Chapter 5 Environmental Impacts of Operation

Chapter 5 presents the potential environmental impacts of operation of Fermi 3. Impacts are analyzed, and a single significance level of potential impact to each resource (i.e., SMALL, MODERATE, or LARGE) is assigned consistent with the criteria that the Nuclear Regulatory Commission (NRC) established in 10 CFR 51, Appendix B, Table B-1, Footnote 3. Unless the significance level is identified as beneficial, the impact is adverse, or in the case of SMALL, may be negligible. The definitions of significance are as follows:

SMALL Environmental effects are not detectable or are so minor that they neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the NRC's regulations are considered small.

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.

This chapter is divided into eleven sections relevant to normal plant operation:

- Land-Use Impacts (Section 5.1)
- Water-Related Impacts (Section 5.2)
- Cooling System Impacts (Section 5.3)
- Radiological Impacts of Normal Operation (Section 5.4)
- Environmental Impacts of Waste (Section 5.5)
- Transmission System Impacts (Section 5.6)
- Uranium Fuel Cycle and Transportation Impacts (Section 5.7)
- Socioeconomic Impacts (Section 5.8)
- Decommissioning (Section 5.9)
- Measures and Controls to Limit Adverse Impacts During Operation (Section 5.10)
- Cumulative Impacts Related to Station Operation (Section 5.11)

These sections present potential ways to avoid, minimize, or mitigate adverse impacts of operation to the maximum extent practical. For the purposes of this chapter, the site, vicinity, and region are defined in Chapter 2.

5.1 Land-Use Impacts

Subsection 5.1.1 describes the impacts of Fermi 3 operation on land use at the Fermi site and within the 7.5-mile vicinity. For the land use impacts analysis, the 7.5-mile vicinity is defined as the area encompassed by a 7.5-mile radius around Fermi, as explained in Section 2.1. Subsection 5.1.2 describes impacts that could occur along transmission lines and in offsite areas resulting from operation and maintenance activities. Subsection 5.1.3 describes potential impacts on historic properties on the Fermi site, along the onsite transmission corridors, and in the vicinity. Background information used in this section is included in Section 2.2.

5.1.1 The Site and Vicinity

After construction is complete, the final site configuration on the Fermi site during operation will consist of a single Protected Area shared by both Fermi 2 and Fermi 3. The structures that remained from decommissioned Fermi 1 will no longer be present on the site. The new Fermi Drive will be used as the main access to the site, while the existing Fermi Drive may be retained as a secondary access road.

The vicinity of the Fermi site is used primarily for cropland and pasture (Figure 2.2-1). Adverse impacts to the Fermi site and vicinity would occur primarily during construction of Fermi 3, as documented in Chapter 4. Impacts on land use in the site and vicinity from Fermi 3 construction were evaluated in Subsection 4.1.1. The periodic operational dredging of the Fermi 3 intake and barge slip area would result in dredge spoils that would be expected to be disposed of in the same Spoil Disposal Pond used for Fermi 2. Maintenance dredging for the Fermi 2 intake embayment has been performed every 4 years. Approximately 22,000 yd^3 of material is removed from the intake embayment during these activities (permit allows for removal of up to 25,000 yd^3 of material each year for five years). This disposal area within Boomerang Road (shown on Figure 2.1-4) has not impacted land use on the Fermi site during Fermi 2 operation. Similarly, disposal of Fermi 3 dredge spoils would not be expected to affect land use during Fermi 3 operation. The dredging for both Fermi 2 and Fermi 3 intakes would occur in their common location approximately once every three to four years (continued dredging of the Fermi 3 barge slip is not anticipated). The increase in quantity of dredge spoils resulting from the Fermi 3 intake is expected to be accommodated by the existing Spoil Disposal Pond. Operation of Fermi 3 is not expected to produce any significant impacts to land use on the site or in the vicinity.

Land use within and adjacent to the existing Fermi site is discussed in Subsection 2.2.1. Figure 2.2-1 illustrates land use within the site and within the 7.5-mile vicinity. No new areas are expected to be disturbed after the construction phase ends, and no agricultural crop production is expected to occur on the Fermi site (except on the possible laydown area parcel in the southwest portion of the site outside the perimeter fence) because the site is largely dedicated to the Detroit River International Wildlife Refuge (DRIWR) beyond the area of the power plant structures. Therefore, operations at the Fermi site are expected to have SMALL impacts on the forest, wetland, maintained grassland, and developed land located within the site. There will likely be positive impacts to the natural areas during operation as the disturbance from construction is restored to wildlife habitat.

5.1.1.1 Land Use Planning and Zoning

The operation of Fermi 3 would comply with Frenchtown Township and Monroe County land use plans and zoning requirements because the site is on land already zoned and planned for Public

Service (Utility) development and use, as shown in the Frenchtown Charter Township Master Plan. The areas west and south of the Fermi site have been zoned for agricultural and residential use and would be minimally affected by operation of Fermi 3. Operation of Fermi 3 would have no impact on area planning and zoning designations and would comply with local plans. As discussed in Section 2.2, Monroe County is updating the 1985 version of the Comprehensive Plan and is expected to make recommendations consistent with current land use and plans for the Fermi site and vicinity.

Table 2.2-2 lists land uses in the Fermi vicinity before construction of Fermi 3. During operation of Fermi 3, a slight reduction in the acreage of wetland and forested areas and a very small increase in the developed area acreage will carry forward, similar to the land use changes that would begin during construction. Similar to that for construction, Fermi 3 operations will not impact land use planning and zoning.

In keeping with the industrial zoning of portions of the vicinity surrounding the Fermi site, there are some land parcels occasionally offered for sale for industrial development. Some businesses may choose to avoid this location because of its proximity to an operating nuclear plant, while others may see the existing industrial infrastructure as an advantage of the location. Depending on the viewpoint of each industry seeking to locate in the area, operation of Fermi 3 could either hinder or accelerate the development of industrial and potential commercial land use in the area.

In summary, Fermi 3 operational impacts on the site vicinity land use planning and zoning are expected to be SMALL, with no mitigation measures needed.

5.1.1.2 **Soil and Agriculture**

During operation of Fermi 3, significant erosion issues that would impact the site or the surrounding vicinity are unlikely. Construction will be completed at the operation phase and stabilization measures will already be in place to prevent erosion and sedimentation impacts to the site and vicinity. Erosion at the Fermi 3 site would be prevented through the observance of erosion control measures and adherence to permits and the Fermi 3 Stormwater Pollution Prevention Plan (SWPPP) during operation. Young vegetation would be in place over most of the areas that had been disturbed during construction, which would help prevent erosion and enhance soil stability. Because there would no longer be a routine need for land clearing, excavation, and similar activities after completion of construction, normal activities carried out during the operation of Fermi 3 would not have significant erosion or soil impacts.

Prime farmland and construction impacts to prime farmland were discussed in Subsection 2.2.1.1 and Subsection 4.1.1.2, respectively. Land on the Fermi site is not used for agriculture except for the rectangular parcel in the southwest corner of the site that may be used for temporary construction laydown (Figure 2.1-4). This parcel is the only area that contains prime farmland and that is being used as farmland. Impacts to land use on this parcel would occur temporarily during construction. During Fermi 3 operation, this parcel is likely to be returned to agricultural use and would not be impacted by plant operation.

Overall soil and agricultural land use impacts from Fermi 3 operation are expected to be SMALL.

5.1.1.3 **Cooling Tower Impact on Land Use**

Section 3.4 contains a detailed description of the operation of the cooling towers and the closed-cycle cooling system. The cooling tower effect with the potential to affect land use is salt deposition from cooling tower drift.

Drift associated with natural draft designs can extend to greater distances relative to those from mechanical draft towers, with mechanical tower drift largely remaining in the immediate environs of the towers. As explained in Subsection 5.3.3.1.3, drift would not be expected to cause damage to vegetation or agriculture in the vicinity because drift and the salt concentrations that it would contain would be deposited largely northeast of the site in Lake Erie. Agricultural areas are mostly west of the Fermi site and would be minimally impacted by cooling tower drift. The maximum concentration of salt in the cooling tower drift would occur in winter (0.02 kg/km^2/month) and would be far lower than the level considered as a SMALL impact by the NRC. The potential plume would be very unlikely to reach the ground. Therefore, no impact to land use from cooling tower drift is expected onsite or in the vicinity.

Moreover, Table 4.2 of the NRC's Generic Environmental Impact Statement for License Renewal (GEIS) (NUREG-1437) gives estimates of salt-drift deposition rates estimated to cause acute injury to vegetation, including some of the principal crops grown in the vicinity such as corn and soybeans. According to the GEIS, corn and soybeans are two of the most sensitive crops with regard to salt deposition. The GEIS cites figures of 1.82 kg/ha/week (1.6 lb/acre/week) for corn and 7.28 kg/ha/week (6.6 lb/acre/week) for soybeans as the levels above which acute injury to these crops can be expected. The projected maximum salt concentration for Fermi 3 is far below the levels determined to cause acute damage to crops, and salt deposition would fall into Lake Erie, not onto crop fields, during the majority of the year. Levels for chronic crop injury were not provided; however, Table 4.3 of the GEIS shows that none of the eight nuclear plants with natural draft cooling towers that were monitored for vegetation damage from cooling tower drift showed adverse effects after one year.

In summary, the impacts to land use due to cooling tower salt deposition are SMALL, and no mitigative measures are needed.

5.1.1.4 **Spills**

The measures discussed in Subsection 4.1.2 to prevent spills onsite during construction will be carried through and also implemented during operation. Environmental training will be provided to plant staff to increase their awareness of potential effects of spills on the environment and to assist their compliance with best spill avoidance practices as outlined in the Spill Prevention, Control and Countermeasure (SPCC) Plan. During this training, emphasis would be given to the adjacent location of wetlands and Lake Erie as reasons for special caution on the part of site workers when handling materials that could be spilled and have negative environmental effects. If a spill did occur, the impact on land use during operation would be temporary; the spill area would be avoided as cleanup progressed and would be returned to its normal use upon completion of spill cleanup. Staff training and observance of spill avoidance measures at the Fermi 3 site is expected to result in SMALL impacts to land use onsite and in the vicinity from potential spills.

5.1.1.5 **Other Land Use Considerations**

Noise levels during Fermi 3 operation are expected to be similar to ambient noise levels during Fermi 2 operation. Operational noise levels for Fermi 2 have not impacted land use in the vicinity. Therefore, it is reasonable to assume that Fermi 3 noise impacts during operation will be SMALL and will likewise not impact land use in the vicinity. Noise impacts during operation are discussed in more detail in Subsection 5.8.1.3.

Subsection 5.8.2.4.2 describes the potential for significantly increased traffic flow following Fermi 3 commercial operation. However, it is likely that significant traffic congestion would only be seen during outage periods, typically during shift changes. Accordingly, it is judged that the impacts to land use based on increased traffic would be SMALL.

5.1.2 **Transmission Corridors and Offsite Areas**

As stated in NUREG-1555, Section 5.1.2:

> In some cases transmission lines may be constructed and operated by an entity other than the applicant. In such cases, impact information may be limited and the reviewer should proceed with the assessment using the information that can be obtained.

