

**PJM Generator Interconnection
X3-076 Loudoun - Meadowbrook 500 kV
825 MW Capacity / 930 MW Energy
Feasibility Study Report**

*May 2012
DMS #685559v1*

Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, §36.2, as well as the Feasibility Study Agreement between Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company.

Preface

The intent of this Feasibility Study is to determine a plan, with preliminary cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by IC. As a requirement for interconnection, IC may be responsible for the cost of constructing Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM and the underlying system. All facilities required for interconnection of a generation interconnection project must be designed to meet ITO technical specifications.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. IC is responsible for its right of way, real estate, and construction permit issues.

General

Queue project X3-076 was studied as a(n) 930 MW (825 MW of which was Capacity) injection into VEPCO system with two options. The primary option was a tap between Loudoun 500 kV and Meadow Brook 500 kV line. The secondary option was an interconnection into the Remmington 230 kV substation. Project X3-076 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Primary Option

The following contingencies resulted in overloads for the primary option:

Option 1 Impactful Contingencies	
Contingency Name	File Description
PJM17	CONTINGENCY 'PJM17' DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1 /* CNASTONE PEACHBTM 500 END
PJM67	CONTINGENCY 'PJM67' DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN CNASTONE 500 END
PJM76	CONTINGENCY 'PJM76' REMOVE MACHINE 1 FROM BUS 200034 /* PB2 END
PJM77	CONTINGENCY 'PJM77' REMOVE MACHINE 1 FROM BUS 200035 /* PB3 END
PP1EB	CONTINGENCY 'PP1EB' / NO PATH OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / 200003 BRIGHTON 500 200004 CNASTONE 500 1 END
WELTONSP _KEMPTOWN	CONTINGENCY 'WELTONSP_KEMPTOWN' DISCONNECT BRANCH FROM BUS 235634 TO BUS 235636 CKT 1 END

Network Impacts:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

X3-076 Opt. 1 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
001	N-1	PP1EB	METED	Germantown-Germantown Reactor 138 kV line	204530	204531	1	DC	94.08	95.25	ER	104	7.54
002	N-1	PJM67	PJM	EMORY GR500-Conastone 500 kV line	200101	200004	1	DC	91.8	92.49	ER	2901	124.53
003	Non	Non	PJM	EMORY GR500-Conastone 500 kV line	200101	200004	1	DC	85.54	86.44	NR	2338	130.28
004	N-1	PP1EB	METED	Germantown Reactor-Germantown 138/115 kV transformer	204531	204529	1	DC	94.08	95.25	ER	104	7.54
005	N-1	PP1EB	BG&E	Granite 2311 & 2312-North West 2311 & 2310 230 kV line	220972	220962	1	DC	92.65	93.59	ER	621	36.42
006	N-1	WELTONSP KEMPTOWN	DVP	Loudoun 500 kV-Brambleton 500 kV 500 kV line	314913	314933	1	DC	90.17	97.92	ER	2323	191.33

Multiple Facility Contingency

(Double Circuit Tower Line Contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No problems identified.

Contribution to Previously Identified OverLoads

(OverLoads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have % allocation of cost responsibility which will be calculated and reported for the Impact Study.)

X3-076 Opt. 1 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
007	N-1	PP1EB	BG&E	High Ridge 2316-Howard 2332 230 kV line	220941	220954	1	DC	119.05	119.82	ER	941	44.67
008	N-1	PJM17	PECO	Nottingham Reactor-Nottingham 230 kV line	213846	213844	1	DC	117.68	118.5	ER	627	31.75
009	N-1	PP1EB	PENELEC	Roxbury-Roxbury 138/115 kV transformer	200532	200520	1	DC	124.75	126.27	ER	138	12.99
010	N-1	PJM17	BG&E PL	Conastone-Otter Creek Switchyard 230 kV line	220963	208048	1	DC	155.49	156.56	ER	531	35.52
011	N-1	PJM17	BG&E PL	Graceton-Safe Harbor Units 3-4 Tap 230 kV line	220964	208071	1	DC	119.17	120.12	ER	485	28.78
012	N-1	PJM17	BG&E PECO	Graceton-Cooper 230 kV line	220964	214089	1	DC	164.16	165.22	ER	485	31.75
013	N-1	PP1EB	BG&E	Howard 2312-Granite 2311 & 2312 230 kV line	220953	220972	1	DC	117.43	118.3	ER	728	38.93
014	N-1	PJM17	PECO	Cooper-Peach Bottom 230 kV line	214089	213869	1	DC	161.68	162.73	ER	485	31.75
015	N-1	PJM17	PECO	Peach Bottom-Nottingham Reactor 230 kV line	213869	213846	1	DC	117.75	118.56	ER	627	31.75
016	N-1	PJM76	PJM	Conastone-Peach Bottom 500 kV line	200004	200013	1	DC	138.78	139.38	ER	281 5	133.2
017	N-1	PJM76	AP PJM	Kemptown-EMORY GR500 500 kV line	235632	200101	1	DC	131.77	135.24	ER	290 1	129.77
018	Non	Non	AP PJM	Kemptown-EMORY GR500 500 kV line	235632	200101	1	DC	146.83	150.98	NR	233 8	129.77

