstly, the canal channel will have to be excavated along its entire length. There are a number of drainage ditches which can be utilised, but in the most part complete excavation is required.

The course of this particular section of the canal means that several roads will require bridging, specifically Storey Bar Road, Gull Road and the main A47 Road. All these roads will require bridge crossings over the proposed canal. The three individual bridges will have to provide a minimum air draught of 2.4 metres and a span of 10.6 metres to allow free passage of water craft beneath them. Car Dyke is a scheduled ancient monument and preliminary discussions with English Heritage indicate that they would not support this route.

4.4 Option A: Car Dyke

4.4.1 Description



The Car Dyke joins with the new build canal section discussed previously at the A47 roundabout just south of the village of Eye and links with the Folly River at Fen Bridge next to Werrington End Farm. The total length of the watercourse is approximately 5.5km in length.

Historically, the Car Dyke was a navigation channel, but currently isn't used as such. As a result, water levels are low and the channel is both shallow and narrow. In order for it to be restored to a working navigation, the channel will require need and widening to allow free passage of water craft. There are a number of locations where the Car Dyke passes beneath roads and roundabouts, through culverts and low bridges. These locations provide the main constraints along the Car Dyke as currently boats are obviously unable to pass through these structures.

4.4.2 Recommendations

If the Car Dyke is going to be utilized as a navigable watercourse there are a number of constraints which will have to be overcome.

Firstly, the Car Dyke channel will need to be made deeper and wider. It is recommended that the channel will have to have an approximate width of 10.6 metres with a minimum depth of 1.4 metres. Consideration will therefore have to be given to dredging and excavating the entire watercourse to accommodate boat use.

Secondly, there are a number of locations along the Car Dyke which obstruct boat transport completely. The first is the point at which the Car Dyke flows beneath the A47 roundabout, just east of the village of Eye. Currently, a box culvert allows transport of the watercourse through the roundabout. If boats are to navigate this location successfully two major new road bridge structures will be required and the current road system will have to be altered to accommodate the new canal.

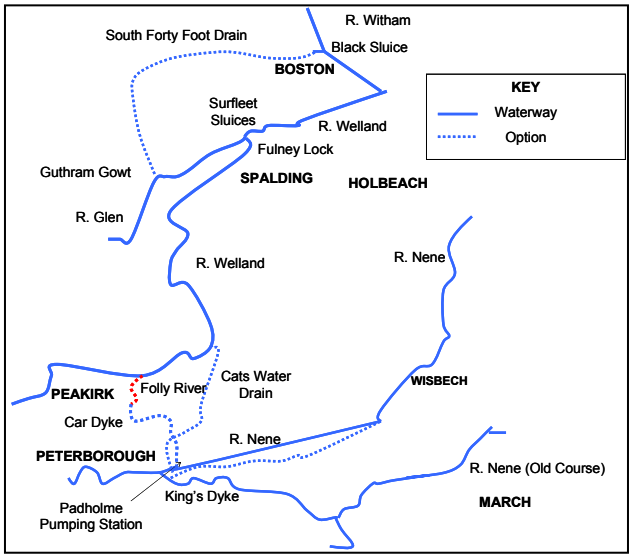
The Car Dyke is once again culverted through a 300mm concrete culvert beneath White Post Road. This culvert will need replacing with a road bridge to enable boats to pass freely.

Fen Bridge situated at the northern end of the Car Dyke at the confluence with the Folly River, will require works to heighten the existing structure. This concrete arch bridge is in good condition but at present the head room through the arch is not sufficient to allow boats to pass freely. It is recommended that bridges along the Car Dyke will need to provide a minimum of 2.4 metres of air draught.

Finally Car Dyke is a scheduled ancient monument and English Heritage would probably be adverse to any works infringing on the site.

4.5 Option A: Folly River

4.5.1 Description



The Folly River meets the Car Dyke at Fen Bridge and travels in a northerly direction before converging with the River Welland at Peakirk Pumping Station. The length of this watercourse is approximately 3km. The channel is both wide and deep and in its current condition could support boat traffic. The Folly River passes beneath Thorney Road Bridge just east of Peakirk village which does not provide a constraint to navigation. There is, however, a “Dog Leg “bend along the channel which may cause issues for large boats attempting to navigate the bend.

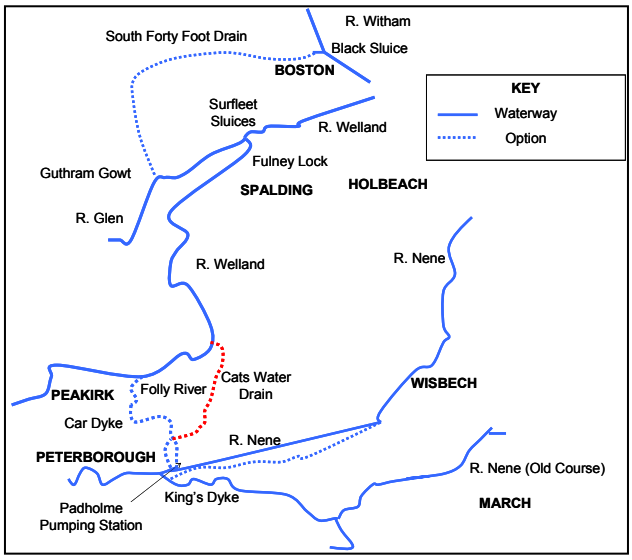
The Peakirk Pumping Station, located at the confluence of the Folly River with the River Welland, currently prevents boat access into the River Welland as the pumping station has a combined weed screen situated within the main channel. In order to allow free access into the River Welland, consideration will have to be given to the construction of a bypass channel around Peakirk Pumping Station. The change of water levels from one watercourse into another will also mean the construction of a Lock to account for this change.

4.5.2 Recommendations

This short length of watercourse, linking the Car Dyke with the River Welland, causes few constraints to the project. The “Dog Leg” bend, discussed earlier, may require bend sweetening works to allow free passage of larger crafts through the bend. Access into the River Welland will be achieved by constructing a Lock on the approach into the Peakirk offtake channel at the point where it meets the Folly River. In addition, a bypass channel will be required to bypass the pumping station and allow access into the Welland just up stream. The bypass channel will need to be approximately 200 metres long and 10.6 metres wide with a depth of 1.4 metres to accommodate water craft.

4.6 Option B: Cats Water Drain / Kennulph's Drain

4.6.1 Description



The Cats Water Drain / Kennulph's Drain route has been identified as an alternative method of accessing the River Welland. This link avoids the use of the New Build Canal, Car Dyke and the Folly River discussed in sections 4.3, 4.4 and 4.5 and utilises the existing Cats Water Drain as a route guide.

The Cats Water Drain will converge with the new build canal section discussed in section 4.2 at Flag Fen before travelling in a northerly direction to the East of the village of Eye. It will then travel beneath the A47 Road, eventually making its way through Nene Terrace. The length of the Cats Water Drain between Flag Fen and Nene Terrace is approximately 10km in length. The condition of the current channel is unsuitable for navigation as water levels are severely limited and the channel is both narrow and shallow. During the time of inspection the Cats Water Drain was completely dry in places.