The 345 kV transmission system and associated corridors are exclusively owned and operated by ITC*Transmission*. The Applicant has no control over the construction or operation of the transmission system. Accordingly, the operational impacts are based on publicly available information, and reasonable expectations of the configurations and practices that ITC*Transmission* would likely follow based on standard industry practice. However, the information described in this subsection does not imply commitments made by ITC*Transmission* or Detroit Edison, unless specifically noted.

A description of the existing and proposed transmission corridors associated with the Fermi site is provided in Subsection 2.2.2 and Section 3.7. The transmission corridor already exists and has been maintained as a transmission corridor, but is undeveloped in one section. Three new 345 kV transmission lines are proposed from the Fermi site to the Milan Substation. Land use within a 0.5 mile band of the existing and proposed 345 kV transmission corridors is discussed in Subsection 2.2.2, and the Fermi transmission corridors (120 kV and 345 kV) are shown on Figure 2.2-3.

<u>Onsite</u>

The approximate route and impact areas associated with the short length of new transmission corridor that would be constructed within the Fermi site are shown on Figure 2.1-4 and described in Subsection 2.2.2.2, and land use construction impacts from the onsite transmission line are described in Subsection 4.1.2.

The majority of the impacts from the new onsite transmission corridor will occur during construction. During operation, some towers may occasionally be flooded at their bases due to large precipitation events or seiche events in Lake Erie that fill the drainage area up to the boundaries of the adjacent forested areas; however, the presence of the towers in these areas will not affect the water carrying capacity (function) of the drainage area. The towers will be designed for corrosion resistance and the tower foundations will be designed to accommodate the onsite conditions. Impacts to the DRIWR during operation are expected to be minimal and are described in Section 5.6.

It is expected that Detroit Edison would contract with ITC*Transmission* to maintain the corridor, transmission towers, and transmission lines on the Fermi site. It is expected that ITC*Transmission* would implement the same maintenance practices and procedures as those used on transmission equipment owned by ITC*Transmission*.

Maintenance activities along the new onsite transmission corridor would be occasional. Typical maintenance activities will likely involve trimming of tree branches infringing on the ROW from surrounding forested areas near Toll Road and Doxy Road near the cooling tower. Vegetation management is to be limited to the minimum needed to keep the transmission line free from intrusion of vegetation that could interfere with safe, reliable operation of the line. During operation, access to the formerly forested portions of the corridor near Toll Road would be from the new Fermi Drive northeast along the corridor within the already cleared area, and Doxy Road would provide access to the small forested portion near the cooling tower. Access to the towers near the drainage area in the central portion of the transmission line would be from established access pathways following those same pathways used during construction, as shown on Figure 2.1-4. These pathways would not become permanent access roads; rather, they would be established pathways similar to a non-paved trail so that permanent access road impacts are avoided. Vehicles will not be driven on the access pathways during operation; maintenance access to the onsite transmission corridor will be by other means so that impacts to the wetland areas around the transmission corridor are avoided. The central portion of the onsite transmission corridor near the drainage area and other areas with vegetation with limited height (largely phragmites and cattail) would need very little maintenance since the natural vegetation height would not present a safety hazard to the transmission lines.

Refer to Subsection 5.6.3.4 and Subsection 5.8.1.3 for descriptions of operation-related noise impacts on the Fermi site. Visual impacts during operation are described in Subsection 5.6.3.1 and Subsection 5.8.2.6.

Measures to minimize impacts from the onsite transmission corridor during operation include selective use of pesticides and herbicides only if and where needed in accordance with ITC*Transmission's* membership in the EPA voluntary Pesticide Environmental Stewardship Program (PESP), minimizing the potential for impacts to wildlife and the nearby drainage. During operation of the onsite transmission corridor, vegetative cover would be expected to be in place to stabilize the soil and prevent erosion; this vegetation would include both existing vegetation in the central portion of the corridor and re-established low-height vegetation in the formerly forested areas.

Maintenance activities are expected to be executed using Best Management Practices (BMPs) with the goal of avoiding and minimizing erosion during equipment access to the onsite transmission corridor. The Soil Erosion and Sedimentation Control Plan and the Pollution Incident Prevention

Plan (PIPP) for Fermi 3 or similar practices are expected to be used by ITC*Transmission* during all maintenance or other activities during operation of the onsite transmission corridor.

In light of the measures described above that will be taken to minimize impacts from operation of the onsite transmission corridor, impacts to land use on the Fermi site are expected to be minimal.

Offsite

Effects of transmission line corridor construction on land use were evaluated in Subsection 4.1.2 . Various aspects of transmission line operation (e.g., ozone production and noise) have the potential for an indirect impact to land use through their effects on wildlife and humans. These effects are evaluated in Section 5.6. None of these potential impacts is expected to be significant to agricultural or other land uses in the area.

The transmission corridor is expected to have only minimal impact on land use during operation of Fermi 3. There would be occasional vehicular traffic in the corridor for maintenance purposes, which could result in SMALL impacts to vegetation and soils and minor amounts of soil erosion. These minor impacts would likely be contained within the immediate area of the transmission corridor.

Land use impacts that would occur within the transmission line corridor would be expected to be confined to the corridor area and would occur mostly during construction, as described in Subsection 4.1.2. The new transmission lines and towers are likely to have only impacts on the land uses adjacent to the corridor due to vegetation management and noise from maintenance and inspection vehicles, workers, and corridor inspection by helicopter. Very small amounts of erosion and sedimentation may occur as a result of the infrequent vehicle traffic in the corridor, especially if vehicles access the area during wet weather. These impacts are likely to be short-term and occasional in nature.

5.1.2.1 **Planning and Zoning**

ITC*Transmission* would be responsible for maintaining the transmission corridor and structures in compliance with the land use plans and zoning requirements (where applicable, as discussed in Subsection 2.2.2 and Subsection 4.1.2) of Monroe, Wayne, and Washtenaw Counties, which are crossed by the transmission corridor. The area crossed by the transmission corridor is removed from residences as much as possible along the route and primarily traverses agricultural land in a corridor that has already been authorized and maintained for transmission use. This agricultural land comprises a very small portion of the available agricultural land in the region, and agriculture can still be practiced in the transmission corridor under the new lines. It is reasonable to conclude, therefore, that operation of a corridor would have SMALL impacts on the surrounding land use.

5.1.2.2 **Transportation and Rights-of-Way**

During operation of Fermi 3, the ITC*Transmission* system infrastructure will already be in place, including portions of the system that were constructed across roads, pipelines, or other utilities

According to the NRC, experiences with high voltage lines have demonstrated that inductive coupling or direct faulting with railroad communication and signal lines occurs on a regular basis (Reference 5.1-1). Neither the 345 kV line from the Fermi site to the Brownstown Station nor the 345 kV line from the Fermi site to the Milan Substation are immediately adjacent to or closely parallel to railroad signal or communication equipment. The route to the Milan Substation has about five rail crossings and does not closely parallel railroad routes in the area. The existing route to Brownstown Substation has about three rail crossings, and the circuits that run east of I-75 parallels the same route as the Canadian National and Norfolk Southern rail lines. However, the rail lines are approximately 0.5 mile east of transmission corridor at the closest point, which is likely too far from the transmission lines to experience adverse effects. As a result, no induced voltage problems are anticipated. (Reference 5.1-1).

Transmission line operation as it relates to transportation and rights-of-way is anticipated to have SMALL impacts on land use in the transmission corridor.

5.1.2.3 **Agricultural and Soil Issues**

Agricultural land use is prevalent along the transmission corridor route. Agricultural land usually has minimal occupancy so that there would not be a significant number of residences in close proximity to the transmission lines. Some agricultural uses may be slightly curtailed in the areas directly adjacent to or under the corridor. Agricultural use on the Fermi site occurs only on the rectangular parcel in the southwest; this parcel would not be affected by operation of the transmission lines because the lines are on the north side of Fermi Drive and the agricultural activity is south of Fermi Drive.

Maintenance activities undertaken during operation of the transmission corridors would occur within the new 170-foot wide onsite corridor and an assumed 300-foot wide offsite corridor and would not impact land use in adjacent areas. Seasonal maintenance may cause some temporary erosion and compaction along certain portions of the transmission corridor and on any access roads that have gravel or other unpaved surfaces. Erosion impacts are not expected to affect adjacent properties outside the transmission corridor. During operation of the transmission lines, vegetative cover will have been established and will prevent erosion onto adjacent land. The use of best management practices along the corridor during operation would minimize erosion impacts.

It is expected that ITC*Transmission* will implement best management practices. This would likely involve minimal maintenance vehicles and access roads to the extent possible, and limiting transmission line maintenance work during wet weather conditions. For these reasons, SMALL impacts to agricultural land and soils are expected both along the new offsite transmission corridor and to soils in and around the expanded onsite corridor.

5.1.2.4 **Spills**

It is anticipated that ITC*Transmission* spill prevention and response will be in accordance with applicable regulatory standards typically through the observance of preventative measures. It is expected that care will be taken during operation to avoid spills of transformer oils and fluids and to avoid using maintenance vehicles with oil or other fluid leaks when performing maintenance work on the transmission lines.

5.1.2.5 **Maintenance Activities**

There will be new impacts created as a result of operation of Fermi 3 with regard to maintenance of transmission corridors. Fermi 3 would use three new 345 kV transmission lines in the existing transmission corridors discussed in Subsection 2.2.2 and Section 3.7. Therefore, the impacts due to operation of the new transmission lines would be expected to be greater than those associated with the operation of Fermi 2 because of the greater area occupied by the lines serving both units compared to only one unit.

The impacts usually associated with transmission line right-of-way maintenance consist of erosion/siltation and disturbance of wildlife and wildlife habitat, and similar impacts where rights-of-way cross floodplains and wetlands. Right-of-way maintenance is expected to be conducted similar to current operations because the corridor used for the proposed route is already maintained.

Normal inspection of the right-of-way is expected to be conducted by helicopter, possibly minimizing the need to regularly cut back the entire right-of-way. Clearing is expected to be limited to the minimum needed to allow access by maintenance vehicles and to keep the line free from intrusion of trees that could potentially interfere with safe, reliable operation of the line. Permanent access roads would not be anticipated, since the land in this area is flat (Reference 5.1-1).

The transmission corridor is expected to be managed by periodic removal of tall trees (where present) within the right-of-way and removal or trimming of such trees at the edge of the right-of-way. This maintenance practice is in widespread use among utilities and has not been known to have significant impacts to land use. Population numbers of most of the wildlife species occurring on the right-of-way may fluctuate in accordance with the cutting or mowing cycle, with the lows in numbers occurring shortly after the periodic trimming, mowing, or cutting. Some pesticides may be selectively used during maintenance of transmission corridors by ITC*Transmission*. ITC*Transmission* is a member of the U.S. Environmental Protection Agency's (EPA) voluntary Pesticide Environmental Stewardship Program (PESP). PESP members practice environmental stewardship as an integral part of pest control. Members of the program also adopt risk reduction strategies and undertake specific steps toward reaching their goals of pesticide practices that reduce risks to humans and the environment. (Reference 5.1-2) Pesticides and herbicides are expected to be used selectively and only where needed, minimizing the potential for significant impact to wildlife and aquatic resources. Existing access roads are expected to be used for right-of-way maintenance, as needed.