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

X3-076 Opt. 1 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
019	Op	PP1EB	BG&E	High Ridge 2316-Howard 2332 230 kV line	220941	220954	1	DC	115.24	115.7	ER	941	50.35
020	Op	PP1EB	BG&E	Howard 2332-Granite 2326 & 2332 230 kV line	220954	220973	1	DC	87.47	88.36	ER	728	40.1
021	Op	PJM17	PECO	Nottingham Reactor-Nottingham 230 kV line	213846	213844	1	DC	104.64	105.53	ER	627	35.79
022	Op	PP1EB	PENELEC	Roxbury-Roxbury 138/115 kV transformer	200532	200520	1	DC	155.66	156.33	ER	138	14.64
023	Non	Non	PENELEC	Roxbury-Roxbury 138/115 kV transformer	200532	200520	1	DC	105.77	107.13	NR	124	10.45
024	Op	PP1EB	METED	Germantown-Germantown Reactor 138 kV line	204530	204531	1	DC	121.42	122.74	ER	104	8.5
025	Op	PJM67	PJM	EMORY GR500-Conastone 500 kV line	200101	200004	1	DC	90.3	90.91	ER	290 1	140.38
026	Non	Non	PJM	EMORY GR500-Conastone 500 kV line	200101	200004	1	DC	89.48	90.3	NR	233 8	146.86
027	Op	PJM17	BG&E PL	Conastone-Otter Creek Switchyard 230 kV line	220963	208048	1	DC	136.34	137.56	ER	531	40.05
028	Op	PJM17	BG&E PL	Graceton-Safe Harbor Units 3-4 Tap 230 kV line	220964	208071	1	DC	119.18	119.96	ER	485	32.45
029	Op	PJM17	BG&E PECO	Graceton-Cooper 230 kV line	220964	214089	1	DC	136.84	137.44	ER	485	35.79
030	Op	PP1EB	BG&E	Howard 2312-Granite 2311 & 2312 230 kV line	220953	220972	1	DC	105.42	105.94	ER	728	43.89
031	Op	PP1EB	PENELEC METED	Carlisle Pike-Gardners 115 kV line	200504	204528	1	DC	95.79	96.67	ER	126	6.88
032	Op	PP1EB	METED	Germantown Reactor-Germantown 138/115 kV transformer	204531	204529	1	DC	121.42	122.74	ER	104	8.5
033	Op	PJM17	PECO	Cooper-Peach Bottom 230 kV line	214089	213869	1	DC	134.81	135.41	ER	485	35.79

X3-076 Opt. 1 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
034	Op	PJM17	PECO	Peach Bottom-Nottingham Reactor 230 kV line	213869	213846	1	DC	104.71	105.6	ER	627	35.79
035	Op	PJM17	PL	Safe Harbor Units 3-4 Tap- Manor Substation 230 kV line	208071	208019	1	DC	127.04	127.69	ER	579	31.51
036	Op	PP1EB	AP PENELEC	Greene-Roxbury 138 kV line	235188	200532	1	DC	103.71	104.97	ER	189	14.64
037	Op	PJM76	PJM	Conastone-Peach Bottom 500 kV line	200004	200013	1	DC	121.48	122.15	ER	281 5	150.15
038	Op	PJM77	AP PJM	Kempton-EMORY GR500 500 kV line	235632	200101	1	DC	120.31	123.84	ER	290 1	146.29
039	Non	Non	AP PJM	Kempton-EMORY GR500 500 kV line	235632	200101	1	DC	132.03	136.4	NR	233 8	146.29
040	Op	WELTONSP_ KEMPTOWN	DVP	Loudoun 500 kV-Brambleton 500 kV 500 kV line	314913	314933	1	DC	92.15	101.34	ER	232 3	215.68

Short Circuit

(Report Overduty breakers here)

Analysis found new breakers for the primary option to be over-duty in the ITO transmission area.

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With x3-076_DOM_opt1	Duty Percent Without x3-076_DOM_opt1	Duty Percent Difference	Note
314913	LOUDOUN 500.kV	H1T569	S	101.30%	96.30%	5.00%	New Over-duty
314913	LOUDOUN 500.kV	H2T558	S	101.30%	96.30%	5.00%	New Over-duty
314913	LOUDOUN 500.kV	H2T559	S	101.30%	96.30%	5.00%	New Over-duty
3070	BRAMBLETON 230.kV	2045T2095	S	100.10%	98.30%	1.80%	New Over-duty
3070	BRAMBLETON 230.kV	2094T2095	S	100.10%	98.30%	1.80%	New Over-duty

- The estimated cost to replace 3 overduty breakers H1T569, H2T558 and H2T559 at Loudoun substation with 50 kA breakers will be \$650,000 per breaker and will take 15 months including equipment order time.
- The estimated cost to replace 2 overduty breakers 2045T2095 and 2094T2095 at Brambleton substation with 63 kA breakers will be \$205,000 per breaker and will take 10 months including equipment order time.

Secondary Option

The following contingencies resulted in overloads for the secondary option:

Option 2 Impactful Contingencies	
Contingency Name	File Description
2039&2040	CONTINGENCY '2039&2040' /* LN 2039 & 2040 OPEN BRANCH FROM BUS 314063 TO BUS 314099 CKT 1 /* 2039 MORRISVILLE - MARSH RUN CT OPEN BRANCH FROM BUS 314063 TO BUS 314099 CKT 2 /* 2040 MORRISVILLE - MARSH RUN CT REMOVE MACHINE C FROM BUS 315030 /* MARSH RUN CT END
535&2114	
569&2101	CONTINGENCY '569&2101' /* OPEN BRANCH FROM BUS 314913 TO BUS 314916 CKT 1 /* OPEN BRANCH FROM BUS 314130 TO BUS 314119 CKT 1 /* BRISTER TO NOKESVILLE OPEN BRANCH FROM BUS 314119 TO BUS 314125 CKT 1 /* NOKESVILLE TO VHILL OPEN BRANCH FROM BUS 314125 TO BUS 314037 CKT 1 /* V HILL TO GAINES END
8LDYSMTH _8POSSUM _026	CONTINGENCY '8LDYSMTH_8POSSUM_026' DISCONNECT BRANCH FROM BUS 314911 TO BUS 314922 CKT 1 /* 500/500KV, AREA 345/345. END
8LOUDOUN _8MORRSVL _029	CONTINGENCY '8LOUDOUN_8MORRSVL_029' DISCONNECT BRANCH FROM BUS 314913 TO BUS 314916 CKT 1 /* 500/500KV, AREA 345/345. END
LN 2030	CONTINGENCY 'LN 2030' /* LOUDOUN - GAINESVILLE AND TX 2 & LN 172 OPEN BRANCH FROM BUS 314061 TO BUS 314037 CKT 1 /* LOUDON TO GAINESVILLE OPEN BRANCH FROM BUS 314037 TO BUS 314115 CKT 1 /* GAINESVILLE TX 2 (DVP LN 172) OPEN BRANCH FROM BUS 314037 TO BUS 314045 CKT 1 /* GAINESVILLE TX 3 TO NOVEC OPEN BRANCH FROM BUS 314115 TO BUS 314123 CKT 1 /* GAINESVILLE TO WELLINGTON DP OPEN BRANCH FROM BUS 314123 TO BUS 314157 CKT 1 /* WELLINGTON DP TO GODW172 OPEN BRANCH FROM BUS 314147 TO BUS 314157 CKT 1 /* LN 197 MICRON TO GODWIN OPEN BRANCH FROM BUS 314049 TO BUS 314147 CKT 1 /* MICR172 - LOMA172 OPEN BRANCH FROM BUS 314049 TO BUS 314159 CKT 1 /* LOMAR TX OPEN BRANCH FROM BUS 314147 TO BUS 314160 CKT 1 /* MICRON TX OPEN BRANCH FROM BUS 314147 TO BUS 314161 CKT 1 /* MICRON TX OPEN BRANCH FROM BUS 314157 TO BUS 314162 CKT 1 /* GODWIN TX END

Option 2 Impactful Contingencies	
Contingency Name	File Description
LN 2114	CONTINGENCY 'LN 2114' /* REMINGTON CT - GAINESVILLE - 230 KV OPEN BRANCH FROM BUS 314085 TO BUS 314110 CKT 1 /* REMINGTON CT TO ELK RUN CT OPEN BRANCH FROM BUS 314110 TO BUS 314037 CKT 1 /* ELK RUN CT TO GAINESVILLE END
PJM17_X3-068B	CONTINGENCY 'PJM17_X3-068B' DISCONNECT BRANCH FROM BUS 911010 TO BUS 200013 CKT 1 /* CNASTONE PEACHBTM 500 500 END
PJM67	CONTINGENCY 'PJM67' DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN CNASTONE 500 500 END
PJM76	CONTINGENCY 'PJM76' REMOVE MACHINE 1 FROM BUS 200034 /* PB2 END
PJM77	CONTINGENCY 'PJM77' REMOVE MACHINE 1 FROM BUS 200035 /* PB3 END
PP1EB	CONTINGENCY 'PP1EB' / NO PATH OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / 200003 BRIGHTON 500 200004 CNASTONE 500 1 END
WELTONSP_KEMPTOWN	CONTINGENCY 'WELTONSP_KEMPTOWN' DISCONNECT BRANCH FROM BUS 235634 TO BUS 235636 CKT 1 END

Network Impacts:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

X3-076 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
001	N-1	PP1EB	METED	Germantown-Germantown Reactor 138 kV line	204530	204531	1	DC	94.07	95.25	ER	104	7.6
002	Non	Non	PJM	EMORY GR500-Conastone 500 kV line	200101	200004	1	DC	85.53	86.44	NR	2338	131.84
003	N-1	8LOUDOUN _8MORRSV L_029	DVP	Elk Run 115 kV-Gainesville 230 kV 230 kV line	314110	314037	1	DC	92.87	117.46	ER	796	195.71

X3-076 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
004	N-1	PP1EB	METED	Germantown Reactor- Germantown 138/115 kV transformer	204531	204529	1	DC	94.07	95.25	ER	104	7.6
005	N-1	PP1EB	BG&E	Granite 2311 & 2312-North West 2311 & 2310 230 kV line	220972	220962	1	DC	92.64	93.64	ER	621	38.53
006	N-1	PJM17 _X3-068B	BG&E PL	Graceton-Safe Harbor Units 3-4 Tap 230 kV line	220964	208071	1	DC	97.44	98.43	ER	485	30.19
007	N-1	8LDYSMTH _8POSSUM _026	DVP	Bristers 500 kV-Ox 500 kV 500 kV line	314900	314919	1	DC	97.6	102.54	ER	2598	128.21
008	N-1	WELTONSP _KEMPTOW N	DVP	Loudoun 500 kV-Brambleton 500 kV 500 kV line	314913	314933	1	DC	90.11	96.19	ER	2323	151.93
009	N-1	LN 2114	DVP	Remington CT 230 kV-Marsh Run 230 kV 230 kV line	314085	314099	1	DC	34.86	102.1	ER	608	408.84

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

X3-076 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
010	DCTL	2039&204 0	DVP	Elk Run 115 kV-Gainesville 230 kV 230 kV line	314110	314037	1	DC	91.11	193.97	ER	796	818.76
011	DCTL	2039&204 0	DVP	Remington CT 230 kV-Elk Run 115 kV 230 kV line	314085	314110	1	DC	69.82	148.17	ER	1045	818.76
012	DCTL	535&2114	DVP	Remington CT 230 kV-Marsh Run 230 kV 230 kV line	314085	314099	1	DC	34.94	110.74	ER	608	460.86

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue.)