To enable the Cats Water Drain to be linked into the River Welland a new build section of canal will be required linking the Cats Water Drain with existing Kennulph's Drain at Kennulph's Farm. The new build section of the canal will be required to span between Nene Terrace and the access point into Kennulph's Drain, situated just East of Kennulph's Farm. Once access into the Kennulph's Drain is established, navigation can follow the watercourse to Postland Pumping Station. Postland Pumping Station marks the point at which access can be gained into the River Welland through the Cowbit Wash. At the present time there are no existing lock structures providing access into the Welland River.

4.6.2 Recommendations

4.6.2.1 Cats Water Drain

The Cats Water Drain is not in an adequate condition to support boat navigation. For navigation to be possible the entire watercourse will need to be excavated to a width of 10.6 metres and will have to provide 1.8 metres of navigation depth to accommodate boat passage. Water levels will also require investigation.

The Cats Water Drain currently flows beneath two main roads, the A47 Road just East of Eye and the B1443 Road approximately 2km upstream of the A47 crossing. At the present time, the Cats Water flows beneath these roads through concrete culverts. In order for boats to pass beneath these roads new bridges will need to be constructed to facilitate boat and vehicle transport. It is recommended that each bridge will have to allow 2.4metres of air draught above the water level of the watercourse.

4.6.2.2 *New Build Canal Section*

To establish a link between the Cats Water Drain at Nene Terrace and the access point into the Kennulph's Drain, a 2.5km section of new canal will have to be excavated and built. The width of the canal section should allow 10.6m of width clearance and a navigation depth of 1.8 metres.

The new build canal will have to pass beneath the A1073 Road at Grid Reference (GR) TL23070804 and as a result, a new road bridge will be required. This road bridge will have to provide 2.4 metres of headroom clearance from the surface water level.

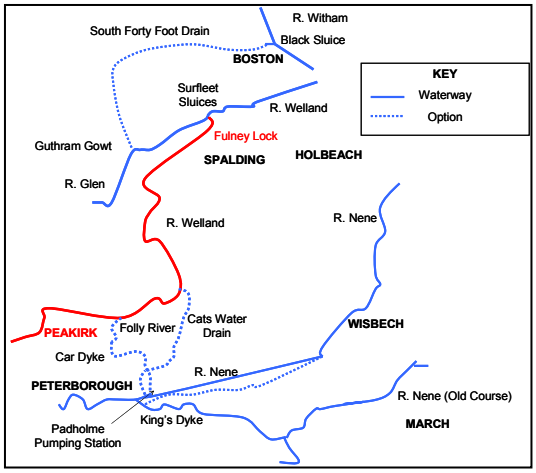
4.6.2.3 *Kennulph's Drain*

The Kennulph's Drain is currently an internal drainage ditch providing drainage to the surrounding farm land. It runs from east to west from GR TL23020806 to Postland Pumping Station on the Cowbit Wash embankment. To enable the Kennulph's Drain to be used as a navigable watercourse the entire length of the drain (2.5km) will require excavating to a navigable depth of 1.8 metres and will require a width of 10.6 metres to allow free passage of water craft.

To enable access into the River Welland, two new locks will need to be constructed at the site of the existing Postland Pumping Station and at the point at which the Kennulph's Drain enters the River Welland. Locks will be needed to accommodate the change in water levels between the associated watercourses.

4.7 River Welland: Peakirk to Fulney Lock

4.7.1 Description



The River Welland from the Peakirk Pumping Station runs, through the village of Crowland in a northerly direction into the town of Spalding to its fluvial limit at Fulney Lock. The River Welland between Peakirk and the Wash is a navigable waterway providing adequate channel clearance and water depths along its course. The total length of the River Welland, between Peakirk and Fulney Lock, is approximately 26km in length. Moorings are provided within Spalding and Fulney Lock.

There are a number of bridges spanning the Welland, most notably those in Spalding. Generally, most of the bridges provide headroom of 1.2 metres depending on water levels. There is also a farmer's access bridge at Cowbit, approximately 7km downstream of Crowland Bridge which causes a restriction to navigation due to insufficient Headroom. It is the recommendation of this study that all bridges which have headroom of below 2.4 metres should be replaced or refurbished to provide headroom of 2.4 metres to avoid navigation constraints. Alternatively, watercraft could be diverted into the Coronation Channel, thus avoiding the use of Spalding town centre as a navigation route and therefore preventing the need for bridge works to be carried out within Spalding.

Apart from the constraints caused by the bridges discussed above, the only other navigational constraint along the Welland is that of Fulney Lock, located at the northern end of Spalding. Craft

presently navigating the Welland can only negotiate Fulney Lock two hours before and after high tide due to insufficient water levels at other times. The lock is also in poor structural condition, adding to the problem of navigation.

The lack of water levels at Fulney Lock causes a major constraint to navigation of the Welland as only a limited number of boats can access the tidal Welland in a given day. This causes severe delays and interruptions to navigation. Consideration will have to be given to this problem if an increased number of boats are to use this stretch of river in the future.

4.7.2 Recommendations

The River Welland is navigable between Peakirk and Spalding and as a result, there are only minor constraints with navigation that have to be addressed.

Firstly, there are a number of bridges that require heightening or replacing to accommodate increased boat traffic and varying sizes of craft. The Bridge at Cowbit is one such example. Within Spalding there are ten bridge crossings ranging from small footbridge structures to major road crossings. Generally, all the bridges provide a minimum of 1.2 metres of headroom. It is recommended, however, that all new bridges should provide 2.4 metres of headroom to prevent larger craft from being restricted.

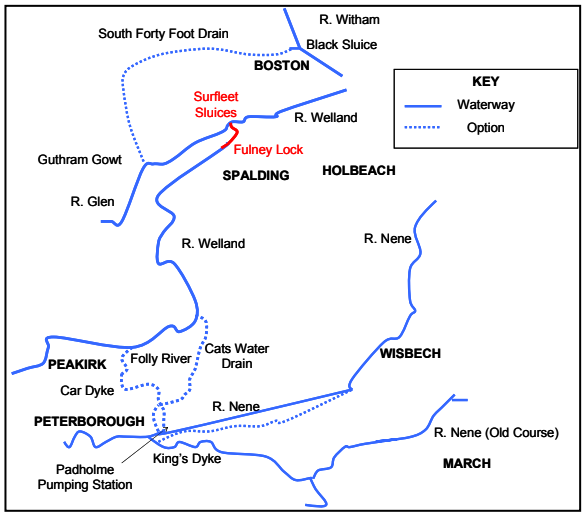
Fulney Lock is the second navigation constraint which needs to be addressed if increased boat traffic is to be accommodated. At the current time, the existing Fulney Lock is in poor condition and holds up navigation as it can only be negotiated two hours prior or after high tide due to lack of water levels. The Fulney Lock will therefore require refurbishment or replacement with a new lock structure. Alternatively, the fluvial limit of the Welland could be extended downstream to Vernatt's Drain by constructing a sluice / lock upstream of the outfall. This would allow Fulney Lock to be decommissioned. This option is discussed in section 4.8.

There are a number of locations along the River Welland that have been identified as potential target sites for opportunity. For example, town corridor enhancements are recommended through Spalding incorporating waterside improvements, increased moorings and an emphasis on information and interpretation with access improvements.