During heavy vehicle access to the transmission corridor, especially during wet weather conditions, erosion may occur on unpaved transmission line access roads. Access roads are typically constructed only where and if needed and would use water diversion measures, if necessary, to direct water off the sides of the access roads and prevent erosion impacts. The topography in the Fermi region is flat, which is expected to assist in minimizing potential erosion impacts from transmission access roads. During operation of the transmission corridor, vegetative cover would be expected to be in place to stabilize the soil and prevent erosion.

Because of their periodic nature and typically small areas being maintained at any one time, the effects of right-of-way area maintenance on land use are expected to be SMALL during operation of Fermi 3.

5.1.3 Historic Properties

The number and location of archaeological and above-ground resources identified as a result of cultural resources investigations are presented in Subsection 2.5.3. Additional information is provided in Table 2.5-62, Table 2.5-63, and Figure 2.5-26. This subsection presents the operational impacts to these resources.

Direct effects of Fermi 3 operation will occur only within the Fermi site. The archaeological APE is situated entirely within the Fermi site and, thus, Fermi 3 operational impacts to archaeological resources would occur only within the archaeological APE. The above-ground resources APE includes the entire Fermi site. With the possible exception of Fermi 1 deconstruction (which is undergoing SHPO review for National Registry of Historic Places (NRHP) eligibility), there are no impacts to historic properties on the Fermi site as a result of Fermi operation. Impacts to resources outside of the Fermi site would be limited to such indirect impacts as noise-related and visual impacts.

5.1.3.1 Archaeological Sites

Subsection 2.5.3 describes the archaeological findings on the site. Because no archaeological findings are evident on the site, the expected operational impacts are expected to be SMALL, with no mitigative measures needed. However, Detroit Edison will ensure compliance is maintained with the Native American Graves Protection and Repatriation Act with regard to post-construction excavation activities.

5.1.3.2 Above-Ground Resources Sites

No above-ground resources within the Fermi site have been assessed as to NRHP eligibility; therefore, Fermi 3 operational activities would have no impact on resources that are listed on the NRHP or that have been determined eligible for listing on the NRHP. Fermi 1 has not been assessed as to its NRHP eligibility. A determination of NRHP eligibility for Fermi 1 is pending SHPO review.

Subsection 2.5.3 describes the NRHP-listed and NRHP-eligible above-ground resources within the site vicinity. Fermi 3 operations that would impact these sites are limited to noise-related and visual impacts. The Fermi site currently houses Fermi 2, which currently produces indirect effects in the form of ambient noise and visual impacts associated with two cooling towers. Because these impacts currently exist, and have existed for at least three decades, any additional impacts associated with Fermi 3 operation would not introduce any elements that are substantive different from those that already exist. Impacts to historic above-ground resources within a 10-mile radius are considered SMALL, and mitigation is not warranted.

5.1.4 **References**

5.1-1 Detroit Edison Company, “Enrico Fermi Atomic Power Plant, Unit 2, Applicant’s Responses to Federal Agency Comments on AEC Draft Environmental Statement,” Docket 50-341, June 1,1972.

5.1-2 U.S. Environmental Protection Agency, “Pesticide Environmental Stewardship Program (PESP),” http://www.epa.gov/oppbppd1/pesp/member_pages/itc.htm, accessed 17 June 2008.

5.2 Water-Related Impacts

This section provides information that describes the hydrological alterations, plant water supply, and water-related impacts of plant operations. Water-related impacts from plant operations are addressed in the following subsections:

- Hydrologic Alterations and Plant Water Supply (Subsection 5.2.1)
- Water-Use Impacts (Subsection 5.2.2)

5.2.1 Hydrologic Alterations and Plant Water Supply

Fermi 3 operations that may cause hydrologic alterations include withdrawal of water from Lake Erie, discharge of blowdown to Lake Erie, discharge of stormwater to Swan Creek and Lake Erie, discharge from dewatering from proposed Fermi 3 construction area into the overflow canal, dredging of the intake bay, and discharge from the Spoil Disposal Pond into Lake Erie.

5.2.1.1 Physical Characteristics of Surface Water and Groundwater

The shoreline of Lake Erie is on the east side of the Fermi site. Lake Erie has a surface area of approximately 9,900 square miles and a volume of 116 cubic miles (Reference 5.2-1). The western basin of Lake Erie is a very shallow basin with an average depth of 24 feet (Reference 5.2-2). Approximately 80 percent of Lake Erie's total inflow is from the Detroit River, 11 percent is from precipitation, and the remaining nine percent is from tributaries flowing through watersheds in Michigan, Ohio, Pennsylvania, New York and Ontario. The outflow from Lake Erie is not regulated; rather, its outflow is controlled exclusively by the hydrologic characteristics of its outlet rivers (Reference 5.2-3). Surface water physical characteristics are discussed in Subsection 2.3.1.

The main groundwater features near the site are the confined Bass Islands Group aquifer and the unconfined shallow overburden zone. The Bass Islands Group aquifer is under artesian pressure and is confined below by the Salina Group Unit F and above by glacial till. The shallow overburden zone lies above the glacial till layer. FSAR Figure 2.4-250 shows hydrographs representing the flow distribution between water wells within the vicinity of the site. Groundwater physical characteristics are discussed in Subsection 2.3.1.

5.2.1.2 Water Sources

Lake Erie is the makeup water source for the Station Water System (SWS). The SWS provides water to the Circulating Water System (CIRC), Plant Service Water System (PSWS), and Fire Protection System (FPS). Potable water for the Fermi site and makeup demineralizer water is taken from the Frenchtown Township municipal water supply. FSAR Subsection 2.4.11.3 discusses historical low lake levels for Lake Erie. Due to the vast size and capacity of Lake Erie and due to margins in the design of the intake structure to account for low lake levels, the water supply from Lake Erie is expected to be reliable for the operation of Fermi 3.

Groundwater is not used for the operation of Fermi 3. Groundwater capacity characteristics are discussed in Subsection 2.3.1.

5.2.1.3 Plant Withdrawals and Returns

Water withdrawn from Lake Erie is used as makeup water. The SWS draws water from Lake Erie through an intake bay into the pump house located on the west shore of Lake Erie. The SWS pumps provide makeup water to the normal power heat sink (NPHS) cooling tower basins for the CIRC, the auxiliary heat sink (AHS) cooling tower basin for the PSWS, and the FPS. The AHS can be used in conjunction with the NPHS during normal power operation. However, during certain shutdown conditions, heat rejection is performed entirely with the AHS.

Water withdrawn from Lake Erie is either 1) discharged back to the lake as blowdown through a discharge pipe extending into the lake, 2) lost as evaporation, or 3) lost as drift (entrained in water vapor). Water returned to Lake Erie as blowdown is not lost to other Lake Erie users or aquatic communities. Evaporative losses are not replaced and are considered consumptive losses. Drift losses are very small compared to blowdown and evaporative losses. During normal power operation, the CIRC requires a maximum of approximately 34,000 gallons per minute (49 million gallons per day) of makeup water during summer months to replace the evaporation, blowdown, and drift that occurs in the natural draft cooling tower of the NPHS. A much lower makeup water flow, approximately 1,100 gallons per minute on average, is required by the AHS during shutdown. During normal power operation, a maximum of approximately 17,000 gallons per minute (24.48 million gallons per day) are discharged back to Lake Erie. The majority of this discharge is from blowdown of the CIRC. Figure 3.3-1 provides details of cooling water use of Fermi 3, including operational and shutdown modes, and discharge water quality.

Due to the large capacity of Lake Erie with respect to the amount of water needed for the operation of Fermi 3, impacts to the lake volume due to consumptive water losses will be SMALL. Water returned to Lake Erie is subject to National Pollutant Discharge Elimination System (NPDES) permit regulations. Monitoring of pollutants that present a potential concern has been required by the NPDES permit for Fermi 2 and will be required for the NPDES permit for Fermi 3. It is important to note that the Michigan Department of Environmental Quality (MDEQ) has defined the current effluent limits after repeated characterization of the quality of the effluent from Fermi 2. This has included that no additional pollutants had a reasonable potential to cause an exceedance of Michigan Water Quality Standards in the Lake Erie. For this reason, none of the other priority pollutants were the subject of an effluent limitation.

5.2.1.4 Present and Future Surface Water Uses Potentially Affecting Available Water Supply

Consumptive surface water use is discussed in Subsection 2.3.2. The Great Lakes Basin has nine main sectors of water consumption: Public Water Supply, Self-Supply Domestic, Self-Supply Irrigation, Self-Supply Livestock, Self-Supply Industrial, Self-Supply Thermoelectric (Fossil Fuel), Self-Supply Thermoelectric (Nuclear), Hydroelectric, and Self-Supply Other. Consumptive use for each sector is listed in Table 2.3-29. According to the MDEQ, the main sectors of water consumption regarding the region of influence from the operation of Fermi 3 are the following: Power Generation (Nuclear), Power Generation (Fossil Fuel), Public Water Supply, Agricultural Irrigation, Self-Supply Industrial, and Golf Course Irrigation. Flow rates and total water use concerning these sectors is provided in Table 2.3-34. Yearly consumptions and water withdrawals for all of Lake Erie are shown on Table 2.3-30 through Table 2.3-33. Projected water-use is described in Subsection 5.2.2.5.

The consumptive water needs of Fermi 3 are a small fraction of the present and projected future consumptive water needs of other Lake Erie surface water users. Considering the vast size of Lake Erie, it is concluded that present and future surface water uses will have a SMALL impact on the availability of Lake Erie for Fermi 3 consumptive water use. No mitigative measures are needed.

5.2.1.5 **Present and Future Groundwater Uses**

Groundwater is not planned to be used as a water source for either withdrawal or discharge during the operation of Fermi 3; therefore, the operation of Fermi 3 will have SMALL impacts on groundwater use in the vicinity of the Fermi site, and no mitigative measures are needed.

5.2.1.6 **Operational Activities Causing Other Hydrologic Alterations**

The intake bay is dredged approximately every four years to maintain appropriate operating conditions. A temporary increase in turbidity may occur in Lake Erie during dredging activities; however, this additional turbidity will be easily assimilated by the large volume of Lake Erie. Dredging material is expected to be disposed of in the Spoil Disposal Pond, where sedimentation will occur prior to discharge back to Lake Erie under NPDES permit regulations. The periodic dredging of the intake bay will thus impose SMALL impacts to Lake Erie, and no mitigative measures are needed.

Discharge from Fermi 3 could also cause hydrologic alterations. However, the design objective of the discharge pipe diffuser is to maximize thermal and chemical dissolution while minimizing bottom scour. The thermal and chemical discharge effects are described in Subsection 5.3.2.2. In sum, hydrogeologic alterations due to plant discharges are expected to be SMALL with no mitigative measures needed.