X3-076 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
013	N-1	PP1EB	BG&E	High Ridge 2316-Howard 2332 230 kV line	220941	220954	1	DC	119.05	119.86	ER	941	47.07
014	N-1	PP1EB	BG&E	Howard 2332-Granite 2326 & 2332 230 kV line	220954	220973	1	DC	100.35	101.18	ER	728	37.62
015	N-1	PJM17 X3-068B	PECO	Nottingham Reactor- Nottingham 230 kV line	213846	213844	1	DC	107.89	108.74	ER	627	32.74
016	N-1	PP1EB	PENELEC	Roxbury-Roxbury 138/115 kV transformer	200532	200520	1	DC	124.74	126.25	ER	138	12.9
017	N-1	PJM17 X3-068B	BG&E PL	Conastone-Otter Creek Switchyard 230 kV line	220963	208048	1	DC	164.81	165.92	ER	531	36.67
018	N-1	PJM17 X3-068B	BG&E PECO	Graceton-Cooper 230 kV line	220964	214089	1	DC	151.53	152.62	ER	485	32.74
019	N-1	PJM77	PJM	Conastone-X3-068 TAP 500 kV line	200004	911010	1	DC	137.83	138.39	ER	2815	135.9
020	N-1	PJM17_X3 -068B	PECO	Cooper-Peach Bottom 230 kV line	214089	213869	1	DC	149.05	150.14	ER	485	32.74
021	N-1	PJM17_X3 -068B	PECO	Peach Bottom-Nottingham Reactor 230 kV line	213869	213846	1	DC	107.96	108.8	ER	627	32.74
022	N-1	PJM17_X3 -068B	PL	Safe Harbor Units 3-4 Tap-Manor Substation 230 kV line	208071	208019	1	DC	110.36	111.17	ER	579	29.35
023	N-1	PP1EB	BG&E	Howard 2312-Granite 2311 & 2312 230 kV line	220953	220972	1	DC	117.43	118.34	ER	728	41.11
024	DCTL	569&2101	DVP	Bristers 500 kV-Ox 500 kV 500 kV line	314900	314919	1	DC	102.27	110.29	ER	2598	208.43
025	N-1	PJM67	AP PJM	Kempton-EMORY GR500 500 kV line	235632	200101	1	DC	131.73	134.67	ER	2901	122.22
026	Non	Non	AP PJM	Kempton-EMORY GR500 500 kV line	235632	200101	1	DC	147.02	147.7	NR	2338	128.01
027	N-1	LN 2030	DVP	Cannon Branch 230 kV- Prince WilliamsDel Pt 230 kV 230 kV line	314016	314117	1	DC	131.52	159.18	ER	319	88.23
028	N-1	PJM77	PJM	X3-068 TAP-Peach Bottom 500 kV line	911010	200013	1	DC	145.09	145.65	ER	2815	135.9

Short Circuit

(Report over-dutied breakers.)

Analysis found 28 new breakers for the secondary option to be over-duty in the ITO transmission area.

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With x3-076_DOM_opt2	Duty Percent Without x3-076_DOM_opt2	Duty Percent Difference	Note
890	REMINGTON CT 230.kV	2077T2086	S	125.20%	96.80%	28.40%	New Over-duty
890	REMINGTON CT 230.kV	208662	S	125.20%	96.80%	28.40%	New Over-duty
890	REMINGTON CT 230.kV	H962	S	125.00%	96.60%	28.40%	New Over-duty
890	REMINGTON CT 230.kV	H9T299	S	125.00%	96.60%	28.40%	New Over-duty
80	REMINGTON 230.kV	280T2077	S	124.80%	89.50%	35.30%	New Over-duty
891	REMINGTON S1 230.kV	SX1262	S	119.20%	93.40%	25.80%	New Over-duty
892	REMINGTON S2 230.kV	SX3462	S	119.20%	93.40%	25.80%	New Over-duty
890	REMINGTON CT 230.kV	207762	S	119.00%	90.40%	28.60%	New Over-duty
890	REMINGTON CT 230.kV	29962	S	118.90%	90.40%	28.50%	New Over-duty
891	REMINGTON S1 230.kV	GT162	S	115.70%	90.20%	25.50%	New Over-duty
891	REMINGTON S1 230.kV	GT262	S	115.70%	90.20%	25.50%	New Over-duty
892	REMINGTON S2 230.kV	GT362	S	115.70%	90.20%	25.50%	New Over-duty
892	REMINGTON S2 230.kV	GT462	S	115.70%	90.20%	25.50%	New Over-duty
314063	MORRISVILLE 230.kV	L1T2039	S	105.30%	96.60%	8.70%	New Over-duty
314063	MORRISVILLE 230.kV	L1T2040	S	105.30%	96.60%	8.70%	New Over-duty
314063	MORRISVILLE 230.kV	L2T2039	S	105.30%	96.60%	8.70%	New Over-duty
314063	MORRISVILLE 230.kV	L2T2040	S	105.30%	96.60%	8.70%	New Over-duty
3071	MARSH RUN 230.kV	29902	S	103.70%	87.90%	15.80%	New Over-duty
3071	MARSH RUN 230.kV	299T2040	S	103.70%	87.90%	15.80%	New Over-duty
3071	MARSH RUN 230.kV	28002	S	103.00%	87.80%	15.20%	New Over-duty
3071	MARSH RUN 230.kV	280T2039	S	103.00%	87.80%	15.20%	New Over-duty
3071	MARSH RUN 230.kV	203902	S	102.90%	84.60%	18.30%	New Over-duty
3071	MARSH RUN 230.kV	204002	S	102.90%	84.60%	18.30%	New Over-duty
14900	BRISTERS 500.kV	H1T539	S	100.30%	98.10%	2.20%	New Over-duty
14900	BRISTERS 500.kV	H1T545	S	100.30%	98.10%	2.20%	New Over-duty
314918	NORTH ANNA 500.kV	57302	S	100.30%	99.40%	0.90%	New Over-duty
314918	NORTH ANNA 500.kV	57502	S	100.30%	99.40%	0.90%	New Over-duty
314918	NORTH ANNA 500.kV	57602	S	100.30%	99.40%	0.90%	New Over-duty

