deployed from a gantry system into the discharge water from each unit. Four flowmeters were positioned at the mouth of the net. Sample volume was determined by taking the average reading of the four flowmeters.

Tautog and cunner were the predominant species entrained at the egg stage (Tables 4-3 and 4-5). Anchovy, winter flounder, Atlantic menhaden, American sand lance, and grubby were the predominant species entrained as larvae from 1976 through 2003 (Tables 4-3 and 4-4). Data from the most recent sampling period are shown separately in Table 4.3 to highlight substantial differences in entrainment of anchovy and Atlantic menhaden compared to the long-term average. Winter flounder was the second most common species entrained by Millstone operations from 1976 through 2003 (Table 4-3), varying from 2.9×10^7 (1977) to just under 5.0×10^8 (1992) larvae (Table 4-4). Dominion conservatively assumed 100-percent mortality for entrained organisms, which is consistent with EPA's entrainment mortality assumption (EPA 2004a).

Population abundances of important species subject to entrainment at Millstone (Section 2.2.5.5) were compared to regional trends to determine if entrainment mortality was significantly impacting local or regional populations. For anchovy, Atlantic menhaden, and American lobster, population trends observed near the plant were similar to regional trends. For American sand lance, cunner, and tautog, population abundances at Millstone varied without trend, and no apparent relationship existed between abundances observed at Millstone and regional trends. Regional data were not available for grubby, but the population has varied without trend in the vicinity of Millstone. For most species, distribution and spawning occurred throughout the region and was not confined to Millstone or other specific locations in Long Island Sound. Two species, cunner and tautog, appear to maintain relatively small home ranges, and there is evidence to suggest that tautog exhibit some degree of spawning site fidelity. Both species have exhibited apparent declines in regional populations, but abundance estimates near the plant appear to vary without trend. Winter flounder populations in the vicinity of the plant also reflected regional abundance trends. However, winter flounder differ from other important species, in that winter flounder exhibits natal stream fidelity. Localized impacts to this species during spawning and larval growth could dramatically influence local population dynamics.

Since the 1970s, Dominion has examined many aspects of winter flounder population abundance and biology, attempted to determine the direct impacts associated with plant operations, and compared the plant-related impacts to other adverse impacts on the species (Dominion 2002a; 2003a; 2004b). In addition to sampling larvae at the plant discharges, Dominion has conducted extensive surveys of adult, juvenile, and larval winter flounder abundance in the Niantic River and in areas near the Millstone site. Dominion's winter flounder monitoring program has identified a steady decline in adult winter flounder in the Niantic River

since approximately 1982 (Dominion 2004b), but noted in the ER (Dominion 2004a) that this trend has also been observed in Long Island Sound in areas beyond the influence of Millstone operations.

Table 4-3. Percent Composition of Fish Larvae Collected at the Millstone Discharges from June 1976 through May 2002 and Fish Eggs from 1979 Through 2001 (April Through September Inclusive) Compared to the Percent Composition of Fish Larvae Taken During June 2002 Through May 2003 and Fish Eggs During April Through September 2002[a]

Scientific Name	Common Name	1976 to 2002 larvae (%)	2002 to 2003 larvae (%)	1979 to 2001 eggs (%)[b]	2002 eggs (%)[b]
Anchoa spp.	anchovy	44.5	1.5	4.7	<0.1
Pseudopleuronectes americanus	winter flounder	14.2	10.8	-	-
Brevoortia tyrannus	Atlantic menhaden	10.3	74.8	-	-
Ammodytes americanus	American sand lance	7.0	0.8	-	-
Myoxocephalus aenaeus	grubby	5.7	3.9	-	-
Pholis gunnellus	rock gunnel	2.7	1.7	-	-
Tautoga onitis	tautog	2.4	1.8	27.8	24.8
Tautogolabrus adspersus	cunner	2.4	0.3	53.7	52.3
Enchelyopus cimbrius	fourbeard rockling	1.5	0.2	-	-
Liparis spp.	snailfish	1.1	0.1	-	-
Ulvaria subbifurcata	radiated shanny	1.1	<0.1	-	-
Clupea harengus	Atlantic herring	1.0	1.0	-	-
Syngnathus fuscus	northern pipefish	0.9	0.2	-	-
Scophthalmus aquosus	windowpane	0.7	0.2	-	-
Peprilus triacanthus	butterfish	0.7	0.1	-	-
Gobiidae	goby	0.7	0.6	-	-
—	Other/not identified	3.1	2.0	13.8	22.9

Source: Dominion 2004b
(a) data from 2002 to 2003 (larvae) and 2002 (eggs) are shown separately due to substantial differences in entrainment of anchovy and Atlantic menhaden compared to the long-term averages.
(b) eggs were only positively identified for tautog, cunner, and anchovy; all other eggs went into the other/not identified category

Table 4-4. Estimated Number of Anchovy, Winter Flounder, American Sand Lance, Grubby, Atlantic Menhaden, and American Lobster Larvae Entrained Each Year from 1976 Through 2003 at Millstone and the Volume of Cooling Water on Which the Entrainment Estimates Were Based

	Anchovy		Winter flounder		American sand lance[a]		Grubby		Atlantic menhaden		American Lobster	
Year	No. Entrained ($\times 10^6$)	Sample Volume[b] ($m^3 \times 10^6$)	No. Entrained ($\times 10^6$)	Sample Volume ($m^3 \times 10^6$)	No. Entrained ($\times 10^6$)	Sample Volume ($m^3 \times 10^6$)	No. Entrained ($\times 10^6$)	Sample Volume ($m^3 \times 10^6$)	No. Entrained ($\times 10^6$)	Sample Volume ($m^3 \times 10^6$)	No. Entrained ($\times 10^6$)	Sample Volume ($m^3 \times 10^6$)
1976	381	738	121	629	-	-	-	-	3	796	-	-
1977	418	821	29	444	81	954	30	489	2	773	-	-
1978	165	912	80	390	176	709	11	554	3	621	-	-
1979	805	786	44	343	110	919	20	546	<1	716	-	-
1980	877	633	168	562	111	960	32	699	2	643	-	-
1981	1452	860	45	373	74	620	42	408	2	711	-	-
1982	451	635	164	638	27	932	48	648	14	743	-	-
1983	623	691	211	541	30	902	54	628	19	564	-	-
1984	169	801	84	508	18	835	38	524	4	557	0.074	182
1985	693	697	80	469	8	712	35	527	44	521	0.123	245
1986	1096	1208	123	1064	4	1577	53	844	5	1217	0.548	640
1987	119	1332	165	1193	30	1712	51	1144	2	893	0.384	407
1988	386	1790	184	1173	74	1291	112	1132	6	791	0.577	804
1989	518	1445	167	889	42	1511	67	857	208	1420	0.379	540
1990	981	1483	133	1174	39	1607	47	998	33	1367	0.559	748
1991	451	899	116	750	7	1278	31	760	56	802	0.284	542
1992	157	1091	492	1076	19	1302	76	1293	51	1220	0.6	450
1993	214	1221	42	1387	46	1801	51	1157	21	1126	0.374	346
1994	507	1033	173	920	58	899	58	843	66	868	0.065	715
1995	171	896	214	1006	90	1532	57	996	86	997	0.659	476
1996	24	138	51	472	18	729	41	467	23	92	0.019	53
1997	17	145	76	173	3	212	28	154	5	135	0.001	52
1998	64	480	84	358	11	440	22	300	33	615	0.125	245
1999	157	1119	146	748	14	860	49	620	124	1377	0.595	238
2000	75	875	333	1003	88	1459	47	754	466	1571	0.327	452
2001	26	1031	377	963	13	1008	178	721	143	908	0.181	605
2002	28	881	119	880	6	760	33	875	1454	1088	0.243	403
2003	-		434	1096	19	725	153	890	-	-	0.115	490

Source: Dominion 2004b

(a) Annual reporting year begins on December 1.

(B) Volume was determined from the condenser and service cooling-water flows at Millstone during the season of occurrence for each taxon.

Table 4-5. Estimated Number of Cunner, Tautog, and Anchovy Eggs Entrained Each Year from 1979 Through 2001 at Millstone and the Volume of Cooling Water on Which the Entrainment Estimates Were Based

	Cunner		Tautog		Anchovy	
Year	No. entrained ($\times 10^6$)	Sample Volume ($m^3 \times 10^6$)[a]	No. entrained ($\times 10^6$)	Sample Volume ($m^3 \times 10^6$)[a]	No. entrained ($\times 10^6$)	Sample Volume ($m^3 \times 10^6$)[a]
1979	1055	423	445	680	323	383
1980	1640	677	962	773	87	359
1981	1535	620	1353	620	285	583
1982	2074	755	1248	719	210	501
1983	1888	462	1019	627	411	377
1984	2089	532	1302	569	883	453
1985	2809	737	1717	774	26	441
1986	2855	1795	3747	1795	523	772
1987	4082	1713	3575	1713	31	740
1988	4294	1800	2693	1800	15	905
1989	4306	1436	3001	1510	5	632
1990	3634	1689	2100	1641	27	724
1991	4116	1223	1513	1214	105	538
1992	2648	1509	1341	1509	18	648
1993	5379	1492	2048	1492	225	626
1994	6099	1381	1989	1381	175	867
1995	5524	1198	2481	1198	29	737
1996	871	256	312	256	4	114
1997	569	185	105	134	<1	92
1998	577	718	494	709	47	376
1999	1963	1222	1173	1222	1	339
2000	4800	1254	2149	1369	<1	849
2001	4339	1416	3015	1416	8	635
2002	3340	1188	2040	1188	<1	750

Source: Dominion 2004b

(a) Volume was determined from the condenser cooling-water flow at Millstone during the season of occurrence for each taxon.

Dominion used mathematical models to place the Millstone entrainment monitoring data in the context of total Niantic River winter flounder larval production and population trends. Dominion developed a mass-balance model to estimate the fraction of Niantic River winter flounder production entrained annually by Millstone operations. The mass-balance model's results were used as inputs to a stochastic population dynamics model, which was used to examine long-term impacts of Millstone operation on the Niantic River winter flounder stock. The model was run under several scenarios that varied fishing rate (no fishing or current fishing rate) and entrainment levels (none, low, medium, and high). The predicted biomass in 2025 was about 58,000 kilograms (kg) (128,000 pounds [lb]) under the scenario of no fishing and no entrainment. When fishing pressure was added (no entrainment), the predicted biomass dropped to 4900 kg (10,800 lb), which represents a reduction of 92 percent of the biomass under the no fishing / no entrainment scenario. When entrainment was added with fishing pressure, the predicted biomass in the year 2025 was reduced to 2800, 2300, and 1050 kg (6170, 5070, and 2310 lb) under low, medium, and high entrainment scenarios. This represents a 43 to 79 percent reduction in biomass compared to the fishing / no entrainment scenario. The modeling did not include an entrainment / no fishing scenario.

Dominion (2004b) estimated that Niantic River winter flounder entrainment ranged from 3.8 to 53 percent of larval production over the past 20 years of monitoring. Similarly, Dominion estimated that entrainment averaged 35 percent of winter flounder larval production between 1999 and 2003, with a range of 17.8 to 53 percent. Dominion (2004b) stated that the higher estimated entrainment of 53 percent in 2003 is unreliable due to the lack of an estimate of natural larval mortality. Because natural mortality for winter flounder larvae affects population independently of Millstone operations, it is an important input in the mass-balance model.

To validate the Niantic River winter flounder larvae entrainment estimates from the mass-balance model, Dominion retained Dr. Joseph Crivello of the University of Connecticut to determine, through a different analytical method, the likely source populations (Niantic, Thames, and Connecticut rivers) of winter flounder larvae entrained at Millstone (Crivello 2003). Dominion then compared its model estimates to those derived by Crivello (2003), who used genetic identification techniques for two sample periods. During 2001, the mass-balance model predicted 19.7 percent entrainment of Niantic River winter flounder larvae; Crivello (2003) predicted 21.9 percent. In 2002, the model predicted 13.8 percent entrainment compared to Crivello's prediction of 12.3 percent. The close agreement of these independent estimates derived from different analyses suggests that, at least for the years examined, the mass-balance model entrainment estimates were valid.

The percentage of water entrained by Millstone operations also supports the validity of the mass-model estimates of the fraction of Niantic River winter flounder production entrained annually by Millstone operations. Millstone Units 2 and 3 have rated circulating water flows of 34.6 m^3/s (1220 ft^3/s) and 56.6 m^3/s (2000 ft^3/s), respectively, but cooling-water use is determined by plant operating conditions or the need to take units off line for scheduled or

unscheduled maintenance. According to Dominion (2004a), the mean tidal flow in Twotree Channel is approximately 3400 cubic meters per second (m^3/s) (120,000 cubic feet per second [ft^3/s]). Tidal flow in Niantic Bay is estimated to be 2830 m^3/s (100,000 ft^3/s). The percent of Twotree Channel and Niantic Bay tidal flows entrained by Millstone operations ranged from 1 to 4 percent, with the lowest water entrainment (less than 2 percent) associated with extended plant shutdowns in 1996 to 1999. Dominion (2004a) estimates that the fraction of Niantic River flow withdrawn by Millstone is approximately 15 percent.

Dominion (2004b) interprets the relatively consistent larval abundance (based on monitoring and the mass-balance model) versus the trend of lower juvenile abundance as an indication that recruitment failure is probably related to high mortality associated with factors other than entrainment. Dominion (2004b) suggests that a "bottleneck" in the ecosystem is preventing nonentrained, late-stage larvae and subsequent juveniles from reaching reproductive maturity. This bottleneck may be attributable to the presence of predators at critical stages of winter flounder development, the impact of water temperature, the presence of aqueous constituents (anthropogenic or natural) that exert acute or sublethal toxic impacts, or other unknown factors.

Dominion (2004b) provided two additional theories to support the hypothesis that entrainment is not the primary cause of winter flounder decline. First, the extended shutdowns of Units 2 and 3 during 1997 to 1999 did not result in markedly stronger year classes or enhanced recruitment of adult winter flounder associated with the Niantic River. Second, regional winter flounder populations are declining.

Dominion suggests that a compensatory mechanism is responsible for the high observed larval entrainment in recent years despite low abundance of Niantic River winter flounder spawners. The applicant believes that the high abundance of newly hatched larvae could be due to increased egg survival from decreased predation on eggs or increased fecundity of spawner females at the lower population size. Higher abundance of later-stage larvae could be due to lower mortality at both lower population density and decreased mortality associated with warmer spring temperatures.

Dominion (2004b) suggests that there are many factors adversely influencing winter flounder, including fishing pressure, regional water temperature increases, the presence or absence of predators at critical life stages, the acute or sublethal impacts caused by the presence of natural or anthropogenic constituents, and natural population fluctuations that may independently exist. Based on its monitoring, model analyses, and the 316(b) determination in the current NPDES permit, Dominion concluded that the impacts of entrainment "do not require mitigation beyond those measures that are required by the NPDES permit, as periodically amended" (Dominion 2004a).

The CTDEP has expressed an ongoing concern with entrainment impacts associated with Millstone operations, particularly for Niantic River winter flounder. The agency is in agreement

with the applicant that multiple factors, including overfishing, environmental changes related to regional temperature increases, and entrainment impacts from Millstone operations have contributed to the decline of the Niantic River winter flounder population. The area of disagreement between the applicant and the CTDEP involves the extent to which each factor has contributed to the decline of Niantic River winter flounder. The CTDEP believes that Millstone is having a significant impact on the Niantic River winter flounder due to entrainment of winter flounder larvae. Crecco (2003) claims that although the abundance of one-year-old age class and adult (ages 4+) Niantic River winter flounder declined steadily from 1991 to 2001, similar declines have not occurred in Long Island Sound, indicating that some factor specific to the Niantic River (i.e., entrainment) has resulted in recruitment failure in the Niantic River.

The CTDEP has noted that the recent high larval entrainment estimates for Niantic River winter flounder do not reflect the marked reduction in the number of female winter flounder that spawn in the Niantic River and the correspondingly reduced estimates of Niantic River winter flounder egg production. CTDEP staff does not agree with the applicant's assertion that the apparent incongruence in entrainment estimates and population trends is due to a compensatory mechanism that results in increased survival of early life stages at low spawner abundance. A CTDEP contractor reviewed and evaluated the mass-balance model used by Dominion to estimate Niantic River winter flounder entrainment. Specifically, CTDEP staff was concerned that the high Niantic River winter flounder larval entrainment estimates were due to the violation of one or more of the model's assumptions (Greig et al. 2002).

The review concluded that the recent high-entrainment estimates for Niantic River winter flounder are the result of assessments of in-river larval abundance that are possibly inaccurate due to intrusion of non-Niantic River larvae into the river, and larval sampling in preferred spawning areas or areas where larvae are concentrated by currents (Greig et al. 2002). The study also concluded that additional overestimation of Niantic River winter flounder larval entrainment resulted from the approach used in the mass-balance model for estimating larval densities in Niantic Bay. In addition, Greig et al. (2002) examined current patterns in the Niantic Bay and suggested that assumptions in the model related to predicting entrainment based on transport of larvae through the zone of entrainment are incorrect. Based on these findings, Greig et al. (2002) questioned the utility of the mass-balance model input data for understanding the impact of entrainment on Niantic River winter flounder. Dominion responded to the report with detailed comments addressing these points and other issues raised in the review (Dominion 2002b; 2003b).

In a subsequent report written by CTDEP staff, Crecco (2003) asserts that the lack of relationship between late-stage larval and juvenile abundance indices in the river and future recruitment of Niantic River winter flounder supports the hypothesis that larval abundance indices for the Niantic River are highly biased due to the influx of non-Niantic River flounder larvae. Based on a Ricker-type stock recruitment model developed by CTDEP staff (Crecco 2003), entrainment levels for Niantic River winter flounder were estimated at 40 to

50 percent from 1977 to 1997 (compared to Millstone's estimate of 14 percent for the same time period). The licensee presented counter arguments by citing Crivello's work that relied on genetic markers to validate the origins of the larvae (Crivello 2003). Crecco (2003) further asserts that the persistently low recruitment levels during time periods in which Millstone was shut down are consistent with the presence of critical depensation, a situation in which the spawning stock size has fallen below some critical level and can no longer successfully recruit new fish to the population.

NOAA Fisheries staff concurs with the applicant and CTDEP staff that Niantic River winter flounder are being impacted by overfishing, environmental changes related to regional temperature increases, and entrainment from Millstone operations. NOAA Fisheries staff believes that significant impacts from entrainment at Millstone are likely occurring due to the high volume of cooling water entrained through the cooling system, the number of larvae entrained, and the location of plant intakes in relation to current flowing out of the Niantic River. NOAA Fisheries staff emphasized that there is considerable uncertainty surrounding winter flounder life history, which has made it difficult to evaluate how the population is being impacted by various stressors. Nevertheless, NOAA Fisheries staff does not believe that the compensatory mechanism suggested by Dominion is likely to occur in prey species such as winter flounder. In addition, based on research conducted by NOAA Fisheries scientists, there is some evidence of offshore reproduction for winter flounder, which suggests that the assumption of natal stream fidelity might not always be true.

In order to assess the impacts of entrainment associated with Dominion activities, NRC staff reviewed the applicant's ER, annual monitoring data, and pertinent peer-reviewed journal articles written or co-authored by Dominion staff. NRC staff also consulted with CTDEP and NOAA Fisheries, and interviewed Crivello at the University of Connecticut concerning the fish genetics work he had performed as a consultant to Dominion. Crivello also provided peer-reviewed journal articles summarizing his work.

NRC staff adopted a weight-of-evidence approach consistent with Menzie et al. (1996) to evaluate the information. NRC staff identified the survival and sustainability of the Niantic River winter flounder as the primary assessment endpoint (AE) of interest, with an AE defined by Menzie as an "explicit expression of the environmental value to be protected." NRC staff also identified five general categories of measurement endpoints (MEs), which Menzie defines as "lines of evidence used to evaluate the assessment endpoint." These MEs included studies of regional fish population trends (primarily as recreational or commercial catch data), local fish population assessments near the power plant, larval sampling near the power plant, genetic investigations of the origin of entrained larvae, and entrainment modeling. The identified MEs produced 10 relevant lines of evidence that addressed, to some extent, the impact of Dominion activities on winter flounder survival and sustainability. Each line of evidence was evaluated to determine its overall use and utility in supporting the primary AE, by considering 11 attributes that included the strength of association between the ME and AE, site specificity, impact

specificity, ability of the ME to judge environmental harm, temporal and spatial representativeness, and other attributes described by Menzie et al. (1996). By evaluating each line of evidence relative to the attributes, it was possible to develop a semi-quantitative assessment of the overall use and utility of each ME relative to the primary AE. NRC staff then examined the different MEs for their level of agreement with and strength of support for the different positions presented by the applicant, CTDEP, NOAA Fisheries, and independent research.

The CTDEP has based its assessment of Millstone's impacts primarily on a comparison of local (Niantic River) winter flounder trends to regional trends, with the assertion that the local decline has been more severe than the regional decline. In contrast, Dominion cites the similarity in local versus regional trends in winter flounder as evidence that Millstone is not having a significant impact on the population (Dominion 2004b). NRC staff examined various data sources (see section 2.2.5) and did not detect enough difference between trends in the local and regional abundance data to conclude with certainty that the discrepancy is significant. NRC staff noted that the apparent differences in trends shown graphically in Crivello (2003) become much less discernable when data from the same time periods are compared, particularly for adult flounder (age 4+). NOAA Fisheries has concluded that the Southern New England/Mid-Atlantic stock of winter flounder is overfished and overexploited (NOAA 1998; NOAA 2003) and has instituted measures to reduce fishing pressure throughout Long Island Sound and the Southern New England/Mid-Atlantic region. Thus, there is ample evidence to suggest that fishing pressure is directly contributing to the decline of the stock and may represent the major impact to this resource. The extent to which Dominion contributes to or exacerbates the problem in the Niantic River system is not elucidated by fish population studies reviewed in this SEIS.

Associations have also been made between the timing of Millstone operations and local trends in winter flounder. Greig et al. (2002) note that a shift occurred in the Niantic River winter flounder in or around 1991, approximately four years after the commissioning of Unit 3. The four-year time interval is relevant because it represents the lag between larval stages vulnerable to entrainment and reproductive maturity for females in a cohort. Dominion noted that Unit 3 went online in 1986, not four, but rather five years before 1991, which weakens the association somewhat. Dominion also pointed out that the fishing mortality rate increased substantially in 1983 and peaked in the early 1990s, and that spawner abundance in 1984 (two years before Unit 3 startup) was approximately half the levels seen from 1976 to 1983 (Dominion 2003b). Dominion (2001a) noted that there was no large change in the abundance of adult Niantic River winter flounder following the retirement of Unit 1 in 1995 or the larger, temporary shutdowns of Units 2 and 3 in 1996–1998. Crecco (2003) attributes the lack of positive response of the Niantic River winter flounder to reduced entrainment and reduced fishing pressure during the 1996–1998 time period as further evidence of critical depensation. As discussed earlier, Dominion attributes recruitment failure to a "bottleneck" that reduces recruitment of postentrainment early life stages. NRC staff acknowledges that both

compensatory and depensatory mechanisms are possible for the Niantic River winter flounder, but that the mechanisms are hypothesized rather than having been directly observed or measured. It also cannot be ruled out that depensatory and compensatory processes are occurring simultaneously at different life stages.

Entrainment models developed by Dominion and the CTDEP do not agree on the fraction of Niantic River winter flounder larval production that is entrained. However, the only recent entrainment estimates for Units 2 and 3 operation that are available for this review are based on the mass-balance model developed by Dominion. NRC staff reviewed the CTDEP critique of the model (Greig et al. 2002) and the subsequent response from Dominion (Dominion 2003b), and concluded that the model provided the best available estimate of entrainment, particularly considering the corroboration for two separate years provided by Crivello (2003). Although NRC staff acknowledges that CTDEP staff finds the high entrainment estimates produced by the model to be implausible given low spawner abundance, NRC staff has not found sufficient evidence in this review to warrant eliminating from consideration the information provided by the model. NRC staff notes further that the mass-balance model is conservative in that it tends to overestimate larval entrainment.

The stochastic population dynamics model used by Dominion to predict Niantic River winter flounder biomass under various scenarios suggests that fishing has a much greater impact on the population than entrainment. However, the value chosen for the medium entrainment scenario (14.2 percent) was derived by averaging annual estimates of entrainment since 1986 (excluding 1996 to 1998 due to extended shut-down periods and 2000 due to incomplete data). NRC staff has noted that the average annual entrainment estimate for recent years under Units 2 and 3 operation (1999 to 2003, excluding 2000) was 30.6 percent, compared to 14.2 percent for earlier years under three-unit operation (1986 to 1995). Although increasing the input values for entrainment would increase the predicted impact from entrainment, the magnitude of the increase is unknown. Further, NRC staff notes that the modeling did not include a scenario of entrainment without fishing pressure.

4.1.1.2 Assessment of Impact

The staff's evaluation of past impacts of entrainment on Niantic River winter flounder is inconclusive because unresolved questions remain about population dynamics, life history, and unknown factors that may be impacting the population. The available data do not allow the staff to unequivocally link or decouple population declines with Millstone operations. A better understanding of environmental factors that seem to be affecting the mortality rates for late-stage larvae is needed. Until spawning success can be correlated with particular year classes, assignment of impact to various contributors is speculative.

The staff concludes that the impact of entrainment on species other than winter flounder is not detectable. Abundance trends for most important fish and shellfish species (anchovy, Atlantic

menhaden, American lobster, American sand lance, cunner, and tautog) were similar between the Millstone area and the region. Regional abundance data were not available for grubby, but the local abundance did not show a decline. Cunner and tautog have exhibited apparent declines in regional abundance, but abundance estimates near the plant appear to vary without trend. Regardless of cause, the Niantic River winter flounder spawning population appears to have reached critically low levels and to be highly vulnerable to collapse. Poor recruitment success due to unknown causes is a contributing factor in the decline, but there is large uncertainty regarding the extent of the impact from Millstone operations. Because the spawning adult population is very low, and in consideration of the 20-year license renewal period, the staff's conclusion is that the impacts of entrainment would be MODERATE.

During the course of the SEIS preparation, the staff considered mitigation measures for the continued operation of Millstone, Units 2 and 3. Dominion and CTDEP are discussing mitigation measures as part of the NPDES permit renewal application. Mitigation options being discussed include the following: reducing intake flow during the winter flounder spawning season; performing regular inspection, maintenance, and refueling during the spawning season; importing fish into the Niantic Bay; installing fine mesh screens at the intake structures; and installing cooling towers. CTDEP is responsible for the review and issuance of NPDES permits in Connecticut and also responsible for implementation of the CWA in Connecticut. The NRC does not have authority over matters concerning discharge permits or compliance with the CWA. The NRC, however, recommends that before any significant mitigation is implemented at Millstone to lessen the impact on winter flounder, a thorough understanding of the causes for the unusually poor recruitment of juveniles is necessary. This understanding can only be obtained through the implementation of a detailed study to determine the reasons behind the "bottleneck" or significant loss of early post-entrainment life stages from causes other than entrainment by Millstone. Until fishery resource managers are able to correlate spawning success with recruitment, any mitigation may not result in any improvement in the Niantic River winter flounder population size. The staff expects that any measures identified in the NPDES permitting process will provide mitigation for impacts related to entrainment. Any mitigation measures imposed by the state of Connecticut as a result of the ongoing NPDES permit review would be expected to reduce entrainment losses to winter flounder and lessen the impact of plant operations on the Niantic River winter flounder.