Stormwater runoff during the operation of Fermi 3 may potentially result in hydrologic alterations to the receiving waters; however, stormwater runoff will be adequately controlled by design considerations and by the SWPPP. Stormwater from the finished grade will be directed to a sump which will discharge to an overflow canal via an outlet pipe. The overflow canal will discharge to the North Lagoon which will discharge to Swan Creek, eventually leading to Lake Erie. Stormwater may also travel directly to either the North Lagoon or to the South Lagoon. The South Lagoon discharges to Lake Erie. The SWPPP will ensure that any increase in sediment loading to Swan Creek and/or Lake Erie is adequately controlled to minimize water quality impacts. Therefore, stormwater runoff impacts to Swan Creek and Lake Erie will be SMALL due to the operation of Fermi 3.

Dewatering will not be required during operation of Fermi 3; therefore, groundwater flow and quality will not be affected. Construction dewatering is addressed in Section 4.2.

The operational activities described will have no impact on the flood handling capability of the floodplain.

5.2.1.7 Surface Water and Groundwater Users Affected by Hydrologic Alterations

Surface water withdrawn from Lake Erie supplies the CIRC, the PSWS, and the FPS. Potable water and makeup demineralizer water is supplied from the Frenchtown Township municipal water supply. As stated in Subsection 5.2.1.5, groundwater is not used as a source of makeup or potable water for the operation of Fermi 3.

Detailed information on water-use for the area is presented in Subsection 2.3.2. Figure 3.3-1 shows that a maximum net water consumption of approximately 17,000 gallons per minute (24 million gallons per day) from Lake Erie will occur due to evaporation and drift from the natural draft cooling tower. This will occur during maximum normal power operation. Due to the large volume of Lake Erie and the compliance with effluent limitations, no effects on any other water users, including surface water and groundwater users, in the vicinity of Fermi 3 are anticipated from water usage during operational activities. Accordingly, water-use impacts are considered to be SMALL, and mitigation is not needed.

5.2.1.8 Legal Restrictions

The EPA has promulgated regulations that implement Section 316(b) of the Clean Water Act for new and existing electric power producing facilities. Additional information related to how Fermi 3 meets the performance standards specified in the EPA regulations implementing Section 316(b) is provided in Subsection 5.3.1.2.

To limit the potential of stormwater from impacting surface water bodies, Fermi 2 maintains an SWPPP and an NPDES permit regulating stormwater discharge. Operational activities associated with a new nuclear unit would require either the modification of NPDES permit MI0037028, under which the Fermi 2 operates, or obtaining a new NPDES permit. The SWPPP will also be updated for the operation of Fermi 3.

No Native American tribes are located wholly within the 50-mile region, and no Native American land claims have been made in the Fermi 7.5-mile vicinity; therefore, Native American land use plans do not apply to the Fermi region. A very small portion of the Walpole 46 First Nations Reserve northeast of the Fermi site in Ontario, Canada, is just inside the 50-mile region (Reference 5.2-4).

In summary, the applicable statutory and legal restrictions on water use and consumption would have only a SMALL impact on the ability of Fermi 3 to obtain the necessary water from Lake Erie.

5.2.2 Water-Use Impacts

The scope and review of this section includes 1) analysis of hydrologic alterations that could have impacts on water-use, including availability, 2) analysis of water quality changes that could affect water-use, 3) analysis and evaluation of direct, indirect and cumulative impacts resulting from these alterations and changes, 4) analysis and evaluation of practices to minimize or avoid potential impacts, and 5) evaluation of compliance with Federal, State, regional, local, and affected Native American tribal regulations applicable to water-use and water quality.

5.2.2.1 **Plant Operational Activities Potentially Impacting Water-Use**

Lake Erie is the main surface water body that could potentially be affected by operational activities of Fermi 3. These activities include surface water withdrawn from Lake Erie, discharges to Lake Erie, dredging of Lake Erie, and stormwater runoff to Swan Creek, and certain onsite water bodies, and Lake Erie. Discharges to Lake Erie come from 1) the discharge pipe, and 2) the Spoil Disposal Pond, and 3) the overflow canal pipe. The Spoil Disposal Pond discharges settled water from dredging operations.

5.2.2.1.1 **Surface Water**

A description of Lake Erie, the hydrologic alterations and their related operational activities, and the physical effects of the hydrologic alterations is presented in Subsection 5.2.1. Surface water features are discussed in Subsection 2.3.1.

As discussed in Subsection 5.2.1.7, a maximum net water consumption of approximately 17,000 gallons per minute (24 million gallons per day) will occur by the operation of Fermi 3. This quantity of water will not have a significant impact on the level of the lake due to its vast capacity; therefore, impacts to the lake are considered to be SMALL, and mitigative measures are not needed.

5.2.2.1.2 **Groundwater**

The uppermost hydrogeologic unit present at the site is the shallow overburden zone. The primary source of recharge for the shallow overburden zone is direct precipitation onto the land surface. During periods of high lake water levels, the shallow overburden zone may temporarily receive recharge locally from Lake Erie and connected surface water features. The Bass Island Group aquifer lies beneath the shallow overburden zone at the site. The primary recharge source for the Bass Island Group aquifer is downward vertical flow from the overlying shallow overburden zone. A detailed description of groundwater within the site vicinity is described in Subsection 2.3.1.2.

Groundwater is not used for safety-related or water supply purposes at Fermi 3. A permanent dewatering capability is not used at Fermi 3. Therefore, impacts to groundwater during normal operations are anticipated to be SMALL, and no mitigative measures are needed.

5.2.2.2 **Potential Water-Use Impacts**

Although cooling towers are considered to be closed-cycle cooling systems, concentrations of dissolved salts (inherent in the Lake Erie water supply) accumulate in the circulation system as a result of evaporative water loss. To maintain proper cooling, a certain percentage of the mineral-rich stream (blowdown) must be discharged and replaced with fresh water (makeup). Since the cooling tower is chemically treated, the discharge flow will include these concentrations, as well. Subsection 5.4.1 discusses the cooling tower discharge as it is used for radiological effluent dilution.

5.2.2.2.1 **Chemical Impacts**

Cooling tower water chemistry must be maintained with anti-scaling compounds and corrosion inhibitors because cooling towers concentrate solids (minerals and salts) and organics that enter the system in makeup water. Similarly, a biocide/algaecide must be added to the system to prevent the growth of fouling bacteria and algae. Chemicals to be added to the liquid effluent streams are listed in Table 3.6-1. Water-treatment chemicals planned for use at Fermi 3 include the following types:

- Biocide/Algaecide
- Corrosion inhibitor
- Scale inhibitor
- Dehalogenation

Operation of the cooling towers is based on two cycles of concentration under normal full power operating conditions. Under average conditions, blowdown is approximately 14,000 gallons per minute. During summer months, the maximum blowdown will be approximately 17,000 gallons per minute. (Figure 3.3-1)

The quantity of blowdown discharged to Lake Erie is far less than the capacity of the lake; therefore, concentrations of solids and residual water-treatment chemicals in the cooling tower blowdown will quickly dissipate. Furthermore, the discharge of Fermi 3 will be constrained by effluent limitations imposed by its NPDES permit. For these reasons, chemical impacts on the water quality of Lake Erie are expected to be SMALL, and mitigative measures are not needed. Minimal chemical constituents and or wastes are expected to be discharged to Lake Erie from the operation of Fermi 3. Constituents discharged directly or indirectly to Lake Erie are expected to be at or below NPDES permitted levels. They are projected to be very low based on the dilution effects of Lake Erie. Section 3.6 and Section 5.5 discuss the non-radioactive waste systems and discharge in more detail.

5.2.2.2.2 **Thermal Impacts**

Discharges from Fermi 3 will be regulated under the NPDES program, which regulates the discharge of pollutants into waters of the State of Michigan. Under NPDES regulations, waste heat is regarded as thermal pollution and is regulated in the same way as chemical pollutants.

Discharges to Lake Erie include cooling tower blowdown; therefore, the Fermi 3 effluent will have an elevated temperature. The maximum effluent temperature under normal operation conditions is 86°F. For the Fermi 3 discharge pipe, a high-rate effluent diffuser will be used to maximize mixing and minimize the thermal mixing zone. CORMIX v.5, Module 2, which is used for the prediction of multiport diffuser discharges, and Module 1, which is used for the prediction of single port dischargers, were used as appropriate for the thermal analysis (see Subsection 5.3.2 for details) (Reference 5.2-5). Several separate scenarios were evaluated in order to illustrate seasonal changes in currents, water depths, temperatures, effluent characteristics, and the Water Quality Standards (WQS). Due to the outfall's configuration and offshore location, the predicted mixing zone will affect a very small section of the western lake, and the plume will dissipate relatively quickly. The plume is predicted to dissipate 1291 feet from the shoreline; therefore, it is very unlikely for the plume to be re-entrained by the cooling water intake or to impinge on the shore. As demonstrated in Subsection 5.3.2.1, the thermal plume resulting from the operation of Fermi 3 will be minimal when compared with the breadth of western Lake Erie. Accordingly, impacts to water use resulting from additional thermal discharges associated with Fermi 3 are expected to be SMALL. Consequently, no mitigative measures are needed.

5.2.2.3 **Operational Limitations**

Fermi 3 may share an NPDES permit with Fermi 2 or eventually have its own separate permit. The NPDES permit will have effluent concentration limitations and discharge limits in order to comply with State and Federal water pollution control laws. The NPDES permit will encompass both operational discharges and stormwater discharges. See Subsection 2.3.3 for details related to the water quality of Lake Erie. Examples of limitations imposed by the NPDES permit for Fermi 2 are limitations on total residual chlorine (TRC), total mercury, pH, total suspended solids (TSS), oil and grease, total copper, total iron, and flow (Reference 5.2-6).

5.2.2.4 **Impacts on Current Water-Use**

Subsection 5.2.1.4 identifies the nine main sectors of water consumption in the Great Lakes Basin and the main sectors of water consumption in the region of influence of Fermi 3. In the Great Lakes Basin, non-consumptive withdrawals comprise 95 percent of water-use, and consumptive withdrawals comprise five percent. The vast majority of withdrawals, 90 percent, are from lakes, while five percent is withdrawn from streams and five percent from groundwater sources. Comparing the quantity of withdrawals within the vicinity of Fermi 3, provided in Table 2.3-34, with the water supplies of Lake Erie, represented in Table 2.3-27, shows that the water usage by current generation of electrical power is relatively small. The net total supply for Lake Erie, based in 2005, averages approximately 46,000 billion gallons per year, and the most conservative quantity of withdrawals estimated per year for Monroe County totals approximately 670 billion gallons per year, which is approximately 1.4 percent of Lake Erie's total net supply.

Water withdrawal is summarized in Subsection 5.2.1.3 and covered more in depth in Section 3.3. Due to the large capacity of Lake Erie with respect to the amount of water withdrawn for Fermi 3, operation of the plant will have a SMALL impact on current water-use in the vicinity of the site, and no mitigative measures are needed. Additionally, there are no expected operational activities that impact water-use in the transmission corridor areas.