In addition, the analysis also showed a significant fault contribution (i.e. above 3%) to six breakers for the secondary option, which were already identified as over-duty. The breakers are listed below:

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With x3- 076_DOM_opt2	Duty Percent Without x3- 076_DOM_opt2	Duty Percent Difference	Note
314916	MORRISVILLE 500.kV	SC122	S	118.80%	114.40%	4.40%	> 3% contribution
314916	MORRISVILLE 500.kV	H2T569	S	118.70%	115.30%	3.40%	> 3% contribution
314916	MORRISVILLE 500.kV	H1T573	S	115.90%	112.60%	3.30%	> 3% contribution
314916	MORRISVILLE 500.kV	H1T580	S	115.90%	112.60%	3.30%	> 3% contribution
314916	MORRISVILLE 500.kV	H2T545	S	115.90%	112.60%	3.30%	> 3% contribution
314916	MORRISVILLE 500.kV	569T580	S	106.60%	102.40%	4.20%	> 3% contribution

The estimated cost to replace two overdutied 500 kV breakers H1T539 and H1T545 at Bristers substation with 50 kA breakers will be \$650,000 per breaker and will take 14 months including equipment order time.

The estimated cost to replace three overdutied 500 kV breakers 57302, 57502 and 57602 at North Anna substation with 63 kA breakers will be \$685,000 per breaker and will take 15 months including equipment order time.

The estimated cost to replace 23 overdutied 230 kV breakers at Marsh Run, Morrisville and Remington substations with 63 kA breakers will be \$205,000 per breaker and will take 20 months including equipment order time.

Allocations to previously identified over duty breakers will be provided as part of the System Impact Study.

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

X3-076 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contributio n
	Type	Name			To	From			Before	After	Type	MVA	
029	Op	PP1EB	BG&E	High Ridge 2316-Howard 2332 230 kV line	220941	220954	1	DC	115.27	115.76	ER	941	53.06
030	Op	PP1EB	BG&E	Howard 2332-Granite 2326 & 2332 230 kV line	220954	220973	1	DC	87.47	88.41	ER	728	42.41
031	Op	PJM17 X3-068B	PECO	Nottingham Reactor-Nottingham 230 kV line	213846	213844	1	DC	103.81	104.73	ER	627	36.9
032	Op	PP1EB	PENELEC	Roxbury-Roxbury 138/115 kV transformer	200532	200520	1	DC	155.59	156.26	ER	138	14.54
033	Non	Non	PENELEC	Roxbury-Roxbury 138/115 kV transformer	200532	200520	1	DC	105.73	107.09	NR	124	10.42
034	Op	PP1EB	METED	Germantown-Germantown Reactor 138 kV line	204530	204531	1	DC	121.41	122.74	ER	104	8.57
035	Non	Non	PJM	EMORY GR500-Conastone 500 kV line	200101	200004	1	DC	89.47	90.31	NR	2338	148.62
036	Op	PJM17 X3-068B	BG&EPL	Conastone-Otter Creek Switchyard 230 kV line	220963	208048	1	DC	136.96	138.22	ER	531	41.34
037	Op	PJM17 X3-068B	BG&E PECO	Graceton-Cooper 230 kV line	220964	214089	1	DC	136.14	136.74	ER	485	36.9
038	Op	8LOUDDUN _8MORRSVL _029	DVP	Elk Run 115 kV-Gainesville 230 kV 230 kV line	314110	314037	1	DC	92.87	120.59	ER	796	220.62
039	Op	PJM77	PJM	Conastone-X3-068 TAP 500 kV line	200004	911010	1	DC	121.05	121.74	ER	2815	153.2
040	Op	PP1EB	PENELEC METED	Carlisle Pike-Gardners 115 kV line	200504	204528	1	DC	95.71	96.57	ER	126	6.7
041	Op	PP1EB	METED	Germantown Reactor-Germantown 138/115 kV transformer	204531	204529	1	DC	121.41	122.74	ER	104	8.57
042	Op	PJM17 X3-068B	PECO	Cooper-Peach Bottom 230 kV line	214089	213869	1	DC	134.11	134.71	ER	485	36.9
043	Op	PJM17 X3-068B	PECO	Peach Bottom-Nottingham Reactor 230 kV line	213869	213846	1	DC	103.88	104.8	ER	627	36.9

X3-076 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contributio n
	Type	Name			To	From			Before	After	Type	MVA	
044	Op	PJM17 _X3-068B	PL	Safe Harbor Units 3-4 Tap- Manor Substation 230 kV line	208071	208019	1	DC	115.5	116.42	ER	579	33.09
045	Op	PJM17 _X3-068B	BG&E PL	Graceton-Safe Harbor Units 3-4 Tap 230 kV line	220964	208071	1	DC	101.4	101.97	ER	485	34.03
046	Op	PP1EB	AP PENELEC	Greene-Roxbury 138 kV line	235188	200532	1	DC	103.64	104.89	ER	189	14.54
047	Op	PP1EB	BG&E	Howard 2312-Granite 2311 & 2312 230 kV line	220953	220972	1	DC	105.46	106.02	ER	728	46.34
048	Op	8LDYSMTH _8POSSUM _026	DVP	Bristers 500 kV-Ox 500 kV 500 kV line	314900	314919	1	DC	93.37	98.93	ER	2598	144.52
049	Op	PJM67	AP PJM	Kempton-EMORY GR500 500 kV line	235632	200101	1	DC	118.76	122.21	ER	2901	137.77
050	Non	Non	AP PJM	Kempton-EMORY GR500 500 kV line	235632	200101	1	DC	132.57	133.32	NR	2338	144.3
051	Op	WELTONSP _KEMPTOWN	DVP	Loudoun 500 kV-Brambleton 500 kV 500 kV line	314913	314933	1	DC	92.1	99.39	ER	2323	171.27
052	Op	LN 2114	DVP	Remington CT 230 kV-Marsh Run 230 kV 230 kV line	314085	314099	1	DC	34.86	110.66	ER	608	460.87
053	Op	LN 2030	DVP	Cannon Branch 230 kV-Prince WilliamsDel Pt 230 kV 230 kV line	314016	314117	1	DC	130.49	161.67	ER	319	99.46
054	Op	PJM76	PJM	X3-068 TAP-Peach Bottom 500 kV line	911010	200013	1	DC	128.62	129.29	ER	2815	153.2