4.8 River Welland: Fulney Lock to Surfleet Sluices

This section considers the River Welland downstream of Fulney Lock to its confluence with the River Glen at Surfleet Sluices.

4.8.1 Description



This stretch of the Welland has an approximate length of 5.5km and is tidal. The River channel is both wide and deep. Navigation of this stretch is currently possible but can cause difficulties to boat users due to its tidal nature.

There are two structures along the stretch, Fulney Lock (discussed previously) and Surfleet Sluices, which is located at the confluence of the tidal Welland with the mouth of the River Glen at Surfleet Sea's End. At the present time, the Surfleet Sluices are in good condition but hinder navigation. The lack of an effective lock structure together with the strong currents around the Surfleet Sluices make navigation into and through the sluices difficult. The other major hindrance to navigation is the fact that boat users can only pass through the Surfleet Sluices two hours prior or after high tide due to insufficient water levels at other times.

4.8.2 Recommendations

The River Welland between Fulney Lock and Surfleet Sluices is currently a problematic area for navigation. As a result, two options have been formulated to improve the navigation of the Welland and provide more efficient access into the River Glen.

Option A: Replacement of Surfleet Sluices

Surfleet Sluices currently provide the only access point into the River Glen from the River Welland. To accommodate increased boat numbers in the future and to make navigation of the Surfleet Sluices more efficient, a new tidal lock structure is proposed to replace the current Surfleet Sluices.

If a new tidal lock structure is to be built, consideration will have to be given to dredging the approach bend into the new lock and providing additional moorings.

Option B: Welland / Vernatts Drain Link

Option B involves the conversion of the tidal section of the River Welland stretch, between Fulney Lock and Surfleet Sluices, into a non-tidal navigation channel, and in addition creating a new link from the Welland into the Vernatts Drain. The Vernatts Drain can then be used to access the River Glen close to Surfleet Sluices.

This proposal will involve the construction of a sluice gate structure on the River Welland approximately 4.5km downstream of the Fulney Lock. A new sluice gate will effectively make the Welland upstream of the structure fluvial, thus removing the navigation constraints associated with the Fulney Lock. A new link between the River Welland and the Vernatts Drain can then be established upstream of the new sluice gates, enabling water craft to access the Vernatts Drain north of Spalding. Once into the Vernatts Drain, boats can access the River Glen via a short new build channel section accessing the River Glen at Surfleet Sea's End.

If the Vernatts Drain option is to be considered, a new lock will need to be constructed along the River Welland at the point of access into the Vernatt's Drain. In addition, a new channel section will have to be excavated to establish a link from the Vernatts Drain into the River Glen. This short section of new canal will be approximately 900 metres in length and should provide 10.6 metres of width and 1.8 metres of navigable depth. It is worth mentioning at this time that the use of the Vernatt's drain is at this stage only a proposal and will require the permission of the Welland and Deepings IDB before the proposal can be considered. If permission can be gained the Vernatt's Drain option is considered to be the most favoured option in navigation terms.

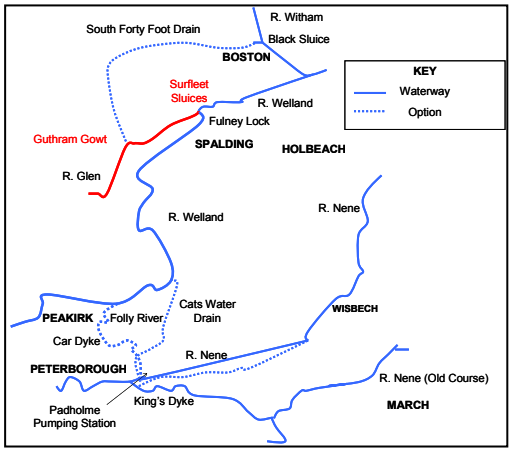
This proposal has several navigation advantages. Firstly, Fulney Lock will be able to be decommissioned thus removing the associated navigation constraints discussed previously. Secondly, boats will no longer need to negotiate the difficult bend into the Surfleet Sluices currently required to access the Glen. This will remove the need for any works to be carried out to the Surfleet Sluices. Finally, the incorporation of a new sluice will mean that boats will no longer have to negotiate any tidal reaches of the River Welland.

This proposal also has flood defence advantages as approximately 9 km of tidal defence would not have to be raised to accommodate sea level rise.

The use of Vernatt's Drain as a navigation channel is, at this stage, only a proposal. The feasibility of this proposal is dependent on whether permission can be gained to use the Vernatt's Drain as a navigation route. Permission will have to be agreed with the Deepings and Welland IDB who currently own the watercourse.

4.9 River Glen: Surfleet Sluices to Guthram Gowt

4.9.1 Description



The River Glen, between Surfleet Sluices and Guthram Gowt, passes through the villages of Surfleet and Pinchbeck before arriving at Guthram Gowt. The approximate length of this stretch of the Glen is 13.5km.

The Glen is currently used for navigation, but shallow water depths upstream of Pinchbeck restrict larger boats from using the Glen. There are several bridge crossings along the stretch, all of which have adequate headroom to accommodate boat passage. There are no other structures present along this reach and the channel is wide enough to enable boats to safely navigate the Glen upstream as far as Guthram Gowt.

Guthram Gowt marks the point at which the River Glen runs closest to the junction of the South Forty Foot Drain. At the present time, there is no means of leaving the Glen and accessing the South Forty Foot. The South Forty Foot Drain provides the main link to Boston.

In terms of navigation, the only constraint identified along the Glen that would hinder boat passage is the lack of channel depth between Pinchbeck and Guthram Gowt.

4.9.2 Recommendations

There are very few works required along the River Glen which have been identified in this study.

Consideration should however be given to dredging the Glen between Pinchbeck and Guthram Gowt. Dredging is required to restore navigable depths to the watercourse. For the purpose of this study, an air draught of 1.4 metres has been established from the winter retention levels of – 0.65AOD. This gives 2.05 metres draught from the summer retention level of 0.00AOD. Using these criteria, 8km of channel will require dredging.

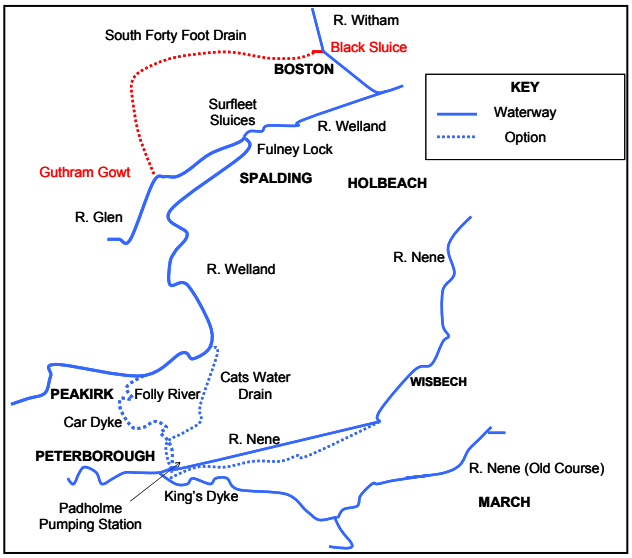
Dredging this section would require permission from the EA before works can be carried out.

To enable a link to be established into the South Forty Foot Drain from the Glen, a double lock structure would be required. A double lock is required because the flood levels of the Glen need to be maintained and the change in levels between the Glen and the South Forty Foot is some 1.8 metres.

It is not envisaged that this will be technically difficult, but there may be issues associated with scale and cost. In addition, low water levels in the River Glen are frequently experienced and it may be appropriate to consider an alternative method of maintaining and replenishing water to the locks just downstream of Guthram Gowt. This could be achieved by constructing a surface storage reservoir near the lock structure, together with a pump station.

4.10 South Forty Foot Drain: Guthram Gowt to Black Sluice

4.10.1 Description



The South Forty Foot Drain starts at Guthram Gowt where the watercourse runs close to the River Glen, discussed in section 4.9. The drain runs northwards towards Donnington, then north-east through Swineshead before flowing easterly towards Boston. The approximate length of the South Forty Foot route is approximately 33km in length.

The actual channel is navigable throughout most of its length in terms of width and depth, but there are a number of obstructions within the channel which need some consideration.

The other major constraint associated with the South Forty Foot is the current lack of access into the River Witham at Boston. Historically, Black Sluice was once a tidal lock allowing access into the Witham. Today, however, the Black Sluice doesn't allow access through its gates. Viable options on how to overcome this constraint are discussed in section 4.11.

4.10.2 Recommendations

- A new channel section is required from the proposed new lock on the River Glen into the existing South Forty Foot Drain (approximately 200 metres) to the North of Guthram Gowt. The new channel section should allow 10.6 metres in width with a navigation depth of 1.4 metres. There is a small drain between the two watercourses which could be used as a route guide and then excavated to appropriate dimensions

- Associated with the link channel from the Glen into the South Forty Foot, the proposed channel will have to flow beneath the A151 Road. A new road bridge structure will therefore be required to allow passage of the channel beneath it. The road bridge should allow 2.4 metres of headroom clearance to accommodate boat passage.

- At the junction between Dyke Fen and Guthram Gowt, two water mains cross the channel. These obstruct navigation and therefore need re routing to allow adequate headroom of 2.4 metres.

- Forty Foot Farm Bridge (GR TR169238) currently crosses the South Forty Foot Drain with piers in the channel. A new foot bridge is required without piers within the channel, with a clear span to give 2.4 metres of headroom.

- Sections of the South Forty Foot between Donnington and Guthram Gowt have not been maintained as a navigable watercourse and will require dredging to achieve the navigation depths of 1.4 metres required (approximate length 14.5km).

- The Black Hole Drove Pumping Station has been built across the channel some 2.6 km north of Guthram Gowt. A new bypass channel and lock would be required to bypass the structure and access the lower water level that is maintained upstream of the pumping station. The Bypass channel should allow 1.4 metres of navigation depth and should be 10.6 metres in width.

- At Caswell's Bridge, works are required to strengthen existing columns. The existing columns are located within the channel and provide an obstacle to navigation. The columns will require reinforcement to withstand a possible boat collision.

- Channel repair works are required in the vicinity of the railway bridge at Northing. Dredging will be required and bank reinforcement around the bridge vicinity.

- The connection of the South Forty Foot to the River Witham at Boston needs to be re-established. Currently, Black Sluice marks the end point of the South Forty Foot. There are currently no means of accessing the Witham from the South Forty Foot. There are several viable options to resolving this problem and these are reviewed in section 4.11.

4.11 Black Sluice Connection into the River Witham

4.11.1 Recommendations

In section 4.10 it was pointed out that there is currently no means of accessing the River Witham from the South Forty Foot Drain at Boston. The Black Sluice, which currently marks the confluence of the two watercourses, is a tidal sluice structure with no facilities for allowing boat navigation through the sluices. As a result two viable options have been considered and are discussed below.

Option A: Restoration of Black Sluice into a Tidal Sea Lock

To enable passage of craft through the existing Black Sluice structure, major modification of Black Sluice would be required. This would involve the construction of a sea-going lock with sluice gates and modification of the approach to the existing sluice gates.

This option overcomes the problem of land acquisition and disruption of the highway system, but it will be difficult to maintain flood defence capability during the construction of the new facility. This option will be costed and allowed for in the overall estimate.

Option B: Non Tidal Option bypassing Black Sluice

The alternative option considered involves leaving the Black Sluice in its current position and instead creating a bypass channel to the west of Black Sluice. This will involve excavating a channel through Summerfield car park and beneath the London Road. The bypass channel will also contain a lock to enable boats to access each watercourse and the varying water levels of each system effectively.

In order for this option to be feasible it is proposed that a new tidal barrage will have to be constructed just upstream of the Black Sluice on the River Witham. This will effectively make the River Witham upstream of this new structure fluvial, thus enabling easy passage of boats from the inland waterways of the South Forty Foot into the River Witham.

The area downstream through Boston town centre will effectively become non tidal which will mean that the existing tidal defences through the town will not have to be raised to cope with climate change. In addition, Grand Sluice which is currently situated upstream, could be decommissioned and water levels controlled from the new tidal barrage structure downstream.

The design of the proposed tidal barrage structure could reflect that of the existing Grand Sluice structure and will incorporate a lock to enable navigation through it.

This option has been costed and allowed for in the overall estimate.

4.12 Northern Route Options Tables.

Link		**River Nene to Welland**
Options		**Reasons**
Option A	**Rejected**	The main disadvantage of this option is the status of Car Dyke, and the cost of replacing bridges, which have recently been constructed
Option B	**Preferred Option**	

Link		**River Welland to Glen**
Options	**Description of Works**	**Reasons**
Option: A	**Rejected**	The renovation of Surfleet Sluices and Fulney Locks will not provide a good passage for inland waterway craft. They would still be limited by tide cycles. Would not assist future flood defence management.
Option: B	**Preferred Option**	The relocation of the tidal sluices from the Coronation channel to upstream of Vernatts Drain will enable a non-tidal waterway to be created, Fulney lock could be decommissioned and 9km of tidal embankments would not need to be raised in the future.

Link		**South Forty Foot Connection into the River Witham**
Options	**Option Status**	**Reasons**
Option: A	**Rejected**	Would still require navigation in tidal waters. Would not assist flood defence.
Option: B	**Preferred Option**	Would provide a non-tidal link, and could assist in flood defence management through the town. Option B could also be of assistance in the town regeneration proposals.

Table 4-1

PART 2

5 Engineering Works Required

5.1 Southern Route

This route passes through Earith, Ely, Littleport, Denver Sluice, Outwell, Upwell, March, Chatteris and finally terminates back at Earith. The route is approximately 88km long.