5.2.2.5 **Estimated Future Water-Use**

Projected water-use is described in Subsection 2.3.2.3. A direct linear relationship was assumed between population and water usage for the water user groups of Public Supply, Self-Supplied Domestic Users, and Industrial Users. For the user group categories of Irrigation, Livestock, and Thermoelectric Power Generation, no direct linear relation with population was assumed. Projected use estimates for these categories were maintained at the level of usage reported in the year 2000. Projected water-use by user group for Monroe County is presented in Table 2.3-40. Due to the vast size of Lake Erie, operation of Fermi 3 will have a SMALL impact on the availability of water for future water-use.

5.2.2.6 Potential Impacts from Hydrologic Alterations and Operational Activities

Subsection 5.2.1.3 concludes that the operation of Fermi 3 is expected to have SMALL impacts on Lake Erie due to water withdrawals and returns. Subsection 5.2.1.6 concludes that the operation of Fermi 3 will have SMALL impacts on Swan Creek and Lake Erie due to stormwater runoff, dredging operations, and discharge of liquid radwaste and neutralized demineralizer wastes. Subsection 5.2.1.6 also concludes that there will be no impact to the flood handling capability of the floodplain. Consequently, mitigative measures are not needed for hydrologic alterations and operational activities.

5.2.2.7 Discharge Design

For Fermi 3, a high-rate effluent diffuser will be used to maximize mixing and minimize the thermal mixing zone. Based on the conceptual design, the effluent outfall is located approximately 1300 ft offshore of the plant location. The modeled multiport diffuser consisted of three individual ports spaced evenly over 32.8 ft. Each port is 16.5 inches in diameter and located 19.7 inches above the lakebed. The ports are assumed to discharge into water approximately 8 feet deep, depending on the time of year. The ports are designed to achieve a desired exit velocity and direction.

Three modeling sets were designed to provide a complete analysis of the thermal discharge effects. Subsection 5.3.2 presents the process and data for each of the three modeling sets. The modeling results indicate that the thermal impacts on Lake Erie will be SMALL, and mitigative measures are not needed.

5.2.2.8 Regulatory Compliance

The EPA has promulgated regulations that implement Section 316(b) of the Clean Water Act for new and existing electric power producing facilities. Additional information describing how Fermi 3 meets the performance standards specified in the EPA regulations implementing Section 316(b) is provided in Subsection 5.3.1.2.2.

The U.S. Army Corps of Engineers (USACE), MDEQ, and other appropriate agencies will be consulted, and permits and approvals will be obtained, as necessary. Operational activities associated with a new nuclear unit would require either the modification of NPDES permit MI0037028, under which the existing Fermi 2 facility operates, or obtaining a new NPDES permit. The SWPPP will also be updated for the operation of Fermi 3 to limit the potential of stormwater from impacting surface water bodies.

As mentioned in Subsection 2.2.3, no Native American tribes are located wholly within the 50-mile region and no Native American land claims have been made in the Fermi 7.5-mile vicinity.

5.2.3 References

5.2-1 Great Lakes Information Network, “People in the Great Lakes Region,” http://www.great-lakes.net/envt/flora-fauna/people.html, last updated 1 November 2006, accessed 8 October 2007.

5.2-2 Government of Canada and U.S. Environmental Protection Agency, Great Lakes National Program Office, "The Great Lakes: An Environmental Atlas and Resource Book," Third Edition, 1995, http://www.epa.gov/glnpo/atlas/glat-ch1.html, accessed 3 October 2007.

5.2-3 U.S. Army Corps of Engineers, "Current Regulated Outflows," http://www.lre.usace.army.mil/greatlakes/hh/outflows/current_regulated_outflows, last modified 16 February 2007, accessed 13 November 2007.

5.2-4 Hilderman Thomas Frank Cram, "Case Studies - First Nation Involvement in Protected Areas: Management Frameworks, Mechanisms, Structures, A Background Working Paper - Poplar River First Nation Land Management Plan," (27 October 2003), http://www.poplarriverfirstnation.ca/docs/AsatiwisipeAki_caseStudy.pdf, accessed December 2007.

5.2-5 Jirka, G.H., R.L. Doneker, and S.W. Hinton, "User's Manual for CORMIX: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters," Developed for U.S. Environmental Protection Agency, Office of Science and Technology, 2007.

5.2-6 Michigan Department of Environmental Quality, "National Pollutant Discharge Elimination (NPDES) Permit – Detroit Edison Company Fermi 2 Power Plant," Permit No. MI0037028, September 30, 2005.

5.3 Cooling System Impacts

This section describes the potential impacts to environmental resources at the Fermi site due to the operation of the Fermi 3 cooling system, including impacts associated with the operation of the intake system and associated cooling tower. The Station Water System (SWS) provides make-up water to Fermi 3 from Lake Erie and consists of a cooling water intake structure including water intake screens, pumps, piping, and valves. The natural draft cooling tower (NDCT) discharges evaporative losses to the atmosphere and effluent discharge to Lake Erie.

Discussions in Section 5.3 are broken down into the following four subsections: Subsection 5.3.1 presents the physical impacts of the intake system during operation as well as impacts on aquatic ecosystems. Subsection 5.3.2 presents potential physical impacts resulting from the thermal discharge system, as well as impacts on aquatic ecosystems. Subsection 5.3.3 presents the aesthetic and physical environmental impacts on the atmosphere and terrestrial ecosystems in the vicinity of the heat-discharge system during operation. Subsection 5.3.4 presents the human health impacts associated with the cooling system.

5.3.1 Intake System

This subsection describes the physical impacts of the intake system including shoreline erosion, bottom scouring, and induced turbidity, as well as the resulting impacts to the aquatic ecosystems. Subsection 3.4.2 describes the Fermi 3 intake system components, intake flow rates, and intake velocity calculations. Descriptions of Lake Erie bathymetry, substrate characterizations, lake levels, and current patterns exhibited in the vicinity of the intake structure, including illustrations, are included in Subsection 2.3.1 and Subsection 5.3.2. Figure 5.3-1 shows the intake structure relative to Lake Erie and the overall station layout.

5.3.1.1 Hydrodynamic Descriptions and Physical Impacts

5.3.1.1.1 Hydrodynamic Descriptions

The intake structure for Fermi 3 is located approximately one mile south of the mouth of Swan Creek on the western shoreline of Lake Erie. Two rock groins extend 600 feet east into the Lake to form the intake bay and effectively reduce the zone of hydraulic influence associated with the pumping activities. The record high and low levels of the lake water are well within the boundaries of the intake bay to ensure constant pumping capability. A hydrodynamic description is provided in Section 3.4.

5.3.1.1.2 Physical Impacts

Possible physical impacts resulting from the Fermi 3 intake include shoreline erosion, bottom scouring, induced turbidity, and silt buildup. Construction dredging and the withdrawal of water through the intake bay have the potential to increase erosion and shoreline scouring in the area of the intake structure. The historic deposition of fine sediments susceptible to hydrodynamic influence suggests that turbidity near the intake structure may increase during periods of pumping and dredging as well. To offset this effect, the rock groins extend into the lake, limiting the turbidity to the intake bay and protecting the shoreline from the zone of influence associated with the pumping activities. In addition, the closed-cycle design only requires water to replace evaporative loss, thus pumping rates are of low volume and will not be sufficient to cause significant impacts. Although the groins minimize impacts from pumping, they slightly alter the intensity and paths of natural shoreline water currents, possibly redirecting sediment loads that could lead to silt buildup in deeper waters.

Periodic maintenance dredging of the intake bay is expected, contributing to the aforementioned physical impacts. Dredge spoils from periodic dredging is expected to be disposed of in the onsite Spoil Disposal Pond, as required in the existing Section 404 permit as outlined by the USACE in conjunction with the MDEQ NPDES permit. A temporary increase in turbidity would occur in the lake near the Fermi site during dredging activities. However, due to the short-term duration of the dredging operations, the dredging activities would not affect long-term water quality.

Fermi 2 intake has not significantly altered the ambient conditions in Lake Erie or the surrounding areas. The addition of Fermi 3 intake system utilizes the existing intake bay and will operate in similar fashion to Fermi 2, therefore, physical impacts to the area in the vicinity of the intake structure are anticipated to be SMALL and no mitigative measures are needed. Substrate characteristics, water quality, and bathymetry are more specifically discussed in Subsection 2.3.3 and Subsection 5.3.2.

5.3.1.2 **Aquatic Ecosystems**

Cooling water is withdrawn solely from Lake Erie, therefore impacts associated with the SWS intake system operation are limited to aquatic resources within the lake, specifically in the area associated with the intake bay for the SWS (identified in Subsection 2.4.2). This subsection identifies potential impacts, describes design features implemented to minimize these impacts, identifies important aquatic species, and presents previous impact studies in order to articulate a comprehensive characterization of the impacts to aquatic ecosystems resulting from operation of Fermi 3.

5.3.1.2.1 **Potential Impacts**

Potential impacts to aquatic ecosystems associated with the operation of the Fermi 3 intake structure and cooling water systems are entrapment, impingement, and entrainment.

Entrapment refers to the attraction of aquatic organisms to an area with physical barriers that are difficult to escape from. Physical barriers at the Fermi 3 intake structure include the rock groins, trash rack, and traveling screens. An organism's susceptibility to entrapment at a power plant intake is dependent upon behavioral response to many factors that include: the cooling system and intake structure location, design and construction configuration, velocity of flow into the intake, capacity or volume of water withdrawn by the pumps, time of day, water levels and currents, water temperature, and other water quality characteristics. Biological factors affecting entrapment include: species assemblages and population densities of organisms near the intake at the time of pumping, size of organisms, swimming speed of organisms, and overall health or physical condition of the organisms.

Entrapped organisms are often subsequently subjected to impingement or entrainment depending upon the factors mentioned previously. Impingement refers to frequent or sustained physical contact with trash racks or traveling screens, while entrainment refers to smaller, planktonic organisms passing through the screens and into the circulatory system. Impinged organisms may sustain physical damage or mortality from the screens, while entrained organisms are subjected to the thermal and chemical[1] conditions encountered in the plant.

5.3.1.2.2 Measures and Controls that Limit Adverse Impacts

Environmental impacts from cooling water intakes are regulated through Section 316(b) of the Clean Water Act (CWA). The EPA enforces the CWA using the NPDES permit system. The NPDES permitting program requires that the location, design, construction, and capacity of cooling water intake structures reflect the best available technology (BAT) for minimizing environmental impacts. For many facilities, this entails construction of closed-cycle cooling systems to limit adverse impacts related to impingement and entrainment. Intake structure traveling screens can also be modified to help reduce impingement and entrainment mortality. The status of the Fermi 3 NPDES permit application is discussed in Section 1.2.

Entrapment is effectively minimized by locating the Fermi 3 intake near the Fermi 2 intake, while impingement and entrainment are limited by a variety of features. Employing a closed-cycle cooling system comprised of a cooling basin and natural draft cooling tower, Fermi 3 exhibits use of the BAT that significantly reduces impingement and entrainment numbers compared to an open-cycle system. The intake structure is also constructed and designed to minimize impacts to the environment. The addition of a trash rack, as well as the design of the mesh size of the traveling screens, have been implemented to reduce impingement potential at the intake. The screens are designed with a low pressure back spray system that initially washes impinged organisms from the screens and returns them back to the ambient waters via a sluiceway system. Following the low pressure wash a high pressure spray then removes any remaining debris from the screens. The point of return will be outside the zone of influence for the existing intake bay. Operational measures executed in daily operation that allow for minimal impacts to aquatic resources include: maintenance of a low intake velocity of 0.5 fps or less (Subsection 3.4.2.1) which allows most aquatic organisms to avoid the intake altogether, as well as regular washing of the intake screens to minimize impingement time of any organisms impacted.

5.3.1.2.3 Principal Aquatic Resources

This subsection briefly describes the aquatic resources that have the potential to be impacted by the cooling system for Fermi 3. These resources include “important species” (as defined by NUREG-1555) such as plankton, benthic invertebrates, commercial and recreational fisheries, and threatened and endangered species; and the overall fish population. For a detailed description of the aquatic ecology associated with the Fermi site refer to Subsection 2.4.2.

1. The addition of a biocide, sodium hypochlorite, takes place as water enters the pump house. Once the water has passed through the trash rack and traveling screens, a diffuser injects the biocide into the flow before the flow proceeds into the pumps. The purpose of the biocide is to control the growth and infestation of nuisance organisms on plant structures (refer to Subsection 3.3.2.1).

5.3.1.2.3.1 **Important Species**

The groups discussed below represent the important aquatic species that are potentially affected by Fermi 3 operation.

Plankton

Plankton are small plants or animals that float, drift, or weakly swim in the water column of any body of water. They are important as indicators of changes in nutrient levels and serve as a primary food source for many other aquatic organisms. As previously documented in Subsection 2.4.2, plankton diversity and abundance in Lake Erie is highly variable from season to season and year to year. This high variability makes it almost impossible to predict or quantify the levels of impacts associated with entrainment. Because planktonic organisms are limited by their size and their inability to move freely throughout the water column they are highly susceptible to the intake flows associated with cooling water intake systems. Based on the biological data presented in previous entrainment studies, it is anticipated that ichthyoplankton impacts may be significant at Fermi 3. The important species of greatest concern include: gizzard shad, emerald shiner, spottail shiner, freshwater drum, carp, white bass, and yellow perch.

Effects to the overall abundances of plankton and zooplankton population densities are anticipated to be SMALL. This is due to the relatively small area the Fermi intake system affects as compared to the total area of Lake Erie and its plankton population.

Benthic Invertebrates

Benthic invertebrates inhabit the bottom of aquatic environments, and are important to aquatic ecosystems as water quality indicators, shoreline protection, spawning habitat, and a food source. Examples of important benthic fauna include: aquatic worms, midges, freshwater bivalves, sea stars, crabs, and lobsters. Periodic maintenance dredging to remove silt accumulation will remove and prevent most benthic inhabitants from becoming well established within the embayment. For those species that are able to become established between dredge events, they are less likely to be impacted by impingement and entrainment than pelagic species due to their sessile and/or benthic nature. Thus impacts are anticipated to be SMALL.

Commercial and Recreational Fisheries

Lake Erie supports one of the largest freshwater commercial fisheries in the world; subsequently significant impacts to any commercially important species would be detrimental to the local economy as well as the aquatic ecology of the area. Commercial and recreational harvest in Lake Erie, specifically the western basin, is dominated by yellow perch (*Perca flavescens*) and walleye (*Sander vitreus*), as well as the rainbow smelt (*Osmerus mordax*) and white bass (*Morone chrysops*). Species of sport fish and commercially important species most commonly collected in impingement samples include: freshwater drum, yellow perch, and white bass. Walleye and rainbow smelt have also been collected in impingement samples, but generally in much smaller numbers. The economic value of the regional commercial fisheries is discussed in Subsection 2.4.2.3.

A number of studies have been conducted to determine the impacts of impingement and entrainment on commercial and recreational fish populations in western Lake Erie. The majority of the studies suggested that impacts to these populations are minimal or insignificant. Many of these studies were performed at plants utilizing a once-through cooling system where impingement rates are significantly higher than in a closed-cycle system; therefore, impacts to commercial and recreational fish populations are also minimal or insignificant. Collectively, calculations of total impingement impacts to the sport and commercial fishery have been estimated to be as low as 0.04 percent and as high as 0.5 percent. These studies are discussed in Subsection 5.3.1.2.4. Based on the perennial success of the Lake Erie commercial and recreational fisheries, historical studies, and the closed-cycle cooling system employed by Fermi 3, the impacts of the Fermi 3 intake on important aquatic species are anticipated to be SMALL.

Threatened and Endangered Species

Any impacts to threatened and endangered species as a result of the Fermi 3 cooling system construction and operation are of obvious importance. Although no threatened or endangered species were documented in a 1991-1992 impingement and entrainment study conducted at the Fermi site (Reference 5.3-39), an online review yielded three species with the possibility of occurrence at the site. The U.S. Fish and Wildlife Service (USFWS) online threatened and endangered species database identified the Northern riffleshell (*Epioblasma torulosa*) as the only federally listed species within Monroe County having potential to occur in or near the Fermi site (Table 2.4-15). There are no historical records of this species occurring on the Fermi site or near the intake bay. Accordingly, the impact of the Fermi 3 intake on federally-listed threatened and endangered species is expected to be SMALL, and no mitigation measures are needed.

The brindled madtom (*Noturus miurus*) is listed as a state species of concern, while American lotus (*Nelumbo lutea*) is listed as threatened in the State of Michigan. Although no confirmed occurrences of the brindled madtom have been noted within the intake bay, it has been documented as having potential to occur at the Fermi site. American lotus has been documented throughout inland areas of the Fermi site; however, it has not been documented as occurring in or near the intake bay on the lake. More detailed discussions of life history and habitat utilization of each of these species can be found in Subsection 2.4.2. Habitat[2] associated with the brindled madtom has not been identified in or adjacent to the intake bay, therefore limiting the likelihood for impacts resulting from the cooling system. These studies are discussed in Subsection 5.3.1.2.4. Operational impacts to American lotus are not anticipated since they are located outside the area of influence of the Fermi 3 intake. Accordingly, the impact of the Fermi 3 intake on state-listed threatened and endangered species is expected to be SMALL, and no mitigating measures are needed.

2. The brindled madtom (*Noturus miurus)* is common to slow-moving rivers with soft substrates and scattered emergent vegetation. Lake habitats are usually characterized by soft bottoms with an abundance of leaves and twigs.

Agency Communications

Both state and federal wildlife agencies were contacted regarding threatened and endangered species with the potential to inhabit the Fermi site. In a letter of response, the Michigan Department of Natural Resources (MDNR) identified both the American lotus (state threatened) and the brindled madtom (state species of concern) as aquatic species potentially occurring at the Fermi site, as discussed previously. In addition, the MDNR expressed concerns regarding the potential of suitable habitat being present within the Fermi site, specifically within the construction footprint. The MDNR stated that impacts may include direct destruction of species or disturbance of critical habitat. The impacts of construction on aquatic ecology are discussed in Subsection 4.3.2.

5.3.1.2.3.2 **Fish**

The abundance and distribution of fish populations is of paramount importance to the aquatic ecosystem of western Lake Erie. Although no current data pertaining to impingement has been collected at the Fermi intake structure, historical Fermi data, as well as studies at other Lake Erie power plants, indicate that relatively few species are common or abundant in impingement samples. Review of these studies suggests that gizzard shad, carp, freshwater drum, emerald shiner, white bass, and yellow perch are the dominant species impacted by impingement. It is anticipated that impingement will be dominated by gizzard shad, which have comprised as much as 95 percent of the total abundance in area impingement samples. As described in Subsection 2.4.2, gizzard shad are a very abundant, pelagic species that serves as an important prey species for many other forage species.

The intake bay for the SWS may act as a temporary haven for fish and could result in an increase in impingement of aquatic organisms. Utilization of this area as a haven or cover area is believed to occur mostly during the cold winter months. This time of year has been documented as having the highest levels of impingement, specifically for gizzard shad which are susceptible to cold shock mortality. However, based on the historical data collected at Fermi, the overall number of fish impinged is relatively low as compared to other plants on the Western Basin of Lake Erie. The low design intake velocity ($\leq$ 0.5 fps, Subsection 5.3.1.1) will help prevent healthy fish from being drawn toward or becoming impinged on to the intake screens.

The design improvements of the intake screens and trash rack, as well as the commitment to maintaining a low intake velocity ($\leq$ 0.5 fps), serve to minimize impingement potential of fish species as a result of Fermi 3 operation. Review of applicable fisheries and impingement data has not yielded evidence of alterations in overall species distribution or abundance in western Lake Erie affected by the introduction of the Fermi intake. These studies are discussed in Subsection 5.3.1.2.4. Because of the co-location of the Fermi 3 intake with the existing intake structure, the aforementioned statements substantiate the conclusion that impacts to fish resources at the Fermi site due to operation of Fermi 3 would be SMALL.

5.3.1.2.4 **Previous Studies Applicable to Fermi 3 Cooling System Impacts**

This subsection presents summaries of selected studies used in the assessment of the potential impacts to aquatic resources resulting from the Fermi 3 cooling system. This list is not exhaustive;

additional information from the references of this subsection and Subsection 2.4.2 were utilized to obtain a comprehensive characterization of cooling system impacts.

NRC Generic Environmental Impact Statement (GEIS)

The NRC published an extensive study in 1996 detailing operational impacts of nuclear plants on various environmental resources. In considering the effects of closed-cycle cooling systems intake structure on aquatic ecology, the NRC studied and evaluated the impingement of juvenile and adult fishes and shellfish and the entrainment of planktonic organisms, including ichthyoplankton, phytoplankton, and zooplankton. These studies concluded that the impacts of closed-cycle cooling systems on impingement and entrainment are insignificant (Reference 5.3-1). Based on the above information, it can be concluded that impacts to aquatic resources at the Fermi site due to the operation of the intake system would be SMALL.

Impingement and Entrainment Impact Studies

As previously stated, there are many factors that can affect impingement and entrainment. The design and operation of the Fermi 3 intake system is such that it provides a significant reduction in the amount of adverse environmental impacts. Biological data associated with the aquatic ecology of the western basin of Lake Erie and with impingement and entrainment studies from multiple plants on the western basin of Lake Erie supports the expectation that impacts associated with impingement and entrainment are SMALL.

Impingement and Entrainment Study - Fermi 2 Power Plant, 1991-1992 (Reference 5.3-39)

No recent impingement and entrainment data has been collected at the Fermi plant. Historical impingement data were collected on the Fermi 2 intake screens over a one year period from October 1991 to September 1992. Estimates of annual impingement resulted in total of 1944 fish representing 23 fish species and nine families. The dominant species identified were gizzard shad, with 1380 specimens comprising 71 percent of the total. Other dominant species included white perch (7.1 percent), rock bass (3.3 percent) and freshwater drum (3.2 percent). Ten of the 23 species impinged were considered sport fish species. Seasonal abundances of fish were represented by increased numbers of fish collected during the winter and fall months and decreased numbers of fish collected during the summer months. The increased numbers of fish during the winter months was represented primarily by gizzard shad which are susceptible to cold water temperatures which reduce their mobility.