ITO Analysis

ITO assessed the impact of the proposed queue project X3-076 interconnection as a 930 MW of energy (825 MW Capacity) injection into the ITO transmission system. The system was assessed using the summer 2015 RTEP case provided to ITO by PJM, this 825 MW capacity injection occurred at a tap point of line 535 (approximately 49.5% of length from Meadow Brook) and a secondary interconnection point was also evaluated at the Remington CT 230 kV Substation. This analysis did include the impacts of the generation capacity for all higher order queue generators within the ITO transmission system. When performing a generation analysis, ITO main analyses include load flow study results under single contingency (both normal and stressed system conditions) and import/export system conditions. ITO criterion considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. For import/export studies, ITO considers a transmission facility overloaded if it exceeded 100% of its emergency rating. A full listing of ITO planning criteria and interconnection requirements can be found in the ITO facility connection requirements, which are publicly available at: <http://www.dom.com>.

As part of its generation impact analysis ITO routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions, stress system conditions and import/export system conditions. The results of these studies are discussed in more detail below.

Primary Option:

The ITO analyzed the reliability impacts of a 825 MW capacity injection into this new 500 kV switching station. This analysis used the ITO's reliability criteria as identified in Appendix A of Dominion's Facility Connection Requirements. The results of these reliability studies have identified the following deficiencies as noted below.

1. The first being when local generation including the proposed X3-076 Facility is operated at their maximum capability. The result of this study is shown below.

None identified.

2. Critical system condition studied was no Possum Point Unit #5.

None identified.

3. The third being import and export conditions into and out of the Dominion System. Any new facility that is interconnected with the Dominion System should not significantly decrement FCITC between utilities. The results of these studies can be found in Tables A and B.

Area	Summer 2015	Summer 2015 with X3-076	Limiting Element
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

Area	Summer 2015	Summer 2015 with X3-076	Limiting Element
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

ITO planning criteria requires at least 2000 MW of import and export capability. The results of these import and export studies are indicate that the proposed generation facility will not impact ITO import or export capability.

The results of these studies evaluate the system under a limited set of operating conditions and do not guarantee the full delivery of the capacity and associated energy of this proposed generation facility under all operating conditions. NERC planning and operating reliability criteria allow for the re-dispatch of generating units to resolve projected and actual deficiencies in real time and planning studies. Specifically, NERC category C contingency conditions (N-1-1) allow for re-dispatch of generating units to resolve potential reliability deficiencies. For ITO planning criteria the re-dispatch of generating units for these contingency conditions is allowed as long as the projected loading does not exceed 115% of a facility short term emergency rating. These study results are also predicated on the Potomac-Appalachian Transmission Highline and Mid-Atlantic Power Pathway projects being in-service. Both of these projects have been put in abeyance by PJM. These projects are no longer modeled in the RTEP cases but are still required to be modeled in the queue studies. PJM will identify potential operating constraints that may prevent the proposed queue request from operating at its maximum generating capability during the system impact study phase.

Attachment Facilities:

Generation Substation: Install metering and associated Protection Equipment. Estimated Cost \$700,000. This work is estimated to take 24-30 months to complete.

Transmission Line: Construct half-mile long 500 kV Attachment line(s) between the generation substation and the proposed transmission switching station. Estimated cost \$1,500,000. This work is estimated to take 24-30 months to complete, as noted in the Attachemnt A: One-line.

Direct Connection Network Upgrades:

Create a Remington CT 500 kV Switching Station: Add three new 500 kV breakers to interconnect the proposed new generation station with line 535 (Meadow Brook to Loudoun) Attachment A: One-line. The estimated cost of this work is \$7,000,000 and take 24-30 months to complete.

Non-Direct Connection Network Upgrades:

X3-076 Opt. 1 ###	ITO	Work Description	Estimated Cost	Approximate Duration
001 002	METED	Based on an initial review, TO determined that the reactor cannot be upgraded. Therefore the apparent mitigation action will be to replace the Germantown 138/ 115 kV transformer and miscellaneous substation components.	\$5,028,600	36
	PJM	The two breaker bay at Conastone for the Brighton line is over the continuous rating. Upgrade Conastone bay with two 4000A breakers, four 4000A breaker disconnects and a 4000 A line switch need to be either.	\$3,000,000	36
003 004	PJM	Same as X3-076-1-002	already captured	already captured
	METED	Same as X3-076-1-001	already captured	already captured
005	BG&E	The overload can be alleviated by reconductoring the line with 2167 ACSR which will increase the rating to 1105 MVA. There will also be substation terminal cost upgrades associated with the reinforcement.	\$23,600,000	72
006	DVP	This is a PJM Base Line Project already. B1694. Rebuild Loudoun - Brambleton 500. Estimated inservice date 5/1/2016. Estimated Cost: \$40M.	b1694	b1694
007 008	BG&E	Rebuild line to accommodate double bundle 1272 ACSR Existing: Circuit 2332-A is 1590 kcm ACSR @ 160 deg. C Assumptions: Length of line is 8.9 miles 2+ year CPCN process required Existing tower removal included	\$24,000,000	60
	PECO	Replace Line 220-08 reactor and by-pass circuit switcher at Nottingham substation to get a minimum summer emergency rating of 741 MVA.	\$1,700,000	24
009	PENELEC	Install a standard 115kV Circuit Breaker with 3000A.	\$717,300	18
010	BG&E/PL	Otter Creek to Conastone 230 kV line 4.7 mile total rebuild 2302 to PA border to new rating 648/802. Notes: Rebuild to 230 kV single 1590 MCM conductor circuit. CPCN require adds about 18 months. A PPL project, S0233, to re-conductor Manor-Conastone with 1590 ACSR is underway. This project will equip the line to handle 653/793 MVA (Summer Normal/Emergency).	\$19,000,000	60