4.1.2 Impingement of Fish and Shellfish

For power plants with once-through heat-dissipation systems, impingement of fish and shellfish on debris screens of cooling-water systems associated with nuclear power plants is considered a Category 2 issue, requiring a site-specific assessment before license renewal. The staff visited the site, consulted with regulatory agencies, and independently reviewed the applicant's ER, NPDES permit, and impingement studies submitted to the CTDEP.

Section 316(b) of the CWA requires that the location, design, construction, and capacity of cooling-water intake structures reflect the best technology available for minimizing adverse environmental impacts. Impingement of fish and shellfish on the debris screens of the cooling-water intake system is a potential adverse environmental impact that can be minimized by use of the best available technology.

On July 9, 2004, EPA published a final rule in the Federal Register (69 FR 41575) addressing cooling-water intake structures at existing power plants whose flow levels exceed a minimum threshold value of 189 million L/d (50 million gpd) (EPA 2004b). The rule is Phase II in EPA's development of 316(b) regulations that establish national requirements applicable to the location, design, construction, and capacity of cooling-water intake structures at existing facilities that exceed the threshold value for water withdrawals. The EPA requirements, which are implemented through NPDES permits, are designed to minimize the adverse environmental impacts associated with the continued use of the intake systems. Licensees will be required to demonstrate compliance with the Phase II performance standards in accordance with the provisions of the new rule. Licensees may be required to alter the intake structure, redesign the cooling system, modify station operation, or take other mitigative measures as part of the NPDES permit renewal process. The new performance standards are designed to reduce impingement losses due to plant operation. Any required site-specific mitigation measures would be expected to result in less impact from impingement during the license renewal period.

As described by Dominion, routine impingement monitoring for Unit 2 began in 1975 at start-up and continued until 1987 (Dominion 2002a). Routine impingement monitoring has never been conducted for Unit 3 because that unit included a fish return system in its original design. Although Unit 1 has been permanently shut down and is not being considered in the current application for relicensing, monitoring reports from 1976 to 1983 present combined impingement data from Units 1 and 2. For that reason, Unit 1 data are included here for those years. For the purpose of identifying the most commonly impinged species, the staff assumed that the proportional representation of taxa impinged was similar between the two units.

Impingement survival is the most relevant issue for recent and future operations, since fish return systems are currently in place for Units 2 and 3. Below is a discussion of the effectiveness of Units 2 and 3 fish return systems and impingement mortality.

4.1.2.1 Impingement Monitoring

For Unit 2 routine impingement monitoring, from 1975 to 1977, all impinged organisms (fish and invertebrates) were collected, identified, and counted daily over a 24-hour period. In 1977, the collection frequency was reduced to three 24-hour samples per week. Monthly impingement rates were estimated using sample count data and actual water volumes entrained at Millstone. Impingement estimates for days not sampled were calculated by multiplying the average impingement density (number per unit volume of cooling water used on days sampled) by the

volume of cooling water impinged. The actual and estimated daily counts were used to estimate monthly and annual impingement. Beginning in 1984, the sampling effort was stratified to increase the precision of the estimates for periods of high impingement for winter flounder and other fishes that are prevalent in samples during late winter. Under this stratified sampling plan, the sampling effort was reduced to once weekly from April to November, then increased from December to March, peaking at four times per week in February.

Impingement rates at Unit 2 decreased significantly following the 1983 removal of a cofferdam that was in place during the construction of the Unit 3 cooling-water intake structure. Having documented this decrease in impingement for several years, NUSCO requested relief from routine impingement monitoring for Unit 2 from the CTDEP (NUSCO 1987a) and received concurrence that further quantification was unnecessary, with the exception of any impingement events where the daily total exceeded 300 organisms. Routine impingement monitoring for Unit 2 ceased in December 1987.

The taxa that were most numerous in Millstone's impingement samples from 1976 to 1987 included winter flounder, anchovy (primarily bay anchovy), grubby, silverside (primarily Atlantic silverside [*Menidia menidia*]), Atlantic tomcod (*Microgadus tomcod*), threespine stickleback (*Gasterosteus aculeatus*), and blackspotted stickleback (*Gasterosteus wheatlandi*) (Table 4-6).

Estimates for American sand lance were skewed due to the impingement of approximately 480,000 American sand lance during the week of July 18, 1984. This represents approximately 98 percent of the total impingement for this species. Excluding the major impingement event, American sand lance impingement averaged about 600 individuals annually. Because of the extraordinary nature of that event and the otherwise relatively low impingement numbers, American sand lance was not considered to be among the most commonly impinged species. The six invertebrate taxa that were most abundant in impingement samples included Atlantic long-finned squid *(Loligo pealei)*, lady crab (*Ovalipes ocellatus*), rock crab (*Cancer irroratus*), green crab (*Carcinus maenas*), blue crab (*Callinectes sapidus*), and American lobster (*Homarus americanus*).

In 1991, NUSCO submitted an evaluation of winter flounder impingement to the CTDEP at that agency's request (NUSCO 1991). Because routine impingement monitoring for Unit 2 ceased in 1987, 1988 to 1990 estimates for Unit 2 were developed using a regression model that predicted impingement based on the catch of winter flounder at the Niantic Bay trawl station. Annual Unit 3 impingement was predicted by multiplying Unit 2 estimates by 1.74. This multiplier was based on a 1987 comparative impingement study for Units 2 and 3, which established the ratio of winter flounder impingement for Units 2 and 3 (NUSCO 1991). Results of this study are presented in Table 4-7.

Table 4-6. Total and Range of Total Annual Impingement Estimates of Fishes and Macroinvertebrates at Millstone from 1976 Through 1987 (Units 1 and 2 Combined for 1976 to 1983 and Unit 2 Alone for 1984 to 1987)

Scientific Name	Common Name	Smallest Annual Estimates	Largest Annual Estimates	Estimated Total (1976–87)	Percent of Total[a]
			MACROINVERTEBRATES		
Loligo pealei	Atlantic long-finned squid	1491	24,109	142,495	37.5
Ovalipes ocellatus	lady crab	1343	31,952	120,460	31.7
Cancer irroratus	rock crab	633	7925	44,456	11.7
Carcinus maenas	green crab	656	6687	29,950	7.9
Callinectes sapidus	blue crab	437	1963	14,317	3.8
Homarus americanus	American lobster	501	1967	11,900	3.1
Libinia spp.	spider crabs	119	1598	8517	2.2
	Top seven taxa	8866	66,196	372,095	98.0
	Others	126	1721	7520	2.0
	Total	9946	67,290	379,615	
			FISHES		
Ammodytes americanus	American sand lance	8	485,411	487,089[a]	46.9 (1.3)
Pseudopleuronectes americanus	winter flounder	624	23,544	88,665	8.5 (15.9)
Anchoa spp.	anchovy	12	52,280	82,567	8.0 (14.8)
Myoxocephalus aenaeus	grubby	647	14,634	61,984	6.0 (11.1)
Menidia spp.	silverside	136	12,187	56,368	5.4 (10.1)
Microgadus tomcod	Atlantic tomcod	8	11,868	34,728	3.3 (6.2)
Gasterosteus spp.	sticklebacks[b]	0	9918	30,656	2.9 (5.5)
Gasterosteus aculeatus	threespine stickleback[b]	0	9472	22,640	2.1 (4.1)
Gasterosteus wheatlandi	blackspotted stickleback[b]	0	14,381	20,719	2.0 (3.7)
Tautogolabrus adspersus	cunner	57	3851	20,131	1.9 (3.6)
Syngnathus fuscus	northern pipefish	384	6572	17,478	1.7 (3.1)

Table 4-6. (contd)

Scientific Name	Common Name	Smallest Annual Estimates	Largest Annual Estimates	Estimated Total (1976–87)	Percent of Total[a]
			Fishes		
Peprilus triacanthus	butterfish	135	4061	17,415	1.7 (3.1)
Urophycis spp.	hake	41	9419	15,944	1.5 (2.9)
	Top thirteen taxa	6404	506,492	956,384	92.1 (85.3)
	Others	2039	20,992	82,086	2.0 (14.7)
	Total	8560	511,387	1,038,470	

Source: Adapted from Jacobson et al. 1998
(a) Number in parentheses represents the percent of total excluding the 1984 American sand lance impingement event. Approximately 480,000 American sand lance were estimated to have been impinged during the week of July 18, 1984 (98% of total sand lance impingement). The event did not impact the percent of total values for macroinvertebrates.
(b) Threespine *(Gasterosteus aculeatus)* and blackspotted *(G. wheatlandi)* sticklebacks were not identified as separate until 1981.

4.1.2.2 Impingement Mortality

A fish return sluiceway was completed at Unit 2 in 2000. Dominion (2001b) reported on a one-year study of impingement survival for Unit 2. A similar one-year study of impingement survival for Unit 3 was conducted in 1993 (NUSCO 1994) after several improvements had been made to the original fish return system design to comply with CTDEP requirements of at least a 70-percent rate of return sluiceway efficiency. These studies showed high survival for crustaceans (76 to 93 percent) in all water temperatures and for demersal fishes (74 to 88 percent) in cool and cold water periods (Table 4-8). Pelagic fish, such as Atlantic menhaden and butterfish, and Atlantic long-finned squid had relatively poor survival

Table 4-7. Estimated Annual Impingement and Impingement Mortality of Winter Flounder at Millstone, Units 2 and 3 from 1986 to 1990

Year	Estimated Impingement at Unit 2 (100% mortality)	Estimated Impingement at Unit 3	Survival due to Unit 3 Sluiceway	Impingement Mortality at Unit 3	Total Impingement Mortality
1986	1108	1928	590	1338	2446
1987	634	1103	335	768	1402
1988	800	1392	546	846	1646
1999	907	1578	1056	522	1429
1990	524	912	108	804	1328

Source: Adapted from NUSCO 1991

(0 to 14 percent). Pelagic fish were the most impinged species group with about 1300 fish impinged over one year compared to less than 400 for any other group.

Table 4-8. Survival of Organisms Collected at the Millstone, Units 2 and 3 Aquatic Returns Based on Body Type and Water Temperature (Data for Unit 2 Collected Biweekly from July 2000 to June 2001; Data for Unit 3 Collected Biweekly from January to December 1993)

Category	Temperature Category[a]	Total Impinged		Percent Survival			
				Initial		72-h	
		Unit 2	Unit 3	Unit 2	Unit 3	Unit 2	Unit 3
Crustacean	cold	9	29	78	96	78	90
	cool	20	74	90	97	85	93
	warm	63	102	86	100	76	84
Demersal	cold	140	127	94	94	86	88
	cool	66	33	91	94	74	88
	warm	26	9	54	78	27	67
Pelagic	cold	14	140	64	61	14	0
	cool	289	23	40	13	1	0
	warm	799	45	4	4	0.5	0
Squid	cool	45	82	64	56	33	7
	warm	44	60	4	22	0	5

Source: adapted from NUSCO 1994 and Dominion 2001b

(a) Water temperatures ranged from 3.5 °C to 7.0 °C (38.3 °F to 44.6 °F) (cold), 8.0 °C to 15 °C (46.4 °F to 59.0 °F) (cool) and 16 °C to 22 °C (60.8 °F to 71.6 °F) (warm).

Table 4-9 shows the survival rate for significant species in the Millstone vicinity. Survival rates for winter flounder and American lobster were at or near 100 percent, but were somewhat lower for other demersal species. Survival rates were poor for the pelagic species (bay anchovy, Atlantic menhaden, and silversides).

4.1.2.3 Assessment of Impact

Bay anchovy abundance in the vicinity of Millstone reached its highest level in 1981, dropped dramatically between 1981 and 1982, and has gradually decreased since that time. Due to lack of quantitative data for Long Island Sound or the mid-Atlantic region, it is not possible to evaluate whether the decrease in anchovy abundance near Millstone reflects regional population trends, although Dominion (2004b) reported that sharp drops in abundance have also occurred in the past decade in Narragansett Bay and in Chesapeake Bay. Dominion (2004b) describes bay anchovy as genetically homogeneous due to high levels of stock mixing and considerable movement. The species reaches maturity at approximately three months, spawns repeatedly during the summer, and has a high natural mortality rate.

Table 4-9. Impingement Survival of Significant Species Collected at the Millstone Units 2 and 3 Aquatic Returns (Data for Unit 2 Collected Biweekly from July 2000 to June 2001; Data for Unit 3 Collected Biweekly from January to December 1993)

Scientific Name	Common Name	Category[a]	Total Impinged		Percent Survival			
					Initial		72 hr	
			Unit 2	Unit 3	Unit 2	Unit 3	Unit 2	Unit 3
Pseudopleuronectes americanus	winter flounder	D	16	43	100	97	100	94
Homarus americanus	American lobster	C	10	26	100	100	100	100
Anchoa mitchilli	bay anchovy	P	5	15	0	0	0	0
Brevoortia tyrannus	Atlantic menhaden	P	915	16	14	50	0.3	0
Menidia menidia	silversides	P	13	160	70	63	23	0
Myoxocephalus aenaeus	grubby	D	49	42	94	100	78	86
Tautogolabrus adspersus	cunner	D	32	3	69	67	56	67
Tautoga onitis	tautog	D	16	8	94	100	69	87

Source: adapted from NUSCO 1994 and Dominion 2001b
(a) D = demersal; C = crustacean; P = pelagic.

Atlantic menhaden support the largest commercial fishery along the Atlantic coast (Dominion 2004b). The status of the Atlantic menhaden fishery is considered to be healthy, and abundance estimates in the Millstone vicinity suggest an overall increase in larval population size from 1987 until the present (Dominion 2004b). Silverside population abundance in the Millstone vicinity has varied from year to year without apparent trend. Due to lack of regional abundance data, it is not possible to compare the population trends in the Millstone area to the region. Cunner sampling near Millstone has shown a decline in the population since the late 1970s. This decline is similar to regional abundance estimates, which suggest that cunner stocks have also experienced a steady decline in Long Island Sound (Dominion 2004b). Tautog abundance in the Millstone vicinity has varied without trend since the 1970s. The Connecticut recreational harvest of tautog has also varied considerably since the 1970s. Annual fishing mortality rates in the 1990s of 42 percent have potentially reduced the size of the stock, and the species is considered to be overfished (Dominion 2004b).

Fish stocks that have high or moderate impingement mortality at Millstone do not appear to have declined as a result of Millstone operations. Tautog and silverside populations have varied without trend in the vicinity of the plant, while Atlantic menhaden appear to have increased. Cunner declines near Millstone are similar to regional trends, and anchovy declines also appear to be reflecting a regional decline in the stock.

The staff has reviewed the available information, including reports provided by the applicant, information provided by regulatory agencies, public comments, and other public sources. Using this information, the staff evaluated the potential impacts due to impingement of fish and shellfish by continued operation and maintenance of Millstone. It is the staff's conclusion that the potential impacts due to impingement of fish and shellfish during the renewal term would be SMALL.

During the course of the SEIS preparation, the staff considered mitigation measures to further reduce impacts to winter flounder and other aquatic organisms as part of the continued operation of Millstone Units 2 and 3. Based on impingement numbers in Table 4-6 and on survival data from Table 4-7, NRC staff does not believe that further mitigation is warranted. However, Dominion and CTDEP are discussing mitigation measures as part of the NPDES permit renewal application. CTDEP is responsible for the review and issuance of NPDES permits and the implementation of the CWA in Connecticut. Therefore, CTDEP has authority over matters concerning discharge permits or compliance with the CWA and can impose additional mitigation measures to reduce losses due to impingement. Any mitigation measures imposed by the state of Connecticut as a result of the ongoing NPDES permit review would be expected to reduce entrainment losses to winter flounder and lessen the impact of plant operations on the Niantic River winter flounder.

4.1.3 Heat Shock

For plants with once-through cooling systems, heat shock impacts are a Category 2 issue and require plant-specific evaluation before license renewal. The NRC made impacts on fish and shellfish resources resulting from heat shock a Category 2 issue because of continuing concerns about thermal discharge impacts and the possible need to modify thermal discharges in the future in response to changing environmental conditions (NRC 1996).

Information to be considered includes (1) the type of cooling system (whether once-through or cooling pond) and (2) evidence of a CWA Section 316(a) variance or equivalent State documentation. To perform this evaluation, the staff reviewed the Dominion ER (Dominion 2004a), visited the Millstone site, and reviewed the applicant's NPDES permit (CT0003263), issued on December 14, 1992, and in force until the CTDEP acts on Millstone's 1997 application for NPDES permit renewal (Dominion 2004a). The staff also independently reviewed monitoring reports for the cooling-water discharge mixing zone.

Millstone has a once-through cooling system that withdraws water from Niantic Bay for condenser cooling and discharges it into Long Island Sound. Dominion also has Section 316(a) variance for thermal effluent limits. Section 316(a) of the CWA establishes a process whereby a thermal effluent discharger can demonstrate that thermal discharge limitations are more stringent than necessary to protect a balanced indigenous population of fish and wildlife and obtain alternative facility-specific thermal discharge limits. In renewing Millstone's NPDES permit in 1992, the CTDEP determined that thermal discharges from Millstone were sufficiently protective of fish and wildlife communities of Niantic Bay and eastern Long Island Sound to allow alternative thermal effluent limitations under Section 316(a) of the CWA. The NPDES permit also requires continued monitoring of the supplying and receiving waters, including studies of intertidal and subtidal benthic communities and finfish communities and "detailed studies" of lobster and winter flounder populations.

In 1972, a fish kill of Atlantic menhaden—attributed to heat shock or gas bubble disease—occurred in the quarry (NUSCO 1972). A fish barrier was installed later that year to prevent larger fishes from entering the quarry. When the second quarry cut was opened in 1982, a similar fish barrier was installed at that opening. Both barriers were replaced in 1999 and remain in place. Temperatures within the quarry occasionally exceed the lethal threshold temperatures for some species. However, Millstone has remained in compliance with the NPDES thermal and discharge volume limits at the quarry cut.

The current NPDES permit limits the maximum temperature of the discharge points at the quarry cut to 40.6 °C (105 °F), with a maximum temperature increase of 17.8 °C (32 °F) above the intake water temperature. Under unusual conditions, the temperature at the quarry cut can exceed the intake water temperature by 24.4 °C (44 °F) for a period not exceeding 24 hours. In the event that the temperature differential exceeds 17.8°C (32 °F), the CTDEP requires notification. The average temperature of the receiving waters cannot be raised by more than 2.2 °C (4 °F), and discharge temperature cannot increase the normal temperature of the receiving water above 46.1 °C (83 °F). The boundary of the mixing zone cannot exceed a radius of 2438 m (8000 ft) from discharge outlet at the quarry cut. The maximum allowed daily flow of the discharges is 1.0×10^{10} L/d (2.7×10^{9} gpd).

Thermal impacts associated with Millstone operations have been studied since 1979 and are reported in Dominion (2004b) and NUSCO (1987b). The impacts to rocky intertidal communities are limited to approximately 150 m (492 ft) of shoreline on the east side of the discharge to Long Island Sound including Fox Island. This area has been exposed to the thermal effluent since the opening of the second quarry cut in 1983 and has developed a resilient community of seaweeds and invertebrates. The intertidal community that developed under the thermal regimes in the discharge area is characterized by the absence or abbreviated season of occurrence of cold water species (*Chondrus* spp., *Monostroma* spp., and *Dumontia contorta*), and the presence or extended season of occurrence of warm water species (*Codium fragile, Sargassum filipendula, Gracilaria tikvahiae*, and more recently,

Hypnea musciformis). Abundant growth of *Ascophyllum* spp. has also been noted during many study years and has been attributed to elevated temperatures from the Millstone discharge. However, high nodal growth of *Ascophyllum nodosum* has also occurred during growth seasons when all Millstone units were shut down. Increased growth was not evident during the first year following Unit 3 restart, or from 2001 to 2003 when Units 2 and 3 were operating. It is possible that other factors such as ambient temperature conditions, nutrients, and light might be contributing to the *Ascophyllum* growth. Temperature monitoring at eelgrass beds in the vicinity of Millstone has not shown evidence of influence from plant discharges.

An analysis of the thermal plume characteristics associated with the discharge of cooling water from Millstone was conducted by Adams (2001). The analysis described plume configurations for four tidal cycles (maximum flood, slack after flood, maximum ebb, and slack after ebb) under various operational scenarios and pump configurations. The report calculated plume parameters for three-unit operation and for the operation of only Units 2 and 3. Results indicate that, when all pumps are operating, the operation of Units 2 and 3 produces a near-field thermal plume with a slightly higher temperature but a smaller length when compared to that of three-unit operation.

Additionally, isotherm trends for the worst-case scenario (three-unit operation) are presented in Dominion 2004b and reproduced in Figure 4-1 for four tidal conditions. For all four tidal conditions, the highest temperatures were confined to the areas south and east of the quarry cut, extending from Millstone Point to Twotree Island. Maximum flood conditions shifted the isotherms slightly west; strong ebb tides shifted them east. Under three-unit operation, the 4.4 °C, 3.3 °C, and 2.2 °C (8 °F, 6 °F, and 4 °F) isotherms are generally confined to a triangular area of approximately 1200 m (4000 ft) per side defined by Millstone Point, Twotree Island, and White Point (Figure 4-1). The 0.8 °C (1.5 °F) isotherm is present in the outer reaches of Niantic Bay only under extreme tidal flood conditions and enters Jordan Cove only during maximum ebb tide events.

The staff has reviewed the available information, including that provided by the applicant, the staff's site visit, consultations with regulatory agencies, and other public sources, such as public comment on the draft SEIS. Based on a review of these data, the staff has concluded that thermal effects are generally confined to the area immediately adjacent to the quarry cut and most likely do not present a thermal barrier to migrating fish, since access to Jordan Cove and the Niantic River is not compromised. The staff evaluated the potential impacts to aquatic resources due to heat shock during continued operation. It is the staff's conclusion that the potential impacts to fish and shellfish due to heat shock during the renewal term would be SMALL.

During the course of the SEIS preparation, the staff considered mitigation measures to further reduce impacts to winter flounder and other aquatic organisms as part of the continued operation of Millstone Units 2 and 3. Based on a review of the data, the NRC staff does not

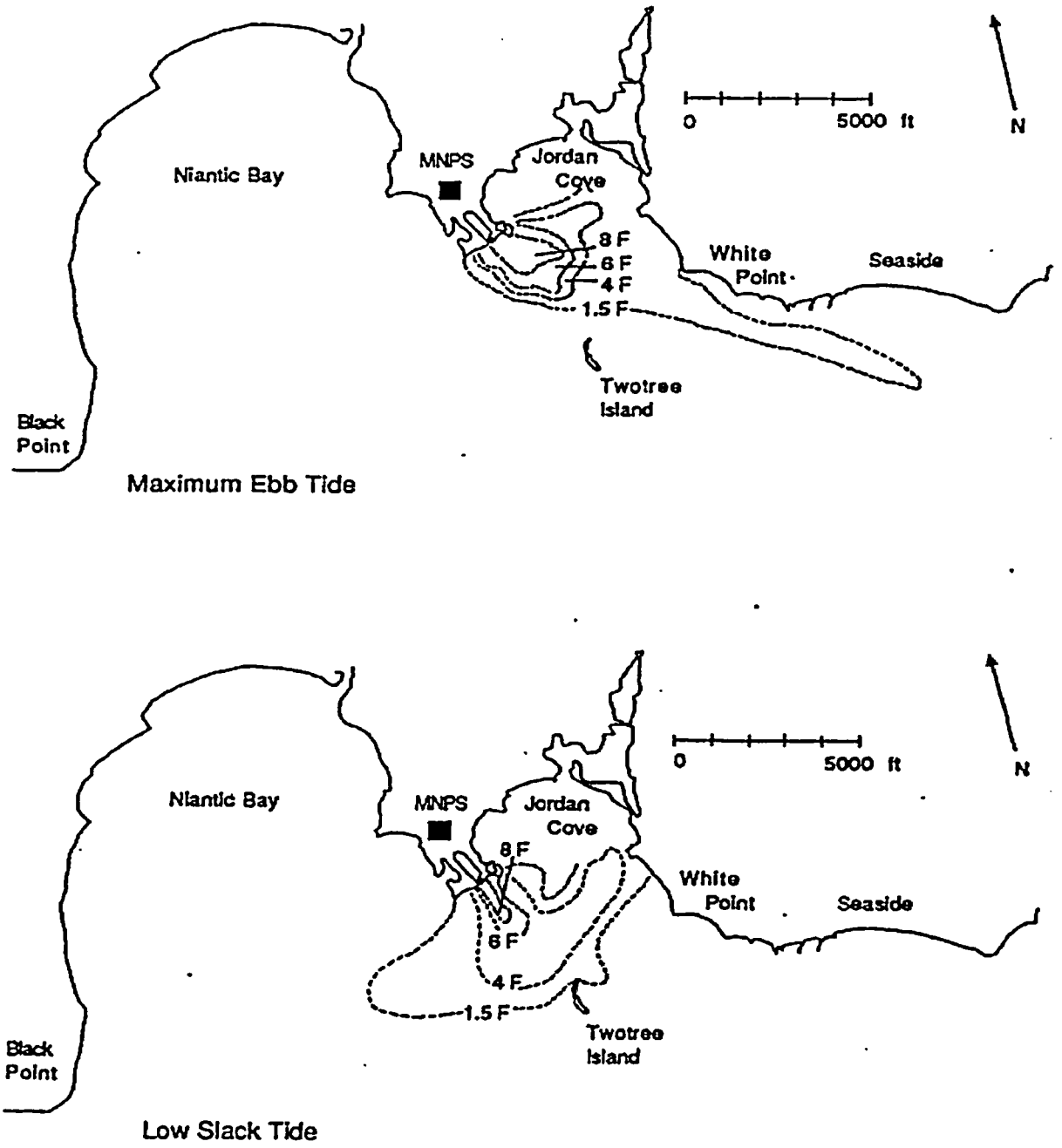

Figure 4-1. Locations of Selected Three-unit Thermal Plume Isotherms (0.8 °C, 2.2 °C, 3.3 °C, and 4.4 °C [1.5 °F, 4 °F, 6 °F, and 8 °F]) Under Various Tidal Conditions Source: Dominion 2004b.