Entrainment of juvenile species was sampled at two different locations downstream of the two traveling screens. A total 13,547 fish representing 15 fish species and 10 families were documented. The dominant species collected were gizzard shad (59 percent), spottail shiner (18 percent), yellow perch (7 percent), and emerald shiner (5 percent). Seasonal abundances of juvenile fish were represented by increased numbers during the summer months (June and July) and the fewest numbers collected from October through February. Gizzard shad represented the highest abundance during the summer months which corresponds with their peak spawning periods.

Impingement and Entrainment Studies – Davis Besse Nuclear Power Station, 1978 (Reference 5.3-43 and Reference 5.3-40)

Impingement studies were conducted at the Davis-Besse plant near Locust Point, Ohio indicating that a total of 6607 fish representing 20 species were impinged over a one year period. Goldfish was the dominant species (49 percent), followed by yellow perch (24 percent), emerald shiner (15 percent), gizzard shad (6 percent), black crappies (1 percent), freshwater drum (1 percent), and rainbow smelt (1 percent). Impingement losses during this study were determined to be extremely low as compared to other plants in the Western Basin. Furthermore, losses attributed to impingement on the sport fish and commercial fishery were valued at only 0.04 percent by number and 0.001 percent by weight of the Ohio harvest. The study concludes that impingement losses related to Davis- Besse have an insignificant impact on Lake Erie fish stocks and that further justification is probably unnecessary.

Entrainment monitoring samples were represented by a total of 8 taxa including: gizzard shad, emerald shiner, walleye, freshwater drum, yellow perch, rainbow smelt, spottail shiner, and carp. Annual entrainment was estimated by multiplying ichthyoplankton concentration at the intake by the intake volume. Gizzard shad, walleye, and emerald shiners dominated the samples comprising 76 percent, 15 percent, and 5 percent respectively. Annual entrainment was estimated at 6,311,371 larvae and 44,278 eggs during 1978. The study states that the number of larvae entrained can vary greatly from year to year depending on a variety of conditions, but concludes that due to the low volume intake of the closed-cycle cooling system necessitates a very low-level impact on western basin fish populations.

Fish Impingement and Entrainment Studies – Acme Power Station, 1976-1977 (Reference 5.3-41)

Impingement and entrainment data from the Acme Power Station in Toledo, Ohio indicated that gizzard shad and emerald shiner were the most dominant species impinged. Impingement was highly seasonal with approximately 95 percent occurring during the winter months (October through February). Additional dominant species impinged included freshwater drum, white bass, alewife, spottail shiner, yellow perch, and channel catfish. Impacts attributed to impingement were documented as having less than 0.5 percent reduction of both commercial and sport fish harvest combined. Entrainment samples were comprised of 15 taxa that included gizzard shad, freshwater drum, white bass, and carp. Seasonal peaks in entrainment were documented with increased entrainment occurring during the months of April through July and the lowest levels occurring in the winter.

Impingement and Entrainment Studies – Bayshore Power Station, 1976-1977 (Reference 5.3-42)

Impingement and entrainment data from the Bayshore Power Station near Harbor View, Ohio indicated impingement samples were dominated by gizzard shad, emerald shiner, and alewife. Impingement was shown to occur with much higher frequency in winter months, thus freshwater drum, walleye, white bass, and yellow perch were a greater component of the summer impingement samples due to reduced gizzard shad impingement. Entrainment data consisted of 19 taxa dominated by gizzard shad and white bass, representing 78.4 percent and 11.6 percent of total entrainment data, respectively. Impingement and entrainment numbers were compared with Ohio Division of Wildlife data for Lake Erie. The study concludes that impingement and entrainment losses of young-of-the-year (YOY) fish at the Bayshore Power Station were not shown to have an adverse effect on the populations of YOY fish in Lake Erie.

Lake Erie Fish Characterization Studies

Fisheries Survey of Selected Lake Erie Coastal Marshes in Michigan, 2005

This fisheries survey of western Lake Erie bays and estuaries was conducted in September 2005 as a joint venture by the MDNR and USFWS. The survey utilized electrofishing and seining to sample four locations along the Lake Erie coast: the Huron River Estuary, the Swan Creek Estuary, Plum Creek Bay, and North Maumee Bay. The Swan Creek Estuary was sampled at nine sites along Swan Creek ranging from approximately 0.5 to 2.5 miles from the Fermi site. A total of 38 species of fish from 13 families were collected at these sampling sites. Species most well represented in the catch included gizzard shad, bluntnose minnow, mimic shiner, bluegill, pumpkinseed, goldfish, and largemouth bass. The study concludes that speciation at each site was similar and that the Swan Creek Estuary had the highest catch per effort (CPE) of the sampling sites.

Status of the Fisheries in Michigan Waters of Lake Erie, 2006

This fisheries report is prepared annually by the MDNR, and contains statistics relating to commercial and sport harvest for the year. Relevant statistics presented include: estimates of total commercial and sport harvest on Lake Erie, value of the commercial harvest, harvest rates for selected species, and graphs and tables of various data from multiple years. Analysis of the data yields variation in abundances of the species presented between subsequent years, but no long-term trends of increase or decrease in abundance are evident.

5.3.1.3 **Conclusions**

Operation of the SWS for Fermi 3 is anticipated to have SMALL effects on aquatic resources at the Fermi site. In the Generic Environmental Impact Statement, the NRC stated that closed-cycle cooling systems, such as the SWS, have minimal water requirements which result in smaller impacts to aquatic organism when compared with water usage for open-cycle or once-through cooling water systems (Reference 5.3-1). The SWS for Fermi 3 will be designed, operated, and maintained in accordance with 40 CFR 125, "Requirements Applicable to Cooling Water Intake Structures for New Facilities under Section 316 (b) of the Act," including the intake velocities.

Fermi 3 has adapted the BAT similar to those already in place for Fermi 2. These include: use of a closed-cycle cooling system, an intake designed and oriented to minimize attractant flows, addition of a trash rack upstream of the screens, traveling screens modified with appropriate mesh size and a backspray system with an associated sluiceway, and a through-screen intake velocity that is less than 0.5 fps.

The principal aquatic resources with the potential to be impacted by the cooling system for Fermi 3 have been identified, including: plankton, benthic invertebrates, commercial and recreational fisheries, threatened and endangered species, and fish. Appropriate agency consultations regarding impacts to threatened and endangered species have been initiated.

An extensive literature review of available information on the aquatic ecology of Lake Erie and impacts of similar facilities has been performed as well. Operation of Fermi 2 has not been shown to have a measurable impact on any important species in the area. The information provides a compelling case of long-term regional evidence of no significant impact from power plants located on the western basin of Lake Erie.

Based on the information gathered and presented within this section, overall impacts to aquatic resources resulting from the Fermi 3 intake are considered SMALL, and no mitigative measures are needed.

5.3.2 Discharge System

This subsection describes the physical impacts of Fermi 3 discharge to surrounding waters and the potential impacts of the cooling water discharge on water quality and aquatic ecosystem in the western basin of Lake Erie, the receiving waterbody for the project.

The use of cooling towers for Fermi 3 represents BAT under Phase I of Section 316(b) of the Clean Water Act and also acts to greatly reduce the thermal loading to Lake Erie. Despite this, facility effluent, comprised largely of cooling tower blowdown, will contain heat derived from the facility and the ambient air. It is common in such situations to consider a thermal mixing zone in which effluent is actively mixing with ambient water. For Fermi 3, a high-rate effluent diffuser will be used to maximize mixing and minimize the thermal mixing zone.

5.3.2.1 Thermal Description and Physical Impacts

The effluent from Fermi 3 would discharge directly into the western basin of Lake Erie through a newly-constructed discharge pipe. Figure 5.3-1 shows the Fermi 3 discharge relative to Lake Erie and the overall site layout. A description of the site layout is provided in Subsection 2.3.1. The Fermi 3 discharge is described in Subsection 3.4.2. As part of the impact assessment process for the project, the effluent discharge was evaluated to determine the physical characteristics and associated impacts of the thermal component of the discharge. The CORMIX model (Reference 5.3-2) was used to conduct the analysis.

5.3.2.1.1 Thermal Plume Analysis

The dissipation of the thermal plume was modeled in a conservative fashion under a variety of conditions in order to understand the potential range of impacts. The set of modeled cases was constructed based on anticipated variation in the effluent flow and temperature as well as known variation in receiving water temperature, current velocity, and water depth. Several cases were included to represent a broad range of relatively common events (e.g., four separate scenarios based on conditions encountered in each month) as well as potentially worst-case events that occur very rarely but might affect plume behavior (e.g., westward lake water flow that could result in thermal plume impacts at the shoreline wetlands). A sensitivity analysis was also performed to explore how the predicted thermal plume responds to changes in model input parameters.

CORMIX is a mathematical modeling tool developed for the analysis, prediction, and design of aqueous toxic or conventional pollutant discharges into diverse water bodies. It was developed by the EPA for use as an analysis tool for the permitting of industrial, municipal, thermal, and other point source discharges to receiving waters. CORMIX v.5, Module 2, which is used for prediction of multiport diffuser discharges, and Module 1, which is used for the prediction of single port dischargers, were used as appropriate for this analysis. The assumptions, methods, data, and results of the modeling are described below.

5.3.2.1.1.1 **Modeling Assumptions**

Based on the preliminary design, the simulated effluent outfall is located approximately 1300 ft offshore of the plant location. The outfall consists of a multiport diffuser 33 feet in length, with three ports spaced evenly at approximately 1300, 1317, and 1333 feet from the shore. Ports centered 1.6 feet above the lake bed were assumed to discharge into water approximately 8 feet deep, depending on the time of year. Due to the outfall's configuration and offshore location, the plume will dissipate relatively quickly and is very unlikely to be re-entrained by the cooling water intake. While the configuration of the outfall will be refined during the final design, this conceptual design is adequate for determination of maximum effects of increased thermal discharge. In fact, the results of this assessment will be used to refine the design and, if necessary, modify the outfall to reduce thermal impacts.

5.3.2.1.1.2 **Methods**

Dilution and thermal plume dimensions are affected by the discharge structure design, effluent flow and temperature characteristics, and receiving water temperature, depth, and velocity characteristics. CORMIX input parameters consist of descriptions of the discharge's local bathymetry, ambient conditions, discharge geometry and effluent properties. The nature of the receiving water, the discharge effluent characteristics, and the water quality standards all vary with month; some characteristics vary with season or meteorological conditions. Therefore the modeling effort for Fermi 3 incorporates seasonal variability of these parameters to provide a complete characterization of the effects of thermal discharge on the receiving lake system.