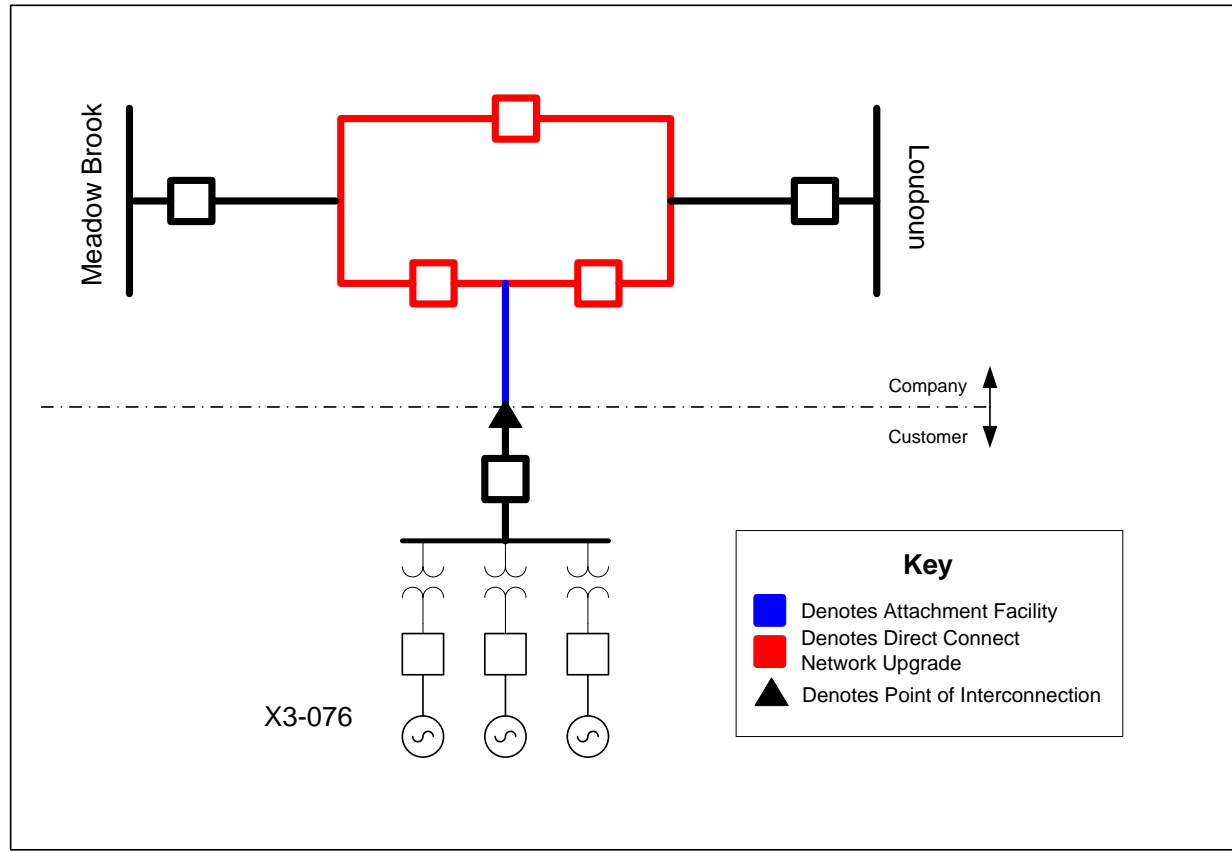
X3-076 Opt. 1 ###	ITO	Work Description	Estimated Cost	Approximate Duration
011	BG&E/PL	<p>PPL: A PPL project, S0232, to re-conductor Manor-Graceton 230 kV with 1590 ACSR is underway. This project will equip the line to handle 653/793 MVA (Summer Normal/Emergency). Estimated cost: \$22.7M. Estimated in-service date: November 2013</p> <p>BGE: Line rated 559/674. There are substation limitations at Graceton that will be removed with project b0497.</p>	s0232 b0497	s0232 b0497
012 013	BG&E/PECO	<p>PECO portion: Reconductor Line 220-93 from Cooper Substation to Graceton Substation to get a minimum summer emergency rating of 725 MVA. The line is approximately 4 miles long. This cost is for the PECO portion only.</p> <p>BGE: Upgrade: Upgrade 1.8 Mile from Graceton to the PA border. <u>230kV</u> Construct using 2167 MCM conductor. <u>Substation</u> \$400,000 to install a tie breaker into an existing bay 24 months to build.</p>	\$9,200,000	60
	BG&E	Replace wire drops and upgrade structures to achieve 825 MVA rating.	\$500,000	18
014	PECO	Reconductor Line 220-08 from PB Tap to Cooper Substation to get a minimum summer emergency rating of 741 MVA. The line is approximately 1.4 miles long.	\$1,000,000	24
015	PECO	Reconductor Line 220-08 from Nottingham Reactor to PB Tap to get a minimum summer emergency rating of 741 MVA. The line is approximately 14 miles long.	\$10,000,000	48