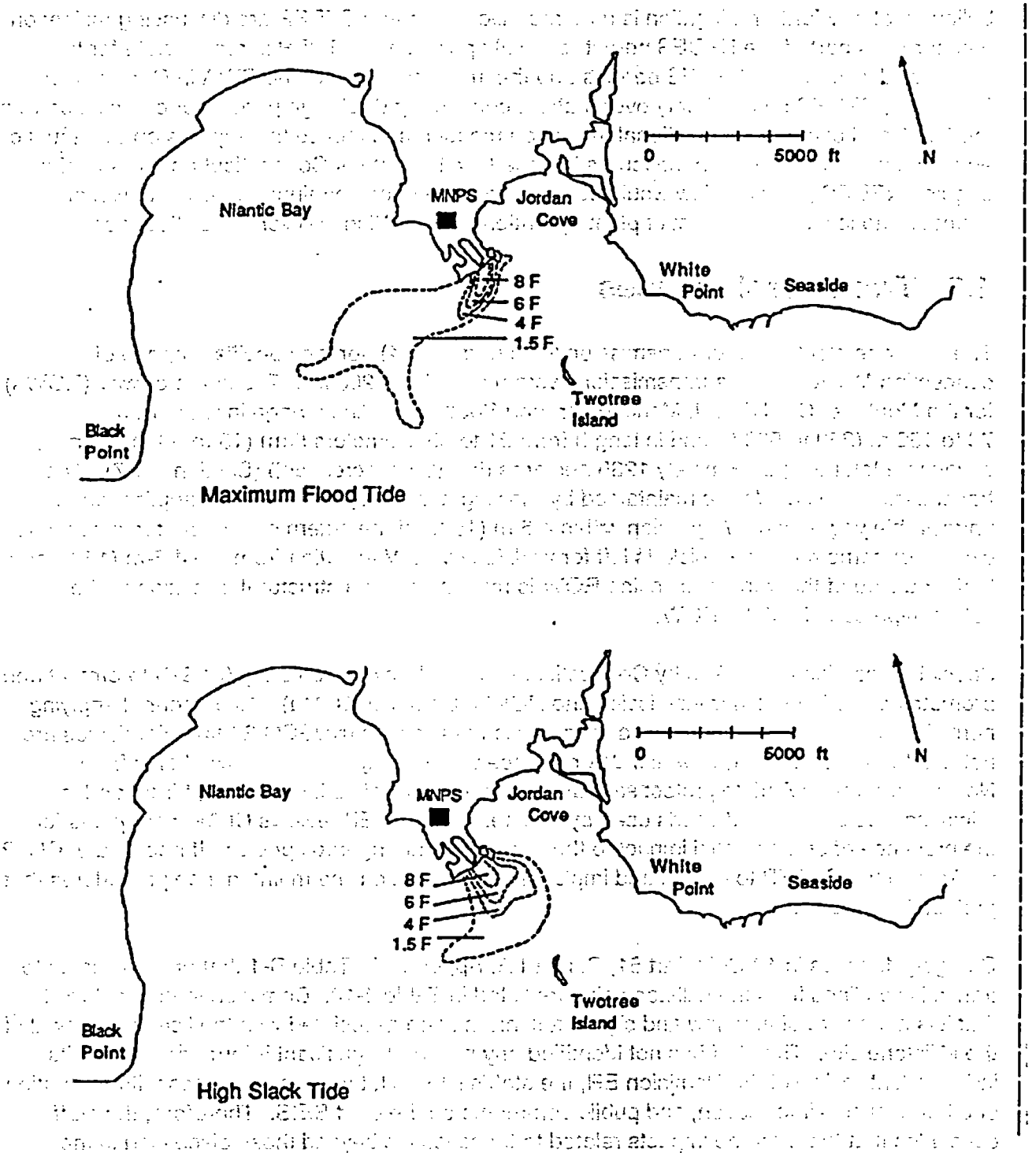

Figure 4-1. (contd)

believe that any further mitigation is required. Dominion and CTDEP are discussing mitigation measures as part of the NPDES permit renewal application. CTDEP is responsible for the review and issuance of NPDES permits and the implementation of the CWA in Connecticut. Therefore, CTDEP has authority over matters concerning discharge permits or compliance with the CWA and can impose additional mitigation measures to reduce the impacts on the aquatic environment. Any mitigation measures imposed by the state of Connecticut as a result of the ongoing NPDES permit review would be expected to reduce entrainment losses to winter flounder and lessen the impact of plant operations on the Niantic River winter flounder.

4.2 Transmission Lines

The Millstone plant has four transmission lines (Figure 2-4), for the specific purpose of connecting Millstone to the transmission system (Dominion 2004a). The rights-of-way (ROWs) for the Montville, Card Street, Manchester, and Southington lines range in width from 76 to 152 m (250 to 500 ft) and in length from 21 to 85 kilometers (km) (13 to 53 miles [mi]), covering a total of approximately 1235 hectares (ha) (3052 acres [ac]) (Section 2.1.7). The transmission line ROWs are maintained by mowing, trimming, and herbicide application to undesirable vegetation. Vegetation within 4.5 m (15 ft) of the outermost conductor is kept short except for some red cedar thickets left for wildlife cover. Vegetation from the 4.5-m (15-ft) edge to the outside of the transmission line ROW is maintained as a structural transition to the habitat type outside of the ROW.

Special precautions are taken by Connecticut Light and Power Company (CL&P) to protect and promote quality habitat in transmission line ROWs (Dominion 2004a). All personnel applying herbicides are required to possess a valid applicators license (NUSCO 2004). Herbicides are not used within 3 m (10 ft) of wetlands or surface water. Vegetation is mowed only from November through April to protect saturated soils, to avoid disturbing nesting birds, and to minimize loss of fruits and seeds used by wildlife. The CTDEP reviews CL&P work plans for the presence of and potential impact to threatened or endangered species. If necessary, CL&P works with the CTDEP to design and implement transmission line maintenance procedures that protect the species.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to transmission lines from the Millstone site are listed in Table 4-10. Dominion stated in its ER that it is not aware of any new and significant information associated with the license renewal of the Millstone site. The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the

GEIS. For all of those issues, the staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-10. Category 1 Issues Applicable to the Millstone Transmission Lines During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
TERRESTRIAL RESOURCES	
Power line ROW management (cutting and herbicide application)	4.5.6.1
Bird collision with power lines	4.5.6.2
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3
Flood plains and wetland on power line ROW	4.5.7
AIR QUALITY	
Air quality effects of transmission lines	4.5.2
LAND USE	
Onsite land use	4.5.3
Power line ROW	4.5.3

A brief description of the staff's review and GEIS conclusions, as codified in Table B-1, for each of these issues follows. (For each issue below, references to the Dominion ER are to Dominion 2004a.)

- Power line ROW management (cutting and herbicide application). Based on information in the GEIS, the Commission found that

  > The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, consultation with the U.S. Fish and Wildlife Service (FWS) and the CTDEP, its evaluation of other information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts from power line ROW maintenance during the renewal term beyond those discussed in the GEIS.

- Bird collision with power lines. Based on information in the GEIS, the Commission found that

  > Impacts are expected to be of small significance at all sites.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, consultation with the FWS and the CTDEP, its evaluation of other information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts of bird collisions with power lines during the renewal term beyond those discussed in the GEIS.

- Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock). Based on information in the GEIS, the Commission found that

  > No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts of electromagnetic fields on flora and fauna during the renewal term beyond those discussed in the GEIS.

- Flood plains and wetlands on power line ROW. Based on information in the GEIS, the Commission found that

  > Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, consultation with the FWS and CTDEP, its evaluation of other information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts from power line ROWs on flood plains and wetlands during the renewal term beyond those discussed in the GEIS.

- Air quality effects of transmission lines. Based on the information in the GEIS, the Commission found that

  > Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no air quality impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

- Onsite land use. Based on the information in the GEIS, the Commission found that

  > Projected onsite land use changes required during ... the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no onsite land use impacts during the renewal term beyond those discussed in the GEIS.

- Power line ROW. Based on information in the GEIS, the Commission found that

  > Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts of power line ROWs on land use during the renewal term beyond those discussed in the GEIS.

There is one Category 2 issue related to transmission lines, and another issue related to transmission lines is being treated as a Category 2 issue. These issues are listed in Table 4-11 and are discussed in Sections 4.2.1 and 4.2.2.

Table 4-11. Category 2 and Uncategorized Issues Applicable to the Millstone Transmission Lines During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
	HUMAN HEALTH		
Electromagnetic fields, acute effects (electric shock)	4.5.4.1	H	4.2.1
Electromagnetic fields, chronic effects	4.5.4.2	NA	4.2.2

4.2.1 Electromagnetic Fields—Acute Effects

In the GEIS (NRC 1996), the staff found that, without a review of the conformance of each nuclear plant transmission line with National Electrical Safety Code (NESC) criteria (NESC 1997), it was not possible to determine the significance of the electric shock potential. Evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the potential shock hazard if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents. According to the applicant:

> . . . transmission lines were designed and constructed in accordance with the National Electrical Safety Code and industry guidance that was current when the lines were built. Ongoing right-of-way surveillance and maintenance of Millstone transmission facilities ensure continued conformance to design standards. (Dominion 2004a).

In addition to compliance with the NESC limit of 5 milliampere (mA) electric-field-induced current, the transmission lines are phased to produce the lowest possible electromagnetic fields.

As described in Appendix E (Section 3.1.3) of the ER, there are four 345 kilovolt (kV) lines that were designed and constructed before the NESC promulgated the 5-mA rule on induced current. In 1987, a parking lot for the Cross Road Mall in Waterford, Connecticut was constructed under the four transmission lines.

CL&P conducted extensive studies of the electric shock potential in the parking lot and has concluded that the lines in this location are constructed in accordance with NESC provisions for limiting induced current shock, including vehicles that use this area. (Dominion 2004a).

Although Millstone has not conducted studies along the entire transmission line ROW, the Cross Road Mall is the most probable location for induced current shock.

The staff has reviewed the available information, including that provided by the applicant, the staff's site visit, the scoping process, and other public sources. Using this information, the staff evaluated the potential impacts for electric shock resulting from operation of Millstone and associated transmission lines. The staff considered the cumulative impacts of past, current, and foreseeable future actions at the site regardless of which agency (Federal or non-Federal) or person undertakes such other actions. It is the staff's conclusion that the potential impacts for electric shock during the renewal term would be SMALL.

4.2.2 Electromagnetic Fields—Chronic Effects

In the GEIS, the chronic impacts of 60-hertz (Hz) electromagnetic fields from power lines were not designated as Category 1 or 2, and will not be until a scientific consensus is reached on the health implications of these fields.

The potential for chronic impacts from these fields continues to be studied and is not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy. A recent report (NIEHS 1999) contains the following conclusion:

> The NIEHS concludes that ELF-EMF [extremely low frequency-electromagnetic field] exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the staff to change its position with respect to the chronic impacts of electromagnetic fields. The staff considers the GEIS finding of "not applicable" still appropriate and will continue to follow developments on this issue.

4.3 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to Millstone in regard to radiological impacts are listed in Table 4-12. Dominion stated in its ER that it is not aware of any new and significant information associated with the renewal of the

Millstone OLs. The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-12. Category 1 Issues Applicable to Radiological Impacts of Normal Operations During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
HUMAN HEALTH	
Radiation exposures to public (license renewal term)	4.6.2
Occupational radiation exposures (license renewal term)	4.6.3

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows. (For each issue, references to the Dominion ER are to Dominion 2004a.)

- Radiation exposures to public (license renewal term). Based on information in the GEIS, the Commission found that

  > Radiation doses to the public will continue at current levels associated with normal operations.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts from radiation exposures to the public during the renewal term beyond those discussed in the GEIS.

- Occupational radiation exposures (license renewal term). Based on information in the GEIS, the Commission found that

  > Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other

available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts from occupational radiation exposures during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to radiological impacts of routine operations.

4.4 Socioeconomic Impacts of Plant Operations During the License Renewal Period

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to socioeconomic impacts during the renewal term are listed in Table 4-13. Dominion has stated in its ER that it was not aware of any new and significant information associated with the renewal of the Millstone OLs (Dominion 2004a). The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS (NRC 1996). For these issues, the staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS (NRC 1996). For these issues, the staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-13. Category 1 Issues Applicable to Socioeconomics During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
SOCIOECONOMICS	
Public services: public safety, social services, and tourism and recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6
Public services: education (license renewal term)	4.7.3.1
Aesthetic impacts (license renewal term)	4.7.6
Aesthetic impacts of transmission lines (license renewal term)	4.5.8

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows. (For each issue below, references to the Dominion ER are to Dominion 2004a.)

- Public services: public safety, social services, and tourism and recreation. Based on information in the GEIS, the Commission found that

Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.

The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts on public safety, social services, and tourism and recreation during the renewal term beyond those discussed in the GEIS.

- Public services: education (license renewal term). Based on information in the GEIS, the Commission found that

  Only impacts of small significance are expected.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts on education during the renewal term beyond those discussed in the GEIS.

- Aesthetic impacts (license renewal term). Based on information in the GEIS, the Commission found that

  No significant impacts are expected during the license renewal term.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no aesthetic impacts during the renewal term beyond those discussed in the GEIS.

- Aesthetic impacts of transmission lines (license renewal term). Based on information in the GEIS, the Commission found that

  No significant impacts are expected during the license renewal term.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no aesthetic impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

Table 4-14 lists the Category 2 socioeconomic issues, which require plant-specific analysis, and environmental justice, which was not addressed in the GEIS.

Table 4-14. Environmental Justice and GEIS Category 2 Issues Applicable to Socioeconomics During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
SOCIOECONOMICS			
Housing impacts	4.7.1	I	4.4.1
Public services: public utilities	4.7.3.5	I	4.4.2
Offsite land use (license renewal term)	4.7.4	I	4.4.3
Public Services: transportation	4.7.3.2	J	4.4.4
Historic and archaeological resources	4.7.7	K	4.4.5
Environmental Justice	Not addressed[a]	Not addressed[a]	4.4.6

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. Therefore, environmental justice must be addressed in the staff's environmental impact statement.

4.4.1 Housing Impacts During Operations

In determining housing impacts, the applicant chose to follow Appendix C of the GEIS (NRC 1996), which presents a population characterization method that is based on two factors, "sparseness" and "proximity" (GEIS Section C.1.4 [NRC 1996]). Sparseness measures population density within 32 km (20 mi) of the site, and proximity measures population density and city size within 80 km (50 mi). Each factor has categories of density and size (GEIS Table C.1), and a matrix is used to rank the population category as low, medium, or high (GEIS Figure C.1).

All or parts of 15 counties, the city of Hartford, and sections of the Hartford and the New London-Norwich Metropolitan Statistical Areas are located within 80 km (50 mi) of Millstone, and four states also fall within this radius. Approximately 73 percent of Millstone's employees live in New London County while another 12 percent reside in Middlesex County. Another 14 percent are distributed across 14 counties in Connecticut, Massachusetts, and Rhode Island with numbers ranging from 1 to 60 employees per county. As estimated from 2000 U.S. Census Bureau information, 2,868,207 people live within 50 miles of Millstone. This equates to a population density of 219 persons per square kilometer (km^2) (567 persons per square mile [mi^2]). Applying the GEIS proximity measures, Millstone is classified as Category 4 (greater than or equal to 190 persons per square mile within 50 miles).

According to the GEIS sparseness and proximity matrix, the Millstone ranks of sparseness, Category 4, and proximity, Category 4, result in the conclusion that Millstone is located in a high-population area.

10 CFR Part 51, Subpart A, Appendix B, Table B-1 states that impacts on housing availability are expected to be of small significance at plants located in a high-population area where growth-control measures are not in effect. Millstone is located in a high-population area of southeastern Connecticut. Dominion plans to add no more than five additional permanent employees during the license renewal term. Dominion's analysis determined that some towns are applying growth control measures designed to guide but not preclude growth. There are no growth limits in Waterford, but the town regulates residential densities within zoning districts by establishing the maximum number of units allowed for any given parcel and by considering the most appropriate development pattern. The Dominion ER (Dominion 2004a) concluded that impacts to housing availability from a plant population growth of up to five employees would be SMALL and would not warrant mitigation during continued operations based on the NRC criteria.

SMALL impacts result when no discernible change in housing availability occurs, changes in rental rates and housing values are similar to those occurring statewide, and no housing construction or conversion is required to meet new demand (NRC 1996). The GEIS assumes that an additional staff of 60 permanent per-unit workers might be needed during the license renewal period to perform routine maintenance and other activities.

The U.S. Census Bureau (USCB) reported that there were 7986 housing units in Waterford in 2000, and a total of 110,674 in New London County. The vacancy rate in Waterford was 5.6 percent (444 units) while it was 9.8 percent (10,839) in New London County (USCB 2000). According to the 1998 *Plan of Preservation, Conservation & Development*, there is the theoretical potential for about 4000 additional housing units in Waterford. The plan recommends that Waterford continue to provide for a diversity of housing types, and encourage the availability of housing for a variety of age and income groups. While housing is a regional issue of concern in southeastern Connecticut, the focus of that concern is the provision of housing for the increasing numbers of service workers associated with the casino, tourism and service sector, and the provision of appropriate housing for the increasing numbers of single occupancy and elderly households (Southeastern Connecticut Council of Governments [SCCOG] 2004).

The staff reviewed the available information relative to housing impacts and Dominion's conclusions. Based on this review, the staff concludes that the impact on housing during the license renewal period would be SMALL, and additional mitigation would not be warranted.

4.4.2 Public Services: Public Utility Impacts During Operations

Impacts on public utility services are considered SMALL if there is little or no change in the ability of the system to respond to the level of demand, and thus there is no need to add capital facilities. Impacts are considered MODERATE if overtaxing of service capabilities occurs during periods of peak demand. Impacts are considered LARGE if existing levels of service (e.g., water or sewer services) are substantially degraded and additional capacity is needed to meet ongoing demands for services. The GEIS indicates that, in the absence of new and significant information to the contrary, the only impacts on public utilities that could be significant are impacts on public water supplies (NRC 1996).

Millstone acquires potable water from the city of New London through pipes owned by Waterford. Millstone's 2000 to 2001 potable water usage averaged 1.257×10^6 L/d (3.320×10^5 gpd). This usage represents approximately 5.2 percent of the city of New London's daily capacity and 6 percent of its average daily use. Impact on local water supplies is not expected to change during continuing operations at Millstone as a result of license renewal. Adding direct and indirect employees (as a result of five additional license renewal employees) would not significantly impact the capacity in the region's water supplies. Analysis of impacts on the public water supply system considered both plant demand and plant-related population growth. Millstone water usage is not expected to change during the license renewal period and no refurbishment activities are planned for Millstone. Average daily water withdrawals are near authorized withdrawal limits (capacities) in some areas, and, while the region overall has excess capacity, it is expected to eventually experience water shortages in some areas. Although future water shortages are a concern for the region, their occurrence would be independent of the license renewal process. Dominion concluded that impacts to the public water supply from plant-related population growth and plant demand would be SMALL and mitigation would not be warranted (Dominion 2004a). The recently approved Thames Basin Regional Water Interconnection Project will provide alternative water supply sources for Waterford by interconnecting the Norwich, Groton, and the New London / Waterford systems. This project provides a degree of redundancy to the Waterford water system while mitigating pressure deficiencies that have been a concern for fire fighting in the Quaker Hill neighborhood. Piping water from Groton will provide a less costly solution than developing new sources, while increasing the safe yield available for present and future demands (City of Waterford 2002).

The staff has reviewed the available information, including the Dominion analysis discussed above. Based on this information, the staff concludes that the potential impacts of Millstone during the license renewal period upon water use would be SMALL, and that additional mitigation would not be warranted.

4.4.3 Offsite Land Use During Operations

Offsite land use during the license renewal term is a Category 2 issue (10 CFR 51, Subpart A, Appendix B, Table B-1). Table B-1 of 10 CFR 51 Subpart A, Appendix B notes that "significant changes in land use may be associated with population and tax revenue changes resulting from license renewal."

Section 4.7.4 of the GEIS defines the magnitude of land-use changes as a result of plant operation during the license renewal term as follows:

SMALL—Little new development and minimal changes to an area's land-use pattern.

MODERATE—Considerable new development and some changes to the land-use pattern.

LARGE—Large-scale new development and major changes in the land-use pattern.

Dominion has identified a maximum of five additional permanent employees during the license renewal term (Dominion 2004a). Using this upper-bound employment assumption, the staff calculated that there could be an increase in total population of 15 people from continued operation of Millstone within southeastern Connecticut during the license renewal term. This represents about 0.006 percent of the current population of the area.

Section 3.7.5 of the GEIS (NRC 1996) states that if plant-related population growth is less than 5 percent of the study area's total population, offsite land-use changes would be small, especially if the study area has established patterns of residential and commercial development, a population density of at least 23 persons/km^2 (60 persons/mi^2), and at least one urban area with a population of 100,000 or more within 80 km (50 mi). Population growth related to Millstone license renewal is expected to be less than 0.006 percent of the area's 2000 total population of 2,868,207; Waterford and the southeastern Connecticut region have established patterns of residential and commercial development, a population density of 219 persons/km^2 (567 persons/mi^2), and there are two cities (Hartford and New Haven) each with a population of about 123,000 in 2000 within a 80-km (50-mi) radius. Consequently, the staff concludes that population changes resulting from license renewal would be likely to result in SMALL offsite land-use impacts.

Tax revenue can affect land use because it enables local jurisdictions to be able to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land-use impacts during the license renewal term should consider (1) the size of the plant's payments relative to the community's total revenues, (2) the nature of the community's existing land-use pattern, and (3) the extent to which the community already has public services in place to support and guide development. If the plant's tax payments are projected to be small relative to the community's

total revenue, tax-driven land-use changes during the plant's license renewal term would be SMALL, especially where the community has pre-established patterns of development and has provided adequate public services to support and guide development. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction's revenue, the significance level would be SMALL. If the plant's tax payments are projected to be medium to large relative to the community's total revenue, new tax-driven land-use changes would be MODERATE. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land-use changes would be LARGE. This would be especially true where the community has no pre-established pattern of development or has not provided adequate public services to support and guide development.

In 1999, prior to electric deregulation, property tax payments from Millstone accounted for 69 percent of Waterford tax revenues or $34.8 million. In 2000, after deregulation, Millstone taxes paid to Waterford represented 36 percent of the town's total annual property tax revenues or $11.7 million (Dominion 2004a). Based on an analysis by the town of Waterford (2003), tax payments from Millstone will continue to account for 25 to 30 percent of annual tax revenues.

The town of Waterford has anticipated the need to reduce its overall fiscal reliance on Millstone as a consequence of the change in assessment methodologies for electric power utilities. The *Town of Waterford Long Range Financial Management Plan* provides a toolkit with over 140 recommendations to assist the town of Waterford and the Waterford Public Schools to control and reduce costs (Waterford 2000).

The nontax economic benefits of Millstone on New London County will continue to be substantial. Millstone's impact between April 2001 and April 2002, was $515.2 million in New London County. The main expenditure by Dominion for Millstone is salaries. Direct and indirect compensation accounted for $118.3 million paid to employees residing in New London County during this period. In 2004, the average salary with benefits for a permanent employee at Millstone is $100,256, which is 50 percent higher than the average for New London County. In 2001, Dominion purchases in New London County were $34 million (Nuclear Energy Institute 2004).

The criteria in the GEIS (Section C.4.1.5.2) result in the assignment of an impact level of MODERATE when tax levels are greater than 10 percent. However, the case study assumed a certain level of refurbishment. There are no major refurbishment activities planned at Millstone to support license renewal, and no new sources of plant-related tax payments are expected that could significantly affect land use in New London County. Millstone has been and likely will continue to be an important economic force for New London County. However, Millstone has not been the primary factor in land-use change in Waterford or New London County. Waterford's slow rate of population growth (0.4 percent since 1980) is the same as New London County. There is still a large amount of land that is zoned and suitable for residential, commercial, and industrial development in Waterford. Southeastern Connecticut has been

addressing many planning issues including housing, water, transportation, and development patterns on a regional level. Land use patterns and trends are similar in Waterford and other suburban towns in southeastern Connecticut. In addition, continued operation of Millstone over the license renewal term would be important to maintaining the current level of development and public services in Waterford. Based on these considerations, it is the staff's conclusion that the tax-related land-use impacts are likely to be SMALL.

4.4.4 Public Services: Transportation Impacts During Operations

On October 4, 1999, 10 CFR 51.53(c)(3)(ii)(J) and 10 CFR Part 51, Subpart A, Appendix B, Table B-1 were revised to clearly state that "Public Services: Transportation Impacts During Operations" is a Category 2 issue (see NRC 1999 for more discussion of this clarification). The issue is treated as such in this SEIS.

There is no refurbishment planned at Millstone and, therefore, refurbishment impacts to the local transportation system are not anticipated and further evaluation is not necessary. Dominion reports that there would be no more than five additional license renewal term employees (Dominion 2004a). This is in addition to the station workforce of 1550 to 1650 employees and long-term contractors and a periodic outage workforce of as many as 800 additional workers.

Waterford, New London County, and the southeastern Connecticut region have a well-developed transportation system. In 2001, the segments of Route 156 passing by the Millstone access (at High Ridge Drive) had a volume to capacity ratio of 0.40, which means that there is unused capacity (SCCOG 2003). A new traffic signal will be installed at the intersection of Route 156 and Gardiners Wood Road, and recent changes to the intersection of Route 156 at Route 213 (Great Neck Road) should mitigate the congestion experienced there at certain times of day. The regional transportation plan for southeastern Connecticut contains a number of recommendations to address transportation concerns that could affect Waterford and Millstone because Millstone is the eleventh largest regional nonresidential traffic generator, and one of six high-security sites in southeastern Connecticut. The highest priority projects for southeastern Connecticut that affect Millstone are the completion of Route 11, and capacity improvements to Interstate 95. These projects remain unfunded (SCCOG 2003).

The staff has reviewed the Dominion ER (Dominion 2004a) and other information made available during interviews with local officials and observation of the transportation conditions around Millstone. The staff concludes that, based on the information available, increasing the current permanent workforce of Millstone during the license renewal period would result in a SMALL impact upon transportation, such that mitigation would not be warranted.

4.4.5 Historic and Archaeological Resources

The National Historic Preservation Act of 1966 (NHPA) requires Federal agencies to take into account the impacts of their undertakings on historic properties. The historic preservation review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation at 36 CFR Part 800. Pursuant to the NHPA, the NRC is to make a reasonable effort to identify historic properties in the area of potential effects. If no historic properties are present or affected, the NRC is required to document its finding and notify the State Historic Preservation Officer before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve possible adverse impacts of the undertaking.

On August 5, 2003, the Connecticut deputy state historic preservation officer indicated that the license renewal of Units 2 and 3 at Millstone would have "no effect" on historic properties (Connecticut Historical Commission 2004). However, earlier correspondence with the State Historic Preservation Office (Connecticut Historical Commission 2003) indicated the need to restrict activities to existing developed areas and that any new use of previously undeveloped areas within Millstone would require evaluation and new consultation. In addition, by letter dated October 6, 2004, the State Historic Preservation Office (Commission on Culture and Tourism 2004) stated, "This office expects that the proposed undertaking will have no effect on historic, architectural, or archaeological resources listed on or eligible for the National Register of Historic Places." The staff reviewed information contained in the ER prepared by Dominion (Dominion 2004a), conducted a search of archives and records stored at the Connecticut Historical Commission office in Hartford, and examined published literature about the archaeology and history of Connecticut. The staff also sent letters to the Narragansett Indian Tribe and the Mashantucket Pequot Tribal Nation inviting them to provide input to the scoping process relating to the NRC's environmental review of the applications and informing them that the NRC planned to coordinate compliance with Section 106 of the NHPA through the requirements of the National Environmental Policy Act of 1969 (NEPA), as outlined in 36 CFR 800.8. Neither the Narragansett Indian Tribe nor the Mashantucket Pequot Tribal Nation expressed concerns regarding historic, cultural, or archaeological resources.

It is unlikely that significant historic resources are present in the previously developed portions of Millstone. However, provisions for dealing with the inadvertent discovery of significant subsurface archaeological deposits and human remains are part of the administrative control procedures in place at Millstone, in the unlikely event such deposits and remains are encountered during routine operations and maintenance. As described in Chapter 3, major refurbishment of Millstone is not expected during the license renewal period, and it is anticipated that there will be no need to use the currently undeveloped portions of the Millstone site for operations during the renewal period. Millstone management is aware of the known cultural resources at Millstone and is committed to taking them into account during the license renewal period (Dominion 2004a). Continued operation of Millstone would be expected to have

a beneficial impact on these or any potential unknown or undiscovered historic or archaeological resources in undisturbed areas for the duration of the license renewal period by protecting the natural landscape and vegetation and by restricting access to the plant site.

Based on the staff's cultural resources analysis and consultation, the finding that Dominion did not identify any major refurbishment activities related to the renewal of the Millstone Units 2 and 3 OLs, and that operation will continue within the bounds of plant operations as evaluated in the Final Environmental Statement (U.S. Atomic Energy Commission 1973), it is the staff's conclusion that the potential impacts on historic and archaeological resources would be expected to be SMALL, and that mitigation is not warranted.

