Arup Project Risk Register

Risk ID	Option	Design Assumption	Risk Description	Cause	Impact	Probability	Cost	Risk Score	Probability	Minimum (£)	Most Likely (£)	Maximum (£)	EMV	Assessment Notes	Mitigation Action(s)
001	Gate 2 Eastern Route	Existing utility searches have not been undertaken. It is assumed that all major overland services are visible on publicly available Google Earth and working with / crossing buried services can be undertaken with appropriate mitigation measures	Conflict with major buried utility services such as high pressure gas or high voltage electricity and unknown over land services resulting in pipeline route changes or costly mitigation	Conflict with major utility services	Pipeline by traditional open cut trenches may not be feasible. Alternative will be to cross services at, greater depth requiring trenchless methods	H	L	MEDIUM	70%	£488,000	£732,000	£1,220,000	£540,867	Additional cost of using trenchless methods for crossings (assumed each crossing length is 100m and assumed no of crossings is 5 across entire route - based on similar 10km scheme) Cost of 100m using traditional open cut trenches - £82,000 (based on average open trench construction for all diameters) Cost of 100m using (most expensive/worst case) trenchless method - £326,000 (based on construction under buildings and water for all pipe diameters Min - Cost of 2 crossings using alternative methodology ML - Cost of 3 crossings using alternative methodology Max - Cost of 5 crossings using alternative methodology No information available on location of services	Utility searches to be undertaken as design progresses
002	Gate 2 Western Route	Existing utility searches have not been undertaken. It is assumed that all major overland services are visible on publicly available Google Earth and working with / crossing buried services can be undertaken with appropriate mitigation measures	Conflict with major buried utility services such as high pressure gas or high voltage electricity and unknown over land services resulting in pipeline route changes or costly mitigation	Conflict with major utility services	Pipeline by traditional open cut trenches may not be feasible.	H	L	MEDIUM	70%	£488,000	£732,000	£1,220,000	£540,867	Additional cost of using trenchless methods for crossings (assumed each crossing length is 100m and assumed no of crossings is 5 across entire route - based on similar 10km scheme) Cost of 100m using traditional open cut trenches - £82,000 (based on average open trench construction for all diameters) Cost of 100m using (most expensive/worst case) trenchless method - £326,000 (based on construction under buildings and water for all pipe diameters Min - Cost of 2 crossings using alternative methodology ML - Cost of 3 crossings using alternative methodology Max - Cost of 5 crossings using alternative methodology No information available on location of services	Utility searches to be undertaken as design progresses
003	Gate 2 Western Route	It has been assumed that pipeline crossing existing railway lines are to be undertaken using trenchless techniques e.g. Tunnelling or pipe jerking (Rail crossing)	Trenchless methods infeasible for any reason e.g. poor Geotech, or not permitted by railway line operator.	Unknown ground conditions Opposition from railway line operator	Crossing may require other methods e.g. tunnelling, which may be more expensive	M	L	LOW	50%	£390,400	£585,600	£976,000	£309,067	Additional cost of using more expensive trenchless method (total number of rail crossings on Gate 2 W Route is 5 and crossing length is 80m - based on the maximum possible length achievable using the technique) Cost of 80m using tunnelling/pipe jerking method - £65,600 (based on average construction for all diameters) Cost of 80m using (most expensive/worst case) trenchless method - £260,800 (based on construction under buildings and water for all pipe diameters Min - Cost of 2 crossings requiring more expensive trenchless method ML - Cost of 3 crossings requiring more expensive trenchless method Max - Cost of 5 crossings requiring more expensive trenchless method No information available on ground conditions to inform design, equal likelihood of poor ground conditions to favourable ground conditions.	Undertake early consultation with railway line operator Undertake detailed ground investigations as design progresses
004	Gate 2 Eastern Route	It has been assumed that pipeline crossing existing railway lines are to be undertaken using trenchless techniques (Rail crossing)	Trenchless methods infeasible for any reason e.g. poor Geotech, or not permitted by railway line operator.	Unknown ground conditions Opposition from railway line operator	Crossing may require other trenchless methods e.g. tunnelling, which may be more expensive	M	L	LOW	50%	£390,400	£585,600	£976,000	£309,067	Additional cost of using more expensive trenchless method (total number of rail crossings on Gate 2 E Route is 5 and crossing length is 80m - based on the maximum possible length achievable using the technique) Cost of 80m using tunnelling/pipe jerking method - £65,600 (based on average construction for all diameters) Cost of 80m using (most expensive/worst case) trenchless method - £260,800 (based on construction under buildings and water for all pipe diameters Min - Cost of 2 crossings requiring more expensive trenchless method ML - Cost of 3 crossings requiring more expensive trenchless method Max - Cost of 5 crossings requiring more expensive trenchless method No information available on ground conditions to inform design, equal likelihood of poor ground conditions to favourable ground conditions.	Undertake early consultation with railway line operator Undertake detailed ground investigations as design progresses