X3-076 Opt. 1 ###	ITO	Work Description	Estimated Cost	Approximate Duration
016	PJM	<p>BGE:</p> <ul style="list-style-type: none"> At Conastone construct a new two breaker 4000A bay (breakers D, F) with two 63 kA breakers. Includes line termination structures, allowance for a second line and the relocation of the 500kV cap bank. 36 months to complete - \$14M Construct a new 500kV line from Conastone - Peachbotton rated for a minimum of 2939/3733 SN/SE. Build 9.6 miles 500KV line from Conastone to Pennsylvania line. Purchase 150' R/W. Total for project \$46.8 million 5-7 years <p>PECO:</p> <ul style="list-style-type: none"> Replace existing Peach Bottom-Conastone 500kV Line (5012) terminal equipment at Peach Bottom Substation to match the conductor summer normal and emergency rating of 2920 / 3707 MVA (PECO portion only)- \$5 million, 3 years Build new second Peach Bottom-Conastone 500kV Line on separate towers from existing 5012 Line with a minimum summer emergency rating of 3510 MVA (PECO portion only)- \$20 million, 5 years [Right-of-way costs are not included] 	\$85,800,000	84
017	AP/PJM	Same as X3-076-1-002	already captured	already captured
018	AP/PJM	Same as X3-076-1-002	already captured	already captured
THERMAL NON-DIRECT CONNECTION NETWORK UPGRADE COSTS			\$183,545,900	84

Primary Option Contingency OverLoad Summary:

Option 1														
Contingency	Overloads Identified													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Non	003	018	023	026	039									
PJM17	008	010	011	012	014	015	021	027	028	029	033	034	035	
PJM67	002	025												
PJM76	016	017	037											
PJM77	038													
PP1EB	001	004	005	007	009	013	019	020	022	024	030	031	032	036
WELTONSP _KEMPTOWN	006	040												

Primary Option One-Line:



Secondary Option:

ITO analyzed the reliability impacts of a 825 MW capacity injection into the existing 230 kV Remington CT Substation. This analysis used the ITO's reliability criteria as identified in Appendix A of ITO Facility Connection Requirements. The results of these reliability studies have identified the following deficiencies as noted below.

1. The first being when local generation including the proposed X3-076 Facility is operated at their maximum capability. The result of this study is shown below.

An outage of Line #2114 overloads Line #299(Remington CT to Marsh Run) by 3% of its STE Rating of 608 MVA.

2. Critical system condition studied was no Possum Point Unit #5.

An outage of Line #2114 overloads Line #299(Remington CT to Marsh Run) by 3% of its STE Rating of 608 MVA.

3. The third being import and export conditions into and out of the Dominion System. Any new facility that is interconnected with the Dominion System should not significantly decrement first contingency incremental transfer capability between utilities. The results of these studies can be found in Tables A and B.

Area	Summer 2015	Summer 2015 with X3-076	Limiting Element
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

Area	Summer 2015	Summer 2015 with X3-076	Limiting Element
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

ITO planning criteria indicates a need to have approximately 2000 MW of import and export capability. The results of these import and export studies are indicate that the proposed generation facility will not impact ITO import or export capability **Note the results for the studies with X2-082 included are based on the proposed reliability deficiencies noted below. Since facilities are overloaded for single contingency conditions the first contingency incremental transfer would be negative without the inclusion of these proposed solutions.

The results of these studies evaluate the system under a limited set of operating conditions and do not guarantee the full delivery of the capacity and associated energy of this proposed generation facility under all operating conditions. NERC Planning and Operating Reliability Criteria allow for the re-dispatch of generating units to resolve projected and actual deficiencies in real time and planning studies. Specifically NERC Category C Contingency Conditions (N-1-1) allow for re-dispatch of generating units to resolve potential reliability deficiencies. For Dominion Planning Criteria the re-dispatch of generating units for these contingency conditions is allowed as long as the projected loading does not exceed 115% of a facility STE Rating. These study results are also predicated on the PATH and MAPP Projects being in-service. Both of these projects have been permanently deferred by PJM. These projects are no longer modeled in the RTEP Cases but are still required to be modeled in the Queue Studies. PJM will identify potential operating constraints that may prevent the proposed queue request from operating at its maximum generating capability during the system impact study phase.

Required Non-Direct Connect Network Upgrades:

Reconductor the approximately two mile long Line #299 at an estimated cost of \$1,000,000 and the approximate time to construct is 24 months.

Required Interconnection Facilities:

Attachment Facilities:

Generation Substation: Install metering and associated protection equipment for an estimated cost of \$700,000. This work will take approximately 24 to 30 months to complete.

Transmission Line: Construct half-mile long 230 kV Attachment Facility line(s) between the generation substation and the existing Remington CT transmission switching station for an estimated cost \$1,000,000. This work will take approximately 24 to 30 months to complete (see Attachment B: One-Line).

Direct Connection Network Facilities:

Remington CT 230 kV Switching Station: Add one new 230 kV breaker to interconnect the proposed new generation station to the Remington CT 230 kV Switching Station as depicted in Attachment B: One-Line. The estimated cost and duration of this work is \$1,500,000 and 24-30 months.

Secondary Option Contingency OverLoad Summary:

Option 2															
Contingency	Overloads Identified														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2039&2040	010	011													
535&2114	012														
569&2101	024														
8LDYSMTH _8POSSUM _026	048	007													
8LOUDOUN_8MORRSVL _029	038	003													
LN 2030	027	053													
LN 2114	009	052													
Non	002	026	033	035	050										
PJM17_X3-068B	006	015	017	018	031	036	037	042	043	044	045	020	021	022	
PJM67	025	049													
PJM76	054														
PJM77	019	028	039												
PP1EB	001	004	005	013	014	016	023	029	030	032	034	040	041	046	047
WELTONSP_KEMPTOWN	008	051													

Secondary Option One-Line:

