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INITIAL FEASIBILITY STUDY FOR NORTH EAST REINFORCEMENT PROJECT

1. INTRODUCTION

National Grid commissioned ESB International to carry out an initial feasibility study for a possible 220kV overhead line between the existing Louth 220kV Station to the proposed Corduff 220kV Station via a new 220kV Station near Drybridge. The line route should be preferably double circuit. A solution based on a new single circuit 220kV line is also considered, but would be considerably less robust than the double circuit option. With the single circuit option, uprating of the Woodland - Louth and Maynooth - Louth 220 kV lines would also be required to a capacity of 1700A in Summer.

This report covers the two aspects of this initial feasibility study separately. Firstly a feasibility study for the new line route is described and secondly the options for upgrading the two 220kV lines are presented.

ESB International has carried out studies based on published information, 1;50,000 Ordnance Survey mapping and field studies. Feasible routes have been identified and analysed and are presented in the report.

2. NEW OVERHEAD LINE ROUTES

This section of the report outlines the findings from a preliminary feasibility study into the new 220kV line routes required for this project.

The development as proposed would involve the construction of the following
A new Double or Single circuit 220kV line between the proposed Corduff 220kV substation to a proposed 220kV substation located in the vicinity of the existing Drybridge 110kV substation North of Drogheda.
A new Double or Single circuit 220kV Line between the proposed 220kV substation located in the vicinity of the existing Drybridge 110kV substation to the existing Louth 220kV substation.

It also contains a discussion of the use of double circuit or single circuit options.

2.1 Possible Substation Locations Near Drybridge

For the proposed North East reinforcement study three possible 220kV site locations within 3.5 km of the existing Drybridge 110kV substation were identified for the proposed development during preliminary inspections of the area. The candidate substation sites were chosen based on the use of a new double circuit line.

The main criteria for the selection of a 220kV transmission station are as follows.

1 Site must be of adequate proportions to accommodate a typical 220kV substation.

2 Access route must be adequate to accommodate delivery of plant.

3 Sites are normally chosen in remote areas taking into consideration line routes, to reduce the visual impact on the population. Landscaping the boundary fence can be an option both during and after construction.

4 Noise pollution is also a consideration

5 Soil resistivity must be within approval standards.

6 Ground should be firm to hard for ease of construction, preferably, with good natural drainage.

7 Site should be reasonably level

8 Remote from all private dwellings

The candidate sites are indicated on the enclosed map TC 16043 in the appendices. These sites were assessed based on a roadside examination and without reference to county planners, land ownership and subsurface soil conditions.

Station Site Option 1

This is a large field of adequate proportions. Access to the field is by a country lane. The field is low lying with no immediate dwellings in the immediate area. One first inspection the ground is of good quality. The field is relatively flat and would require no site grading.

Station Site Option 2

Site number 2 is also a large field and is located on the opposite side of option No. 1. The ground slopes up hill from east to west. The site would have to be levelled to accommodate the location of the substation. Access and ground quality is adequate.

Station site Option 3

Site no.3 is located off the main Drogheda M1. This option is on a large field. The site is elevated and landscaping would be required as the station would be visible from the M1.
Ground quality is good and access would be via a small country lane.

2.2 220kV Overhead Lines – Feasible Route Corridors

A number of route corridor options within the study area were examined, based on the following objectives:

- Minimising the impact on the landscape
- Avoidance of cultural heritage sites and areas of ecological interest
- Consideration of the County Development Plans
- Avoidance of towns and development areas
- Optimum crossing of roads, rivers and other obstacles

The following more specific factors were mapped for preliminary route selection purposes:

- Urban settlement and forestry
- Sites of ecological sensitivity (NHA's SAC's)
- Sensitive landscapes
- Scenic routes and designations (e.g. Areas of Outstanding Natural Beauty)
- Archaeological landscapes

The following factors are also acknowledged as being potential route determinants:

- Location of residences schools and businesses
- Unstable ground conditions
- Protected vistas/views
- Archaeological sites (SMR listed sites)

However these latter factors are more appropriately considered when determining final route alignment and mast locations within a pre-selected corridor and so were dealt at that stage.

A desk top study coupled with a site verification was undertaken to assess the feasibility of bringing a 220kV Double Circuit or Single Circuit line from the proposed Corduff 220kV substation to a new proposed 220kV substation in the vicinity of Drybridge 110kV substation and then onto the existing Louth 220kV substation. The initial step of the feasibility study consisted the gathering of information such as, Sensitive Landscapes, Areas of High Scenic Quality, Natural Heritage Areas (NHA), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Sites and Monuments Records (SMR), Areas of Scientific Interest and Recreational Areas (Sruna).The above elements are documented on the TC 16011 map in the appendices. This map was used as a tool in identifying possible route corridors within the study area.

Five route corridors were identified (A,B,C,D,E) with two sub routes on A one on route B and one on route D.

The following published documentation was consulted

Fingal, Meath, Louth County Development Plans
1: 50,000 Discovery Series Maps
Sites and Monuments Record
Duchas maps for protected areas

2.3 Description of the Study Area

The study area (see appendix 1) is bordered to the West by the existing Finglas - Woodland and the Louth - Woodland 220kV Lines and to the East by the coastline. The Northern and Southern Boundaries are defined by access into Louth and Corduff 220kV Stations.

The area in the vicinity of the proposed Corduff 220kV station is zoned for various types of industrial, comercial and residential development. This area is developing rapidly.