005	Gate 2 Western Route	It has been assumed that pipeline crossing of rivers and all other water courses will be undertaken using directional drilling techniques (River crossings)	Directional drilling methods infeasible for any reason e.g. poor Geotech	Unknown ground conditions	Crossing may require other trenchless methods e.g. tunnelling or open trenches with water management (river diversion or cofferdams) which will be more expensive	M	M	MEDIUM	50%	£390,400	£976,000	£2,147,200	£536,800	Additional cost of using more expensive trenchless method (total number of river crossings on Gate 2 W Route is 11 and crossing length is 80m - based on the maximum possible length achievable using the technique) Cost of 80m using directional drilling method - £65,600 (based on average open trench construction for all diameters) Cost of 80m using (most expensive/worst case) trenchless method - £260,800 (based on construction under buildings and water for all pipe diameters Min - 2 crossings require tunnelling method ML - 5 Max - 11 No information available on ground conditions to inform design, equal likelihood of poor ground conditions to favourable ground	Undertake detailed ground investigations as design progresses
006	Gate 2 Eastern Route	It has been assumed that pipeline crossing of rivers and all other water courses will be undertaken using directional drilling techniques (River crossings)	Directional drilling methods infeasible for any reason e.g. poor Geotech	Unknown ground conditions	Crossing may require other trenchless methods e.g. tunnelling or open trenches with water management (river diversion or cofferdams) which will be more expensive	M	L	LOW	50%	£390,400	£976,000	£1,756,800	£504,267	Additional cost of using more expensive trenchless method (total number of river crossings on Gate 2 E Route is 9 and crossing length is 80m - based on the maximum possible length achievable using the technique) Cost of 80m using directional drilling method - £65,600 (based on average open trench construction for all diameters) Cost of 80m using (most expensive/worst case) trenchless method - £260,800 (based on construction under buildings and water for all pipe diameters Min 2 crossings require tunnelling method Most-likely 5 crossings require tunnelling method Max 9 crossings require tunnelling method No information available on ground conditions to inform design, equal likelihood of poor ground conditions to favourable ground	Undertake detailed ground investigations as design progresses
007	Gate 2 Western Route	It has been assumed that pipeline crossing of public highways and roads will be undertaken using directional drilling techniques (Road Crossings)	Directional drilling methods infeasible for any reason e.g. poor Geotech	Unknown ground conditions	Crossing may require other trenchless methods e.g. tunnelling, which may be more expensive	M	M	MEDIUM	50%	£585,600	£1,366,400	£2,928,000	£748,267	Additional cost of using more expensive trenchless method (total number of road crossings on Gate W Route is 67 and crossing length is 80m - based on the maximum possible length achievable using the technique) Cost of 80m using directional drilling method - £65,600 (based on average open trench construction for all diameters) Cost of 80m using (most expensive/worst case) trenchless method - £260,800 (based on construction under buildings and water for all pipe diameters) Min 3 crossings require tunnelling method Most-likely 7 crossings require tunnelling method Max 15 crossings require tunnelling methods (based on number of major road crossings/A roads) No information available on ground conditions to inform design, equal likelihood of poor ground conditions to favourable ground	Undertake detailed ground investigations as design progresses
008	Gate 2 Eastern Route	It has been assumed that pipeline crossing of public highways and roads will be undertaken using directional drilling techniques (Road Crossings)	Directional drilling methods infeasible for any reason e.g. poor Geotech	Unknown ground conditions	Crossing may require other trenchless methods e.g. tunnelling, which may be more expensive	M	M	MEDIUM	50%	£585,600	£1,366,400	£2,928,000	£748,267	Additional cost of using more expensive trenchless method (total number of road crossings on Gate E Route is 70 and crossing length is 80m - based on the maximum possible length achievable using the technique) Cost of 80m using directional drilling method - £65,600 (based on average open trench construction for all diameters) Cost of 80m using (most expensive/worst case) trenchless method - £260,800 (based on construction under buildings and water for all pipe diameters) Min 3 crossings require tunnelling method Most-likely 7 crossings require tunnelling method Max 15 crossings require tunnelling method (based on number of major road crossings/A roads) No information available on ground conditions to inform design, equal likelihood of poor ground conditions to favourable ground	Undertake detailed ground investigations as design progresses
009	Gate 2 Western Route	Location identified for intermediate pumping station will be feasible	Construction of the pumping station building at the location available may not be feasible due to unforeseen constraints e.g. planning or high cost of land due to current use	Unforeseen constraints e.g. planning requirements or high cost of land due to current use	Proposed location is infeasible resulting in new location and possible re-routing of pipeline and/or additional costs to meet planning requirements	M	M	MEDIUM	60%	£850,000	£1,700,000	£8,500,000	£1,615,000	Cost impact is additional cost to reroute pipeline; minimum, most likely and worst case scenarios assume a % of the total pipeline length requires rerouting. Pipeline length is 100km of pipe (excluding crossings and pumping stations and includes all pipeline diameters) Total pipeline length cost (excluding crossings and pumping stations and is based on pipeline diameters above 350m) - £170,000,000 (£1,700,000 per km) Min 0.5% Most-likely 1% Max 5% % impact is based on risk being localised therefore significant rerouting is not expected there Roughly 1 in 2 chance due to greenfield, likely to be less resistance from stakeholders but possibility of unforeseen ground conditions	Undertake early consultation with local authority and land owners Undertake detailed ground investigations as design progresses Undertake flood risk assessment and modelling

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010	Gate 2 Eastern Route	Location identified for intermediate pumping station will be feasible	Construction of the pumping station building at the location available may not be feasible due to unforeseen constraints e.g. planning or high cost of land due to current use	Unforeseen constraints e.g. planning or high cost of land due to current use	Proposed location is infeasible resulting in new location and possible re-routing of pipeline and/or additional costs to meet planning requirements	M	M	MEDIUM	60%	£850,000	£1,700,000	£8,500,000	£1,615,000	Cost impact is additional cost to reroute pipeline; minimum, most likely and worst case scenarios assume a % of the total pipeline length requires rerouting. Pipeline length is 100km of pipe (excluding crossings and pumping stations and includes all pipeline diameters) Total pipeline length cost (excluding crossings and pumping stations and is based on pipeline diameters above 350m) - £170,000,000 (£1,700,000 per km) Min 0.5% Most-likely 1% Max 5% % impact is based on risk being localised therefore significant rerouting is not expected there Risk more likely than not due to greenfield, likely to be less resistance from stakeholders but higher possibility of unforeseen ground conditions	Undertake early consultation with local authority and land owners Undertake detailed ground investigations as design progresses
011	Gate 2 Western Route	Location identified for break pressure tank will be feasible	Construction of the break pressure tank at the location available may not be feasible due to unforeseen constraints e.g. planning or high cost of land due to current use	Unforeseen constraints e.g. planning or high cost of land due to current use	Proposed location is infeasible resulting in new location and possible re-routing of pipeline and/or additional costs to meet planning requirements	M	M	MEDIUM	60%	£850,000	£1,700,000	£8,500,000	£1,615,000	Cost impact is additional cost to reroute pipeline; minimum, most likely and worst case scenarios assume a % of the total pipeline length requires rerouting. Pipeline length is 100km of pipe (excluding crossings and pumping stations and includes all pipeline diameters) Total pipeline length cost (excluding crossings and pumping stations and is based on pipeline diameters above 350m) - £170,000,000 (£1,700,000 per km) Min 0.5% Most-likely 1% Max 5% % is based on risk being localised therefore significant rerouting is not expected there Risk more likely than not due to greenfield, likely to be less resistance from stakeholders but higher possibility of unforeseen ground conditions	Undertake early consultation with local authority and land owners Undertake detailed ground investigations as design progresses Undertake flood risk assessment and modelling
012	Gate 2 Western Route	Proposed pipeline route has been designed to avoid all identified environmental constraints. It is assumed that there are no stringent requirements not known and therefore not considered in the route design that could make sections of the route infeasible e.g. minimum distance between the identified environmental constraint and proposed construction works being greater than those assumed in design requiring rerouting	Pipeline route may change where requirements for working close to environmental constraints were unforeseen and more stringent than those considered in design	More stringent requirements for working near environmental constraints than those assumed in design.	Sections of pipeline route becoming infeasible requiring rerouting leading to additional costs	L	H	MEDIUM	25%	£1,700,000	£4,250,000	£8,500,000	£1,133,333	Cost of re routing at areas that impact environmental constraints; minimum, most likely and worst case scenarios assume a % of the total pipeline length requires rerouting. Pipeline length is 100km of pipe (excluding crossings and pumping stations and includes all pipeline diameters) Total pipeline length cost (excluding crossings and pumping stations and is based on pipeline diameters above 350m) - £170,000,000 (£1,700,000 per km) Min 1% Most-likely 2.5% Max 5% (Based on the vulnerability of environmental constraints as a result of proximity to the route for best and worst case scenario) Environmental constraints are known therefore risk probability is low however residual risk remains around more stringent unforeseen requirements. Distances from environmental constrains applied in design are conservative, however there are many constraints identified on the map.	Early consultations with relevant stakeholders to identify all requirements for working near environmental constraints are recommended
013	Gate 2 Eastern Route	Proposed pipeline route has been designed to avoid all identified environmental constraints. It is assumed that there are no stringent requirements not known and therefore not considered in the route design that could make sections of the route infeasible e.g. minimum distance between the identified environmental constraint and proposed construction works being greater than those assumed in design requiring rerouting	Pipeline route may change where requirements for working close to environmental constraints were unforeseen and more stringent than those considered in design	More stringent requirements for working near environmental constraints than those assumed in design.	Sections of pipeline route becoming infeasible requiring rerouting leading to additional costs	L	H	MEDIUM	25%	£1,700,000	£4,250,000	£8,500,000	£1,133,333	Cost of re routing at areas that impact environmental constraints; minimum, most likely and worst case scenarios assume a % of the total pipeline length requires rerouting. Pipeline length is 100km of pipe (excluding crossings and pumping stations and includes all pipeline diameters) Total pipeline length cost (excluding crossings and pumping stations and is based on pipeline diameters above 350m) - £170,000,000 (£1,700,000 per km) Min 1% Most-likely 2.5% Max 5% (Based on the vulnerability of environmental constraints as a result of proximity to the route for best and worst case scenario) Environmental constraints are known therefore risk probability is low however residual risk remains around more stringent unforeseen requirements. Distances from environmental constrains applied in design are conservative, however there are many constraints identified on the map.	Early consultations with relevant stakeholders to identify all requirements for working near environmental constraints are recommended
014	Gate 2 Western Route	Contaminated land - cost of disposal of contaminated land is not included in the baseline cost	Contaminated ground may be discovered during excavation and will require disposal at an additional cost to the project, given no allowance has currently been made for ground contamination	Detailed ground information along route is unavailable and current design baseline cost does not include costs for removal of contaminated land	Additional cost of disposal of contaminated land	H	H	HIGH	100%	£2,925,000	£5,850,000	£11,700,000	£6,337,500	Average of 1.5mx1.5m trench depth across 100km pipeline route (per m3 of disposal of contaminated land). Total volume = 225,00m3 Cost of disposal for hazardous waste - £260 per m3 x 225,000 Min 5% of route requiring disposal of contaminated land Most-likely 10% of route requiring disposal of contaminated land Max 20% of route requiring disposal of contaminated land This 'risk' is classified as a 'cost estimating uncertainty' which has arisen from the omissions in cost estimating methodology. Likelihood is at 100% as it is certain some amount of contaminated land will need to be disposed of	Undertake ground investigation surveys
015	Gate 2 Eastern Route	Contaminated land - cost of disposal of contaminated land is not included in the baseline cost	Contaminated ground may be discovered during excavation and will require disposal at an additional cost to the project, given no allowance has currently been made for ground contamination	Detailed ground information along route is unavailable and current design baseline cost does not include costs for removal of contaminated land	Additional cost of disposal of contaminated land	H	H	HIGH	100%	£2,925,000	£5,850,000	£11,700,000	£6,337,500	Average of 1.5mx1.5m trench depth across 100km pipeline route (per m3 of disposal of contaminated land). Total volume = 225,00m3 Cost of disposal for hazardous waste - £260 per m3 x 225,000 Min 5% of route requiring disposal of contaminated land Most-likely 10% of route requiring disposal of contaminated land Max 20% of route requiring disposal of contaminated land This 'risk' is classified as a 'cost estimating uncertainty' which has arisen from the omissions in cost estimating methodology. Likelihood is at 100% as it is certain some amount of contaminated land will need to be disposed of	Undertake ground investigation surveys
016	Gate 2 Western Route	Design of conditioning plant has taken the water design basis for the Sundon works.	Quality of water sent to Sibleys could be more corrosive than conditioning plant was designed for	Alternative source of water sent by Anglian	Additional chemical consumption costs	L	L	LOW	15%	£145,000	£290,000	£1,450,000	£68,875	Design based on Sundon water quality is robust and likelihood of alternative worse sources is low. Impact would be slight increase in chemical consumption. Within design £2.9M provision for treatment of corrosive water. Min - 5% increase in chemical consumption ML - 10% increase in chemical consumption Max - 50% increase in chemical consumption (Assumption for worst case scenario)	
017	Gate 2 Eastern Route	Design of conditioning plant has taken the water design basis for the Sundon works.	Quality of water sent to Sibleys could be more corrosive than conditioning plant was designed for	Alternative source of water sent by Anglian	Additional chemical consumption costs	L	L	LOW	15%	£145,000	£290,000	£1,450,000	£68,875	Design based on Sundon water quality is robust and likelihood of alternative worse sources is low. Impact would be slight increase in chemical consumption. Within design £2.9M provision for treatment of corrosive water. Min - 5% increase in chemical consumption ML - 10% increase in chemical consumption Max - 50% increase in chemical consumption (Assumption for worst case scenario)	
													£24,361,883		