4.4.6 Environmental Justice

Environmental justice refers to a Federal policy that requires that Federal agencies identify and address, as appropriate, disproportionately high and adverse human health or environmental impacts of its actions on minority[a] or low-income populations. The memorandum accompanying Executive Order 12898 (59 FR 7629) directs Federal executive agencies to consider environmental justice under the National Environmental Policy Act of 1969. The Council on Environmental Quality has provided guidance for addressing environmental justice (Council on Environmental Quality 1997). Although the executive order is not mandatory for independent agencies, the NRC has voluntarily committed to undertake environmental justice reviews. On August 24, 2004, the Commission published a Final Policy Statement in the Federal Register on the treatment of environmental justice matters in NRC regulatory and licensing actions (NRC 2004d). The Final Policy Statement reaffirms that the Commission is committed to full compliance with the requirements of NEPA. Specific guidance is provided in NRC Office of Nuclear Reactor Regulation Office Instruction LIC-203, Revision 1, *Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues* (NRC 2004c).

The scope of the review as defined in NRC guidance (NRC 2004c) includes identification of impacts on minority and low-income populations, the location and significance of any environmental impacts during operations on populations that are particularly sensitive, and information pertaining to mitigation. It also includes evaluation of whether these impacts are likely to be disproportionately high and adverse.

(a) The NRC Guidance for performing environmental justice reviews defines "minority" as American Indian or Alaskan Native, Asian, Native Hawaiian or other Pacific Islander, Black races, or Hispanic ethnicity. "Other" races and multiracial individuals may be considered as separate minorities (NRC 2004b).

The staff looks for minority and low-income populations within the 80-km (50-mi) radius of the site. For the staff's review, a minority population exists in a census block group[(a)] if the percentage of each minority and aggregated minority category within the census block group exceeds the corresponding percentage of minorities in the State of which it is a part by 20 percent, or the corresponding percentage of minorities within the census block group is at least 50 percent. A low-income population exists if the percentage of low-income population within a census block group exceeds the corresponding percentage of low-income population in the State of which it is a part by 20 percent, or if the corresponding percentage of low-income population within a census block group is at least 50 percent.

The staff examined the geographic distribution of minority and low-income populations within 80 km (50 mi) of Millstone, using information derived from the 2000 Census for minority and low-income populations (Dominion 2004a). The analysis was supplemented by field inquiries to the Town of Waterford, the SCCOG and the United Way of New London County. Figures 4-2 and 4-3 show the distribution of census block groups for the minority and low-income populations, respectively.

The area within 80-km (50-mi) of Millstone includes parts of four states. USCB data characterize Connecticut as 0.3 percent American Indian or Alaskan Native, 2.4 percent Asian, 0.0 percent Native Hawaiian or other Pacific Islander, 9.1 percent Black races, 4.3 percent all other single minorities, 2.2 percent multiracial, 18.4 percent aggregate of minority races, and 9.4 percent Hispanic ethnicity. Rhode Island is 0.5 percent American Indian or Alaskan Native, 2.3 percent Asian, 0.1 percent Native Hawaiian or other Pacific Islander, 4.5 percent Black races, 5.0 percent all other single minorities, 2.7 percent multiracial, 15.0 percent aggregate of minority races, and 8.7 percent Hispanic ethnicity. New York was characterized as 0.4 percent American Indian or Alaskan Native, 5.5 percent Asian, 0.0 percent Native Hawaiian or other Pacific Islander, 15.9 percent Black races, 7.1 percent all other single minorities, 3.1 percent multiracial, 32.1 percent aggregate of minority races, and 15.1 percent Hispanic ethnicity. Massachusetts with 0.002 percent of the block groups is characterized as 0.2 percent American Indian or Alaskan Native, 3.8 percent Asian, 0.0 percent Native Hawaiian or other Pacific Islander, 5.4 percent Black races, 3.7 percent all other single minorities, 2.3 percent multiracial, 15.5 percent aggregate of minority races, and 6.8 percent Hispanic ethnicity.

(a) A census block group is a combination of census blocks, which are statistical subdivisions of a census tract. A census block is the smallest geographic entity for which the USCB collects and tabulates decennial census information. A census tract is a small, relatively permanent statistical subdivision of counties delineated by local committees of census data users in accordance with USCB guidelines for the purpose of collecting and presenting decennial census data. Census block groups are subsets of census tracts (USCB 2001).

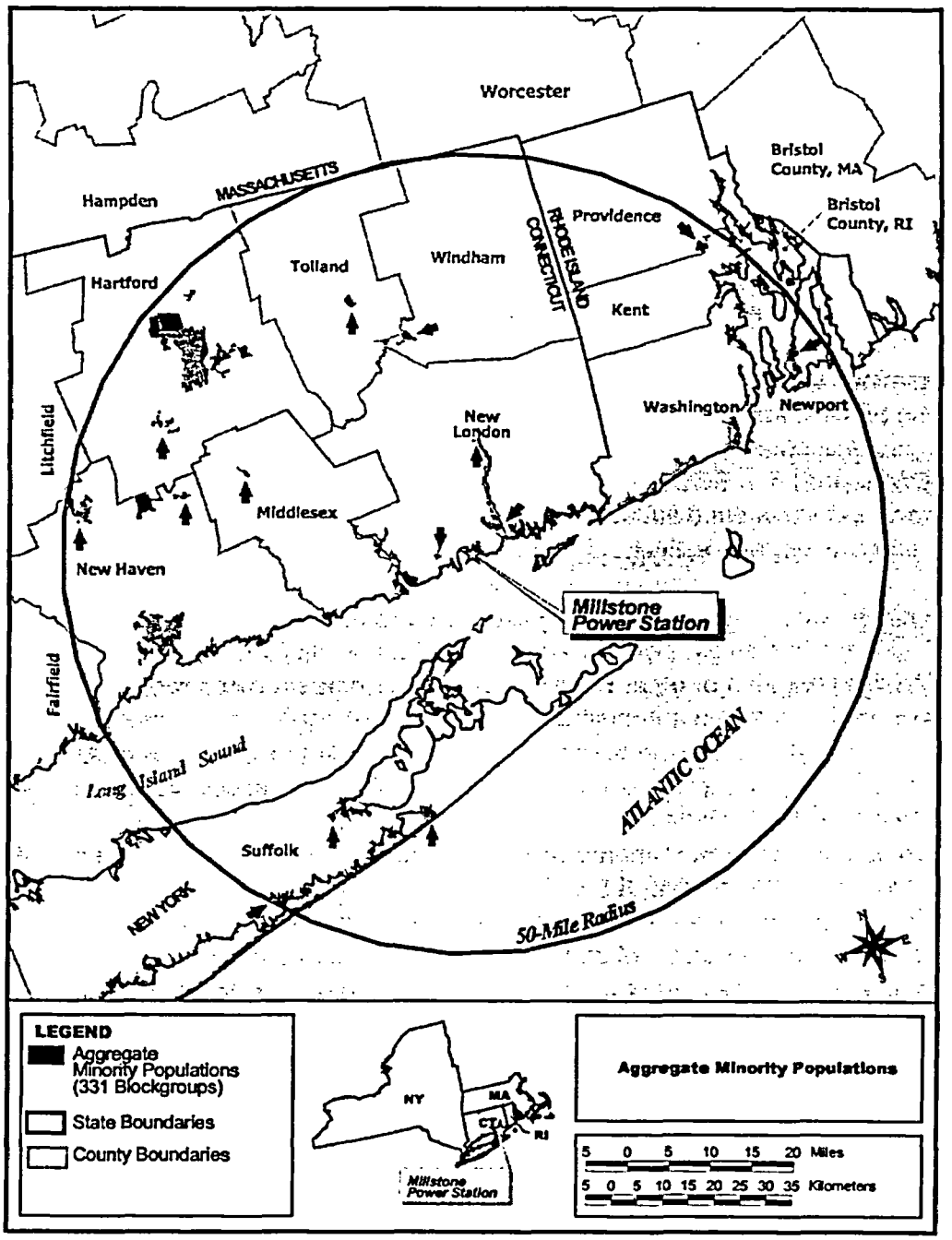

Figure 4-2. Geographic Distribution of Minority Populations (shown in shaded areas) Within 80 km (50 mi) of Millstone Based on Census Block Group Data[a]

(a) Note: Some of the census block groups extend into open water.

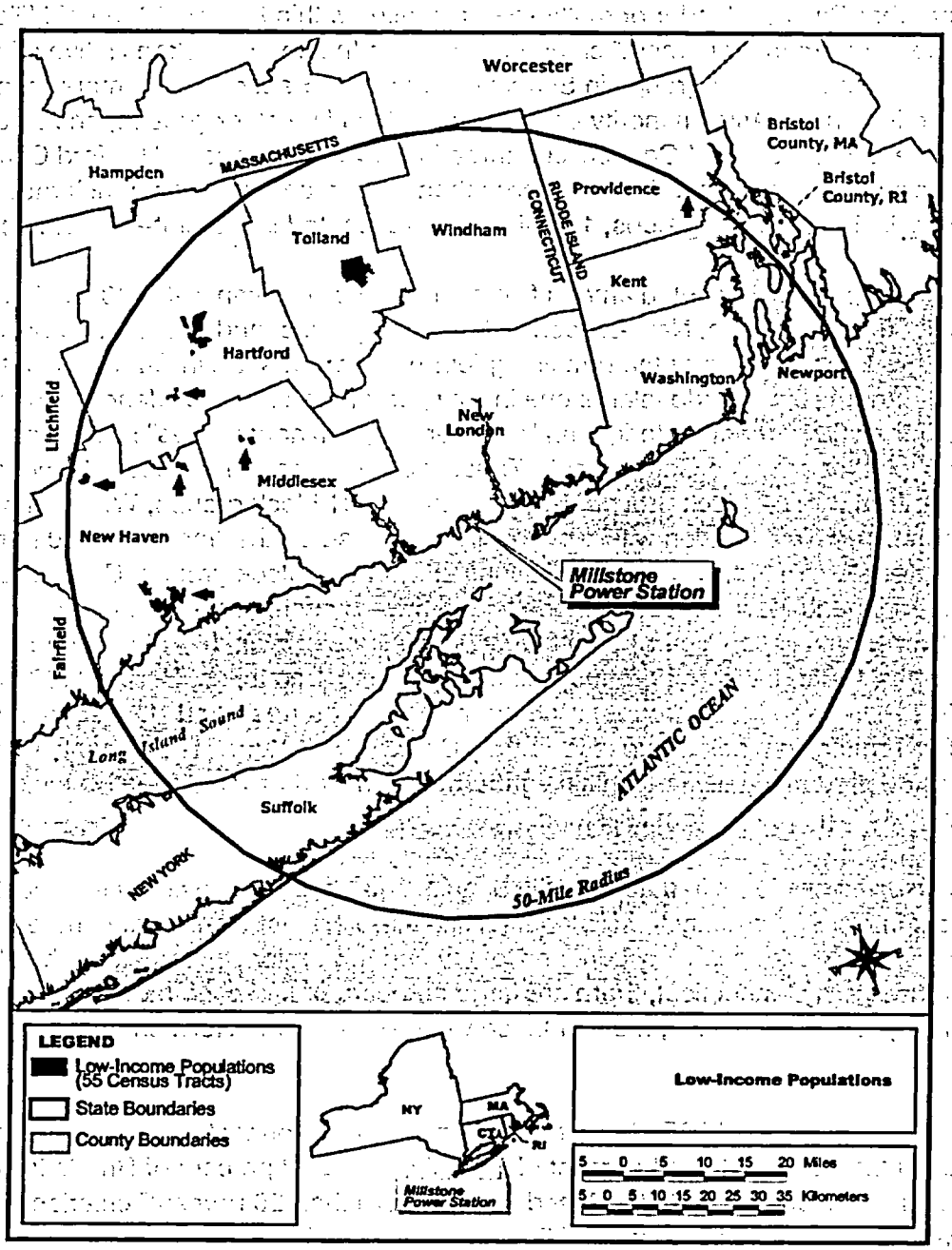

Figure 4-3. Geographic Distribution of Low-Income Populations (shown in shaded areas) Within 80 km (50 mi) of Millstone Based on Census Block Group Data [a]

(a) Note: Some of the census block groups extend into open water.

Based on the "more than 20 percent" or the "exceeds 50 percent" criteria, there are no Native Hawaiian or other Pacific Islander or multiracial minorities within 80 km (50 mi) of Millstone. Based on the "more than 20 percent" criterion, American Indian or Alaskan Native minority populations exist in two block groups in Suffolk County, NY. Based on the "more than 20 percent" criterion, an Asian minority population exists in five block groups, and all of these block groups are in the state of Connecticut: three in New Haven, one in Hartford County and the fifth in Tolland County. Based on the "more than 20 percent" criterion, Black races minority populations exist in 193 block groups, 189 of which are located in the state of Connecticut.

These block groups are distributed among five counties: New Haven with 103 block groups, Hartford with 80 block groups, New London with 4 block groups, and Tolland and Middlesex with 1 block group each. Two of the remaining four block groups are in Suffolk County, New York and the other two in Rhode Island: one in Newport and one in Providence County. Based on the "more than 20 percent" criterion, an "all other single minority races" population exists in 88 block groups that are all in Connecticut. These block groups are distributed among four counties: Hartford with 52 block groups, New Haven with 31 block groups, Windham with 4 block groups, and New London with 1 block group. Based on the "more than 20 percent" criterion, aggregate of minority races populations exist in 331 block groups: Connecticut has 325 block groups, and New York and Rhode Island have 3 each. Based on the "more than 20 percent" criterion, Hispanic ethnicity minority populations exist in 169 block groups. Connecticut has 168 of the block groups distributed among 4 counties: Hartford (83 block groups), New Haven (76 block groups), Windham (6 block groups), and New London (3 block groups). The remaining block group is in Suffolk County, New York. The minority populations identified reside predominantly in ethnic neighborhoods in Hartford and New Haven, approximately 64 km (40 mi) from Millstone.

Very few census blocks identified as minority populations under the environmental justice criteria, occur in closer proximity to Millstone. While there are not significant numbers of migrant agricultural workers in New London County and the region, according to the United Way of Southeastern Connecticut, there are large numbers of low-paid, mostly Asian, service workers employed at the casinos; most of these workers live in the Norwich area.

Dominion reported that the USCB characterized 8 percent of Connecticut, approximately 9 percent of all Massachusetts, 14 percent of New York, and 12 percent of Rhode Island households as "low income" in 2000. Based on the "more than 20 percent" criterion, 55 tracts contain low-income populations and 54 of these tracts are in Connecticut. The other one is in Rhode Island. These low-income households are predominantly in Hartford and New Haven, both approximately 64 km (40 mi) from Millstone (Dominion 2004a).

With the locations of minority and low-income populations identified, the staff proceeded to evaluate whether any of the environmental impacts of the proposed action could affect these

populations in a disproportionately high and adverse manner. Based on staff guidance (NRC 2004c), air, land, and water resources within 80 km (50 mi) of Millstone were examined. Within that area, a few potential environmental impacts could affect human populations; all of these were considered SMALL for the general population.

The pathways through which the environmental impacts associated with Millstone license renewal could affect human populations are discussed throughout this SEIS. The staff evaluated whether minority and low-income populations could be disproportionately affected by these impacts. The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately high and adversely affected. In addition, the staff did not identify any location-dependent disproportionately high and adverse impacts affecting these minority and low-income populations. The staff concludes that offsite impacts from Millstone to minority and low-income populations would be SMALL, and no additional mitigation measures would be warranted.

4.5 Ground-Water Use and Quality

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to Millstone Power Station, Units 2 and 3 ground-water use and quality are listed in Table 4-15. Dominion stated in its ER that it is not aware of any new and significant information associated with the renewal of the Millstone Power Station, Units 2 and 3. The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-15. Category 1 Issues Applicable to Ground-water Use and Quality During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
GROUND-WATER USE AND QUALITY	
Ground-water use conflicts (potable and service water; plants that use <100 gpm).	4.8.1.1
Ground-water quality degradation (saltwater intrusion)	4.8.2.1

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, 10 CFR 51, follows. (For each issue below, references to the Dominion ER are to Dominion 2004a.)

- Ground-water use conflicts (potable and service water; plants that use <100 gpm). Based on information in the GEIS, the Commission found that

  > Plants using less than 100 gpm are not expected to cause any ground-water use conflicts.

  As discussed in Section 2.2.2, Millstone ground-water use is less than 0.068 m^3/s (100 gallons per minute [gpm]). The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and the public comments on the draft SEIS. Therefore, the staff concludes that there would be no ground-water use conflicts during the renewal term beyond those discussed in the GEIS.

- Ground-water quality degradation (saltwater intrusion). Based on information in the GEIS, the Commission found that

  > Nuclear power plants do not contribute significantly to saltwater intrusion.

  The staff has not identified any new and significant information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and the public comments on the draft SEIS. Therefore, the staff concludes that there would be no ground-water quality degradation impacts associated with saltwater intrusion during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to ground-water use and quality for Millstone.

4.6 Threatened or Endangered Species

Threatened or endangered species are listed as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue is listed in Table 4-16.

The issue of threatened or endangered species present at the Millstone site requires consultation with appropriate agencies to determine whether any such species are present and whether they would be adversely affected by continued operation of the nuclear plant during the license renewal term. The staff consulted with the FWS and NOAA Fisheries under provisions of Section 7 of the Endangered Species Act (ESA) concerning the potential impacts of an additional 20 years of operation and maintenance activities at Millstone on Federally listed

Table 4-16. Category 2 Issue Applicable to Threatened or Endangered Species During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)			
Threatened or endangered species	4.1	E	4.6

species. The staff initiated consultation by requesting a list of threatened and endangered species (NRC 2004a, 2004b). FWS and NOAA Fisheries responded with a list of species that potentially occur in the project area (FWS 2004a; NOAA 2004). In November 2004, the staff sent a biological assessment (BA) to FWS and NOAA Fisheries and requested concurrences with the BA (NRC 2004e, 2004f). The FWS concurred with the staff's conclusions in a letter dated January 5, 2005 (FWS 2005). On January 12, 2005, NOAA Fisheries concurred with the staff's conclusions related to whales and sturgeon (NOAA 2005). They also concluded that continued operations of Millstone is not likely to adversely affect the protected turtle species. Copies of the letters between NRC and FWS and NOAA Fisheries are included in Appendix E. During the course of its evaluation, the staff considered mitigation measures for continued operation of Millstone. Based on this evaluation, the staff expects that current mitigation measures are appropriate, and no additional mitigation is warranted.

4.6.1 Aquatic Species

The known range of eight Federally listed marine species includes Long Island Sound. These include three species of whales—North Atlantic right whale (*Balaena glacialis*), finback whale (*Balaenoptera physalus*), and humpback whale (*Megaptera novaeangliae*)—and four species of sea turtle—loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), leatherback turtle (*Demochelys cariacea*), and Kemp's (Atlantic) ridley turtle (*Lepidochelys kempii*) (FWS 2004b). The shortnose sturgeon (*Acipenser brevirostrum*) is a Federally listed endangered species that is found in the Connecticut River and parts of Long Island Sound and is known to venture into salt water. The staff included the shortnose sturgeon in its impact analysis. The staff has evaluated the potential impact on these eight species from an additional 20 years of operation of Millstone and documented in its evaluation in a BA (see Appendix E).

Based on the evaluation in the BA, the staff has concluded that continued operation of the plant during the license renewal term would have no effect on the North Atlantic right whale, the finback whale, the humpback whale, and the shortnose sturgeon. The staff also has concluded that continued operation of the plant during the license renewal term is not likely to adversely affect loggerhead turtle, green turtle, leatherback turtle, and Kemp's ridley turtle. Based on its

evaluation, the staff's conclusion is that the potential impacts on threatened and endangered aquatic species from an additional 20 years of operation of Millstone would be SMALL.

4.6.2 Terrestrial Species

Six terrestrial species that are Federally protected under the ESA are known from counties in Connecticut that contain the Millstone site or are crossed by the Millstone transmission line ROWs. Two of the species, the piping plover (*Charadrius melodus*) and the Puritan tiger beetle (*Cicindela puritana*), are not known or not likely to be found in the future from the site or transmission ROWs. These two species are unlikely to be affected by station operation during the renewal period. Both the bald eagle (*Haliaeetus leucocephalus*) and the roseate tern (*Sterna dougallii*) are known to occasionally use the Millstone site. The New England cottontail rabbit (*Sylvilagus transitionalis*) is not reported from the site or transmission ROWs. However, the habitat maintained by CL&P along the ROWs may be attractive to this species. Habitat for the small whorled pogonia (*Isotria medeoloides*) may exist at the Millstone site or along associated transmission line ROWs. Maintenance practices are unlikely to adversely impact specimens of this species if it exists at the site or along the transmission line ROWs.

The staff has determined that license renewal for Millstone would have no effect on the Puritan tiger beetle and the piping plover and may affect, but it is not likely to adversely affect, the bald eagle, the roseate tern, the New England cottontail, and the small whorled pogonia. Therefore, the staff concludes that the potential impacts of an additional 20 years of operation and maintenance of Millstone on Federal endangered, threatened, proposed, or candidate terrestrial species would be SMALL.

4.7 Evaluation of Potential New and Significant Information on Impacts of Operations During the Renewal Term

As discussed in Section 4.3, radiation exposure issues for the license renewal term are Category 1 issues. During the scoping process and the comment period on the draft SEIS, members of the public (1) expressed concern about the possible impacts on human health from exposure to radiation from Millstone's effluents and (2) cited a number of documents to support their concerns. The NRC Staff reviewed these documents as potential new and significant information regarding the Category 1 radiation exposure issues.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses and dose rates below 100 millisievert (mSv) (10,000 millirem [mrem]). However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary or teratogenic effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose-response relationship is used to describe the

relationship between radiation dose and detriments such as cancer induction. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks.

Thousands of studies have been performed on the biological effects of radiation exposure. None of the scientifically valid studies show health effects at acute doses less than 100 mSv (10,000 mrem). Based on the consensus of the conclusions of national and international experts such as the National Council on Radiation Protection and Measurements and the International Commission on Radiological Protection (ICRP), the NRC and EPA have established conservative dose limits for the protection of human health. In 40 CFR Part 190, EPA set a limit of 25 mrem/yr to the whole body of a member of the public from the entire nuclear fuel cycle, including nuclear power plants. NRC established dose design objectives in 10 CFR Part 50, Appendix I, to implement the EPA standards for radiological effluents from nuclear power plants.

As discussed in Sections 2.1.4, 2.2.7, and 4.3 of this SEIS, Dominion monitors the amounts of radionuclides released in the effluents from Millstone to ensure compliance with these regulations. Dominion also conducts an environmental radiological monitoring program to confirm the expected levels of radioactive materials in the area around Millstone. Based on recent experience, the NRC staff expects the releases of radioactive material from Millstone to be well within regulations during the license renewal period and much less than 1 millirem per year (mrem/yr) to the maximally exposed member of the public. The same member of the public receives an average dose of approximately 360 mrem/yr from natural background and medical sources of radiation (NRC 2005a). The NRC inspects Dominion's radiological effluent and environmental radiological monitoring programs at Millstone, and CTDEP also conducts environmental radiological monitoring around Millstone.

Cancer is not rare; in fact, cancer is very common in the U.S. population. According to the American Cancer Society, more than a half million Americans die from cancer each year, more than 1500 people a day. There are many possible causes and risk factors for cancer, including radiation exposure. However, according to the health risk estimates in ICRP Publication 60 (ICRP 1990), the risk of radiation exposure causing cancer is extremely low at doses below 1 mrem/yr.

In 1990, at the request of Congress, the National Cancer Institute (NCI) conducted a study, "Cancer in Populations Living Near Nuclear Facilities," to look at cancer mortality rates around 52 nuclear power plants (including Millstone), nine Department of Energy facilities, and one former commercial fuel reprocessing facility (NCI 1990). The study "produced no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities." In addition, based on analyses of data from the Connecticut Tumor Registry, the Connecticut State

Department of Public Health (CTDPH) concluded that there is no evidence of increased cancer incidence in Connecticut due to radiation exposure from Millstone (NRC 2005b).

During scoping, some commenters stated that operation of Millstone resulted in excess cancers in the population around the plant site. Several reports were cited including the following: *Elevated Childhood Cancer Incidents Proximate to U.S. Nuclear Power Plants* (Mangano et al. 2003), *2,500 Excess Cancer Cases in New London County Since 1970: Radioactive Emissions from Millstone May Be The Cause* (Mangano 1998), *Cancer in Populations Living Near Nuclear Facilities* (National Cancer Institute 1990), and *Cancer Incidence in Connecticut Counties, 1995–1999* (CTDPH 2004). During scoping, other commenters stated that there is no relationship between cancer incidence and nuclear power plants, citing a Connecticut Academy of Science and Engineering (CASE) study titled *Study of Radiation from the Connecticut Yankee Nuclear Power Plant* (CASE 2000) and *Cancer in Populations Living Near Nuclear Facilities* (National Cancer Institute 1990). These reports and referenced studies were based on data obtained from the Connecticut Tumor Registry and the Surveillance, Epidemiology, and End Result (SEER) reports, which are published by NCI.

Mangano (1998) provided summary information on cancer incidence and mortality rates in New London County and the four towns near Millstone before and after startup. The information summarized appears to be based on the Connecticut Tumor Registry data and an NCI report (NCI 1990). Mangano (1998) suggested that the increase in cancer may be related to operations at Millstone; however, no evidence was provided to support a causal relationship between increased cancer incidence and Millstone operations.

Mangano et al. (2003) performed a more extensive review of cancer incidence and mortality for children living within 48 km (30 mi) of 14 nuclear power plants in the eastern U.S. (including Millstone) from 1970 through 1997. The cancer incidence and mortality rates were compared with data considered to be representative of the U.S. population. Mangano et al. (2003) reported no significant difference in childhood cancer mortality rates between counties surrounding the nuclear power plants and the U.S. population. However, Mangano et al. (2003) referenced an NCI report (NCI 1990) that showed a significantly increased relative risk of leukemia in children ages 0 to 9 years who lived in five counties near four nuclear plants in Connecticut and Iowa. Similarly, the incidence rate for all cancers for children 0 to 9 years in counties near Millstone was 1.0 percent higher compared to the incidence estimate for the remainder of Connecticut and Rhode Island. The mortality rate for all cancers for children 0 to 9 years in counties near Millstone was 26.7 percent lower than the U.S. rate (Mangano et al. 2003).

The NCI study (NCI 1990) reviewed 35 years of cancer incidence and mortality data for counties where 62 nuclear facilities are located. These data were compared with the cancer rates of comparable regional counties located away from nuclear facilities. The study reported that the relative risk of leukemia for New London County (location of Millstone) was significantly

higher compared to the control counties for leukemia for children under 10 years (NCI 1990). The relative risk was the highest of all sites reported (relative risk of 3.04, where 1.0 indicates the same relative risk compared to the control counties). The study stated that this high risk, in part, reflected the unusually low incidence of cancer in the control counties compared to the national rate. The report also noted that the incidence of leukemia in children under 10 in New London County was elevated before startup of Millstone. There were 30 cases of leukemia in children from 1961 to 1970 before Millstone startup (30 cases in 10 years is 3.00 cases per year) and 44 cases from 1971 to 1984 after Millstone startup (44 cases in 14 years is 3.15 cases per year before correction for population increase). The report (NCI 1990) concluded:

> Comparisons of study and control counties exhibit substantial variation, as should be expected, because the matching cannot remove all variation due to demographic factors. Properly taking this into account, there is no evidence of systematically higher cancer risks in the study counties. Moreover, even the highest relative risks for individual facilities were compatible with the general level of variation seen....