To the north of this area there are several settlements with high development pressure and potential such as Kilbride, Dunsaughlin, Ratoath, Ashbourne, Oldtown, and Ballyboughil. There is widespread ribbon development in the vicinity of these towns. The land character in this area is generally flat or gently sloping. Routeing opportunities do exist but ribbon development in the area from Dunsaughlin to Ratoath to Ashbourne to Oldtown requires careful routeing. There are several well run action groups in this vicinity campaigning on various issues but most particularly against proposed dumps. Community resistance to an overhead line in this area will be vocal, organised and based primarily on non landowners.

East of the M1/N1 between Balbriggan and Swords/Malahide is not suitable for overhead line routeing due to its location relative to Corduff, high density development, location of protected areas and overhead line visibility from the coastline.

The terrrain develops into low hills in the area of Garristown to Naul and on to Balbriggan. Much of this area has been classified as “sensitive landscape” and Areas of High Amenity by the Fingal County Development Plan and as “Sruna” in the Meath County Development Plan. Line Routeing opportunities in this area are limited by these classifications.

Near the coast North of Balbriggan the land is lower. There is some amount of ribbon development in this area particularly near Stamullin. There are extensive beach recreation/holiday areas such as Mosney, Laytown and Bettystown. The Irish Army have an aircraft landing strip at Gormanstown. The impact of a high overhead line on this facility would require clarification. There is development pressure near Duleek and a Sruna area and racetrack at Bellewstown where the land is generally higher than to the east making line routeing difficult.

To the north of Duleek the lanscape is dominated by the Boyne Valley and the town of Drogheda. There is very strong planning authority resistance to overhead lines crossing the boyne valley. Between Slane and Drogheda are areas renowned

internationally including Newgrange. There may be some possibility of locating the overhead line adjacent to a proposed Drogheda bypass motorway. The visual impact on the nearby archaeological areas would need to be confirmed. To the East of Drogheda there is widescale high quality ribbon development and an area of high amenity. Any 220kV overhead line proposal in this area is frought with difficulty and is likely to encounter very high public resistance.

North of the Boyne in the area from Collen to Ballymakenny the area is hilly and very high. Much of this area is classified as Areas of High Scenic Quality in the Louth County Development Plan. To the East the land slopes down towards the coast and the high areas would provide backdrops against which there is some capability to visually absorb a transmission line when viewed from the coast.

Routeing possibilities in the area between Dunleer and Ardee are quite good. The coastline south of Dundalk towards Castlebellingham should be avoided. The proposed M1 motorway route may offer an overhead line route. An SPA/NHA area at Mansfieldstown should also be avoided. The terrain between Ardee/Dunleer and Louth 220kV station is generally flat or gently sloping with limited ribbon development.

2.4 Route Corridor A Evaluation (Red Line)

The proposed route would exit the Corduff 220kV substation and head NE for 500m crossing on its path the existing Drybridge – Finglas 110kV Line and a minor road. The line then swings NW in direction for 7.5 km crossing the Dublin Meath border and the Ward river. The proposed line traverses across landscape that is dominated by large hedgerows. The line crosses approximately 350m to the NE of Kilbride Cross roads and intercepts the proposed Ashbourne Bypass at Harlockstown 3km East of Rathoath on the R125. At this point the line will parallel the proposed bypass for 4.5km and eventually cross the N2 2Km North of Ashbourne. The land in this section of the study area is flat and dominated by high hedge rows.

The proposed line next runs parallel to the N2 for 3km passing the Dublin-Meath County boundary on two occasions and the river Hurley. The line marginally skirts through the sensitive region around Garristown and heads NE for 4km meandering through the hills of Hilltown and Ashpark and eventually crosses a minor road 1km south of Ardcath. The landscape in this section is dominated with localised hills.

The line then crosses the existing Finglas – Platin 110kV line and follows a NE direction traversing through the valleys avoiding on its way the Denhamstown quarry and the hilltops of Mullaghteelin and Greenanstown.

The line next crosses the main Naul – Drogheda (R108) at right angles and then turns immediately northwards to join into the proposed route B option 1.5 km NW of Stamullin and then meets the proposed route C option at Balloy.

Sub Route A1 (Grey Line)

Sub route A1 NW of Ashbourne avoids the sensitive area around Garristown and Fairy House race track. The line would cross the R155 to Ratoath, the N2 and two minor roads in comparison to the N2 plus two minor road crossings if route A was adopted.

Sub route A1 would travel approximately 700m from a school in Crickstown on the R155 and also cross the existing Drybridge – Finglas 110kV line twice. The crossing of the N2 at right angles is reasonable.

Sub Route A2 (Grey Line)

Sub route A2 option North of Garristown traverses through a corridor between the Sruna Area at Bellewstown and the R152 (Duleek - Drogheda road). The presence of a 220kV transmission line would have significant visual impact on the surrounding landscape in this area. The sub route diverts at Piercetown and heads in a NNE direction for 3.5km crossing five minor roads. At Carnes East the line briefly heads north to avoid the Sruna area at Bellewstown. At this point the proposed transmission line will be exposed as it travels over open countryside crossing on the way the existing Finglas- Platin 110kV Line and the R150 2km East of Duleek.

The line turns NE for 1.5km in order to avoid the school to the North at Caulstown The line then heads North to connect into the proposed route C option.

Sensitive Areas associated with Route A and the associated sub routes

Sensitive landscape at Garristown

The paralleling of the proposed line with the N2 bypass at Ashbourne

Crossing of the N2 at Ashbourne

Affected Counties : Dublin, Meath, Louth

County Boundary Crossings: Three

2.5 Route B (Green Line)

The proposed Route B option would leave the proposed Corduff 220kV substation and head in a NE direction for 3.5km crossing on the way the Existing Drybridge – Finglas 110kV Line, a minor road and then the existing Finglas – Platin 110kV Double Circuit line before it traverses across the N2 south of the R121. At this point the line would also clip a small pocket of sensitive landscape. The line travels North for 10.5km crossing the Ward River and the existing Glasmore – Finglas 110kV Line. The line passes through Corrstown golf club and meanders between the R130 and the R122.

The line crosses the R125 and the Broad Meadow River at right angles and continues Northbound until it crosses the R122 on two occasions North of Oldtown. In this area the line navigates within this confined corridor to avoid the sensitive landscapes of Garristown and Naul. The line parallels the R122 for 3km and crosses the Delvin River and then deviates to the NW to cross the R108 1km North of Naul.

The line then heads northwards to avoid the village of Stamullin to the East and then passes over the motorway at Moorechurch. The line travels NW to avoid Julianstown and crosses the River Nanny and the R150 1km West of Julianstown. The proposed line would cross the N1 1.5km North of Julianstown due to the extensive ribbon development along the N1 leading into Drogheda.

The line heads northwards once again crossing the main Dublin – Dundalk railway line and crosses the R150 1km West of Mornington before it crosses the NHA and SPA area 3.5km East of Drogheda. Once the line crosses the estuary just west of Beaulieu House it turns in a NW direction crossing the R166 (Drogheda – Clogherhead road) and once again the Dublin – Dundalk railway line before it connects in to the proposed 220kV substation.

Route B1 Sub Route (Grey Line)

Route B1 follows Route A for 2.5km and turns NE for 3.5km crossing the Finglas – Platin 110kV Line, Dublin – Meath County boundary on two occasions, Ward River, N2, and then reconnects into the route B option North of the Ward river.

Sensitive Areas associated with Route B and the associated sub route

Crossing of the N2 and the small pocket of Sensitive landscape at Bishopswood

The routing of the line between the two sensitive landscapes of Naul and Garristown

Crossing of the N1 North of Julianstown

Crossing of the NHA and SPA area East of Drogheda

Beaulieu Estate North East of Drogheda

Affected Counties : Dublin, Meath, Louth

County Boundary Crossings : Five

2.6 Route C Option (Light Blue Route)

The route C option would follow the route B option for 10km from Corduff and then deviates to the NE crossing the R122 2km South of Oldtown. The proposed line then crosses the R129 and the R 108 2km West and 2.5km North of Ballyboghil avoiding

Nags head and Hollywood Golf course to the North. The line will transect the Sensitive landscape around Naul to the South and to the East as it follows the motorway. The proposed Glasmore – Balbriggan 110kV line also parallels this section of motorway. As the line exits the sensitive landscape it continues to follow the existing and proposed motorway for 24km crossing on the way various roads the R122 (Naul – Balbriggan road), R108 (Naul – Drogheda road), the river Delvin and Nanny , R150 (Duleek-Julianstown road) R152 (Duleek-Drogheda).

At this point the proposed 220kV line will run alongside the existing Drybridge – Platin 110kV line for 4km.Once the line crosses the Boyne River it crosses the N51 (Slane – Drogheda road) skirts along the area of High Scenic Quality at Tullyallen, crosses the R168 (Drogheda – Collon road) and then on its final leg it turns NE across the motorway followed by the crossing of the N1 before it enters into the proposed substation.

Sensitive Areas associated with Route C

Sensitive landscape at Naul

Paralleling the motorway between Balbriggan and Drogheda

The Lower Boyne Valley at Drogheda

The area of High Scenic Quality at Tullyallen North West of Drogheda

Crossing of the N1 North West of Drogheda

Affected Counties: Dublin, Meath, Louth

County Boundary Crossings : Three

2.7 Route D option (Dark Blue Route)

Route D option would exit the proposed Drybridge 220kV substation and head in a NE direction for 2 km crossing on its path the main Dublin – Dundalk railway line and a minor road. The line then runs parallel with the railway line for 5.5km at which point it then once again crosses the rail track to head in a NW direction for 5km crossing on the way the R132 to Dunleer,R169 and the M1 motorway. The line turns NNW and follows the motorway for 9km crossing the river Dee and avoiding the villages of Dromin and Strabannan to the West before transecting the SPA area at Baganstown.

The line then turns NE to cross the river Glyde the R166, and crosses the Existing Drybridge – Louth 110kV line before crossing the N52 NE of Duffy's cross. The line travels across one minor road before crossing the R171 (Louth – Dundalk road) 1 km east of Louth village. The last leg of its journey the proposed line meanders through the hilltops of Tullcahan to the North of Louth before it terminates at Louth 220kV substation.

Sub Route D1

This sub route avoids close proximity to Louth village in the North.

Sensitive Areas associated with Route D and the associated sub route

Paralleling the Dublin - Dundalk railway track

Paralleling the Dunleer - Castlebellingham Motorway

Transecting the SPA area at Baganstown North East of Ardee

Affected County : Louth

County Boundary Crossings : None

2.8 Route E Option (Pink Route)

Route E option heads NW for 2.5km and crosses the N1 and then the motorway. It then turns northwards and runs parallel to the motorway for 2.5km. The area is designated as a high visual amenity area in Louth County Development Plan. The proposed line route will follow the motorway for 5 km at which point it will intersect with the proposed Route D option. The line immediately turns West for 2.5km crossing the Drybridge –Louth 110kV and avoiding a lake to the North at Lismanus. The line avoids the standing stones at Mullacurry West of Dromin on the R170 (Ardee – Dunleer road). Likewise the Route E option crosses the river Dee and Glyde. The route will cross the new Ardee link road the R170 (Ardee - Dunleer) and numerous minor roads to avoid the designated SPA area at Baganstown. The line must cross the R166 (Tallanstown – Castlebellingham road) as there is intensive ribbon development south of Duffy's cross on the N52 (Ardee – Dundalk road) and to avoid crossing the existing Drybridge – Platin 110kV in two places.

At this point the line will join into the proposed route D option at Kilcroney.

Sensitive Areas associated with Route E

Transecting the area of High Scenic Quality at Ballymakenny North West of Drogheda

Paralleling the motorway between Drogheda - Dunleer

Affected County : Louth

County Boundary crossings : None

2.9 Evaluation of Route Corridors

Route Corridor	Length	Planning Permission Issues	Double Circuit 220kV Option	Single Circuit 220kV Option
Route A And part of Route C	47km	May require cabling near Corduff 220kV substation. Issue may arise due to the Objections likely along entire route and in the vicinity of the Drogheda.	Visual impacts on the landscape would be dominant along the motorways at Ashbourne and Drogheda, the N2 paralleling, Sensitive Landscape at Garristown .	A Single Circuit 220kV Line could be more visually absorbed by the landscape due to good screening by the high hedgerows in the Fingal and Meath landscape.
Route A and sub Route A1 and A2 plus Route C	40km	Issue could arise due to the proposed line paralleling the N2 for 3km	D.C. 220kV line would be visible from the N2 and the paralleling of the motorway	S.C 220kV line Could be absorbed through the existing hedgerows
		Proximity to Duleek , the open landscape and the high elevation between Duleek and Bellewstown	D.C. 220kV line would be visible from the Sruna area at Bellewstown and along the busy R152 Duleek – Drogheda road	

Route Corridor	Length	Planning Permission Issues	Double Circuit 220kV Line Option	Single Circuit 220kV Line Option
Route B	**42km**	May require cabling near Corduff. There is a crossing of an SPA and NHA area East of Drogheda. Traverses between the confined corridor of the two sensitive landscapes at Naul and Garristown. Objections likely along entire route and in the vicinity of the Drogheda.	D.C 220kV line would be visible between the apex of the surrounding sensitive landscapes of Naul and Garristown Plus the crossing of the SPA and NHA area East of Drogheda.	S.C. 220kV line could be better absorbed into the landscape by screening present in the landscape
RouteB and Sub Route B1	**44km**	As above except the line avoids the pocket of sensitive landscape at the intersection of the R121 with the N2 and avoids the crossing of the existing 110kV D.C line.	As above	As above
Route B with Route C	**48km**	As above except traverses between the confined corridor of the sensitive landscape at Naul and the M1 motorway. Objections likely along entire route and in the vicinity of the Drogheda and Balbriggan.	D.C. 220kV line would be visible from the sensitive landscape at Naul and would dominate the landscape as it parallels the motorway.	S.C. 220kV line could be better absorbed into the landscape by screening present in the landscape.
Route D	**34km**	High development potential near Drogheda. The paralleling of the proposed line with the Dublin –Dundalk rail line. May cross edge of SPA area at Bagenstown North East of Ardee.	D.C. 220kV line Would be visible from the main Dublin – Dundalk rail line and the motorway between Dunleer and Castlebellingham.	S.C 220kV line could be better absorbed by the landscape.
Route D and D1	**34km**	Same as route D above	D.C 220kV line would be visible from motorway	S.C.220kV could be absorbed by the landscape
Route E	**34km**	High development potential near Drogheda. May cross edge of area of High Scenic Quality North East of Drogheda.	D.C. 220kV line would be visible as it would traverse through the Area of High Scenic quality which overlooks Drogheda	S.C 220kV line could be better absorbed by the landscape

2.10 Discussion on Routes

From the initial route corridor selection it is clear that a planning application for a project of this nature will encounter a lot of opposition as it transects the North Eastern corridor of Ireland which is one of the most populated areas in the country.

Route C skirts through the sensitive landscape at Naul and would travel parallel to the existing and proposed M1 motorway for 28km and for this reason it would be obvious to motorists for most of the route.

Route A including the sub routes comes within close proximity to the commuter villages of Ratoath and Ashbourne where there has been an explosive increase in the population of these areas in the last few years. The line would also be highly visible from Duleek and the Sruna area at Bellewstown.

Route B would travel largely through a landscape that would reasonably have the capacity to absorb a 220kV Single circuit line. As the route would intersect Route C it would take the option of travelling parallel with the proposed Route C along the motorway for 14.5km instead of taking the route to the East of Drogheda which would cross the NHA and SPA area East of Drogheda.

Two routes D and E were identified in the selection of proposed route corridors from Drogheda to Louth 220kV substation. A combination of these routes would seem to be the best solution. Starting from Drogheda the route would take Route D thus avoiding the area of High Scenic Quality North West of Drogheda. At the intersection of the route D and E South of Dunleer the line would take route E to avoid the SPA area North East of Ardee.

The assessment of the panel of independent environmental consultants and further clarification of the attitudes of the three planning authorities would help clarify which route will be most acceptable as the preferred route.

In general any route between Corduff and Drogheda will encounter severe opposition along its entire length. Crossing the Boyne Valley presents particular difficulties and will be strongly resisted by planning authorities. Even crossing the Boyne along the Drogheda bypass road would still leave the 220kV line highly visible from world renowned archaeological areas. Very strong justification would be required including exhaustive analysis of alternatives before progressing this option. It is recommended that further study be given to other alternative means of providing the required reinforcement such as replacing the existing single circuit line routes with double circuit construction to provide an extra 220kV circuit.

Routeing opportunities to the north of Drogheda towards Louth are reasonable and a 220kV line route in this area is feasible.

3. UPRATE EXISTING 220KV LINE ROUTES

If the new line to be built as a single circuit 220kV line then the Louth – Maynooth and Louth – Woodland 220kV lines must be uprated to 1700A summer rating. This section is a primarily desktop discussion of the technical issues associated with uprating the existing lines.

Louth – Maynooth 220kV Line

The Louth – Maynooth 220kV Line is 74.9km in length. The angle towers are designed to carry 600ACSR CURLEW conductor but most of the intermediates (230 towers) are of the "HL" design which were designed to carry 430ACSR BISON conductor. The line is strung with 600ACSR CURLEW operating at 80°C. In order to carry 600ACSR CURLEW design span lengths were reduced. There is a short section of double circuit line (two spans) at Louth 220kV station.

Louth – Woodland 220kV Line

The Louth – Woodland 220kV Line is 61.5km in length. All towers are designed to carry 600ACSR CURLEW conductor. The line is strung with 600ACSR CURLEW operating at 80°C. The majority of the line is in single circuit configuration. There is also a section of double circuit line (5.9km) at Woodland 400kV station.

3.1 Criteria for Candidate Conductors for Uprating

In determining an overhead line conductor configuration suitable for this project candidates were assessed based on the following criteria in order of priority.

(a) must have rating of at least 1700A (Project Specification)
(b) minimum modification to angle masts/foundations (In order to minimise outages)
(c) minimum modification to intermediate masts/foundations (In order to minimise outages)

Determination of Rating

The first issue to be dealt with is the calculation method and inputs required for determining the rating of a conductor. The various calculation methods available (Morgan, CIGRE, IEEE) generally agree with each other to within a few per cent. ESBI has attempted to replicate the ESB ratings by reference to ESB records for inputs(wind speed, solar radiation, absorbtivity, emissivity, ambient temperature etc). A "best fit" method was developed to do this. A comparison of the resulting calculated ratings were compared against ESB ratings and can be seen in the appendices. Trends can be seen where clearly different methods or input values were used for the different ESB ratings. In response to this situation NG commissioned ESBI to produced a recent report "Review of Overhead Line Current Carrying Ratings" by M.B.Buckley. This report proposed a statistical method of determining inputs for the calculation of thermal ratings. This report has not yet been accepted by NG. A sizable benefit to thermal ratings in coastal areas can result from the

application of this report. However a significant derating of lines in the midlands would also result.

In determining the ratings of candidate conductors in this report the ESBI "best fit" method will be used.

Minimum modification to masts/foundations

The requirement for significant modification to masts or foundations can be required from two main sources- (a) need to raise towers, (b) need to reinforce towers due to increased loadings.

In order to achieve minimum modification to masts the sag tension regime associated with the new conductor should (a) give a maximum operating temperature sag of less than or equal to that already in place on the existing lines and (b) give a tension which will not overload the existing angle towers on the line. In addition the new conductor should ideally give similar transverse wind loads on towers and similar vertical ice loads on towers.

In practice it is impossible to achieve all of the above objectives while still achieving an increased rating. There are, however, some factors which can be used to benefit the analysis.

(a) 220kV angle towers have traditionally been designed to withstand the breaking strength of the conductor. This is not a requirement. An ESB Board Approval in 1976 specified Normal Security lines as being capable of withstanding

(i) 150kg/m^2 wind only on conductor and
(ii) 50kg/m^2 wind on a conductor loaded with 2.5cm radial ice(0.9 SG) and
(iii) 4cm radial ice(0.9 SG) with no wind

In practice 110kV angle towers are designed to withstand 4cm radial ice with 50kg/m^2 wind applying. In this report this loading condition is assumed for calculating tensions on angle towers.

(b) The Irish Special National Conditions of the CENELEC Codes specifies a method for calculating wind pressure on conductor which would lower the wind loads on conductor experienced by towers. The exact wind loads are dependant on terrain type and conductor height above ground. They will not be detailed in this report as the benefit will vary depending on tower location and are more appropriate to detailed design.

(c) Intermediate towers are normally designed for a maximum allowable "wind span" which is proportional to the wind load due lengths of span on either side of a tower. In practice few installed towers have a wind span of the maximum allowable. There is therefore some spare capacity in the vast majority of intermediate towers on the system. In the case of the Louth – Maynooth 220kV Line much of this spare capacity has already been used as the towers carry 600ACSR while the intermediate towers were designed for 430ACSR.

3.2 Candidate Conductor Configurations

Twin Conductors

For previous new line projects twin conductors have been used for ratings of the order required. Twin BISON (430s) ACSR conductor has been used with an ESB specified rating of 1870A which would more than satisfy the Project Specification of 1700A.

A range of conductors were examined as possible twin conductor uprating candidates but the following conductors best illustrate the issues involved with twin conductors. For this report twin ACSR BISON as above and the French twin AAAC Aster 366 and twin AAAC Aster 288 will be examined.

The table below shows the main issues of interest associated with the use of twin conductor. The first line in the table shows the requirements ie a rating of 1700A and a maximum conductor tension of 16600kg from angle tower design.

Uprating Conductor Options for 600 ACSR to 1700A (Summer)					
Type	**Conductor**	**Summer Rating**	**Op Temperature**	**Max Tension (Angle Tower Design)**	**Overload of Intermediates**
	Required	1700A		16600kg	
ACSR	Curlew(Operating)	1130A	80C		100%
ACSR	Curlew(ESBI Est)	1195A	80C		100%
ACSR	Curlew(MBB Report)	1360A	80C		100%
Twin ACSR	Bison (430)	1870A	80C	23674kg *	171%
Twin AAAC	Aster 366	1940A	90C	18950kg *	157%
Twin AAAC	Aster 288	1628A	90C	16752kg *	140%

* Conductor does not meet strength requirements

The size of twin conductor required to deliver the rating of 1700A will significantly overload the angle towers. Similarly there will be a very high overloading of intermediates in a way that is not likely to be counteracted by lower actual wind spans than design wind spans on towers.

A basic requirement for conductor design is that the conductor be capable of carrying 4cm radial ice without exceeding 85% of its rated breaking strength(RBS). 220kV lines with 600ACSR CURLEW conductor are designed for characteristic(equivalent) span lengths of up to 380m. All of the candidate conductors fail to meet the 85% of RBS requirement at this characteristic span length. In order to achieve lower characteristic span lengths new intermediate towers would be required in longer spans.

The uprating of the line with twin conductor would require significant tower reinforcement and also require the installation of new towers on the line.

Single Conductor

The alternative to installing twin conductor is to use a large single conductor. This tends to lead to a greater overall conductor cross sectional area due to a reduced overall surface area for conductor convective cooling.

A range of conductors were examined as possible candidates as shown in the table below. The first line in the table shows the requirements ie a rating of 1700A and a maximum conductor tension of 16600kg.

Uprating Conductor Options for 600 ACSR to 1700A (Summer)					
Type	Conductor	Summer Rating	Op Temperature	Max Tension (Angle Tower Design)	Overload of Intermediates
	Required	1700A		16600kg	
ACSR	Curlew(Operating)	1130A	80C		100%
ACSR	Curlew(ESBI Est)	1195A	80C		100%
ACSR	Curlew(MBB Report)	1360A	80C		100%
ACSR	Plover (819mm2)	1485A	80C		118%
ACSR	Parrot (863)	1532A	80C		121%
ACSR	Falcon (909)	1579A	80C	17304kg	124%
AAAC	Araucaria(EHC)(821)	1588A	90C	15984kg	118%
AAAC	Aster 851	1573A	90C	16402kg	120%
AAAC	Aster 851(EHC)	1619A	90C	16402kg	120%
AAAC	Fictional 920 EHC	1697A	90C	17100kg	125%

It can be seen that the size of single ACSR conductor required to deliver the rating of even 1579A will overload the angle towers. There will be a moderately high overloading of intermediates in a way that may be possible to be counteracted by lower actual wind spans than design wind spans on towers.

There are three grades of AAAC available which meet mechanical strength requirements. Standard conductivity and High Conductivity(HC) are specified in IEC codes. A further grade developed for the UK NGC of Extra High Conductivity(EHC) is also available. In achieving the rating required (subject to rating method) a special AAAC conductor will need to be designed. This conductor would be a AAAC conductor of about 920mm^2 using Extra High Conductivity aluminium alloy. This conductor is shown above as "Fictional 920 EHC" AAAC conductor.

With this fictional conductor there would be a moderately high transverse overloading of intermediates in a way which is somewhat counteracted by lower actual wind spans than design wind spans on towers. For the Louth – Woodland 220kV line 57 single circuit towers would require some further investigation including the application of CENELEC high wind loading conditions. No double circuit towers in the approach to Woodland 400kV Station would need further investigation. For the Louth – Maynooth 220kV line 169 towers would require further investigation. There is a 3% overloading of angle towers which may require no tower modifications.

A basic requirement for conductor design is that the conductor be capable of carrying 4cm radial ice without exceeding 85% of its rated breaking strength(RBS). 220kV lines with 600ACSR CURLEW conductor are designed for characteristic(equivalent) span lengths of up to 380m. All of the candidate single conductors meet the 85% of RBS requirement at this characteristic span length.

3.3 Uprating Conductor Selection – Issues to be resolved

It is clear from the foregoing discussion that twin conductor will not provide a satisfactory solution to upgrading 220kV overhead lines which are designed to 600ACSR normal standard. The solution here will be provided by a single large probably AAAC conductor. In furthering this option the following are required.

(a)Rating: The design of the single large conductor is dominated by the rating required. The variation of calculated thermal rating depending on method of determining environmental input values will have a very significant influence on the final conductor chosen. It is recommended that an approved method of determining thermal rating be developed.

(b)Following the above a conductor choice should be made. If a conductor type which is non standard is to be designed then this should be carried out by an experienced conductor designer. The sag – tension performance should be confirmed by test.

(c)Broken Conductor Condition: Intermediate towers are now designed in ESB for broken conductor under stringing tension. This reflects the more likely failures such as compression joint failures. The stringing tension for a large AAAC conductor is well in excess of that for 600ACSR CURLEW. The acceptability of this to NG should be confirmed.

(d)Other Conditions: Other conditions (eg construction, and anticascade) used in modern design are not explicitly catered for in older tower types such as those on the two lines proposed for uprating. The effect of these modern conditions with the new conductor on the design of existing towers should be confirmed.

(d)An assessment of each tower location in which initial analysis shows to be possibly overloaded should be made to ascertain what measures, if any, are required.

(e)A review of fittings and installation practice should be undertaken. The choice of fittings types will affect construction practice and thus outage times.

(f)A review of aeolian vibration control for large AAAC conductors should be undertaken.

(g)In the case of the Louth - Maynooth 220kV Line it is likely that very significant upgrading work will be required to HL towers leading to very significant outage requirements. Alternative means of uprating this line such as rebuilding adjacent to the line should be considered.

(h)All foundations will be loaded to a level than heretofore even if below their design capacity. A method for estimating the actual capacity of the installed foundations should be researched.

(i)The condition of all towers should be confirmed on site.

3.4 Outage Requirements

It is estimated that in order to restring the Louth – Woodland 220kV line an outage of (or number of outages adding up to) 50 days would be required. This would require cooperation from landowners and approximately ten crews working during the outage period. The estimate also assumes that no significant modification is required to towers or foundations during the outage.

It is impossible to accurately estimate the minimum outage requirement for restringing and upgrading the Louth – Maynooth 220kV line. Considerable reinforcement or replacement of towers is very likely to be required for up to 169 towers. An initial estimate of 80 to 150 days for ten crews can be made. Similarly this estimate assumes full cooperation from landowners, good ground conditions and that enough suitable mobile cranes can be made available for the project. As it is likely that several towers will require replacement there is considerable risk that cooperation may not be forthcoming from landowners.

3.5 Double Circuit on existing Single Circuit Route

This option would entail replacement of all intermediate towers by double circuit towers and the location of a new single circuit angle mast beside the existing single circuit angle mast. The existing single circuit angle mast would be retained. This would minimise outages and leave two single circuit towers at angle positions and double circuit towers at intermediate positions. This option would require planning permission. An initial estimate of the outage time of 180 days for the Louth – Maynooth 220kV line and 130 days for the Louth – Woodland 220kV line would be appropriate. Similarly these estimates assume full cooperation from landowners, good ground conditions and that enough suitable very large mobile cranes can be made available for the project.

3.6 Double Circuit adjacent to existing Single Circuit Route

This option involves building a new double circuit line adjacent to the existing line route and then retiring the existing single circuit line. This option would require planning permission. Minimum outages would be required. The detailed study of this option is outside the scope of this report however, a brief evaluation of this option was undertaken. The new double circuit line would consist of twin conductor (approximately 400mm^2 each) or single 920mm^2 conductor. It is recommended that this option be studied in more depth in the next stage of this project.

A brief study was conducted by ESBI to provide an initial evaluation of the option of running a 220kV double circuit line adjacent to either the Louth - Woodland or the Louth - Maynooth 220kV single circuit lines

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Initial Evaluation of Replacing Louth - Woodland 220kV Line with Double Circuit

The existing Louth – Woodland shares a double circuit length of line between Woodland 220kV station and Fairyhouse. A new length of single circuit 220kV line would be required parallelling the existing double circuit section. There is extensive ribbon development in this area which would require careful routeing.

Initial examination of the existing single circuit line suggests that it can be replaced by a double circuit line within a corridor of 500m width centred on the existing line between Fairyhouse and Kentstown (approximately 7km south of the River Boyne).

For the next 20km north of Kentstown is a very sensitive section of route including two crossings of the N2, two 110kV line crossings, crossing of the Boyne, passing West of Newgrange and a 5km crossing of a designated Area of High Amenity in County Louth.

Initial examination of the last 16km into Louth Station suggests that the existing single circuit line can be replaced with a new double circuit 220kV line.

An initial estimate of 13 crossings of the existing line would be required by the new double circuit line.

Initial Evaluation of Replacing Louth - Maynooth 220kV Line with Double Circuit

Based on initial assessment this appears to be a preferable method of providing a new 220kV circuit between the Dublin Area and Louth.

In replacing the Louth – Maynooth single circuit line with double circuit difficulties will be encountered on exiting the Maynooth substation and at Mullagh due to ribbon development.

Initial examination of the remainder of the existing single circuit line suggests that it can be replaced by a double circuit line within a corridor of 500m width centred on the existing line with the following exceptions.

(a)A route alteration in the vicinity of the Hill of Tara may be required.
(b)Consideration of the options for the crossing of the Boyne Valley will be required.
(c)isolated places where new housing has been built close to the existing line.

An initial estimate of six crossings of the existing 220kV line would be required by the new double circuit line.

The difficulties near Maynooth could be avoided by bringing the new 220kV circuit into Woodland using the spare circuit on the existing 400kV line. This would obviate the need to upgrade to double circuit near Maynooth station or near Mullagh.

3.7 Uprate Existing 110kV Routes

The existing Finglas - Platin and Drybridge - Finglas 110kV lines can be uprated to 850A by restringing with 430ACSR(Bison) conductor. This will also entail the replacement of all polesets on the lines and the addition of approximately 25% more polesets in order to reduce the span lengths such that angle towers will not require replacement.

The Finglas – Platin 110kV line shares a double circuit route with the Finglas - Glasmore West 110kV line for 4.7km. A loading and tower analysis study will be required in order to confirm the suitability of the existing towers for carrying 430ACSR conductor.

3.8 Summary

This section has addressed the issues associated with the uprating/upgrading of 220kV lines towards achieving the project objectives. The study is preliminary and provides initial direction for further progressing the project.

In order to determine a conductor which could provide an uprating an approved set of environmental inputs for thermal rating calculations should be developed.

If uprating the existing 220kV lines to 1700A then initial studies show that it is feasible to restring with a AAAC conductor with a cross sectional area of 900-950mm^2. Use of this conductor will necessitate a reasonable reinterpretation of loading conditions. In addition the acceptability or otherwise of revised conditions such as broken wire and anticascade conditions should be confirmed. The condition of existing towers and foundations should be confirmed.

The results of the preliminary study for uprating can be summarised as follows

Line	Cost (Section 4)	No. Towers to be investigated	Outage Requirement
Louth – Woodland 220kV	€4.4m	57	~50days
Maynooth – Louth 220kV Line	€11.8m	169	80-150days

A preliminary review of the single circuit 220kV routes for upgrading to double circuit was carried out. The outages, risks and costs involved in replacing a single circuit line with a double circuit line along the same route are prohibitive. This study concentrated on the possibility of constructing a new double circuit line parallel to the single circuit line followed by a retirement of the single circuit line. The results of the preliminary study can be summarised as follows.

Line	**Cost (Section 4)**	**General Feasibility**
Louth – Woodland 220kV	€32m	Very Difficult
Maynooth – Louth 220kV Line	€40m	Feasible

4 COSTS AND PROGRAM

The costs given in this section are preliminary based on previous Capital Approval Estimates provided for the Cashla – Oldstreet 220kV Line and other projects. The costs have been adjusted for the larger conductor type proposed and do not include OPGW shieldwire. The costs are only preliminary estimates with no final design or detailed routeing. Costs associated with ESBI fees and planning conditions are not included. All costs are prime TMO costs.

Corduff – Louth Double Circuit 220kV Line (78km)

Construction	€40.7m
Easements	€3.5m
PR/Environment	€0.9m
Legal	€0.7m

Corduff – Louth Single Circuit 220kV Line (78km)

Construction	€22.6m
Easements	€3.5m
PR/Environment	€0.9m
Legal	€0.7m

Uprate Louth-Woodland

Construction	€3.9m
Easements	€0.3m
PR/Environment	€0.1m
Legal	€0.1m

Uprate Louth – Maynooth

Construction	€11.3m
Easements	€0.3m
PR/Environment	€0.1m
Legal	€0.1m

Double Circuit from 400kV crossing to Louth

Construction	€30.0m
Easements	€2.5m
PR/Environment	€0.7m
Legal	€0.5m

Remove Single Circuit from 400kV crossing to Louth

Construction	€2.2m
Easements	€0.0m
PR/Environment	€0.0m
Legal	€0.0m

Uprate Single Circuit Maynooth – 400kV crossing

Construction	€2.3m
Easements	€0.1m
PR/Environment	€0.1m
Legal	€0.05m

Install Double Circuit Loop into Drybridge 220kV station from Louth – Woodland 220kV Line

Construction	€5.9m
Easements	€0.5m
PR/Environment	€0.1m
Legal	€0.1m

The project program will be heavily influenced by the nature and level of consultation eventually decided upon and also will depend on the level of difficulty and issues encountered. If a Corduff – Drybridge option is pursued it is highly likely that extended planning periods and legal actions will result.

A program of six years would be required for the completion of the Corduff-Drybridge-Louth 220kV Line. The uprating of the Louth – Maynooth and Louth – Woodlands 220kV lines would be dependant on the outage availability.

5 CONCLUSION

The construction of a 220kV Double Circuit line between Corduff and Drybridge would be an extremely difficult project to develop. The use of single circuit 220kV line would improve the project viability but would still encounter very major difficulties such as widespread public opposition.

Routeing opportunities between Drybridge and Louth are reasonable and a line route would be feasible.

Uprating of the Woodland – Louth 220kV line is feasible with reasonable outages subject to the acceptability of revised loading conditions, thermal rating calculations and resourcing. It is likely that a number of towers will require some reinforcement A new AAAC conductor size and design would be required.

Uprating of the Louth – Maynooth 220kV line is more difficult as intermediate towers on this line are carrying 600ACSR conductor despite only being designed for 430ACSR conductor. This does not necessarily mean that this line does not meet design standards as there is a tendency for reduced span lengths on this line. In order to restring the line with a larger conductor widespread tower replacement would be required with consequent cost and outage implications.

A number of recommendations are made in section 3.3 of this report to address the various issues associated with uprating these lines.

It is recommended that a route investigation be carried out into replacing the Louth – Maynooth 220kV line with either single circuit or double circuit line at the new required rating.

It is recommended that the costing/feasibility of providing the North East reinforcement requirements by the following method be investigated.

(a) Replace Louth Maynooth 220kV line between the Moneypoint – Woodland 400kV line crossing and Louth with a double circuit line.
(b) Use the spare circuit of the Moneypoint – Woodland 400kV line for access into Woodland.
(c) Uprate the Louth – Maynooth 220 kV line between Maynooth and the Moneypoint – Woodland 400kV line crossing.
(d) Uprate the existing Louth – Woodland 220kV line.
(e) Provide a feed to a new 220kV station near Drybridge by either looping the Louth – Woodland 220kV line or building a new Louth – Drybridge 220kV line.

This would provide two highly rated Louth – Woodland circuits and one highly rated Louth – Maynooth circuit.

This option would be more likely to gain public and planning acceptability as minimum new line routeing is required and the new line routeing will be largely built in the county gaining most from the development.

Appendix 1

Map of Study Area

Appendix 2

Route Corridors Map

Appendix 3

1:10560 (6”) Map showing initial possible 220kV site locations

Appendix 4

Comparison of ESB Ratings vs ESBI "Best Fit" Calculated Ratings