The main works identified along this route are as followed:

5.1.1 Old West River (Ouse)

1. Hermitage Lock near Earith – This lock was found to be in good condition but navigation problems exist during periods of low flow due to lack of water depths. As a result access into Hermitage Lock can be restricted. A new lock may need to be built to accommodate increased boat traffic in the future.
   (Earith to Ely Route Map 1: No 3)

2. The River Ouse between the 20 Pence Marina and Hermitage Lock - In the opinion of local boat users, experiences shallow water levels, often resulting in larger boats becoming grounded. This is especially true around the 20 Pence Bridge where shoals often develop. Approximately 9.5km of the River will require dredging to allow a navigation depth of 1.4 metres.
   (Earith to Ely Route Map 3: No 7)

3. Stretham Ferry Bridge – Local residents and boat users report bank erosion close to the bridge and near the Lazy Otter pub. This stretch of the River Ouse can become shallow at certain times of the year. Bank works are required as well as provisions for additional moorings.
   (Earith to Ely Route Map 4: No 8)

4. West River Bridge (Railway Bridge) – This bridge does not currently restrict boat navigation, but it was noted that the supporting wall was found to be in a poor condition. This may need attention if increased boat traffic is to be expected.
   (Earith to Ely Route Map 4:No11)

5.1.2 Ely Ouse

5. Denver Sluice – The tail of Denver Sluice appeared to be shallow and badly silted making navigation difficult. This stretch may need dredging if the Salters Lode Route is going to be utilised.
   (Ely to Outwell, Route Map 7: No 11)

6. The navigation between Denver Sluice and Salters Lode is notoriously complicated. There is however, some scope for developing a potential “Land Mark Structure” which would attempt to make this section more navigable and at the same time attractive to visitors.
   Requires: 2 x Staircase Locks
   1 x Lift Lock
   1 x Aqueduct (15 metres span)
   1 x new canal section with tow path (approx 800 metres length x 10.6 metres width)
   1 x New Road Crossing

   (Ely to Outwell, Route Map 7: No 10)

5.1.3 Well Creek / Salters Lode

7. Salters Lode – Salters Lode Lock will require extensive refurbishment or replacement. Deterioration of the structure and poor design make it difficult to navigate from the Tidal Great Ouse.
   (Ely to Outwell, Route Map 7: No12)

8. Well Creek – Between Nordelph and Salters Lode, Well Creek, is known to be shallow in places due to siltation problems. Dredging will be required: 2,500 metres.
   (Ely to Outwell, Route Map 8)

9. Creek Farm Bridge – Between Nordelph and Salters Lode, this small bridge has piers within the Well Creek channel. This bridge will need redesigning to allow boat navigation. Piers need to be a minimum 5 metres apart.
   (Ely to Outwell, Route Map 7: No 13)

10. Mullicourt Aqueduct – This structure will require a structural assessment to establish if any engineering works are required.
    (Ely to Outwell, Route Map 8: No 16)

11. Arch Road Bridge (Outwell) – A brick arched road bridge in the centre of Outwell is in good condition but headroom is restricted. Will require works to heighten the bridge to provide 2.4 metres of headroom.
    (Ely to Outwell, Route map 8: No 19)

12. Marmont Priory Lock – Works to the Lock Doors and Penstocks are required to reduce leakage.
    (Outwell to Chatteris, Route Map 1)

5.1.4 River Nene (Old Course)

13. Replace Floods Ferry Bridge with a new bridge providing 2.4 metres of headroom clearance.
    (Outwell to Chatteris: Route Map 5)

14. Replace Staffurth's Bridge with a new bridge providing 2.4 metres of headroom clearance.
    (Outwell to Chatteris: Route Map 5)

5.1.5 Kings Dike / Whittlesey Dike

15. Channel improvements to Briggate Bend and dredging between Ashline Lock and Stanground Lock on Kings Dike. (Approximately 6,000 metres)

16. Ashline Lock – Works to the Lock Doors and Penstocks are required to reduce leakage.
    (North / South Link: Route Map 1)

5.1.6 Forty-Foot Drain (Vermuyden's Drain

17. Low Bridge requires works to increase headroom clearance of the bridge to allow 2.4 metres of clearance.
    (Chatteris to Earith: Route Map 1)

5.1.7 Forty Foot Drain (Vermuyden's Drain) / New Bedford River and Old Bedford River Link

18. **(Option A)** A new aqueduct structure is required to access New Bedford River from Welches Dam. A new canal section is also required between the Old Bedford and New Bedford Rivers.

19. **(Option B)** (Preferred Option) A lock required to access Old Bedford River from Welches Dam using sections to prevent water loss and a new lock at Eirith Sluices.

5.1.7.1 (Option C): Fenton's Lode / New Build Section

20. Fenton Lode (Twenty Foot Drain) confluence with Forty-Foot Drain – There is currently a footbridge and weir structure within the Fenton Lode channel at the neck of the confluence with the Forty-Foot Drain. This will require removal to allow boat passage.
    (Chatteris to Earith, Route Map 1: No 5)

21. Wash-Way Industrial park access bridge requires works to heighten existing bridge to provide a headroom clearance of 2.4 metres
    (Chatteris to Earith, Route Map 1: No 6)

22. Wash Way Industrial Estate Weed Screen / Pump Station – This structure is currently within the Fenton Lode channel on the western edge of Chatteris Town. The structure prevents boat passage and will therefore have to be bypassed with a channel section providing 10.6 metres of width and 1.4 metres of depth.
    (Chatteris to Earith, Route Map 1: No 6)

23. Seward's Farm access bridge requires heightening to allow 2.4 metres of headroom clearance.
    (Chatteris to Earith, Route Map 2: No 9)

24. A new channel between Fenton Lode and the Cranbrook Drain is required – 2,200 metres of new build canal will be required with a width of 10.6 metres and a navigable depth of 1.4 metres.
    (Chatteris to Earith, Route Map 3)

25. The B1050 Road will require bridging to allow the new build canal section to flow beneath it. Works required to heighten the road to allow 2.4 metres of headroom clearance.
    (Chatteris to Earith, Route Map 3)

26. Cranbrook Drain – Requires excavating along its length (2000 metres) to allow 10.6 metres of width and 1.4 metres of navigable channel to allow boat passage. A new lock structure will have to be constructed to allow boat transfer into the Old Bedford River.
    (Chatteris to Earith, Route Map 2 and 3)

27. Ash Bridge – Wooden access bridge requires work to heighten bridge to provide 2.4 metres of headroom clearance.
    (Chatteris to Earith, Route Map 3 no 13)

28. New Lock – Required at the junction of the Cranbrook Drain with the Old Bedford River to allow boat access.
    (Chatteris to Earith, Route Map 3)

5.2 Northern Route

This route links the navigation routes between Boston (on the River Witham System) and Peterborough (on the River Nene System). It includes the use of the restored South Forty Foot to become a navigable waterway, and the creation of a navigable link from the River Glen, at the southern end of the South Forty Foot, to the River Nene at Peterborough.

The main works identified along this route are as follows:

5.2.1 New Build Canal between Padholme Pumping Station and Cats Water Drain

1. Padholme Pumping Station - located just off the River Nene and provides access into a field drain, which runs in a northerly direction. Currently, there are no means of accessing this drain. As a result, a new lock is required to provide an access point into the drain.

2. The existing field drain will require excavating extensively along its 500 metre length to widen the drain to a width of 10.6 metres and a depth of 1.4 metres to provide adequate navigation dimensions.
   (Peterborough to Spalding, Route Map 1: No 1)

5.2.1.1 Option A: New Build Canal between Flag Fen and Car Dyke

3. Drain crossing Storey Bar Road – Road Bridge required that should 2.4 metres of headroom clearance to replace existing culvert.
   (Peterborough to Spalding, Route Map 1: No 3)

4. Drainage channel beneath Gull Road - Road Bridge required that should provide 2.4 metres of headroom clearance to replace existing culvert.
   (Peterborough to Spalding, Route Map 2: No 4)

5. New Build Canal section (2500 metres) – Excavation and Construction of canal section between the Field drain discussed previously and Car Dyke to a navigable depth of 1.4 metres and 10.6 metre width.
   (Peterborough to Spalding, Route Map 2: No 5)

5.2.1.2 Option A: Car Dyke

6. A47 roundabout - The Car Dyke at this point flows beneath the roundabout through a culvert. If boats are to navigate this section successfully, two major new bridge structures will be required and the road system changed to accommodate the new canal.
   (Peterborough to Spalding, Route Map 2: No 6)

7. Dredging of Car Dyke – approximately 8300 metres of the Car Dyke between the A47 roundabout and the Folly River requires dredging and excavating to create a navigable channel. Providing 10.6 metres channel width and 1.4 metres depth.

8. Car Dyke beneath White Post Road - Currently the Car Dyke flows beneath White Post Road through a concrete culvert before re embarking through fields. This culvert will need to be replaced with a road bridge to enable boats to pass beneath the road freely and without obstruction.
   (Peterborough to Spalding, Route Map 2: No 7)

9. Fen Bridge - The existing concrete Arch Bridge, requires works to increase the headroom of the existing bridge to a minimum height of 2.4 metres to allow free passage of boat.
   (Peterborough to Spalding, Route Map 2: No 10)

5.2.1.3 Option A: Folly River

10. Dog Leg Bend – Works to sweeten Dog Leg bend along Folly River required

(Peterborough to Spalding: Route Map 4)

11. Peakirk Pumping Station – Lock required enabling access into the River Welland.

12. Peakirk Pumping Station – Bypass channel required around the pumping station (10.6 metres width x 1.4 metre Depth)
(Peterborough to Spalding: Route Map 4)

5.2.1.4 Option B: Cats Water Drain / Kennulph's Drain

13. Excavation of Cats Water Drain watercourse – 10km of existing channel requires excavating to provide 10.6 metres of width and 1.4 metres of navigation depth
(Alternative Link Peterborough to Spalding: Route Map 1)

14. Water Level Investigation – The lack of water supply into the Cats Water Drain will require further investigation. It may be necessary to build a surface storage reservoir together with a pumping station to enable an adequate water supply into the Cats Water Drain.

15. A47 Road Crossing – Road Bridge required allowing the Cats Water Drain to flow beneath this two carriage way A47 Road. A maximum headroom of 2.4 metres is required to facilitate boat passage.
(Alternative Link Peterborough to Spalding: Route Map 2)

16. B1443 Road Crossing – Road Bridge required allowing the Cats Water Drain to flow beneath this two carriage way, B road road. A maximum headroom of 2.4 metres is required to facilitate boat passage.
(Alternative Link Peterborough to Spalding: Route Map 3)

17. New Build Canal between Nene Terrace and Kennulph's Drain – Works required to excavate and build 2500 metres of new canal.10.6 metres width and 1.4 metres navigable depth required to allow free passage of water craft.
(Alternative Link Peterborough to Spalding: Route Map 3 & 4)

18. A1073 Road Crossing – Road Bridge required allowing new build canal to flow beneath A1073 road. A maximum headroom of 2.4 metres is required to facilitate boat passage.
(Alternative Link Peterborough to Spalding: Route Map 4)

19. Kennulph's Drain – 2,500 metres of the Kennulph's Drain requires excavating to a width of 10.6 metres and a navigable depth of 1.4 metres to allow passage of water craft.
(Alternative Link Peterborough to Spalding: Route Map 4)

20. Lock (Postland Pumping Station) – The construction of a new lock is required to enable watercraft to access the Crowland Wash on the opposite side of the Flood embankment.
(Alternative Link Peterborough to Spalding: Route Map 4)

21. Lock (Accessing River Welland fro Postland Pumping Station) – The construction of a new lock is required to enable water craft to Access the River Welland just south of Crowland.
(Alternative Link Peterborough to Spalding: Route Map 4)

5.2.2 River Welland: Peakirk to Fulney Lock

22. The Peakirk Pumping station marks the confluence of the Folly River, the Maxey Cut and the River Welland. Navigation of this section will need to be established.

23. Bypass Channel – to be excavated and constructed around the Peakirk Pumping Station of width 10.6 metres and to provide 1.4 metres of navigation depth.
(Peterborough to Spalding, Route Map 4)

24. Construction of Peakirk Lock – Providing access from the Folly River into the proposed bypass channel and then into the River Welland. Information regarding the Peakirk pumping station to be gathered to establish purpose.
(Peterborough to Spalding, Route Map 4: No 13)

25. Footbridge Crossing River Welland - This footbridge provides farmers access to the opposite fields. The bridge was found to be in poor condition. Headroom is not sufficient to provide larger boats with enough room to navigate past the bridge. Works required to increase the height of this bridge to allow 2.4 metres of headroom.
(Peterborough to Spalding, Route Map 6: No 16)

26. There are 10 bridges crossing the river through Spalding. All are able to be navigated by boats and barges and during the survey many boats were seen using the watercourse. Background information on navigation through Spalding suggests that several of the footbridges do in fact cause larger boats some difficulty at certain times of the year. The main road bridges however appear to be a sufficient height to facilitate small craft. See map for individual bridge locations. Discussions will have to be held relating to maximum craft size through Spalding and the continued usefulness of the numerous footbridge structures crossing the River Welland through Spalding town centre.
(Peterborough to Spalding, Route Map 8 & 9)

27. Fulney Lock - Fulney Lock is located at the northern end of Spalding and provides access into the Tidal Welland. The lock can currently only accommodate boats 2 hours before and after high tide due to insufficient water levels. This is a major constraint to navigation and would therefore need to be modernised to cope with increased traffic in the future.
(Peterborough to Spalding, Route Map 9: No 24)

5.2.3 River Welland: Fulney Lock to Surfleet Sluices

5.2.3.1 Option A: Replacement of Surfleet Sluices with Tidal Lock

28. Surfleet Sluices – At this location the River Glen and Welland converge. The Surfleet sluices control the tidal inflow from the wash. At the present time, the sluices can only be navigated 2 hours before and after high tide. These sluices will therefore need to be replaced and a new tidal lock to facilitate boat transport.
(Spalding to Boston, Route Map 1: No 1)

29. Dredging – Dredging of approach bend into Surfleet Sluices is required to increase navigation depth.
(Spalding to Boston, Route Map 1: No 1)

5.2.3.2 Option B: Welland / Vernatt's Drain Link

30. Construction of a Tidal Sluice Gate 4.5 km downstream of Fulney Lock – A tidal sluice gate with a lock is required allowing the Welland to become a fluvial navigation. Design of this structure will be similar to that of Marsh Road Sluices in Spalding.
(Spalding to Boston, Route Map 1)

31. Excavation and Construction of new link between the River Welland and Vernatt's Drain - Approximately 90 metres of new canal is required providing a 5.3 metre canal width and 1.4 metres of navigation depth.
(Spalding to Boston, Route Map 1)

32. Construction of Lock – A lock is required to enable access from the new canal section discussed above into the Vernatt's Drain.

33. Excavation and construction of new link between Vernatt's Drain and The River Glen – 900 metres of new canal section between the Vernatt's Drain and the River Glen at Surfleet Sea's End. The new channel requires a 10.6 metre canal width with 1.4 metres of navigable depth.

34. Construction of Lock – A lock is required to enable access from the Vernatt's Drain into the River Glen at Surfleet Sea's End.

5.2.4 River Glen

35. Dredging – Approximately 6.5km of the River Glen between Pinchbeck and Guthram Gowt require dredging to provide 1.4 metres of navigation depth.
(Spalding to Boston: Route Map 2)

36. Double Lock – Construction of two locks to allow access into the South Forty Foot Drain from the River Glen. The change in levels between the two watercourses is 1.8 metres. These locks may require a surface water reservoir and pumping station in order to replenish water levels within the locks (to be investigated).
(Spalding to Boston: Route Map 3)

5.2.5 South Forty Foot Drain: Guthram Gowt to Black Sluice

37. Physical link between River Glen and South Forty Foot – Approximately 200 metres of new channel linking the double lock with the South Forty Foot Drain is required. The existing Weir Dyke can be excavated to provide adequate channel dimensions. The new channel will require a width of 10.6 metres and navigational depth of 1.4 metres.
(Spalding to Boston: Route Map 3: No 4)

38. Construction of Road Bridge – The A151 Road will require bridging to allow free passage of watercraft beneath the road. A headroom of 2.4 metres clearance is required.
(Spalding to Boston: Route Map 3: No 5)

39. Water Mains Re-routing – The two water mains which cross the South Forty Foot at the junction of Dyke Fen require re-routing or heightening to prevent obstruction to the channel.
(Spalding to Boston: Route Map 3: No 6)

40. Forty Foot Bridge – Requires replacement with a new bridge which will not obstruct the channel and will provide 2.4 metres of headroom clearance.
(Spalding to Boston: Route Map 3: No 7)

41. Dredging – The South Forty Foot between Guthram Gowt and Donnington requires dredging to a navigation depth of 1.4 metres. The approximate length is14.5km
(Spalding to Boston: Route Map 1, 2, 3 &4)

42. Black Hole Drove Pumping Station – Excavation of a bypass channel around the existing pumping station is required. A 100 metres length of new channel is required to be excavated and constructed providing 10.6 metres of width and 1.4 metres navigation depth.
(Spalding to Boston: Route Map 4: No 8)

43. Single Lock – required to access the lower water levels experienced on the downstream side of the Black Hole Drove Pumping Station.
(Spalding to Boston: Route Map 4)

44. Caswell's Bridge – Works required to strengthen existing support columns.
(Spalding to Boston: Route Map 4: No 9)

45. Connection of the South Forty Foot into the River Witham needs establishing.

5.2.6 Black Sluice Connection into the River Witham

5.2.6.1 Option A: Restoration of Black Sluice into a Tidal Lock

46. Construction of Sea Lock – Required to allow boat passage through the existing Black sluice
(Spalding to Boston: Route Map 7: No 13)

47. Refurbishment of Sluice gates at Black Sluice.

5.2.6.2 Option B: Non Tidal Option By-passing Black Sluice (Preferred Route)

48. Tidal Barrage and Lock – To enable navigation through Boston to become fluvial, the construction of a Tidal Barrage upstream of the Black Sluice is required. The design of this structure will be similar to that of the existing Grand Sluice which is currently located upstream on the River Witham.
(Spalding to Boston: Route Map 7: No)

49. Bypass canal section – To enable watercraft to access the River Witham, a new canal section will need to be excavated and constructed to the west of Black Sluice through Sommerfields car park. This new canal section will be approximately 250 metres in length and will require a width of 10.6 metres and a navigation depth of 1.4 metres. The proposed new link will also have to pass beneath the London Road.
(Spalding to Boston: Route Map 7: No)

50. London Road: Road Bridge – The London Road will require bridging and should provide 2.4 metres of headroom clearance to accommodate boat access.
(Spalding to Boston: Route Map 7: No)

6 Costings

6.1 Southern Route

The Southern route passes through Earith, Ely, Littleport, Denver Sluice, Upwell, Outwell, March, Chatteris and finally terminates back at Earith. The Whittlesey Dyke and Kings Dyke provide the main link via Stanground Lock into the Northern route at Peterborough.

Table 6-1 shows the summary of costs for the Southern route and also includes option costs for the proposed alternative links into the Old and New Bedford Rivers. Detailed costings are provided in appendix B.

Southern Route		
Watercourse Name	**Cost (£000)**	**Option Costs (£000)**
Old West River (Ouse)	5,900	5,900
Ely Ouse	25,100	25,100
Well Creek	4,300	4,300
River Nene (Old Course)	800	800
Whittlesey Dyke / Kings Dyke	2,500	2,500
Forty Foot Drain (Vermuyden's Drain) Option A: New Bedford Link Option B: Old Bedford Link **(P)**	 2,190,	 4,940
Fenton's Lode / New Build canal section Option C: Chatteris to Earith Link		18,000
Total	40,700	56,600
Total Cost: Southern Route (£)	40,700	

Table 6-1 Summary of Costs (Note **(P)** **= Preferred Option)**

6.2 Northern Route

The Northern Route begins at Padholme Pumping Station on the River Nene and then passes to the East of Peterborough before passing through Spalding and eventually terminates at Boston.

Table 6-2 shows the summary costs for the Northern route and also shows the costs associated with the various alternative route options proposed. Detailed costings are provided in Appendix B.

Northern Route		
Watercourse Name	**Cost (£000)**	**Option Costs (£000)**
New Build Canal (Padholme - Cats Water)	3,800	3,800
Option A : Car Dyke link / Folly River		20,370
Option B : Cats Water Drain Link (P)	49,370	
River Welland: Peakirk to Fulney Lock	2,150	2,150
River Welland : Fulney Lock to Surfleet Sluice Option A: Tidal Lock Renovation Option B: Vernatt's Drain Link (P)	 12,840	 5,650
River Glen	4,590	4,590
South Forty Foot Drain	10,340	10,340
River Witham Connection Option 1: Restoration of Black Sluice Option 2: Non -Tidal Option (P)	 8, 800	 3,500
Total	91,900	50,400
Total Cost : Northern Route (£)	£ 92,000	

Table 6-2 Summary of Costs (Note (P) = Preferred Option)

7 Conclusions

7.1 Southern Route

The study has demonstrated that the creation of a circular Southern route between Earith and Chatteris and a link between the middle level system and the River Nene system is technically feasible.

The existing navigation waterways of the Old West River, Ely Ouse, Well Creek, Nene (Old Course), Kings Dyke, Forty-Foot Drain and the Old Bedford River will require extensive engineering works to be carried out upon them but these works are not considered technically difficult to achieve and can be phased.

Major engineering works along the Southern Route are required at Hermitage Lock, Denver Sluice complex, Salters Lode, Fenton Lode and finally the construction of a new canal section between Chatteris and Earith.

The most significant engineering development will involve the development of the Denver Complex. There are two options for improving the navigation.

Option A is to renovate Salters Lode Lock, however although this will be an improvement the overall conditions of tidal cycles and the navigation of a potion of tidal waters mean that there will not be an improvement for the passage of craft between Well Creek and the Ely Ouse. This will still be a physical limit on increasing boat movement numbers.

Option B - the construction of a land mark aqueduct structure between the Ely Ouse and Well Creek offers real potential for creating a vibrant navigation, but it comes at a cost..

Minor works to the existing navigable waterways will have to be carried out and will include dredging, channel improvements and bridge construction to accommodate increased boat numbers in the future.

Three route options for linking the Forty Foot Drain with the Old Bedford and New Bedford Rivers to access Earith were considered in this study. They included:

Option A – involves using the Forty Foot Drain (Vermuyden's Drain) as navigation down as far as Welches Dam and from Welches Dam accessing the New Bedford River via an Aqueduct structure before linking direct to Earith.

Option B – involves using the Forty Foot Drain (Vermuyden's Drain) as navigation down as far as Welches Dam (as in Option A) and from the Welches Dam accessing the Old Bedford River via a lock structure before linking direct to Earith.

Option C - involves the use of the Forty Foot Drain (Vermuyden's Drain) to its confluence with the Twenty Foot Drain west of Leonard Childs Bridge and from this point utilising the Fenton's Lode through Chatteris before accessing a newly constructed link between Chatteris and Earith via a short length of the Old Bedford River.

Option B has been short listed as the most feasible engineering solution and is considered to be the preferred route option at this stage. Options A and C were not favoured due to the technical and political complexity of negotiating the Middle Level System of the Twenty Foot Drain and Fentons Lode, and the sensitive nature of the Ouse Washes. The Ouse Washes are also a designated nature reserve and therefore development of this area may be environmentally unacceptable.

Finally in terms of cost it has been estimated that the creation of a navigable Southern route with a link into the River Nene system will require investment of **£40.8 million** to secure its long term viability.

7.2 Northern Route

The study has demonstrated that the creation of a navigable Northern route between Peterborough (on the Nene system) and Boston on (the Witham System) is technically feasible.

The existing navigable waterways of the Rivers Nene, Welland, Glen and the South Forty Foot Drain will require extensive engineering works to be carried out upon them in order for them to facilitate future boat use. These have been assessed and are not considered technically difficult to achieve.

The major engineering works along the Northern Route are required at Padholme Pumping Station, Cats Water Drain, Peakirk Pumping Station, Fulney Lock, Surfleet Sluices, Guthram Gowt the South Forty Foot Drain and finally at Black Sluice in Boston. The most significant engineering challenge will be met creating a navigable link from the River Welland into the River Glen via Surfleet Sluices and the creation of a navigable link between the South Forty Foot Drain and the River Witham.

Minor works to the existing navigable waterways will have to be carried out and will include dredging, channel improvements and bridge construction to accommodate increased boat numbers in the future. In addition a number of route options have been investigated and decisions made on which options are the most feasible. These are discussed below.

7.2.1 Peterborough to Spalding Link

Two options were considered for linking the River Nene with the River Witham between Peterborough and Spalding, they include:

Option A – Creation of a new build section of canal between Flag Fen and Car Dyke and then the restoration of the Car Dyke into a navigable waterway to provide access into the River Welland system at Peakirk Pumping Station.

Option B – Restoration of 10 kms of the Cats Water Drain into a navigable waterway from Flag Fen to Nene Terrace and then the creation of a new build canal link from Nene Terrace into the Kennulph's Drain. The restoration of the Kennulph's Drain into a navigable waterway will finally provide access into the River Welland at Postland Pumping Station.

The main conclusions of the study are that:

- **Option B** offers the most feasible engineering solution and is considered to be the preferred route at this stage.

Option B has been short listed as the most feasible engineering solution and is considered to be the preferred route option at this stage. Options A was not favoured due to the complexity of negotiating the Car Dyke watercourse. The use of Car Dyke would require a substantial length of new canal being built between Padholme pumping station and the Car Dyke. Technical issues associated with crossing a number of road networks and the A47 roundabouts together with issues surrounding the heritage status of using the Car Dyke have led to this option being the less favourable than the Catts Water route option.

7.2.2 Spalding to Boston Link preferred option.

Two options have been considered for linking the River Welland with the River Glen between Spalding and Surfleet Sluices they are as follows

Option A – Construction of a Tidal Lock to replace the existing Surfleet sluices structure to enable navigation into the River Glen.

Option B – Construction of a Tidal Sluice gate with Lock downstream of Fulney Lock and just upstream of Vernatt's Drain outfall, and the creation of a link from the River Welland into the Vernatt's Drain and finally an additional link from the Vernatt's Drain into the River Glen at Surfleet Sea's End.

The main conclusions of the study are:-

- **Option B** offers the most feasible engineering solution and is considered to be the preferred route at this stage.

Option A - was not considered a favourable option because the navigation of the tidal section of the River Welland is not ideal for narrow boat use. Negotiating the approach into the current Surfleet sluices is both difficult and time consuming due to the lack of water levels throughout much of the day. The construction of a tidal Lock at Surfleet sluices would improve the problem slightly but would not solve the fundamental problem of allowing easy access into the River Glen. The Option B proposal has the advantage of providing unrestricted non tidal navigation between the Welland and the Glen and also solves the navigation issues surrounding Fulney Lock in Spalding. It may also provide flood defence benefits in removing a considerable length of tidal embankments subject to the uncertainty of sea level rise.

7.2.3 South Forty Foot connection into the River Witham

Two options were been considered for linking the South Forty Foot Drain with the River Witham at Boston they included:

Option 1 – Restoration of the existing Black Sluice into a Tidal Sea Lock to allow navigation from the South Forty Foot into the River Witham.

Option 2 – Construction of a tidal barrage and lock upstream of the existing Black Sluice and the creation of a link to the west of Black Sluice to access the fluvial River Witham.

The main conclusions of the study are:-

- **Option 2** offers the most feasible engineering solution and is considered to be the preferred route at this stage.

Option 1 - was rejected because the restoration of the existing Black Sluice into a Tidal Sea Lock would require narrow boats and other smaller craft to negotiate the tidal section of the River Witham. As discussed previously this is not an ideal situation for narrow boats or smaller boats as navigation can be difficult. The Option 2 proposal involves the construction of a tidal barrage / sluice gate upstream of the existing Black Sluice effectively making the River Witham through Boston a non tidal system. The proposal of linking the South Forty Foot Drain with the Witham just upstream of the Black Sluice prevents the need for boats to navigate any tidal sections of watercourse and is therefore a preferred option.

Finally in terms of cost it has been estimated that the creation of a navigable Northern route linking Peterborough with Boston utilising the Option B, Option B and Option 2 proposals will require investment of approximately **£92.2 Million** to secure its long term viability.

It may also assist flood defence management as the need to raise flood defences through Boston, due to sea level rise and the increased risk of storminess, would not be required. The option would also assist in the regeneration of the Boston waterfront and reduce the need to renovate Grand Sluice, which are the present tidal gates in the River Witham.

8 References

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9 Appendices

Appendix A: ROUTE MAPS

See Engineering Maps on CD

Appendix B: DETAILED COSTINGS

See Engineering Costings Appendix (Report 3B)