The NCI report "found no suggestion that nuclear facilities may be linked causally with excess deaths from leukemia or from other cancers in the populations living nearby." John Boice, Sc.D., chief of NCI's Radiation Epidemiology Branch at the time of the survey, concluded: "From the data at hand, there was no convincing evidence of any increased risk of death from any of the cancers we surveyed due to living near nuclear facilities...." (NCI 2002).

The CTDPH reported cancer incidence rates for the period 1995 to 1999 for Connecticut towns (CTDPH 2002) and counties (CTDPH 2004). Both reports were based on data from the Connecticut Tumor Registry. The county report compared cancer incidence rates for various forms of cancer for each county with the average cancer incidence rate for the State. New London County had the highest incidence rate for all invasive tumors for females and for several forms of cancer for one or both genders. The report for the towns compared the observed number of cancers for various forms of cancer for each town with the expected number of cancers based on the average incidence rates for the State and presented ratios of observed cases to expected cases. The town of Waterford did not have the highest ratio of observed cancers to expected cancers for any form of cancer analyzed. Waterford was in the highest ratio quartile for colorectal cancer in males, lung cancer in females, and melanomas (skin cancer) in females; however, for each of these cancer forms, several other towns had higher ratios.

The CASE study (2000) was initiated because of citizen concerns regarding the potential health impacts from nuclear power plants. The study focused on the Connecticut Yankee plant; however, the report included analyses of leukemia, thyroid cancer, and multiple myeloma from the Connecticut Tumor Registry from 1976 to 1995 for each of Connecticut's 169 towns. The maps in the report show the ratio of the observed cancer cases versus the expected cancer

cases based on the state average incidence and the town population. The town of Waterford was not in the highest ratio category for any cancer except thyroid cancer, and at least three other towns had higher ratios for thyroid cancer. At least 30 towns had higher ratios than Waterford for pediatric leukemia (ages 0 to 14).

The NRC staff and its contractors discussed Millstone's history of radiological effluent and environmental monitoring with officials from CTDEP's Division of Radiation. The reports cited above by CTDPH, CASE, and NCI were also discussed. CTDEP conducts its own radiological environmental monitoring program around Millstone. CTDEP had also reviewed the reports by CTDPH, CASE, and NCI. CTDEP concluded that Millstone's radiological effluent and environmental monitoring data were accurate. CTDEP also concluded that the reports cited above by CTDPH, CASE, and NCI reports showed no evidence of a causal link between public exposure to Millstone's radiological effluents and cancer incidence or mortality rates in Connecticut towns.

In the GEIS, radiation exposure to the public during the license renewal term was considered a Category 1 issue (see Chapter 1 and Section 4.3 for a discussion of Category 1 issues and radiological impacts from normal operations). The GEIS concluded that the risk to the public from continued operation of a nuclear plant would not increase during the license renewal term. Doses to members of the public from Millstone emissions were specifically evaluated in Appendix E of the GEIS and were found to be well within regulatory limits.

During the comment period for the draft SEIS, a number of commenters expressed concern that operation of Millstone results in excess cancers in the population around the plant site. Commenters cited the following documents in support of these concerns:

- House of Representatives. 101st Congress, 2d session. Report 101-463. Radiation Exposure Compensation Act. April 25, 1990.
- State of Connecticut. Department of Public Health. Connecticut Tumor Registry. *Cancer Incidence in Connecticut Counties, 1995-99.* January 2004.
- Steinberg, M. 1998. *Millstone and Me: Sex, Lies and Radiation In Southeastern Connecticut.* Black Rain Press. Niantic, Connecticut. October 1998.
- Exhibit by Cynthia Besade, "Millstone Community Cancer Victims Personally Known."
- Remarks and exhibit by Gail Merill, (3 Pages) including: *Risks of Cancer and Other Diseases From the Operation of Millstone Nuclear Plant,* by Joseph Mangano, MPH, MBA. August 5, 2004.
- Exhibits by Michael Steinberg, Radiation and Public Health Project. Risk of Cancer and Other Diseases from the Operation of the Millstone Nuclear Unit" (14 Pages), "Local health declines when Millstone opens, improves after closing" (1 Page)
- Memo from E.J. Sternglass to Nancy Burton, Esq. Subject: Synergistic interaction of radiation, air pollution and chemicals. March 8, 2005

- *WISE/NIRS Nuclear Monitor* 583 9. "ECRR report challenges entrenched radiation assumptions." February 21, 2003.
- State of Connecticut. Department of Public Health. Connecticut Tumor Registry. *Incidence of Selected Cancers in Connecticut by Town 1995-99.* May 2002.
- Navab, V., R. Hawkins, and M. Resnikoff. 2003. "Health effects of selected industrial chemicals and radionuclides: an introduction." *STAND Technical Report* 2003–2. July 2003.
- Chart titled: *Percent increase in cancer incidence, cancer mortality and other health effects of human exposure to ionizing radiation.* Accessed at: http://www.nirs.org/radiation/radchart.htm. on March 13, 2005.
- Benoit,G., P. Patton, and C. Arnold. 1999. "Trace Metals and Radionuclides Reveal Sediment Sources and Accumulation Rates in Jordan Cove, Connecticut." *Estuaries.* Vol.22, No.1. March 1999.

NRC's dose limits are conservative and supported by the EPA and international agencies, such as ICRP, United Nations Scientific Committee on the Effects of Atomic Radiation, and the European Commission on Radiation Protection. Review and evaluation of new studies and analyses of the health effects of radiation exposure is an ongoing process at the NRC. The scientifically defensible epidemiological studies on the biological effects of ionizing radiation provide solid evidence that the current regulatory standards are protective of human health. Dominion has demonstrated that releases from Millstone during the renewal period are expected to be below regulatory limits.

The NRC staff has reviewed all of the documents listed above and finds that the information in these documents fails to demonstrate that the analysis in the GEIS (as codified in 10 CFR Part 51, Subpart A, Appendix B, Table B-1) of the human health impact of radiation exposure resulting from the operation of Millstone is incorrect.

The staff concludes that the information provided during the scoping process and comment period on the draft SEIS was not new and significant with respect to the findings of the GEIS on the health effects to the public from radiological effluent releases due to Millstone operations.

4.8 Cumulative Impacts of Operations During the Renewal Term

The staff considered potential cumulative impacts during the evaluation of information applicable to each of the potential impacts identified within the GEIS. The impacts of the proposed license renewal are combined with other past, present, and reasonably foreseeable future actions to determine whether cumulative impacts exist. For the purposes of this analysis, past actions were those related to the resources at the time of the plant licensing and construction. Current actions are the operation of the power plant and future actions are

considered to be those that are reasonably foreseeable through the end of plant operation. Therefore, the analysis considers potential impacts through the end of the current license term, as well as the 20-year license renewal term. The geographical area over which past, present, and future actions that could contribute to cumulative impacts is dependent on the type of action considered, and is described below for each impact area.

4.8.1 Cumulative Impacts Resulting from Operation of the Plant Cooling System

For the purposes of this analysis, the geographic area considered is the 80-km (50-mi) region surrounding Millstone. As described in Section 4.1, the staff found no new and significant information indicating that the conclusions regarding any of the cooling-system-related Category 1 issues as related to Millstone are inconsistent with the conclusions in the GEIS. Additionally, the staff has determined that with the exception of entrainment, none of the cooling-system-related Category 2 issues were likely to have greater than a SMALL impact on local water quality or aquatic resources. The staff has determined that entrainment would likely have a MODERATE impact on aquatic resources. As described in Section 2.1.3, Millstone uses the Niantic Bay as a source of cooling water for its condenser. The Niantic Bay is fed by the Niantic River and is connected hydrologically to Long Island Sound. The continuing low winter flounder population levels are likely a result of multiple impacts including fishing mortality, entrainment from Millstone water withdrawals, environmental changes associated with regional increases in water temperature, and predator-prey interactions. In addition, changes to water and sediment quality from runoff, urbanization, and industrial activities may also be stressors. Therefore, the cumulative impact from continued operation of Millstone plant cooling system would be MODERATE. Dominion is involved in an ongoing review of the impacts from Millstone impingement and entrainment related to renewal of its NPDES permit. Additionally, new regulations promulgated by EPA related to intake structure performance standards will require further assessment of intake related impacts. Any additional mitigation related to the NPDES review and EPA's new performance requirements will result in less impact to the Long Island Sound fisheries.

4.8.2 Cumulative Impacts Resulting from Continued Operation of the Transmission Lines

The continued operation of the electrical transmission facilities connecting Millstone to the transmission grid was evaluated to determine if there is the potential for interactions with other past, present, and future actions that could result in adverse cumulative impacts—including both the acute and chronic effects of electromagnetic fields—to terrestrial resources, such as wildlife populations and the size and distribution of habitat areas, and to aquatic resources such as wetlands and floodplains. For the purposes of this analysis, the geographic area that encompasses the past, present and foreseeable future actions that could contribute to adverse cumulative impacts is the area within 80 km (50 mi) of the Millstone site, as depicted in Figure 2-1. As described in Section 4.2, the staff found no new and significant information

indicating that the conclusions regarding any of the transmission line-related Category 1 issues related to Millstone are inconsistent with the conclusions in the GEIS. For the Category 2 issue related to electromagnetic fields—acute impacts (electric shock)—the impact would be SMALL and the uncategorized issue of chronic impacts is still considered "not applicable." There are no known or planned activities within the 80-km (50-mi) radius area of consideration that could potentially produce additional impacts associated with transmission lines. Therefore, the cumulative impacts would be SMALL, and no additional mitigation measures are warranted.

4.8.3 Cumulative Radiological Impacts

The radiological dose limits for protection of the public and workers have been developed by EPA and NRC to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. As described in Section 2.2.7, the public and occupational doses resulting from operation of Millstone are within regulatory limits, and as described in Section 4.3, the impacts of these doses are expected to be SMALL during the license renewal period. For the purposes of this analysis, the area within an 80-km (50-mi) radius of the Millstone plant was included (see Figure 2-1). EPA regulations in 40 CFR 190 limit the dose to members of the public from all sources in the nuclear fuel cycle in the United States, including all nuclear power plants, fuel fabrication facilities, waste disposal facilities, and transport of fuel and waste. In addition, the radiological environmental monitoring program conducted by Dominion in the vicinity of Millstone measures radiation and radioactive material from all sources, including Millstone; therefore, the monitoring program measures cumulative radiological impacts. There are no known or planned activities; however, the NRC and the state of Connecticut would regulate any future actions in the vicinity of Millstone that could contribute to cumulative radiological impacts. Therefore, the staff determined that the cumulative radiological impacts of continued operation of Millstone would be SMALL, and that no additional mitigation is warranted.

4.8.4 Cumulative Socioeconomic Impacts

Much of the analyses of socioeconomic impacts presented in Section 4.4 of this SEIS already incorporate cumulative impact analysis because the metrics used for quantification only make sense when placed in the total or cumulative context. For instance, the impact of the total number of additional housing units that may be needed can only be evaluated with respect to the total number that is expected to be available in the impacted area. Therefore, the geographical area of the cumulative impact analysis varies depending on the particular impact considered, and may depend on specific boundaries, such as taxation jurisdictions, or may be distance related, as in the case of environmental justice.

The continued operation of Millstone is not likely to add to any cumulative socioeconomic impacts beyond those evaluated in Section 4.4. In other words, the impacts of issues such as transportation or offsite land use are likely to be undetectable beyond the regions previously

evaluated and will quickly decrease with increasing distance from the site. The staff has determined that the impacts of license renewal on housing, public utilities, public services, and environmental justice would all be SMALL. The staff has determined that the impact of license renewal on offsite land use would be SMALL because, even though Millstone provides greater than 10 percent of the property tax revenue for the town of Waterford, there are no refurbishment actions planned at Millstone. There are no reasonably foreseeable scenarios that would alter these conclusions with regard to cumulative impacts.

Related to historic resources, there are no structures eligible for the inclusion in the National Register of Historic Places on the Millstone site or along the transmission lines. The staff has concluded that the impacts of license renewal on historic resources would be SMALL. The continued operation and maintenance of the Millstone site and transmission line ROWs would not be expected to impact any properties beyond the site or ROW boundaries. Therefore, the contribution to a cumulative impact on historic resources would be negligible.

Based on these considerations, the staff concludes that continued operation of Millstone is not likely to make a detectable contribution to the cumulative impacts associated with any of the socioeconomic issues discussed in Section 4.4 and, therefore, that the cumulative impacts would be SMALL, and no additional mitigation measures are warranted.

4.8.5 Cumulative Impacts on Ground-water Use and Quality

The Millstone ground-water use is less than 100 gpm. The expected impact on the aquifer due to continued plant operations and ground-water withdrawals would be SMALL as discussed in Section 4.5. There are no known or planned projects that would require withdrawal of groundwater that, if implemented in addition to license renewal, would potentially cause an adverse impact on groundwater. Therefore, the cumulative impact would be SMALL, and no additional mitigation measures are warranted.

4.8.6 Cumulative Impacts on Threatened or Endangered Species

The geographic area considered in the analysis of cumulative impacts to threatened or endangered species includes the Millstone site and the associated transmission line ROWs. As discussed in Sections 2.2.5 and 2.2.6, there are several threatened or endangered species that occur within this area. However, the staff determined in Section 4.6 that continued operation of Millstone would have no impact or is not likely to adversely affect any of these species. Therefore, the continued operation of Millstone would not be expected to contribute to a regional cumulative impact to these species, regardless of whether other actions occur that could have adverse impacts.

Therefore, the staff has determined that the cumulative impacts to threatened or endangered species due to continued operation at the Millstone site and associated transmission line ROWs would be SMALL, and that additional mitigation measures would not be warranted.

4.9 Summary of Impacts of Operations During the Renewal Term

Neither Dominion nor the staff is aware of information that is both new and significant related to any of the applicable Category 1 issues associated with the operation of Millstone during the renewal term. Consequently, the staff concludes that the environmental impacts associated with these issues are bounded by the impacts described in the GEIS. For each of these issues, the GEIS concluded that the impacts would be SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

In Chapter 4, plant-specific environmental evaluations were conducted for 10 Category 2 issues applicable to Millstone operation during the renewal term and for environmental justice and chronic impacts of electromagnetic fields. For nine issues and environmental justice, the staff concluded that the potential environmental impact of renewal term operations of Millstone would be of SMALL significance in the context of the standards set forth in the GEIS and that additional mitigation would not be warranted. For entrainment, the staff's conclusion is that the impact resulting from license renewal would be MODERATE. In addition, the staff determined that a consensus has not been reached by appropriate Federal health agencies regarding chronic adverse impacts from electromagnetic fields. Therefore, the staff did not further evaluate this issue.

4.10 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Property,* Part 800, "Advisory Council on Historic Preservation."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

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5.0 Environmental Impacts of Postulated Accidents

Environmental issues associated with postulated accidents are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[a] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) Single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1 and, therefore, additional plant-specific review of these issues is required.

This chapter describes the environmental impacts from postulated accidents that might occur during the license renewal term.

5.1 Postulated Plant Accidents

Two classes of accidents are evaluated in the GEIS. These are design-basis accidents (DBAs) and severe accidents, as discussed below.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

5.1.1 Design-Basis Accidents

In order to receive NRC approval to operate a nuclear power facility, an applicant for an initial operating license must submit a safety analysis report (SAR) as part of its application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff reviews the application to determine whether the plant design meets the Commission's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in 10 CFR Part 50 and 10 CFR Part 100.

The environmental impacts of DBAs are evaluated during the initial licensing process, and the ability of the plant to withstand these accidents is demonstrated to be acceptable before issuance of the operating licenses (OLs). The results of these evaluations are found in license documentation such as the applicant's final safety analysis report (FSAR), the staff's safety evaluation report (SER), the final environmental statement (FES), and Section 5.1 of this supplemental environmental impact statement (SEIS). A licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant, including any extended-life operation. The consequences for these events are evaluated for the hypothetical maximally exposed individual; as such, changes in the plant environment will not affect these evaluations. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for license renewal, the environmental impacts as calculated for DBAs should not differ significantly from initial licensing assessments over the life of the plant, including the license renewal period. Accordingly, the design of the plant relative to DBAs during the extended period is considered to remain acceptable and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, DBAs are designated as a Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The early resolution of

the DBAs makes them a part of the current licensing basis of the plant; the current licensing basis of the plant is to be maintained by the licensee under its current license and, therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal. This issue, applicable to Millstone, Units 2 and 3 (Millstone), is listed in Table 5-1.

Table 5-1. Category 1 Issue Applicable to Postulated Accidents During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
POSTULATED ACCIDENTS	
Design basis accidents	5.3.2; 5.5.1

Based on information in the GEIS, the Commission found that:

> The NRC staff has concluded that the environmental impacts of design basis accidents are of small significance for all plants.

Dominion Nuclear Connecticut, Inc. (Dominion) stated in its Environmental Report (ER) (Dominion 2004) that it is not aware of any significant new and significant information associated with the renewal of the Millstone OLs. The staff has not identified any significant new information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts related to design basis accidents beyond those discussed in the GEIS.

5.1.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. In the GEIS, the staff assessed the impacts of severe accidents during the license renewal period, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Severe accidents initiated by external phenomena such as tornadoes, floods, earthquakes, fires, and sabotage have not traditionally been discussed in quantitative terms in final environmental statements (FESs) and were not specifically considered for the Millstone site in the GEIS (NRC 1996). However, in the GEIS the staff did evaluate existing impact assessments performed by NRC and by the industry at 44 nuclear plants in the United States and concluded that the risk from sabotage and beyond design basis earthquakes at existing

nuclear power plants is SMALL. Additionally, the staff concluded that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents.

Based on information in the GEIS, the Commission found that:

> The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

Therefore, the Commission has designated mitigation of severe accidents as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue, applicable to Millstone, is listed in Table 5-2.

Table 5-2. Category 2 Issue Applicable to Postulated Accidents During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
	POSTULATED ACCIDENTS		
Severe accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.3.4; 5.4; 5.5.2	L	5.2

The staff has not identified any significant new information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts of severe accidents beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the staff has reviewed severe accident mitigation alternatives (SAMAs) for Millstone. The results of its review are discussed in Section 5.2.

5.2 Severe Accident Mitigation Alternatives

Section 51.53(c)(3)(ii)(L) requires that license renewal applicants consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement (EIS) or related supplement or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance

are identified and evaluated. SAMAs have not been previously considered for Millstone; therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

This section presents a summary of the SAMA evaluations for Millstone conducted by Dominion and described in the ER and the NRC's review of those evaluations. The details of the review are described in the NRC staff evaluations that were prepared with contract assistance from Information Systems Laboratories, Inc. The evaluation for Millstone, Unit 2 is presented in Appendix H; the evaluation for Millstone, Unit 3 is presented in Appendix I. Dominion conducted the SAMA evaluations for Millstone using a four-step approach. In the first step, Dominion quantified the level of risk associated with potential reactor accidents using plant-specific probabilistic risk assessments (PRAs) and other risk models.

In the second step, Dominion examined the major risk contributors and identified possible ways (SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. Dominion initially identified 196 potential SAMAs for Millstone, Unit 2 and 185 potential SAMAs for Millstone, Unit 3. Dominion screened out SAMAs that were not applicable to Millstone, had already been implemented at Millstone (or the Millstone design met the intent of the SAMA), or were related to reactor coolant pump (RCP) seal vulnerability stemming from charging pump dependency on the component cooling water (CCW) system. The Millstone units do not rely on component cooling water systems for RCP seal cooling. This screening reduced the list of potential SAMAs to 44 for Unit 2 and 52 for Unit 3.

In the third step, Dominion estimated the benefits and the costs associated with each of the remaining SAMAs. Estimates were made of how much each SAMA could reduce risk. Those estimates were developed in terms of dollars in accordance with NRC guidance for performing regulatory analyses (NRC 1997b). The cost of implementing the proposed SAMAs was also estimated.

Finally, in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost beneficial, meaning the benefits of the SAMA were greater than the cost (a positive cost benefit). For Unit 2, Dominion determined in its ER that SAMA 3 would be cost beneficial. For Unit 3, Dominion determined that none of the SAMAs would be cost beneficial (Dominion 2004a).

The NRC reviewed Dominion's SAMA analyses. In response to a request for additional information (RAI) (NRC 2004), Dominion assessed the applicability and feasibility of several SAMAs for Unit 2 that were considered by another Combustion Engineering (CE) plant. As a result, Dominion eliminated all of the SAMAs questioned except one—adding a capability to

flash the field on the emergency diesel generator using a portable generator to enhance station blackout (SBO) event recovery. Dominion stated that this SAMA is not expected to be cost beneficial because it would likely require a plant modification to install a disconnect to allow the connection of a portable (temporary) generator, as well as development of a new severe accident management guideline (SAMG). However, Dominion stated that if this SAMA can be accomplished via a SAMG without a hardware modification, the SAMA would be cost beneficial and will be implemented prior to the period of extended operation (Dominion 2004b).

The staff questioned Dominion about lower cost alternatives to some of the SAMAs evaluated for Unit 3 (NRC 2004). As originally proposed, SAMA 112 involved physical modifications to provide steam generator level indication in an SBO scenario, as well as the development of an emergency operating procedure that would direct the manual control of the turbine-driven auxiliary feedwater (AFW) pump. This SAMA was estimated not to be cost beneficial. However, as an alternative to SAMA 112, Dominion considered the development of a SAMG without the hardware modification. This improvement could be effective in a more limited number of sequences in which AFW control power is lost, but steam generator level indications are not. The estimated benefit of this modification is greater than the expected cost after consideration of uncertainties; therefore, it is potentially cost beneficial. As indicated in its RAI response, Dominion plans to complete its evaluation of this SAMA and, if it is cost beneficial, will develop a SAMG addressing manual control of the turbine-driven AFW pump prior to the period of extended operation (Dominion 2004b).

None of these SAMAs relate to adequately managing the effects of aging during the period of extended operation; therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54. Dominion's SAMA analyses and the NRC's review are discussed in more detail below.

5.2.2 Estimate of Risk

Dominion submitted an assessment of SAMAs for Millstone as part of the ER (Dominion 2004a). This assessment was based on the most recent Millstone PRA available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 computer program, and insights from the Millstone Individual Plant Examinations (IPE) for Unit 2 (NNECO 1993) and for Unit 3 (NNECO 1990) and Individual Plant Examination of External Events for Unit 2 (NNECO 1995) and for Unit 3 (NNECO 1991).

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 7.17×10^{-5} per year for Unit 2 and approximately 2.57×10^{-5} per year for Unit 3. These CDFs are based on the risk assessment for internally initiated events. Dominion did not

include the contribution to risk from external events within the Millstone risk estimates; however, it did account for the potential risk reduction benefits associated with external events by increasing the estimated benefits for internal events by a factor of 1.3 for Unit 2 and a factor of 1.6 for Unit 3. The breakdown of CDF by initiating event for Units 2 and 3 is provided in Tables 5-3 and 5-4, respectively.

As shown in Table 5-3, loss-of-coolant accidents (LOCAs), loss of cooling water to the primary side components (COOL) including service water and reactor building closed cooling water (RBCCW), loss of DC power, and transients including anticipated transients without scram (ATWS) are dominant contributors to the CDF for Unit 2. LOCAs are dominated by small-break LOCAs, which make up about 36 percent of the total CDF. Bypass events [i.e., steam generator tube rupture (SGTR) and interfacing systems loss of coolant accident (ISLOCA)] contribute less than four percent to the total internal events CDF.

As shown in Table 5-4, LOCAs, RCP seal LOCAs, transients including ATWS, and loss of offsite power (LOOP) are dominant contributors to the CDF for Unit 3. Bypass events (i.e., SGTR and ISLOCA) contribute less than 5 percent to the total internal events CDF.

Table 5-3. Core Damage Frequency for Unit 2

Initiating Event or Accident Class	CDF (Per Year)	% Contribution to CDF
LOCA	2.66×10^{-5}	37.1
COOL	1.44×10^{-5}	20.1
Loss of DC power	1.03×10^{-5}	14.4
ATWS	8.68×10^{-6}	12.1
Transients	4.66×10^{-6}	6.5
SGTR	2.22×10^{-6}	3.1
SBO	2.15×10^{-6}	3.0
Steamline and main feed line breaks	1.72×10^{-6}	2.4
Loss of offsite power (LOOP)	8.60×10^{-7}	1.2
ISLOCA	1.43×10^{-7}	0.2
Total CDF	7.17×10^{-5}	100

Table 5-4. Core Damage Frequency for Unit 3

Initiating Event or Accident Class	CDF (Per Year)	% Contribution to CDF
RCP Seal LOCA	5.66×10^{-6}	22.0
Transients	4.04×10^{-6}	15.7
LOCAs	3.42×10^{-6}	13.3
LOOP	2.77×10^{-6}	10.8
ATWS	2.39×10^{-6}	9.3
Steamline break inside containment	2.31×10^{-6}	9.0
SBO	1.78×10^{-6}	6.9
Total loss of service water	1.28×10^{-6}	5.0
SGTR	1.00×10^{-6}	3.9
Loss of one vital DC bus	4.18×10^{-7}	1.6
Steamline break outside containment	3.79×10^{-7}	1.5
ISLOCA	2.21×10^{-7}	0.9
Instrument tube LOCA	5.04×10^{-8}	0.2
Total CDF	2.57×10^{-5}	100

In the ER, Dominion estimated the dose to the population within 80 kilometers (km) (50 miles [mi]) of the Millstone site from severe accidents to be approximately 0.174 person-sieverts (person-Sv) (17.4 person-roentgen equivalent man [person-rem]) per year for Unit 2 and approximately 0.128 person-Sv (12.8 person-rem) per year for Unit 3. The breakdown of the total population dose by containment release mode is summarized for Units 2 and 3 in Tables 5-5 and 5-6, respectively.

Intermediate containment failures dominate the population dose risk at Unit 2, followed by SGTR and late-containment failures. Early-containment failures and ISLOCAs make relatively small contributions, each being less than 3 percent of the total. Containment isolation and basemat failures are each indicated to be zero contributors to risk. As indicted in the response to an RAI, these release modes are incorporated into other release modes with similar characteristics (Dominion 2004b).

Late containment failures dominate the population dose risk at Unit 3, followed by SGTR and ISLOCAs. Early failures and containment isolation failures are each indicated to be zero contributors to risk. As indicated in the response to an RAI, these release modes were deleted from the IPE model because of low contribution (i.e., <0.1 percent) (Dominion 2004b).

Table 5-5. Breakdown of Population Dose by Containment Release Mode (Unit 2)

Containment Release Mode	Population Dose (Person-rem[a] Per Year)	% Contribution
Intermediate failure	12.4	71
SGTR	2.5	14.4
Late failure	1.63	9.4
Early failure	0.48	3
ISLOCA	0.42	2.4
Containment isolation failure	0	0
Basemat failure	0	0
Total Population Dose	17.4	100

(a) One person-rem = 0.01 person-Sv

Table 5-6. Breakdown of Population Dose by Containment Release Mode (Unit 3)

Containment Release Mode	Population Dose (Person-rem[a] Per Year)	% Contribution
Late failure	6.60	51.5
SGTR	2.77	21.6
ISLOCA	2.23	17.4
Intermediate failure	0.93	7.2
No containment failure	0.24	1.9
Basemat failure	0.05	0.4
Early failure	0	0
Containment isolation failure	0	0
Total Population Dose	12.8	100

(a) One person-rem = 0.01 person-Sv

The NRC staff has reviewed Dominion's data and evaluation methods and concludes that the quality of the risk analyses is adequate to support an assessment of the risk reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDFs and offsite doses reported by Dominion.

5.2.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, Dominion searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, Dominion considered SAMA analyses performed for other operating plants that have submitted license renewal applications, as well as industry and NRC documents that discuss potential plant improvements, such as NUREG-1560 (NRC 1997a). Dominion identified 196 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures and training for Unit 2 and 185 for Unit 3.

For Unit 2, all but 44 of the the SAMAs were removed from further consideration because they were not applicable to Millstone, they had already been implemented at Millstone (or the Millstone design met the intent of the SAMA), or they were related to RCP seal vulnerability stemming from charging pump dependency on the component cooling water system. The Millstone units do not rely on component cooling water systems for RCP seal cooling. Unit 2 relies on the RBCCW rather than closed cooling water (CCW) for RCP seal cooling and, in Unit 3, the charging pumps do not rely on CCW for RCP seal cooling. For Unit 3, all but 52 of the SAMAs were removed from further consideration based on the same criteria.

The staff concludes that Dominion used a systematic and comprehensive process for identifying potential plant improvements for Millstone, and that the set of potential plant improvements identified by Dominion is reasonably comprehensive and, therefore, acceptable.

5.2.4 Evaluation of Risk Reduction and Costs of Improvements

Dominion evaluated the risk-reduction potential of the remaining 44 SAMAs that were applicable to Unit 2 and the remaining 52 SAMAs that were applicable to Unit 3. A majority of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement. The staff concludes that such bounding calculations overestimate the benefit of the risk reduction and are conservative.

Dominion estimated the potential benefits for each SAMA by generating a revised set of plant damage state frequencies. Using these revised frequencies, a revised Level 3 (dollars averted) calculation was performed. The benefits were increased by a factor of 1.3 for Unit 2 and by a factor of 1.6 for Unit 3 to account for benefits in external events.

The staff has reviewed Dominion's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on Dominion's risk reduction estimates.

Dominion personnel experienced in estimating the cost of performing work at a nuclear plant estimated the costs of the remaining 44 SAMAs that were applicable to Unit 2 and the remaining 52 SAMAs that were applicable to Unit 3. For some of SAMAs considered, the cost estimates were sufficiently greater than the benefits calculated that it was not necessary to perform a detailed cost estimate. Cost estimates typically included procedures, engineering analysis, training, and documentation, in addition to any hardware.

The staff reviewed the bases for the applicant's cost estimates (presented in Section F.3 of Appendix F to the ER). For certain improvements, the staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. The cost estimates provided were in the form of ranges. For purposes of evaluating specific SAMAs, the staff selected the low-end values from the range to represent the costs. For some SAMAs, the costs appeared to be overestimated. Therefore, the staff asked the applicant to justify the costs for those SAMAs that had significant benefits (NRC 2004). In response to the staff's request, Dominion provided a discussion of the components and activities that were considered in estimating the costs of those SAMAs for which the benefit was determined to be $50,000 or more. The discussion included a description of the modification, if any procedure changes and training would be required, and if any new instrumentation and maintenance would be required (Dominion 2004b). The staff reviewed the costs and subsequent explanations and found them to be reasonable and generally consistent with estimates provided in support of other plants' analyses.

The staff concludes that the cost estimates provided by Dominion are sufficient and adequate for use in the SAMA evaluation.

5.2.5 Cost-Benefit Comparison

The cost-benefit analysis performed by Dominion was based primarily on NUREG/BR-0184 (NRC 1997b) and was executed consistent with this guidance. Sensitivity calculations were conducted to examine the potential impact of uncertainties, discount rates other than seven percent, and several parameters and assumptions involved in the severe accident dose calculations. None of these sensitivity calculations altered the results of the cost-benefit comparisons.

For Unit 2, Dominion identified one cost-beneficial SAMA:

SAMA 3: Enhance loss of RBCCW procedure to ensure cool down of RCS prior to seal LOCA. The resolution of this issue is expected to be either a new procedure or a procedure modification that will require actions to prevent or mitigate a seal LOCA upon loss of RBCCW.

As stated in the ER, Dominion is addressing SAMA 3 as part of a comprehensive industry initiative in response to Generic Safety Issue 23, "Reactor Coolant Pump Seal Failure." The

SAMA is being addressed as a current operating license issue and is anticipated to be implemented before the period of extended operation (Dominion 2004a).

In response to an RAI, Dominion assessed the applicability and feasibility for Unit 2 of several SAMAs considered by another Combustion Engineering plant. As a result, Dominion eliminated all of the SAMAs in question except one—adding a capability to flash the field on the emergency diesel generator (EDG) using a portable generator to enhance SBO event recovery. Dominion stated that this SAMA is not expected to be cost beneficial because it would likely require a plant modification to install a disconnect to allow the connection of a portable generator, as well as development of a new SAMG. However, Dominion stated that if this SAMA can be accomplished via a SAMG without a hardware modification, the SAMA could be cost-beneficial and will be implemented prior to the period of extended operation (Dominion 2004b).

For Unit 3, Dominion identified no cost-beneficial SAMAs. In response to an RAI regarding the costs of SAMA 112 (proceduralize local manual operation of AFW when control power is lost), Dominion assessed the applicability and feasibility of a procedure for manual operation of the turbine-driven AFW pump when control power is lost. Dominion stated that this SAMA would likely require a plant modification to provide the level indication that would be necessary during SBO, in addition to a new procedure. However, Dominion stated that if this SAMA can be accomplished via a SAMG, without a hardware modification, then the SAMA could be cost beneficial and will be implemented prior to the period of extended operation (Dominion 2004b).

The staff concludes that, with the exception of the one cost-beneficial SAMA (SAMA 3 for Unit 2) and the two SAMAs that would be cost-beneficial if they can be implemented by SAMG changes without hardware modifications, the costs of the SAMAs would be higher than the associated benefits. This conclusion is supported by uncertainty assessment and sensitivity analysis.

5.2.6 Conclusions

The staff reviewed the Dominion analyses and concluded that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs, the generally large negative net benefits, and the inherently small baseline risks support the general conclusion that the SAMA evaluations performed by Dominion are reasonable and sufficient for the license renewal submittal.

Based on its review of the Dominion SAMA analysis, the staff concludes that none of the candidate SAMAs are cost-beneficial, except for SAMA 3 for Unit 2. Two additional SAMAs, one SAMA involving adding a capability to flash the field on the EDG using a portable generator to enhance SBO event recovery on Unit 2 and SAMA 112 (proceduralize local manual operation of AFW when control power is lost) on Unit 3, are potentially cost beneficial if they can be implemented by a SAMG without hardware modifications. This is based on conservative treatment of costs and benefits. This conclusion is consistent with the low residual level of risk indicated in the PRA for both units and the fact that Millstone has already implemented many of the plant improvements identified from the IPE and IPEEE processes.

Dominion plans to implement SAMA 3 on Unit 2 before the period of extended operation (Dominion 2004a). The other two SAMAs will be implemented prior to the period of extended operation if they can be accomplished as discussed above (Dominion 2004b). None of these SAMAs relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54.

5.3 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy*, Part 100, "Reactor Site Criteria."

Dominion Nuclear Connecticut, Inc. (Dominion). 2004a. *Applicant's Environmental Report–Operating License Renewal Stage, Millstone Power Station, Units 2 and 3.* Dominion Nuclear Connecticut, Inc., Richmond, Virginia. January 2004.

Dominion Nuclear Connecticut, Inc. (Dominion). 2004b. Letter from Leslie N. Hartz, Dominion, to United States Nuclear Regulatory Commission (NRC) Document Control Desk. Subject: Millstone Power Station, Units 2 and 3, Response to Request for Additional Information, License Renewal Applications. (August 13, 2004).

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1997a. *Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance.* NUREG-1560, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1997b. *Regulatory Analysis Technical Evaluation Handbook.* NUREG/BR-0184, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, Section 6.3—Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants. NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2004. Letter from Richard L. Emch, Jr., NRC, to David A. Christian, Dominion. Subject: Request for Additional Information (RAI) Regarding Severe Accident Mitigation Alternatives for the Millstone Power Station, Units 2 and 3 (TAC NOS. MC1827 and MC1828). (June 22, 2004).

6.0 Environmental Impacts of the Uranium Fuel Cycle and Solid-Waste Management

Environmental issues associated with the uranium fuel cycle and solid-waste management are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (U.S. Nuclear Regulatory Commission [NRC] 1996; 1999.)[a] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste [HLW] and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1 and, therefore, additional plant-specific review of these issues is required.

This chapter addresses the issues that are related to the uranium fuel cycle and solid-waste management during the license renewal term, which are listed in Table B-1 of 10 Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B, and are applicable to Millstone Power Station, Units 2 and 3 (Millstone). The generic potential impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the GEIS based, in part, on the generic impacts provided in 10 CFR 51.51(b), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and in 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

to and from One Light-Water-Cooled Nuclear Power Reactor." The staff also addresses the impacts from radon-222 and technetium-99 in the GEIS.

6.1 The Uranium Fuel Cycle

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to Millstone from the uranium fuel cycle and solid-waste management are listed in Table 6-1.

Table 6-1. Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid-Waste Management During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
URANIUM FUEL CYCLE AND WASTE MANAGEMENT	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (spent fuel and high-level waste disposal)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4; 6.6
Low-level waste storage and disposal	6.1; 6.2.2.2; 6.4.2; 6.4.3; 6.4.3.1; 6.4.3.2; 6.4.3.3; 6.4.4; 6.4.4.1; 6.4.4.2; 6.4.4.3; 6.4.4.4; 6.4.4.5; 6.4.4.5.1; 6.4.4.5.2; 6.4.4.5.3; 6.4.4.5.4; 6.4.4.6; 6.6
Mixed waste storage and disposal	6.1; 6.4.5.1; 6.4.5.2; 6.4.5.3; 6.4.5.4; 6.4.5.5; 6.4.5.6; 6.4.5.6.1; 6.4.5.6.2; 6.4.5.6.3; 6.4.5.6.4; 6.6
Onsite spent fuel	6.1; 6.4.6; 6.4.6.1; 6.4.6.2; 6.4.6.3; 6.4.6.4; 6.4.6.5; 6.4.6.6; 6.4.6.7; 6.6
Nonradiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1

Dominion Nuclear Connecticut, Inc. (Dominion) stated in its Environmental Report (ER) (Dominion 2004) that it is not aware of any new and significant information associated with the

renewal of the Millstone operating licenses. The staff has not identified any significant new information during its independent review of the Dominion ER, the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the staff concluded in the GEIS that the impacts would be SMALL except for the collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal, as discussed below, and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the staff review and the GEIS conclusions, as codified in Table B-1, 10 CFR Part 51, for each of these issues follows:

- Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste). Based on information in the GEIS, the Commission found that

  > Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part [10 CFR 51.51(b)]. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.

  The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no offsite radiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (collective effects). Based on information in the GEIS, the Commission found that

  > The 100-year environmental dose commitment to the U.S. population from the fuel cycle, high-level waste and spent fuel disposal excepted, is calculated to be about 14,800 person-roentgen equivalents man (person-rem) (148 person-sieverts [person-Sv]), or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However,

these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits and even smaller fractions of natural background exposure to the same populations.

Nevertheless, despite all the uncertainty, some judgement as to the regulatory National Environmental Policy Act of 1969 (NEPA) implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1.

The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no offsite radiological impacts (collective effects) from the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (spent fuel and high-level waste disposal). Based on information in the GEIS, the Commission found that

  For the high-level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, "Technical Bases for Yucca Mountain Standards," and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 milliroentgen equivalents man (millirem) (1 millsievert [mSv]) per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that

100 millirem (1 mSv) per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem (1 mSv) per year. The lifetime individual risk from 100 millirem (1 mSv) annual dose limit is about 3×10^{-3}.

Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the Department of Energy in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980 [DOE 1980]. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years, and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, Environmental Protection Agency's (EPA) generic repository standards in 40 CFR part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR part 191 protect the population by imposing "containment requirements" that limit the cumulative amount of radioactive material released over 10,000 years. Reporting performance standards that will be required by EPA are expected to result in releases and associated health consequences in the range between 10 and 100 premature cancer deaths with an upper limit of 1,000 premature cancer deaths world-wide for a 100,000 metric tonne (MTHM) repository.

> Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered Category 1.

On February 15, 2002, based on a recommendation by the Secretary of the Department of Energy, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and high-level nuclear waste. The U.S. Congress approved this recommendation on July 9, 2002, in Joint Resolution 87, which designated Yucca Mountain as the repository for spent nuclear waste. On July 23, 2002, the President signed Joint Resolution 87 into law; Public Law 107-200, 116 Stat. 735 (2002) designates Yucca Mountain as the repository for spent nuclear waste. This development does not represent new and significant information with respect to the offsite radiological impacts from license renewal related to disposal of spent nuclear fuel and high-level nuclear waste.

EPA developed Yucca Mountain-specific repository standards, which were subsequently adopted by the NRC in 10 CFR Part 63. In an opinion, issued July 9, 2004, the U.S. Court of Appeals for the District of Columbia Circuit (the Court) vacated EPA's radiation protection standards for the candidate repository, which required compliance with certain dose limits over a 10,000 year period. The Court's decision also vacated the compliance period in NRC's licensing criteria for the candidate repository in 10 CFR Part 63.

Therefore, for the high-level waste and spent fuel disposal component of the fuel cycle, there is some uncertainty with respect to regulatory limits for offsite releases of radioactive nuclides for the current candidate repository site. However, prior to promulgation of the affected provisions of the Commission's regulations, the NRC staff assumed that limits would be developed along the lines of the 1995 National Academy of Sciences report, "Technical Bases for Yucca Mountain Standards," and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository that would comply with such limits could and likely would be developed at some site. Peak doses to virtually all individuals will be 1mSv (100 mrem) per year or less.

Despite the current uncertainty with respect to these rules, some judgment as to the regulatory NEPA implications of offsite radiological impacts of spent fuel and high-level waste disposal should be made. The staff concludes that these impacts are acceptable in that the impacts

would not be sufficiently large to require the NEPA conclusion that the option of extended operation under 10 CFR Part 54 should be eliminated.

The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no offsite radiological impacts related to spent fuel and HLW disposal during the renewal term beyond those discussed in the GEIS.

- Nonradiological impacts of the uranium fuel cycle. Based on information in the GEIS, the Commission found that

  > The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.

  The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no nonradiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Low-level waste storage and disposal. Based on information in the GEIS, the Commission found that

  > The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

  The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts of low-level waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Mixed waste storage and disposal. Based on information in the GEIS, the Commission found that

> The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts of mixed waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Onsite spent fuel. Based on information in the GEIS, the Commission found that

> The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts of onsite spent fuel associated with license renewal beyond those discussed in the GEIS.

- Nonradiological waste. Based on information in the GEIS, the Commission found that

> No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.

The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no nonradiological waste impacts during the renewal term beyond those discussed in the GEIS.

- Transportation. Based on information contained in the GEIS, the Commission found that

  > The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada, are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S-4—Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in § 51.52.

  Millstone meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no impacts of transportation associated with license renewal beyond those discussed in the GEIS.

There are no Category 2 issues for the uranium fuel cycle and solid-waste management.

6.2 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

10 CFR Part 63. Code of Federal Regulations, Title 10, *Energy,* Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."

40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste."

40 CFR Part 197. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 197, "Public Health and Environmental Radiation Protection Standards for Management and Disposal for Yucca Mountain, Nevada."

Dominion Nuclear Connecticut, Inc. (Dominion). 2004. *Applicant's Environmental Report—Operating License Renewal Stage Millstone Power Station, Units 2 and 3.* Waterford, Connecticut.

Energy Policy Act of 1992. 42 USC 10101, et seq.

National Academy of Sciences (NAS). 1995. *Technical Bases for Yucca Mountain Standards.* Washington, D.C.

National Environmental Policy Act (NEPA) of 1969, as amended, 42 USC 4321, et. seq.

Nuclear Energy Institute, Inc. v. EPA. 2004. No. 01-1258. U.S. Court of Appeals for the District of Columbia Circuit.

U.S. Department of Energy (DOE). 1980. *Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste.* DOE/EIS-0046F. Washington, D.C.

U.S. Environmental Protection Agency (EPA). 2001. "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, NV." *Federal Register*, Vol. 66, No. 114, pp. 32074–32135. Washington, D.C. June 13, 2001.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2001. "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada." *Federal Register.* Vol. 66, No. 213, pp.55792–55815. November 2, 2001.

7.0 Environmental Impacts of Decommissioning

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities*, NUREG-0586, Supplement 1 (NRC 2002). The staff's evaluation of the environmental impacts of decommissioning presented in Supplement 1 resulted in a range of impacts for each environmental issue. These results may be used by licensees as a starting point for a plant-specific evaluation of the decommissioning impacts at their facilities.

The incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term are evaluated in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (U. S. Nuclear Regulatory Commission [NRC] 1996; 1999).[(a)] The evaluation in NUREG-1437 includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective off-site radiological impacts from the fuel cycle and from high level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1 and, therefore, additional plant-specific review of these issues is required. There are no Category 2 issues related to decommissioning.

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

7.1 Decommissioning

Category 1 issues in Table B-1 of 10 Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B that are applicable to Millstone, Units 2 and 3 (Millstone), decommissioning following the renewal term are listed in Table 7-1. Dominion Nuclear Connecticut, Inc. (Dominion) stated in its Environmental Report (ER) (Dominion 2004) that it is aware of no new and significant information regarding the environmental impacts of Millstone license renewal. The staff has not identified any significant new information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, or public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of these issues, the staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 7-1. Category 1 Issues Applicable to the Decommissioning of Millstone, Units 2 and 3 Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
DECOMMISSIONING	
Radiation Doses	7.3.1; 7.4
Waste Management	7.3.2; 7.4
Air Quality	7.3.3; 7.4
Water Quality	7.3.4; 7.4
Ecological Resources	7.3.5; 7.4
Socioeconomic Impacts	7.3.7; 7.4

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of the issues follows:

- Radiation doses. Based on information in the GEIS, the Commission found that

  > Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem [0.01 person-Sv] caused by buildup of long-lived radionuclides during the license renewal term.

The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no radiation dose impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Waste management. Based on information in the GEIS, the Commission found that

  > Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.

  The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts from solid waste associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Air quality. Based on information in the GEIS, the Commission found that

  > Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.

  The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts on air quality associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Water quality. Based on information in the GEIS, the Commission found that

  > The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.

  The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its

evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts on water quality associated with decommissioning following the license renewal term beyond those discussed in the GEIS

- Ecological resources. Based on information in the GEIS, the Commission found that

  > Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.

  The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there are no impacts on ecological resources associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Socioeconomic impacts. Based on information in the GEIS, the Commission found that

  > Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.

  The staff has not identified any new and significant information during its independent review of the Dominion ER (Dominion 2004), the staff's site visit, the scoping process, its evaluation of other available information, and public comments on the draft SEIS. Therefore, the staff concludes that there would be no socioeconomic impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

7.2 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

Dominion Nuclear Connecticut, Inc. (Dominion). 2004. *Applicant's Environmental Report—Operating License Renewal Stage Millstone Power Station, Units 2 and 3.* Waterford, Connecticut.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report, Section 6.3—Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report.* NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors.* NUREG-0586, Supplement 1, Volumes 1 and 2, Washington, D.C.

8.0 Environmental Impacts of Alternatives to License Renewal

This chapter examines the potential environmental impacts associated with denying the renewal of an operating license (OL) (i.e., the no-action alternative); the potential environmental impacts from electric generating sources other than Millstone Power Station, Units 2 and 3 (Millstone); the possibility of purchasing electric power from other sources to replace power generated by Millstone and the associated environmental impacts; the potential environmental impacts from a combination of generating and conservation measures; and other generation alternatives that were deemed unsuitable for replacement of power generated by Millstone. The environmental impacts are evaluated using the U.S. Nuclear Regulatory Commission's (NRC's) three-level standard of significance—SMALL, MODERATE, or LARGE—developed using the Council on Environmental Quality guidelines and set forth in the footnotes to Table B-1 of 10 Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B:

SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize important attributes of the resource.

LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The impact categories evaluated in this chapter are the same as those used in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999)[a] with the additional impact category of environmental justice.

8.1 No-Action Alternative

The NRC's regulations implementing the National Environmental Policy Act of 1969 specify that the no-action alternative be discussed in an NRC environmental impact statement (EIS) (see 10 CFR Part 51, Subpart A, Appendix A[4]). For license renewal, the no-action alternative refers to a scenario in which the NRC would not renew the Millstone OLs and Dominion Nuclear

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

Connecticut, Inc. (Dominion) would then cease plant operations by the end of the current licenses and initiate the decommissioning of the plants.

Dominion will be required to shut down Millstone and to comply with NRC decommissioning requirements in 10 CFR 50.82 whether or not the OLs are renewed. If the Millstone OLs are renewed and Dominion continues to operate Millstone during the renewal period, shutdown of the units and decommissioning activities will not be avoided, but will be postponed for up to an additional 20 years.

The environmental impacts associated with decommissioning following a license renewal period of up to 20 years or following the no-action alternative would be bounded by the discussion of impacts in Chapter 7 of the license renewal GEIS (NRC 1996), Chapter 7 of this supplemental environmental impact statement (SEIS), and the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586, Supplement 1 (NRC 2002). The impacts of decommissioning after 60 years of operation are not expected to be significantly different from those occurring after 40 years of operation.

Impacts from the decision to permanently cease operations are not considered in NUREG-0586, Supplement 1.[(a)] Therefore, immediate impacts that occur between plant shutdown and the beginning of decommissioning are considered here. These impacts will occur when the units shut down regardless of whether the licenses are renewed and are discussed below, with the results presented in Table 8-1. Plant shutdown will result in a net reduction in power production capacity. The power not generated by Millstone during the license renewal term would likely be replaced by (1) power purchased from other electricity providers, (2) generating alternatives other than Millstone, (3) demand-side management and energy conservation, or (4) some combination of these options. The environmental impacts of these options are discussed in Section 8.2.

- **Land Use**

  In Chapter 4, the staff concluded that the impacts of continued plant operation on land use would be SMALL. Onsite land use will not be affected immediately by the cessation of operations. Plant structures and other facilities are likely to remain in place until decommissioning. The transmission lines associated with the project are expected to

(a) Appendix J of NUREG-0586 Supplement 1 discusses the socioeconomic impacts of plant closure, but the results of the analysis in Appendix J are not incorporated in the analysis presented in the main body of the NUREG.

Table 8-1. Summary of Environmental Impacts of the No-Action Alternative

Impact Category	Impact	Comment
Land Use	SMALL	Impacts are expected to be SMALL because plant shutdown is not expected to result in changes in onsite or offsite land use.
Ecology	SMALL	Impacts are expected to be SMALL because aquatic impacts are generally positive and terrestrial impacts are not expected because there will not be any land use changes.
Water Use and Quality—Surface Water	SMALL	Impacts are expected to be SMALL because surface water intake and discharges will decrease.
Water Use and Quality—Groundwater	SMALL	Impacts are expected to be SMALL because groundwater use will decrease.
Air Quality	SMALL	Impacts are expected to be SMALL because discharges related to plant operation and worker transportation will decrease.
Waste	SMALL	Impacts are expected to be SMALL because generation of high-level waste will stop, and generation of low-level and mixed waste will decrease.
Human Health	SMALL	Impacts are expected to be small because radiological doses to workers and members of the public, which are within regulatory limits, will be reduced.
Socioeconomics	SMALL to MODERATE	Impacts are expected to be SMALL to MODERATE because of a decrease in employment and tax revenues.
Socioeconomics (Transportation)	SMALL	Impacts are expected to be SMALL because of the decrease in employment would reduce traffic.
Aesthetics	SMALL	Impacts are expected to SMALL because plant structures will remain in place.
Historic and Archaeological Resources	SMALL	Impacts are expected to be SMALL because shutdown of the plant will not change land use.
Environmental Justice	SMALL	Impacts are expected to be SMALL because very few minority / low-income persons live in the immediate vicinity of Millstone. Economic offset likely is due to the general size and availability of other employment opportunities in the region.

remain in service after the plants stop operating. As a result, maintenance of the rights-of-way will continue as before. Therefore, the staff concludes that the impacts on land use from plant shutdown would be SMALL.

- **Ecology**

In Chapter 4 of this SEIS, the NRC staff concluded that the terrestrial and aquatic resource impacts of plant operation would be SMALL, with the exception of entrainment, which would likely be MODERATE. Cessation of operations will be accompanied by a significant reduction in cooling water flow, elimination of any impact due to impingement, entrainment, and the thermal plume. The environmental impacts to aquatic species, including threatened and endangered species, associated with these changes are generally positive. The impact of plant closure would be to cease the impacts due to entrainment. The impact of plant closure on the terrestrial ecosystem will be negligible because the transmission lines to the plant will be maintained and remain energized. Therefore, the staff concludes that ecological impacts from shutdown of the plant would be SMALL.

- **Water Use and Quality—Surface Water**

In Chapter 4 of this SEIS, the NRC staff concluded that impacts of plant operation on surface water use and quality would be SMALL. When the plant stops operating, there will be an immediate reduction in the consumptive use of water because of reduction in cooling water flow and in the amount of heat rejected to the Niantic Bay. There will also be a significant reduction in biocide use. Therefore, the staff concludes that the impacts on surface water use and quality from plant shutdown would be SMALL.

- **Water Use and Quality—Groundwater**

In Chapter 4, the staff concluded that impacts of plant ground-water use on ground-water availability and quality would be SMALL. The staff assumed that the ground-water wells would continue to be used for activities not related to operation of Millstone (e.g., watering of baseball fields). Therefore, the staff concludes that ground-water use and quality impacts from shutdown of the plant would be SMALL.

- **Air Quality**

In Chapter 4, the staff found the impacts of plant operation on air quality to be SMALL. When the plant stops operating, there will be a reduction in emissions from activities related

to plant operation such as use of diesel generators and workers' transportation. Therefore, the staff concludes that the impact on air quality from shutdown of the plant would be SMALL.

- **Waste**

  The impacts of waste generated by plant operation are discussed in Chapter 6. The impacts of low-level and mixed waste from plant operation are characterized as SMALL. When the plant stops operating, the plant will stop generating high-level waste, and generation of low-level and mixed waste associated with plant operation and maintenance will be reduced. Therefore, the staff concludes that the impact of waste generated after shutdown of the plant would be SMALL.

- **Human Health**

  In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of plant operation on human health would be SMALL. After the cessation of operations, the amount of radioactive material released to the environment in gaseous and liquid forms will be reduced. Therefore, the staff concludes that the impact of shutdown of the plant on human health will be SMALL. In addition, the variety of potential accidents at the plant will be reduced to a limited set associated with shutdown events and fuel handling. In Chapter 5 of this SEIS, the NRC staff concluded that the impacts of accidents during operation would be SMALL. Therefore, the staff concludes that the impacts of potential accidents following shutdown of the plant would be SMALL.

- **Socioeconomics**

  In Chapter 4, the NRC staff concluded that the socioeconomic impacts of continued plant operation would be SMALL. There would be immediate socioeconomic impacts associated with the shutdown of the plant because of the reduction in the staff at the plant. There may also be an immediate reduction in property tax revenues for the town of Waterford. The NRC staff concludes that the socioeconomic impacts of plant shutdown would range from SMALL to MODERATE. Some of these impacts could be offset if new power generating facilities are built at or near the current site. See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of the potential socioeconomic impacts of plant shutdown.

- **Socioeconomics (Transportation)**

  In Chapter 4, the staff concluded that the impacts of continued plant operation on transportation would be SMALL. Cessation of operations will be accompanied by a

reduction in traffic in the vicinity of the plant. Most of the reduction will be associated with a reduction in the plant workforce, but there will also be a reduction in shipment of material to and from the plant. Therefore, the staff concludes that the impacts of plant closure on transportation would be SMALL.

- **Aesthetics**

  In Chapter 4, the staff concluded that the aesthetic impacts of continued plant operation would be SMALL. Cessation of plant operations would probably result in the dismantlement of buildings and structures at the site, resulting in a positive aesthetic impact. Operational noise would be reduced or eliminated. Decommissioning would result in the eventual dismantlement of buildings and structures at the site, resulting in a positive aesthetic impact. Noise would be generated during decommissioning operations that may be detectable off site; however, the impact is unlikely to be of large significance and can normally be mitigated. Thus, the aesthetic impacts associated with the no-action alternative and decommissioning would be considered SMALL.

- **Historic and Archaeological Resources**

  In Chapter 4, the staff concluded that the impacts of continued plant operation on historic and archaeological resources would be SMALL. Onsite land use will not be affected immediately by the cessation of operations. Plant structures and other facilities are likely to remain in place until decommissioning. The transmission lines associated with the project are expected to remain in service after the plants stop operating. As a result, maintenance of transmission line rights-of-way (ROWs) will continue as before. Therefore, the staff concludes that the impacts on historic and archaeological resources from plant shutdown would be SMALL.

- **Environmental Justice**

  In Chapter 4, the staff concluded that the environmental justice impact of continued operation of the plant would be SMALL because continued operation of the plant would not have a disproportionately high and adverse impact on minority and low-income populations. Shutdown of the plant could have disproportionately high and adverse impacts on minority and low-income populations because of the loss of employment opportunities at the site and because of secondary socioeconomic impacts (e.g., loss of patronage at local businesses). However, some of these impacts could be offset if new power generating facilities are built at or near the current site. The staff concludes that the environmental justice impacts of plant shutdown would be SMALL. See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of these impacts.

8.2 Alternative Energy Sources

This section discusses the environmental impacts associated with alternative sources of electric power to replace the power generated by Millstone, assuming that the OLs for Units 2 and 3 are not renewed. The order of presentation of alternative energy sources in Section 8.2 does not imply which alternative would be most likely to occur or to have the least environmental impacts.

The following generation alternatives are considered in detail:

- coal-fired generation at the Millstone site and an alternate retired oil-fired plant site (Section 8.2.1);
- natural gas-fired generation at the Millstone site and an alternate retired oil-fired plant site (Section 8.2.2); and
- nuclear generation at the Millstone site and an alternate retired oil-fired plant site (Section 8.2.3).

The alternative of purchasing power from other sources to replace power generated at Millstone is discussed in Section 8.2.4. Other power-generation alternatives and conservation alternatives considered by the staff and found not to be reasonable replacements for Units 2 and 3 are discussed in Section 8.2.5. Section 8.2.6 discusses the environmental impacts of a combination of generation and conservation alternatives.

Each year the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an Annual Energy Outlook. In its Annual Energy Outlook 2004, with Projections to 2025, EIA projects that combined-cycle[a] or combustion turbine technology fueled by natural gas is likely to account for approximately 62 percent of new electric generating capacity between the years 2011 and 2025 (DOE/EIA 2004a). Both technologies are designed primarily to supply peak and intermediate capacity, but combined-cycle technology can also be used to meet base-load[b] requirements. Coal-fired plants are projected by EIA to account for approximately 33 percent of new capacity during this period. Coal-fired plants are generally

(a) In a combined-cycle unit, hot combustion gas in a combustion turbine rotates the turbine to generate electricity. The hot exhaust from the combustion turbine is routed through a heat-recovery boiler to make steam to generate additional electricity.

(b) A base-load plant normally operates to supply all or part of the minimum continuous load of a system and, consequently, produces electricity at an essentially constant rate. Nuclear power plants are commonly used for base-load generation; i.e., these units generally run near full load.

used to meet base-load requirements. Renewable energy sources, primarily wind and biomass units, are projected by EIA to account for the remaining 5 percent of capacity additions. EIA's projections are based on the assumption that providers of new generating capacity will seek to minimize cost while meeting applicable environmental requirements. Combined-cycle plants are projected by EIA to have the lowest generation cost in 2010, followed by wind generation and then coal-fired plants (DOE/EIA 2004a). By 2025, coal-fired plants are projected by EIA to have the lowest generation cost, followed by combined-cycle plants and then wind generation (DOE/EIA 2004a).

EIA projects that oil-fired plants will account for very little of new generation capacity in the United States during the 2002 to 2025 time period because of higher fuel costs and lower efficiencies (DOE/EIA 2004a).

EIA also projects that new nuclear power plants will not account for any new generation capacity in the United States during the 2002 to 2025 time period because natural gas and coal-fired plants are projected to be more economical (DOE/EIA 2004a). In spite of this projection, a new nuclear plant alternative for replacing power generated by Millstone is considered for reasons stated in Section 8.2.3. NRC established a new reactor licensing program organization in 2001 to prepare for and manage future reactor and site licensing applications (NRC 2001).

Millstone Units 2 and 3 have a combined net calculated electrical output of approximately 2024 megawatts electric (MW[e]). The staff assumed construction of four 500-MW(e) units for the coal alternative and five 400-MW(e) units for the natural gas alternative, for a combined capacity of 2000 MW(e), which is consistent with Dominion's Environmental Report (ER) (Dominion 2004). For the nuclear alternative, the staff assumed construction of two 1000-MW(e) plants. This assumption will understate the environmental impacts of replacing the 2024 MW(e) from Millstone by roughly 1.2 percent.

The Dominion ER (Dominion 2004) identified the potential availability of retired oil-fired plant sites in Connecticut as locations for alternative energy production plants. A previously used site would not require construction of transmission lines or other support facilities and may not require construction of a rail spur. In addition, greenfield sites may not be a reasonable alternative because of the high population and limited amount of open space for this type of development. Therefore, greenfield sites are not considered in this analysis.

8.2.1 Coal-Fired Generation

The coal-fired alternative is analyzed for both the Millstone site and an alternate retired oil-fired plant site in Connecticut. Existing transmission lines, cooling systems, and support facilities

would be used (Dominion 2004). Millstone has an existing rail spur, although it may require some improvement if used for a coal-fired facility. The alternate sites may have rail access in place.

Unless otherwise indicated, the assumptions and numerical values used in Section 8.2.1 are from the Dominion ER (Dominion 2004). The staff reviewed this information and compared it to environmental impact information in the GEIS. Although the OL renewal period is only 20 years, the impact of operating the coal-fired alternative for 40 years is considered (as a reasonable projection of the operating life of a coal-fired plant).

The coal-fired plant would consume approximately 5.4 million metric tons (MT) (5.9 million tons) per year of pulverized bituminous coal with an ash content of approximately 4.85 percent (Dominion 2004). Dominion assumes a heat rate[(a)] of 9700 joules (J) of fuel /J of electricity (10,200 British thermal units per kilowatt hour [BTU/kWh]) and a capacity factor[(b)] of 0.85 in its ER (Dominion 2004). After combustion, 99.9 percent of the ash would be collected and disposed of at the plant site. In addition, approximately 170.5×10^3 MT (188.0×10^3 tons) of scrubber sludge would be disposed of at the plant site based on annual lime usage of approximately 58,000 MT (64,000 tons). Lime is used in the scrubbing process for control of sulfur dioxide (SO_2) emissions.

Coal and lime or limestone for a coal-fired plant sited at Millstone most likely would be delivered via rail line. Lime[(c)] or limestone is used in the scrubbing process for control of SO_2 emissions. Rail delivery also would be the most likely option for delivering coal and lime/limestone to an alternative site for the coal-fired plant. Construction at an alternative site could necessitate the construction of a rail spur to the plant. This would require construction of docking and loading facilities onsite.

8.2.1.1 Closed-Cycle Cooling System

The overall impacts at either the Millstone or at an alternate site of the coal-fired generating system using a closed-cycle cooling system with cooling towers are discussed in the following

(a) Heat rate is a measure of generating station thermal efficiency. In English units, it is generally expressed in British thermal units (BTUs) per net kilowatt-hour (kWh). It is computed by dividing the total BTU content of the fuel burned for electric generation by the resulting kWh generation. The corresponding metric unit for energy is the joule (J).

(b) The capacity factor is the ratio of electricity generated, for the period of time considered, to the energy that could have been generated at continuous full-power operation during the same period.

(c) In a typical wet scrubber, lime (calcium hydroxide) or limestone (calcium carbonate) is injected as a slurry into the hot effluent combustion gases to remove entrained sulfur dioxide. The lime-based scrubbing solution reacts with sulfur dioxide to form calcium sulfite which precipitates and is removed in sludge form.

sections and summarized in Table 8-2. The magnitude of impacts for the alternate site (retired oil-fired plant site) will depend on the location of the particular site selected. The Millstone plant currently uses a once-through cooling system. For the purposes of comparison with an alternate site, however, it is assumed that the replacement coal-fired plant sited on the Millstone site would use a closed-cycle cooling system, which would most likely require the acquisition of additional land adjacent to the site. For completeness, the staff also considered the impacts of a once-through cooling system, which are discussed in Section 8.2.1.2.

Table 8-2. Summary of Environmental Impacts of Coal-Fired Generation at Millstone Site and an Alternate Site Using Once-Through Cooling

	Millstone Site		Alternate Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	Uses approximately 164 hectares (ha) (406 acres [ac]) for plant and waste disposal. Additional land may be required at Millstone. Additional offsite land impacts for coal and limestone mining. Additional impacts would occur for rail spur and closed-cycle cooling system towers.	SMALL to MODERATE	Uses approximately 700 ha (1700 ac), for plant, offices, parking, and rail spur. Additional land impacts for coal and limestone mining and cooling-water system.
Ecology	SMALL to MODERATE	Uses undeveloped areas at current Millstone site, additional land adjacent to Millstone site, plus rail corridor. Impacts to terrestrial ecology from cooling tower drift.	SMALL to MODERATE	Impact depends on location and ecology of the site and need for rail or barge facilities. Impacts to terrestrial ecology from cooling tower drift; impact to aquatic resources from surface water body used for intake and discharge.
Water Use and Quality—Surface Water	SMALL	Partial use of existing cooling system (e.g., intake and discharge structures). Operational impacts similar or less than Millstone Units 2 and 3.	SMALL to MODERATE	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the surface water body.
Water Use and Quality—Groundwater	SMALL	Groundwater use is limited.	SMALL to MODERATE	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the aquifers.

Table 8-2. (contd)

Impact Category	Millstone Site Impact	Millstone Site Comments	Alternate Site Impact	Alternate Site Comments
Air Quality	MODERATE	Sulfur oxides • 12,500 MT/yr (13,780 tons/yr) Nitrogen oxides • 4045 MT/yr (4459 tons/yr) Particulates • 131 MT/yr (144 tons/yr) of total PM_{10} particulates • 30 MT/yr (33 tons/yr) Carbon monoxide • 1348 MT/yr (1486 tons/yr) Small amounts of mercury and other hazardous air pollutants and naturally occurring radioactive materials — mainly uranium and thorium	MODERATE	Potentially same impacts as the Millstone site, although pollution-control standards may vary.
Waste	MODERATE	Total waste volume would be approximately 2.63×10^5 MT/yr (2.90×10^5 tons/yr) of ash and scrubber sludge requiring approximately 43 ha (106 ac) for disposal during the 40-year life of the plant.	MODERATE	Same impacts as Millstone site; waste disposal constraints may vary.
Human Health	SMALL	Impacts are uncertain, but considered SMALL in the absence of more quantitative data.	SMALL	Same impact as the Millstone site.
Socioeconomics	SMALL to MODERATE	During construction, impacts would be visible. Up to 2500 workers during the peak period of the five-year construction period, followed by reduction from current Millstone workforce of 1650 to 400; tax base preserved. Impacts during operation would be negligible.	SMALL to LARGE	Construction impacts depend on location, but could be significant if plant is located in an area that is more rural than the Millstone site. City of Waterford would experience loss of tax base and employment, potentially offset by possible economic growth.

Table 8-2. (contd)

	Millstone Site		Alternate Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Socioeconomics (Transportation)	SMALL to LARGE	Transportation impacts associated with construction workers could be noticeable to significant. Impacts could be slight to noticeable during operations. For rail transportation of coal and lime, the impact is considered noticeable to significant.	SMALL to LARGE	Transportation impacts associated with construction workers could be noticeable to significant. Impacts could be slight to noticeable during operation. For rail transportation of coal and lime, the impact is considered noticeable to significant.
Aesthetics	MODERATE	MODERATE aesthetic impact due to visual impact of cooling towers, exhaust stacks, and rail on environment. Noise impact would be SMALL to MODERATE due to proximity of houses.	SMALL to MODERATE	Impacts would depend on characteristics of alternate location.
Historic and Archeological Resources	SMALL to MODERATE	Some construction would affect previously developed parts of Millstone site; cultural resource inventory should minimize any impacts on undeveloped lands.	SMALL to MODERATE	Alternate location would necessitate cultural resource studies.
Environmental Justice	SMALL to MODERATE	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Loss of 1250 operating jobs could reduce employment prospects for minority and low-income populations. Impacts could be offset by possible economic growth and the ability of affected workers to commute to other jobs.	SMALL to MODERATE	Impacts will vary depending on population distribution and make-up at the site.

- **Land Use**

The existing facilities and infrastructure at the Millstone site would be used to the extent practicable, limiting the amount of new construction that would be required. Specifically, the staff assumed that the coal-fired replacement plant alternative would use the once-through system, switchyard, offices, and transmission line ROWs. Much of the land that would be used has been previously disturbed.

The coal-fired generation alternative would necessitate converting roughly an additional 164 ha (406 ac) of the Millstone site for the plant, coal storage, and ash and scrubber sludge disposal. Additional land may be needed since the Millstone site is only 212 ha (525 ac) in size. Although the Millstone site has an existing once-through cooling system, it is likely that the system would need to be significantly modified to accommodate a coal plant with a closed-cycle cooling system (e.g., addition of cooling towers). Additional land-use changes would occur offsite in an undetermined coal-mining area to supply coal for the plant.

In the GEIS, the staff estimated that approximately 8900 ha (22,000 ac) would be affected for mining the coal and disposing of the waste to support a 1000 MW(e) coal plant during its operational life. Partially offsetting this offsite land use would be the elimination of the need for uranium mining to supply fuel for Millstone. In the GEIS, the staff estimated that approximately 400 ha (1000 ac) would be affected for mining the uranium and processing it during the operating life of a nuclear power plant.

The impact of a coal-fired generating unit on land use at the existing Millstone site is best characterized as SMALL to MODERATE. The impact would be expected to be greater than the OL renewal alternative.

Construction of the coal-fired plant at an alternate site could impact up to 700 ha (1700 ac) (NRC 1996). While transmission facilities would be available at a retired oil-fired plant site, additional land may be disturbed if a rail spur is needed for coal and lime delivery. This alternative would result in SMALL to MODERATE land-use impacts.

- **Ecology**

Locating a coal-fired plant at the Millstone site would alter ecological resources because of the need to convert roughly 164 ha (406 ac) of land to industrial use (plant, coal storage, ash and scrubber sludge disposal). Additional land may be needed since the Millstone site is only 212 ha (525 acres) in size. However, some of the land on the Millstone site and the surrounding area would have been previously disturbed. Therefore, the impacts to terrestrial resources would be considered inconsequential to detectable but not

destabilizing. Impacts to aquatic resources would likely be less than those resulting from the current Millstone operations even if the existing intake and discharge structures are used.

Locating a coal-fired plant at an alternate site would alter ecological resources because of the need to convert roughly up to 700 ha (1700 ac) (NRC 1996) of land to industrial use (plant, coal storage, ash and scrubber sludge disposal). Additional land may be disturbed if a rail spur is needed for coal and lime delivery. Impacts could include wildlife habitat loss, reduced productivity, and a local reduction in biological diversity. Cooling tower drift from the closed-cycle cooling system could impact terrestrial resources. If needed, construction and maintenance of a rail spur would have ecological impacts. Overall, the ecological impacts at the Millstone site or at an alternate site would be SMALL to MODERATE.

- **Water Use and Quality—Surface Water**

Coal-fired generation at the Millstone site would likely use water from Niantic Bay for cooling. It is possible that some of the existing intake and discharge structures could be used, but the construction of additional cooling infrastructure would be needed to accommodate a closed-cycle cooling system. Plant discharges would consist mostly of cooling tower blowdown, characterized primarily by an increased temperature and concentration of dissolved solids relative to the receiving water body and intermittent, low concentrations of biocides (e.g., chlorine). Sanitary waste would likely continue to be discharged into the water treatment system of the city of New London. Treated process waste streams and sanitary wastewater may also be discharged. All discharges would be regulated by the Connecticut Department of Environmental Protection (CTDEP) through a National Pollutant Discharge Elimination System permit. There would be a consumptive use of water due to evaporation from the cooling towers. Some erosion and sedimentation would likely occur during construction (NRC 1996). The staff considers the impacts to surface-water use and quality of a new coal-fired plant with a closed-cycle cooling system located at the Millstone site to be SMALL.

Cooling water at an alternate site would likely be withdrawn from a surface-water body and would be regulated by permit. Depending on the source water body, the impacts of water use for cooling system make-up water and the impacts on water quality due to cooling tower blowdown could have noticeable impacts. Therefore, the staff considers the impacts of a new coal-fired plant utilizing a closed-cycle cooling system at an alternate site to be SMALL to MODERATE. Water quality impact from sedimentation during construction was characterized in the GEIS as SMALL. The staff also noted in the GEIS that operational water-quality impacts would be similar to or less than those from other generating technologies. Sedimentation impacts from construction of a coal-fired plant at the Millstone site or at an alternate would be short-term and easily mitigated.

- **Water Use and Quality—Groundwater**

The staff assumed that the groundwater wells would continue to be used for non-Millstone related activities (e.g., watering of baseball fields) located adjacent to Millstone. Ground-water withdrawals would be equal to or less than the no-action and license renewal alternatives. Hence, impacts would be considered SMALL. Use of groundwater for a coal-fired plant located at an alternative site is a possibility. Ground-water withdrawals at an alternate site would likely require a permit from the state of Connecticut. The impacts will depend on the characteristics of the site and the amount of groundwater used. Therefore, the impacts would be considered SMALL to MODERATE.

- **Air Quality**

The air-quality impacts of coal-fired generation vary considerably from those of nuclear generation due to emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), particulates, carbon monoxide, hazardous air pollutants such as mercury, and naturally occurring radioactive materials.

Millstone is located in New London County, which is part of the Eastern Connecticut Intrastate Air Quality Control Region (40 CFR 81.183). The entire state of Connecticut has been designated as an attainment area for carbon monoxide, nitrogen dioxide, lead, and SO_2. New London County is also designated as in attainment for particulate matter with a diameter of 10 micrometers (μm) or less. New London County has been designated as serious nonattainment for the U.S. Environmental Protection Agency (EPA) one-hour ozone standard (40 CFR 81.307; CTDEP 2002a).

A new coal-fired generating plant located in Connecticut would need an operating permit under the Clean Air Act and would have to offset its emissions of NO_x and SO_x through the purchase of allowances (Dominion 2004). The plant would be required to comply with the new source performance standards for such plants set forth in 40 CFR Part 60, Subpart D(a). The standards establish limits for particulate matter and opacity (40 CFR 60.42[a]), SO_2 (40 CFR 60.43[a]), and NO_x (40 CFR 60.44[a]).

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated as attainment or unclassified under the Clean Air Act. All of Connecticut is classified as attainment for criteria pollutants (40 CFR 81.310).

Section 169A of the Clean Air Act (42 United States Code [USC] 7491) establishes a national goal of preventing future and remedying existing impairment of visibility in

mandatory Class I Federal areas when impairment results from human made air pollution. EPA issued a new regional haze rule on July 1, 1999 (64 *Federal Register* (FR) 35714 [EPA 1999]). The rule specifies that for each mandatory Class I Federal area located within a state, the state must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period [40 CFR 51.308(d)(1)]. If a coal-fired plant were located close to a mandatory Class I Federal area, additional air pollution control requirements could be imposed. There are no Class I areas in Connecticut.

In 1998, EPA issued a rule requiring 22 eastern states, including Connecticut, to revise their state implementation plans to reduce nitrogen oxide emissions. Nitrogen oxide emissions contribute to violations of the national ambient air quality standard for ozone. The total amount of nitrogen oxides that can be emitted by each of the 22 states in the year 2007 ozone season (May 1 to September 30) is set out at 40 CFR 51.121(e). For Connecticut, the amount is 38,870 MT (42,850 tons).

Impacts for particular pollutants are as follows:

Sulfur oxides emissions. Dominion states in its ER that an alternative coal-fired plant would use wet scrubber-lime for flue gas desulfurization (Dominion 2004).

A new coal-fired power plant would be subject to the requirements in Title IV of the Clean Air Act. Title IV was enacted to reduce emissions of SO_2 and NO_x, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_2 emissions and imposes controls on SO_2 emissions through a system of marketable allowances. EPA issues one allowance for each ton of SO_2 that a unit is allowed to emit. New units do not receive allowances, but are required to have allowances to cover their SO_2 emissions. Owners of new units must therefore acquire allowances from owners of other power plants by purchase or reduce SO_2 emissions at other power plants they own. Allowances can be banked for use in future years. Thus, a new coal-fired power plant would not add to net regional SO_2 emissions, although it might do so locally.

Regardless, SO_2 emissions would be greater for the coal alternative than the OL renewal alternative.

Dominion estimates that, by using the best technology to minimize SO_x emissions, the total annual stack emissions would be approximately as high as 12,500 MT (13,780 tons) of SO_x (Dominion 2004).

Nitrogen oxides emissions. Section 407 of the Clean Air Act establishes technology-based emission limitations for NO_x emissions. The market-based allowance system used for SO_2 emissions is not used for NO_x emissions. A new coal-fired power plant would be subject to the new source performance standards for such plants at 40 CFR 60.44a(d)(1). This regulation, issued on September 16, 1998 (63 FR 49453 [EPA 1998]), limits the discharge of any gases that contain nitrogen oxides (expressed as NO_2) in excess of 200 nanograms per joule (ng/J) (1.6 pounds per megawatt hour [16 lb/MWh]) of gross energy output, based on a 30-day rolling average.

Dominion estimates that, by using NO_x burners with overfire air and selective catalytic reduction, the total annual NO_x emissions for a new coal-fired power plant would be approximately as high as 4045 MT (4459 tons) (Dominion 2004). This level of NO_x emissions would be greater than the level for the OL renewal alternative.

Particulate emissions. Dominion estimates that the total annual stack emissions would include 131 MT (144 tons) of filterable total suspended particulates and 30 MT (33 tons) of particulate matter having an aerodynamic diameter less than or equal to 10 µm (PM_{10}) (40 CFR 50.6). Fabric filters or electrostatic precipitators would be used for control. In addition, coal-handling equipment would introduce fugitive particulate emissions. Particulate emissions would be greater under the coal alternative than the OL renewal alternative.

During the construction of a coal-fired plant, fugitive dust would be generated. In addition, exhaust emissions would come from vehicles and motorized equipment used during the construction process.

Carbon monoxide emissions. Dominion estimates that the total carbon monoxide emissions would be approximately 1348 MT (1486 tons) per year. This level of emissions is greater than the level for the OL renewal alternative.

Hazardous air pollutants including mercury. In December 2000, EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam generating units (EPA 2000a). EPA determined that coal- and oil-fired electric utility steam generating units are significant emitters of hazardous air pollutants. Coal-fired power plants were found by EPA to emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA 2000a). EPA concluded that mercury is the hazardous air pollutant of greatest concern. EPA found that (1) there is a link between coal consumption and mercury emissions; (2) electric utility, steam generating units are the largest domestic source of mercury emissions; and (3) certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health impacts due to mercury exposures

resulting from consumption of contaminated fish (EPA 2000a). Accordingly, EPA added coal- and oil-fired, electric utility, steam generating units to the list of source categories under Section 112(c) of the Clean Air Act for which emission standards for hazardous air pollutants will be issued (EPA 2000a).

Uranium and thorium. Coal contains uranium and thorium. Uranium concentrations are generally in the range of 1 to 10 parts per million. Thorium concentrations are generally about 2.5 times greater than uranium concentrations (Gabbard 1993). One estimate is that a typical coal-fired plant released roughly 4.7 MT (5.2 tons) of uranium and 11.6 MT (12.8 tons) of thorium in 1982 (Gabbard 1993). The population dose equivalent from the uranium and thorium releases and daughter products produced by the decay of these isotopes has been calculated to be significantly higher than that from nuclear power plants (Gabbard 1993).

Carbon dioxide. A coal-fired plant would also have unregulated carbon dioxide emissions that could contribute to global warming. The level of emissions from a coal-fired plant would be greater than the OL renewal alternative.

Summary. The GEIS analysis did not quantify emissions from coal-fired power plants, but implied that air impacts would be substantial. The GEIS also mentioned global warming from unregulated carbon dioxide emissions and acid rain from SO_x and NO_x emissions as potential impacts (NRC 1996). Adverse human health impacts such as cancer and emphysema have been associated with the products of coal combustion. The appropriate characterization of air impacts from coal-fired generation would be MODERATE. The impacts would be clearly noticeable, but would not destabilize air quality.

Siting a coal-fired generation plant at a site other than Millstone would not significantly change air-quality impacts, although it could result in installing more or less stringent pollution-control equipment to meet applicable local requirements. Therefore, the impacts would be MODERATE.

- **Waste**

Coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash and scrubber sludge. Four 500-MW(e) coal-fired plants would generate approximately 2.63×10^5 MT (2.90×10^5 tons) of this waste annually for 40 years. The waste would be disposed of onsite, accounting for approximately 43 ha (106 ac) of land area over the 40-year plant life. Waste impacts to groundwater and surface water could extend beyond the operating life of the plant if leachate and runoff from the waste storage area occurs. Disposal of the waste could noticeably affect land use and ground-water quality, but with appropriate management and monitoring, it would not

destabilize any resources. After closure of the waste site and revegetation, the land could be available for other uses. Debris would be generated during construction activities.

In May 2000, EPA issued a "Notice of Regulatory Determination on Wastes From the Combustion of Fossil Fuels" (EPA 2000b). EPA concluded that some form of national regulation is warranted to address coal combustion waste products because of the following: (a) the composition of these wastes could present danger to human health and the environment under certain conditions; (b) EPA has identified 11 documented cases of proven damages to human health and the environment by improper management of these wastes in landfills and surface impoundments; (c) present disposal practices are such that, in 1995, these wastes were being managed in 40 percent to 70 percent of landfills and surface impoundments without reasonable controls in place, particularly in the area of ground-water monitoring; and (d) EPA identified gaps in state oversight of coal combustion wastes. Accordingly, EPA announced its intention to issue regulations for disposal of coal combustion waste under subtitle D of the Resource Conservation and Recovery Act.

For all of the preceding reasons, the appropriate characterization of impacts from waste generated from burning coal at the Millstone site is MODERATE; the impacts would be clearly noticeable, but would not destabilize any important resource.

Siting the facility at a site other than Millstone would not alter waste generation, although other sites might have more constraints on disposal locations. Therefore, the impacts would also be MODERATE.

- **Human Health**

Coal-fired power generation introduces worker risks from fuel and limestone mining, from fuel and lime / limestone transportation, and from disposal of coal combustion waste. In addition, there are public risks from inhalation of stack emissions. Emission impacts can be widespread and health risks difficult to quantify. The coal alternative also introduces the risk of coal-pile fires and attendant inhalation risks.

In the GEIS, the staff stated that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates, but it did not identify the significance of these impacts (NRC 1996). In addition, the discharges of uranium and thorium from coal-fired plants can potentially produce radiological doses in excess of those arising from nuclear power plant operations (Gabbard 1993).

Regulatory agencies, including EPA and state agencies, set air emission standards and requirements based on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. As discussed previously, EPA has

recently noted that certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health impacts due to mercury exposures from sources such as coal-fired power plants. However, in the absence of more quantitative data, human health impacts from radiological doses and inhaling toxins and particulates generated by burning coal are characterized as SMALL.

Siting the facility at this site other than Millstone would not change the impact on human health. Therefore, the impacts would be SMALL.

- **Socioeconomics**

Construction of the coal-fired alternative would take approximately five years. The staff assumed that construction would take place while Millstone continues operation and would be completed by the time Millstone permanently ceases operations. The workforce would be expected to vary between 1200 and 2500 workers during the five-year construction period (NRC 1996). These workers would be in addition to the approximately 1650 workers currently employed at Millstone. During construction, the surrounding communities would experience demands on housing and public services that could have noticeable impacts. These impacts would be tempered by construction workers commuting to the site from other counties. After construction, the communities would be impacted by the loss of the construction jobs, although this loss would be possibly offset by other growth occurring in the region.

If the coal-fired replacement plant were constructed at the Millstone site and Units 2 and 3 were decommissioned, there would be approximately 1250 fewer permanent high-paying jobs, with a commensurate reduction in demand on socioeconomic resources and contribution to the regional economy. However, as discussed previously, projected economic growth in southeastern Connecticut could temper or offset the projected loss of jobs from the closure of Millstone. The coal-fired plants would provide a new tax base to offset the loss of tax base associated with decommissioning of the nuclear units. For all these reasons, the appropriate characterization of nontransportation socioeconomic impacts for a coal-fired plant constructed at the Millstone site would be SMALL to MODERATE.

Construction of a replacement coal-fired power plant at an alternate site would relocate some socioeconomic impacts, but would not eliminate them. The communities around Millstone would still experience the impact of Millstone operational job loss (although potentially tempered by projected economic growth), and the communities around the new site would have to absorb the impacts of a large, temporary workforce (up to 2500 workers at the peak of construction) and a permanent workforce of approximately 400 workers. In the GEIS, the staff stated that socioeconomic impacts at an urban site would be smaller than at a rural site, because less of the peak construction workforce would need to move to

the area to work. The Millstone site is within commuting distance of the Hartford metropolitan area and is therefore not considered a rural site. Alternate sites would need to be analyzed on a case-by-case basis. Socioeconomic impacts at a rural site would be SMALL to LARGE.

- **Socioeconomics (Transportation)**

During the five-year construction period of replacement coal-fired units, up to 2500 construction workers would be working at the site in addition to the 1650 workers at Millstone. The addition of these workers could place significant traffic loads on existing highways. Such impacts could be noticeable but are not expected to be overwhelming.

For transportation related to commuting of plant operating personnel, the impacts are minor. The maximum number of plant operating personnel would be approximately 400. The current Millstone workforce is approximately 1650. Therefore, traffic impacts associated with plant personnel commuting to a coal-fired plant would be expected to be negligible compared to the current impacts from Millstone operations.

For rail transportation related to coal and lime delivery to the Millstone site, the impacts would be noticeable to significant. Each train would have approximately 100 open-top rail cars, each holding about 90 MT (100 tons) of coal or lime. Approximately 600 trains per year would be needed to deliver the coal and lime for the four coal-fired units. A total of 12 train trips is expected per week, or nearly 4 trips per day, because, for each full train delivery, there would be an empty train.

Transportation-related impacts associated with commuting construction workers at an alternate site are site-dependent, but could range from MODERATE to LARGE. Transportation impacts related to the commuting of plant operating personnel would also be site-dependent, but can be characterized as SMALL to MODERATE.

At an alternate site, coal and lime would likely be delivered by rail. Transportation impacts would depend upon the site location. Socioeconomic impacts associated with rail transportation would likely be MODERATE to LARGE.

- **Aesthetics**

If sited at Millstone, the four coal-fired power plant units could be as much as 60-m (200-ft) tall and be visible in daylight hours over many miles. The four exhaust stacks would be somewhere in the range of 120 to 185 meters (m) (400 to 600 feet [ft]) high. The units and associated stacks would also be visible at night because of outside lighting. Visual impacts of a new coal-fired plant could be mitigated by landscaping and by color selection for

buildings that is consistent with the environment. Visual impact at night could be mitigated by reduced use of lighting and appropriate use of shielding. Overall, the addition of a coal-fired unit and the associated stack at the Millstone site would likely have a MODERATE aesthetic impact.

Coal-fired generation would introduce mechanical sources of noise that would be audible offsite. Sources contributing to the total noise produced by plant operation are classified as continuous or intermittent. Continuous sources include the mechanical equipment associated with normal plant operations. Intermittent sources include the equipment related to coal handling, solid-waste disposal, transportation related to coal and lime delivery, use of outside loudspeakers, and the commuting of plant employees. Noise impacts associated with rail delivery of coal and lime to a plant at Millstone would be most significant for residents living in the vicinity of the facility and along the rail route. Although noise from passing trains significantly raises noise levels near the rail corridor, the short duration of the noise reduces the impact. Nevertheless, given the frequency of train transport and the many residents likely to be within hearing distance of the rail route, the impacts of noise on residents in the vicinity of the facility and the rail line would be noticeable. Overall, the aesthetic impacts at Millstone due to noise would be detectable. The incremental noise impacts of a coal-fired plant compared to existing Millstone operations would likely be SMALL to MODERATE.

At an alternate site, there would be a visual aesthetic impact from the buildings, exhaust stacks, and power-generation buildings. Noise and light from the plant would be detectable off site. Aesthetic impacts at the plant site would be mitigated because the site was the former location of a retired oil-fired plant. Noise impacts from a rail spur would be similar to the impacts at the existing site. Overall, the visual and noise aesthetic impacts associated with locating at an alternate site can be categorized as SMALL to MODERATE.

- **Historic and Archaeological Resources**

At the Millstone site or an alternate site, a cultural resource inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, that are acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of adverse impacts from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction at the Millstone site or an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on historic and archaeological resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated

corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other rights-of-way). Historic and archaeological resource impacts need to be evaluated on a site-specific basis. The impacts can generally be effectively mitigated, and, as such, impacts would be expected to range from SMALL to MODERATE, depending on the historic and archaeological resources that may be present, and whether mitigation is necessary.

- **Environmental Justice**

  No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement coal-fired plant were built at the Millstone site. Some impacts on housing availability and prices during construction might occur, and this could disproportionately affect minority and low-income populations. Closure of Millstone would result in employment of approximately 1250 fewer operating employees, possibly offset by growth in the southeastern Connecticut area. Following construction of the replacement coal-fired plant, it is possible that the ability of local government to maintain social services could be reduced at the same time as diminished economic conditions reduce employment prospects for minority or low-income populations. Overall, impacts would be SMALL to MODERATE, and would depend on both the extent to which projected economic growth is realized and also on the ability of minority or low-income populations to commute to other jobs outside the southeastern Connecticut area.

  Impacts at other sites would depend upon the site chosen and the nearby population distribution, but would likely also be SMALL to MODERATE.

8.2.1.2 Once-Through Cooling System

This section discusses the environmental impacts of constructing a coal-fired generation system at the Millstone site using once-through cooling. The impacts (SMALL, MODERATE, or LARGE) of this option are the same as the impacts for a coal-fired plant using the closed-cycle system. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8-3 summarizes the incremental differences.

8.2.2 Natural Gas-Fired Generation

The environmental impacts of the natural gas-fired alternative are examined in this section for both the Millstone site and an alternate site (retired oil-fired plant site). The staff assumed that the plant would use a closed-cycle cooling system. In Section 8.2.2.1, the staff also evaluated the impacts of using the existing open-cycle cooling system at the Millstone site.

Table 8-3. Summary of Environmental Impacts of Coal-Fired Generation at the Millstone Site with Once-Through Cooling

Impact Category	Change in Impacts from Once-Through Cooling System
Land Use	Impacts would be less (e.g., through elimination of cooling towers).
Ecology	Impacts would be greater on aquatic ecology at the site; potential impacts associated with entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock.
Water Use and Quality—Surface Water	Increased water withdrawal; thermal load higher than with closed-cycle cooling.
Water Use and Quality—Groundwater	No change
Air Quality	No change
Waste	No change
Human Health	No change
Socioeconomics	No change
Socioeconomics (Transportation)	No change
Aesthetics	Elimination of cooling towers
Historic and Archaeological Resources	No change
Environmental Justice	No change

The Millstone site and an alternate site would need a 41-centimeter (cm) (16-inch [in]) diameter natural gas pipeline constructed from the plant site to a supply point where a reliable supply of natural gas would be available.

The staff assumed that a replacement natural gas-fired plant would use combined-cycle technology (Dominion 2004). In a combined-cycle unit, hot combustion gases in a combustion turbine rotate the turbine to generate electricity. Waste combustion heat from the combustion turbine is routed through a heat-recovery boiler to make steam to generate additional electricity. The staff assumed that a replacement natural gas-fired plant would use combined-cycle combustion turbines as described by Dominion (Dominion 2004). Dominion estimates that the plant would consume approximately 2.4 million m^3 (85.7 billion ft^3) of natural gas annually (Dominion 2004).

Unless otherwise indicated, the assumptions and numerical values used in Section 8.2.2 are from the Dominion ER (Dominion 2004). The staff reviewed this information and compared it to

environmental impact information in the GEIS. Although the OL renewal period is only 20 years, the impact of operating the natural gas-fired alternative for 40 years is considered (as a reasonable projection of the operating life of a natural gas-fired plant).

8.2.2.1 Closed-Cycle Cooling System

The overall impacts of the natural gas-generating system are discussed in the following sections and summarized in Table 8-4. The extent of impacts at an alternate site (retired oil-fired plant) will depend on the location of the particular site selected.

Table 8-4. Summary of Environmental Impacts of Natural Gas-Fired Generation at Millstone and an Alternate Site Using Closed-Cycle Cooling

	Millstone Site		Alternate Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	45 ha (110 ac) for power-block, offices, roads, and parking areas. Additional impact for construction of an underground gas pipeline.	SMALL to MODERATE	45 ha (110 ac) for power-block, offices, roads, and parking areas. Additional impact for construction and/or upgrade of an underground gas pipeline.
Ecology	SMALL to MODERATE	Would use undeveloped areas at current Millstone site, plus gas pipeline. Smaller impacts to aquatic resources because less cooling water required.	SMALL to MODERATE	Impact depends on location and ecology of the site, surface-water body used for intake and discharge, and pipeline routes; potential habitat loss and fragmentation, reduced productivity and biological diversity. Likely plant sites already have power-generation facilities.
Water Use and Quality—Surface Water	SMALL	Would use existing intake and discharge structures. Less water use because closed-cycle replaces once-through cooling system.	SMALL to MODERATE	Impact depends on volume of water withdrawal and discharge and characteristics of surface water body.
Water Use and Quality—Groundwater	SMALL	Millstone site would use little groundwater.	SMALL to MODERATE	Impact would depend on volume of water withdrawal.

Table 8-4. (contd)

	Millstone Site		Alternate Site	
Impact Category	Impact	Comments	Impact	Comments
Air Quality	MODERATE	Sulfur oxides • 136 MT/yr (150 tons/yr) Nitrogen oxides • 511 MT/yr (564 tons/yr) Carbon monoxide • 671 MT/yr (740 tons/yr) PM_{10} particulates • 200 MT/yr (220 tons/yr) Some hazardous air pollutants	MODERATE	Same emissions as Millstone site.
Waste	SMALL	Small amount of ash produced.	SMALL	Same waste produced as if produced at the Millstone site.
Human Health	SMALL	Impacts considered to be minor.	SMALL	Impacts considered to be minor.
Socioeconomics	SMALL to MODERATE	During construction, impacts would be noticeable. Up to 1200 additional workers during the peak of the three-year construction period, followed by reduction from current Millstone workforce of 1650 to 55; tax base preserved. Impacts during operation would be minor.	SMALL to MODERATE	During construction, impacts would be noticeable. Up to 1200 additional workers during the peak of the three-year construction period. City of Waterford would experience loss of tax base and employment, potentially offset by possible economic growth.
Socioeconomics (Transportation)	SMALL to MODERATE	Transportation impacts likely would be noticeable during construction and slight for operations.	SMALL to MODERATE	Transportation impacts likely would be noticeable during construction and slight for operations.

Table 8-4. (contd)

Impact Category	Millstone Site		Alternate Site	
	Impact	Comments	Impact	Comments
Aesthetics	SMALL to MODERATE	Visual aesthetic impact due to plant units and stacks could be mitigated by landscaping and appropriate color selection for buildings. Visual impact at night could be mitigated by reduced use of lighting and appropriate shielding. Noise impacts would be relatively small and could be mitigated.	SMALL to MODERATE	Impact would depend on location of site. Similar to Millstone if located on retired oil-fired plant site.
Historic and Archeological Resources	SMALL to MODERATE	Any potential impacts can likely be effectively mitigated.	SMALL to MODERATE	Same as Millstone; any potential impacts can likely be effectively mitigated.
Environmental Justice	SMALL to MODERATE	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction; loss of 1595 operating jobs at Millstone. Plant could reduce employment prospects for minority and low-income populations. Impacts could be offset by possible economic growth and the ability of affected workers to commute.	SMALL to MODERATE	Impacts vary, depending on population distribution and make-up at site.

- **Land Use**

For siting at Millstone, existing facilities and infrastructure would be used to the extent practicable, limiting the amount of new construction that would be required. Specifically, the staff assumed that the natural gas-fired replacement plant alternative would need to modify and use the existing cooling system, switchyard, offices, and transmission line right(s)-of-way. Much of the land that would be used has been previously disturbed. At Millstone, the staff assumed that approximately 45 ha (110 ac) would be needed for the plant and associated infrastructure. There would be an additional impact for construction of a gas pipeline.

For construction at an alternate site, the staff assumed that 20 ha (50 ac) would be needed for the plant and associated infrastructure for a 1000-MW(e) plant (NRC 1996). Therefore, the staff assumed about 45 ha (110 ac) would be needed to replace the over 2000 MW(e) Millstone power generation. In addition, construction and/or upgrade of an underground pipeline would result in additional land disturbance at an alternate site.

Regardless of where the gas-fired plant is built, additional land would be required for natural gas wells and collection stations. Partially offsetting these offsite land requirements would be the elimination of the need for uranium mining to supply fuel for Millstone. In the GEIS (NRC 1996), the staff estimated that approximately 400 ha (1000 ac) would be affected for mining the uranium and processing it during the operating life of a nuclear power plant. Overall, land-use impacts would be expected to be SMALL to MODERATE.

- **Ecology**

At the Millstone site, there would be minor ecological impacts due to changes land use resulting from siting of the gas-fired plant. There would also be ecological impacts associated with bringing a new underground gas pipeline to the Millstone site. Additionally, there may be some impact on terrestrial ecology from saltwater drift from the cooling towers. Impacts to aquatic resources would likely be less than the current Millstone operations even if the existing intake and discharge structures are used because less cooling water would be required. Ecological impacts at an alternate site would depend on the nature of the land converted for the plant and the possible need for a new gas pipeline. Construction of the transmission line and construction and/or upgrading of the gas pipeline to serve the plant would be expected to have temporary ecological impacts. Ecological impacts to the plant site and utility easements could include impacts on threatened or endangered species, wildlife habitat loss and reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Depending on the location of an alternate site, the cooling make-up water intake and discharge could impact aquatic resources. Overall, the ecological impacts would be expected to be SMALL to MODERATE at either location.

- **Water Use and Quality—Surface Water**

Each of the gas-fired units would include a heat-recovery boiler from which steam would turn an electric generator. Steam would be condensed and circulated back to the boiler for reuse. A natural gas-fired plant sited at Millstone is assumed to use a closed-cycle cooling system. Existing intake and discharges would be used; however, cooling towers and other cooling system components would be constructed, replacing the existing once-through cooling system. Surface-water impacts at the Millstone site would be expected to be SMALL; the impacts would be sufficiently minor that they would not noticeably alter any important attribute of the resource.

A natural gas-fired plant at an alternate site is assumed to use a closed-cycle cooling system with cooling towers. The staff assumed that surface water would be used for cooling make-up water and discharge. Intake and discharge would involve relatively small quantities of water compared to the coal alternative. The impact on the surface water would depend on the volume of water needed for make-up water, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the state of Connecticut. The impacts would be SMALL to MODERATE.

The issue of water-quality impact from sedimentation during construction was characterized in the GEIS as SMALL. The staff also noted in the GEIS that operational water quality impacts would be similar to, or less than, those from other generating technologies. Sedimentation impacts from construction of a natural gas-fired plant at the Millstone site or at an alternate site would be short-term and easily mitigated.

- **Water Use and Quality—Groundwater**

The staff assumed that the ground-water wells would continue to be used for non-Millstone related activities (e.g., watering of baseball fields) located on the Millstone site. Ground-water withdrawals for a natural gas-fired plant at the Millstone site would be equal to or less than the withdrawals for the no-action and license renewal alternatives. Hence, impacts would be SMALL. Use of groundwater for a gas-fired plant located at an alternate site is a possibility. Ground-water withdrawals at an alternate site would likely require a permit from the state of Connecticut. The impacts will depend on the characteristics of the site and the amount of groundwater used. Therefore, the impacts would be SMALL to MODERATE.

- **Air Quality**

Natural gas is a relatively clean-burning fuel. The gas-fired alternative would release similar types of emissions, but in lesser quantities than the coal-fired alternative.

A new gas-fired generating plant located in Connecticut would likely need a prevention of significant deterioration permit and an operating permit under the Clean Air Act. A new combined-cycle natural gas power plant would also be subject to the new source performance standards for such units at 40 CFR Part 60, Subparts Da and GG. These regulations establish emission limits for particulates, opacity, SO_2, and NO_x.

Section 169A of the Clean Air Act (42 USC 7491) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from human made air pollution. EPA issued a new regional haze

rule on July 1, 1999 (64 *Federal Register* [FR] 35714 [EPA 1999]). The rule specifies that for each mandatory Class I Federal area located within a state, the state must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period [40 CFR 51.308(d)(1)]. If a coal-fired plant were located close to a mandatory Class I Federal area, additional air pollution control requirements could be imposed. There are no Class I areas in Connecticut.

In 1998, EPA issued a rule requiring 22 eastern states, including Connecticut, to revise their state implementation plans to reduce nitrogen oxide emissions. Nitrogen oxide emissions contribute to violations of the national ambient air quality standard for ozone. The total amount of nitrogen oxides that can be emitted by each of the 22 states in the year 2007 ozone season (May 1 to September 30) is set out at 40 CFR 51.121(e). For Connecticut, the amount is 38,873 MT (42,850 tons).

EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated attainment or unclassified under the Clean Air Act. The entire state of Connecticut has been designated as an attainment area for carbon monoxide, nitrogen dioxide, lead, and sulfur dioxide. New London County is also designated as in attainment for particulate matter with a diameter of 10 μm or less. New London County has been designated as serious nonattainment for the EPA one-hour ozone standard (40 CFR 81.307; CTDEP 2002a).

Dominion projects the following emissions for the natural gas-fired alternative (Dominion 2004):

Sulfur oxides — 136 MT/yr (150 tons/yr)
Nitrogen oxides — 511 MT/yr (564 tons/yr)
Carbon monoxide — 671 MT/yr (740 tons/yr)
PM_{10} particulates — 200 MT/yr (220 tons/yr)

A natural gas-fired plant would also have unregulated carbon dioxide emissions that could contribute to global warming.

In December 2000, EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam-generating units (EPA 2000a). Natural gas-fired power plants were found by EPA to emit arsenic, formaldehyde, and nickel (EPA 2000a). Unlike coal and

oil-fired plants, EPA did not determine that emissions of hazardous air pollutants from natural gas-fired power plants should be regulated under Section 112 of the Clean Air Act.

Construction activities would result in temporary fugitive dust. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process.

The emissions discussed above would likely be the same at Millstone or at an alternate site. Impacts from the above emissions would be clearly noticeable, but would not be sufficient to destabilize air resources as a whole.

The overall air-quality impact for a new natural gas-fired plant sited at Millstone or at an alternate site would be expected to be MODERATE.

- **Waste**

There will be spent selective catalytic reduction catalyst from NO_x emissions control and small amounts of solid-waste products (i.e., ash) from burning natural gas fuel. In the GEIS, the staff concluded that waste generation from gas-fired technology would be minimal (NRC 1996). Gas firing results in very few combustion by-products because of the clean nature of the fuel. Waste-generation impacts would be so minor that they would not noticeably alter any important resource attribute. Construction-related debris would be generated during construction activities. Overall, the waste impacts would be SMALL for a natural gas-fired plant sited at Millstone or at an alternate site.

- **Human Health**

In Table 8-2 of the GEIS, the staff identifies cancer and emphysema as potential health risks from gas-fired plants (NRC 1996). The risk may be attributable to NO_x emissions that contribute to ozone formation, which, in turn, contributes to health risks. NO_x emissions from any gas-fired plant would be regulated. For a plant sited in Connecticut, NO_x emissions would be regulated by the CTDEP. Human health impacts would not be detectable or would be sufficiently minor. Overall, the impacts on human health of the natural gas-fired alternative sited at Millstone or at an alternate site would be SMALL.

- **Socioeconomics**

Construction of a natural gas-fired plant would take approximately three years. Peak employment would be approximately 1200 workers (NRC 1996). The staff assumed that construction would take place while Millstone continues operation and would be completed by the time it permanently ceases operations. During construction, the communities surrounding the Millstone site would experience demands on housing and public services

that could have noticeable impact. These impacts would be tempered by construction workers commuting to the site from other parts of New London County or from other counties. After construction, the communities would be impacted by the loss of jobs. The current Millstone workforce (1650 workers) would decline through a decommissioning period to a minimal maintenance size. The gas-fired plant would introduce a replacement tax base at Millstone or an alternate site and approximately 55 new permanent jobs. For siting at an alternate site, impacts in New London County resulting from decommissioning of Millstone may be offset by economic growth projected to occur in the region.

In the GEIS (NRC 1996), the staff concluded that socioeconomic impacts from constructing a natural gas-fired plant would not be noticeable and that the small operational workforce would have the lowest socioeconomic impacts of any nonrenewable technology. Compared to the coal-fired and nuclear alternatives, the smaller size of the construction workforce, the shorter construction time frame, and the smaller size of the operations workforce would mitigate socioeconomic impacts. For these reasons, socioeconomic impacts associated with construction and operation of a natural gas-fired power plant at Millstone or at an alternate site would be SMALL to MODERATE. Depending on other growth in the area, socioeconomic impacts could be noticeable, but they would not destabilize any important socioeconomic attribute.

- **Socioeconomics (Transportation)**

Transportation impacts associated with construction and operating personnel commuting to the plant site would depend on the population density and transportation infrastructure in the vicinity of the site. The impacts would be SMALL to MODERATE for siting at Millstone or at an alternate site.

- **Aesthetics**

The turbine buildings, exhaust stacks [approximately 61 m (200 ft) tall], cooling towers, and the plume from the cooling towers would be visible from off site during daylight hours. Visual impacts could be mitigated by landscaping and selecting a color for buildings that is consistent with the environment. Visual impact at night could be mitigated by reduced use of lighting and appropriate use of shielding. The gas pipeline compressors also would be visible. Noise and light from the plant would be detectable offsite. Overall, the aesthetic impacts associated with constructing and operating a natural gas-fired plant at the Millstone site would be SMALL to MODERATE.

At an alternate site, the buildings, cooling towers, cooling tower plumes, and the associated gas pipeline compressors would be visible offsite. Aesthetic impacts would be mitigated by

location of the plant at a retired oil-fired plant site. Overall, the aesthetic impacts associated with constructing and operating a natural gas-fired plant at the Millstone site would be SMALL to MODERATE.

- **Historic and Archaeological Resources**

  At both Millstone and an alternate site, a cultural resource inventory would likely be needed for any onsite property that has not been previously surveyed. Other land, if any, acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of adverse impacts from subsequent ground-disturbing actions related to physical expansion of the plant site.

  Before construction at Millstone or an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on historic and archaeological resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission and pipeline corridors, or other rights-of-way). Impacts to historic and archaeological resources can be managed and mitigated to a certain extent under current laws and regulations. Therefore, impacts to historic and archaeological resources from a natural gas-fired plant would be expected to be SMALL to MODERATE, depending on the resources that may be present and whether mitigation is necessary.

- **Environmental Justice**

  No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement natural gas-fired plant were built at the Millstone site. Some impacts on housing availability and prices during construction might occur, and this could disproportionately affect minority and low-income populations. Closure of Millstone would result in a decrease in employment of approximately 1595 operating employees, possibly offset by general growth in the southeastern Connecticut area. Following construction, the local government's ability to maintain social services could be reduced at the same time as diminished economic conditions reduce employment prospects for minority or low-income populations. Overall, impacts are expected to be SMALL to MODERATE, especially since minority and low-income populations are not in the immediate vicinity of the Millstone site. Projected economic growth in southeastern Connecticut and the ability of minority and low-income populations to commute to other jobs outside the Waterford area could mitigate any adverse impacts.

Impacts at an alternate site would depend upon the site chosen and the nearby population distribution, but would also be expected to be SMALL to MODERATE.

8.2.2.2 Once-Through Cooling System

This section discusses the environmental impacts of constructing a natural gas-fired generation system at the Millstone site using once-through cooling. The impacts (SMALL, MODERATE, or LARGE) of this option are the same as the impacts for a natural gas-fired plant using the closed-cycle system. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8.5 summarizes the incremental differences.

8.2.3 Nuclear Power Generation

Since 1997, the NRC has certified three new standard designs for nuclear power plants under 10 CFR Part 52, Subpart B. These designs are the 1300 MW(e) U.S. Advanced Boiling Water Reactor (10 CFR Part 52, Appendix A), the 1300 MW(e) System 80+ Design (10 CFR Part 52, Appendix B), and the 600 MW(e) AP600 Design (10 CFR Part 52, Appendix C). All of these plants are light-water reactors. On September 13, 2004, the Commission issued the Final Design Approval for the AP1000 Design; the staff anticipates that the certification for this design will be finalized in December 2005. Although no applications for a construction permit or a combined license based on these certified designs have been submitted to NRC, the submission of the design certification applications indicates continuing interest in the possibility of licensing new nuclear power plants. In addition, recent escalation in prices of natural gas and electricity have made new nuclear power plant construction more attractive from a cost standpoint. Additionally, System Energy Resources, Inc., Exelon Generating Company, LLC, and Dominion Nuclear North Anna, LLC, have recently submitted applications for early site permits under the procedures in 10 CFR Part 52, Subpart A.

Consequently, construction of a new nuclear power plant at both the Millstone site and an alternate is considered in this section. The staff assumed that the new nuclear plant would have a 40-year lifetime. Consideration of a new nuclear generating plant to replace Millstone was not included in the Dominion ER.

NRC has summarized environmental data associated with the uranium fuel cycle in Table S-3 of 10 CFR 51.51. The impacts shown in Table S-3 are representative of the impacts that would be associated with a replacement nuclear power plant built to one of the certified designs and sited at Millstone or an alternate site. The impacts shown in Table S-3 are for a 1000-MW(e) reactor and would need to be adjusted to reflect impacts of 2024-MW(e) of new nuclear power.