Multiple objectives were identified as relevant to a complete analysis of thermal discharge effects. To succinctly address each one, the modeling effort was broken into three separate but related modeling sets. The first model set was designed to identify the extent of the thermal mixing zone that will result from the proposed Fermi 3 discharge with regards to the monthly variability in conditions and water quality standards. The second set of model runs used selected, worst-case monthly results to address uncertainties in ambient water depth due to wind-driven seiche or other events. The third model set also used the results from Model Set 1 to evaluate the effects of extreme westward lake current flow on plume dimension and location. The three sets are outlined in Table 5.3-1 and described in further detail below.

<u>Model Set 1</u>

To evaluate the extent of the thermal mixing zone resulting from the proposed additional Fermi plant discharge, an analysis of thermal plumes resulting from plant effluent discharges was done for four scenarios each month (Table 5.3-2). Separate runs were performed for each month in order consider monthly variation in receiving water and effluent temperatures as well as changes in the Michigan Water Quality Standards (WQS) throughout the year. The combination of these scenarios characterized the range of temperature and current velocity conditions that would be expected to contribute to a worst-case situation. The model design addressed the two separate WQS for each month: 1) maximum change in temperature from ambient (i.e., the ΔT), and 2) maximum allowable temperature. The first WQS stipulates that the discharge heat load may not cause more than a 3°F rise in water temperature above ambient outside of the mixing zone. Scenarios 1 and 2 addressed this criterion by applying a low ambient water temperature statistic (10^{th} percentile) for each of two extreme ambient velocity statistics (10^{th} percentile and maximum). The second standard, which specifies the maximum absolute temperature permitted outside of the mixing zone, is assessed in Scenarios 3 and 4. These scenarios used a high ambient water temperature statistic (90^{th} percentile) for each of the two extreme ambient velocity statistics (10^{th} percentile and maximum). Due to the relatively high lake temperature assumed in these scenarios, the conditions are expected to represent a worst-case situation in which the temperature of ambient lake water would be most impacted by the heated discharge. Evaluation of the four scenarios for each month provides the maximum predicted thermal mixing zone that is likely to be observed over the range of expected ambient conditions. Taken together, the 48 separate model runs illustrate the range of plume conditions that are likely to be encountered at the new outfall.

Model Set 2

A sensitivity analysis of the impact of water depth on thermal mixing was performed because the exact water depth at the proposed diffuser location varies with hydrological and meteorological conditions. The range of hydrological variation (i.e., that caused by seasonal variation and rainfall history) is evaluated under Model Set 1. This Model Set was used to evaluate short-term changes associated with meteorological conditions. During wind-driven seiche events, large, short-term variations in water depth have been observed. Though infrequent and of short duration, such changes in water depth could have potential effects on the distribution of the thermal plume and resulting mixing zone dimensions. Performing a series of CORMIX model runs with varying water depth provided predictions of the likely range of thermal plumes under all expected conditions.

In order to address worst-case conditions, lower (and less frequently occurring) water depths were used with the monthly scenario that produced the largest plume with respect to the temperature increase standard in Model Set 1. The one percent, five percent, and twenty percent frequency occurrence of water depths within the worst-case month were used for the depth-related sensitivity analysis. The use of these values allowed an evaluation of the differences in plume dimensions that may result from using low depth values instead of observed monthly average values in the thermal analysis.

It is important to note that seiche-driven water level changes affect the operation of Fermi 2 and are anticipated in the operating procedures of the cooling water system. During acute low-water events associated with persistent west winds, the Fermi 2 cooling water intake may not reliably supply sufficient water for cooling tower makeup. Because this condition was considered in the circulating water system design, the cooling tower basin was constructed to hold more water than would be typically expected. During low-water events, intake and discharge of cooling water is stopped temporarily and the cooling tower is run at higher cycles of concentration for up to several hours using water stored in the basin. Such operation has previously occurred without incident. A similar strategy of design and operation is planned for the Fermi 3 cooling system. While the details are yet to be established, under rare, short-lived low-water conditions, intake from and discharge to the cooling system will cease and increased cycles of concentration will be employed. Such actions mitigate the potential for operation of the diffuser under extreme low water conditions.

Model Set 3

The after-effect of wind-drive seiche can be a westward flow of water in response to the buildup of water in the eastern end of the lake. A hypothetical CORMIX scenario was developed to evaluate the effects of rare westward currents on plume location and dimensions. Specific attention was paid to the potential for plume impingement on the shoreline and plant intake area. To create a worst-case situation, the CORMIX model was set up such that effluent from a single port discharged in a northerly direction to reduce the additional dilution effect of the diffuser and to capture the extent of shoreward plume dispersion due to westward flow. CORMIX v.5 Module 1 was used for this analysis. Modeled ambient current conditions flowed to the west-northwest vector (directly into the shore) with a velocity equal to 1 fps, 1.5 times the maximum observed current velocity in any direction. Though data sources indicate that such a strong westward flow would be an extremely rare and short-lived event, it does provide a worst-case illustration of the thermal plume's behavior and its potential to impact the shoreline.

5.3.2.1.1.3 **Ambient Water Data**

Data were collected to characterize ambient temperature, depth, current, and wind conditions in the western basin of Lake Erie in the vicinity of the discharge location. To perform the CORMIX thermal modeling, it is necessary to characterize typical seasonal ambient conditions by analyzing long-term time-series records. Table 5.3-3 provides a summary of the time series and other relevant data that were used in developing a characterization of ambient conditions. Each of these data sets is discussed below.

Ambient Lake Temperature

Lake water temperature is an important input to the CORMIX model and the impact assessment as it affects the mixing behavior of the plume as well as the comparison to WQS. Limited temperature data for the western basin of Lake Erie were available for characterization of ambient lake temperature in the vicinity of the outfall. Available data were either from locations far from the discharge location or were not collected with sufficient frequency required for detailed month-specific temperature plume analyses. As an alternative, ambient lake temperature data for each month were derived from predicted water temperature generated by the Lake Erie Observational Forecast System (LEOFS), a component of the National Oceanic and Atmospheric Association's (NOAA) Great Lakes Coastal Forecasting System (GLCFS). LEOFS is based on the Princeton Ocean Model, an oceanic hydrodynamic model modified for use in the Great Lakes (Reference 5.3-3, Reference 5.3-4). LEOFS uses near real-time atmospheric observations and numerical weather prediction forecast guidance to produce three-dimensional forecasts of water temperature and currents in addition to two-dimensional forecasts of water levels. Chu et. al. (Reference 5.3-3) detail the skill assessment evaluation of LEOFS using available Lake Erie data on water temperature, current, and level. The skill requirements specific to temperature were found to meet the requirements of NOAA's National Ocean Service, especially when predicting conditions in areas, such as the western basin, that are well-mixed with depth.

LEOFS operates within a grid structure comprised of 1.25-mile square grid cells. LEOFS model temperature characteristics are expected to closely represent the conditions at the discharge location due to the fine resolution of basin-wide dynamics within the forecasting system. The model cell located nearest to the proposed discharge location (approximately 1300 feet from the shore) was selected to provide temperature data output for the outfall location. The LEOFS model cell-averaged depth is 13.8 feet, compared with an average observed depth of 7.9 feet at the specific location of the discharge. Average temperatures are not expected to change over this small-scale change in bathymetry; both depth values are well below the average for the western basin (24 feet) (Reference 5.3-5), which is well-mixed and non-stratified.

The LEOFS model estimates eight temperature values each day (one observation every three hours). These values were averaged into daily means that were used to develop monthly statistics. Daily ambient lake temperature is shown in Figure 5.3-2, summarized as water temperature versus day of the year for the 26-month model period of output. The seasonal water temperature pattern is clearly illustrated and consistent over the two years. For the thermal analysis, temperatures were characterized by the monthly mean, monthly low (10^{th} percentile), and monthly high (90^{th} percentile) values. These statistics are shown in Figure 5.3-2 and presented in Table 5.3-4.

<u>Ambient Lake Depth</u>

The depth of the water column overlying the effluent diffuser is an important determinant of the behavior of the thermal plume and its rate of mixing with the receiving water. Water level in the western basin of Lake Erie is affected by seasonal and inter-annual variations based on the hydrology of the contributing watershed. It is also affected by short-term variations associated with seiche events that occur on the order of hours to a day. While both of these phenomena are potentially important, their causes and time scales are very different. For this reason, they are discussed separately below.

The time series of water level at a buoy offshore of the plant location was downloaded from the NOAA Great Lakes Information Network (GLIN) website (Reference 5.3-6). These data provided monthly water level values from 1964-1969 and 1996-present and hourly water level values from 1996-present (Table 5.3-4). Monthly data for the mean water level for the entire period of record was downloaded and sorted by month (Figure 5.3-3). The entire period of record was used to calculate monthly statistics of water level. The higher resolution data were used to consider the effects of seiche events on the outfall. This data source also indicated that the Lake Erie low water datum is 569.2 feet IGLD 85.

From a 2008 NOAA Office of Coast Survey navigational chart (Reference 5.3-7), water depth at the low water datum at the location of the proposed discharge is approximately six feet. The average monthly water depth was calculated using the observed mean water level data, the datum elevation, and navigational chart water depth in the vicinity of the discharge for each observation in the water level period of record[3]. The values for a given month were averaged to provide the mean monthly water depth at the discharge location that was used in the thermal plume analysis (Table 5.3-5).

Lake Erie is affected by wind-driven seiche events that cause changes in water level and velocity. These events are relatively infrequent and short-lived, but they do present concern when predicting the behavior of a thermal plume. The seiche events are typically caused by westerly winds that push water towards the eastern end of the lake, causing decreased depth in the western edge of the lake. As wind conditions relax or pressure increases, the water moves back towards the west, increasing the local depth in the western end and creating a westward flow of current. Model Set 2 is intended to assess the effects of extreme changes in depth associated with seiche. As noted above, seiche events are accounted for in the operation of Fermi 2 and will be anticipated in the design and operation of Fermi 3. The net effect is that discharge of effluent from the diffuser will not occur at very low lake levels associated with seiche events.

The NOAA hourly water level data from January 1996 through February 2008 was used to characterize the occurrence frequency of historical water depths in the vicinity of the outfall location. Figure 5.3-4 shows the water depth at the outfall. Depth as low as 2 feet clearly occur though they are rare, as shown in Figure 5.3-5. This figure also shows that the average monthly water levels (used in Model Set 1) range from 7.3 to 8.6 feet and occur with relatively high frequency (i.e., their recurrence frequencies are between 20 percent and 80 percent).

Ambient Lake Currents

Lake currents affect the mixing of the plume as well as the direction of its movement. For these reasons, ambient current velocity is an important input parameter to the CORMIX model. Long-term time series of lake currents in the western basin of Lake Erie in the proximity of the discharge outfall have not been collected. Surface water measurements are greatly affected by wave action, and the shallow waters of the western basin (average depth of approximately 24 feet) present an obstacle to the successful deployment of fixed current meters. Flow circulates in a clockwise direction within the basin for approximately half of the year (therefore flowing from south to north in the vicinity of the Fermi plant) with velocity ranging from 0.05 to 0.15 fps. The rest of the year the current circulates in a counter-clockwise direction, producing flow from north to south near Fermi at a similar velocity.

The information in the above narratives does not provide monthly current velocity statistics or specific velocities in the vicinity of the discharge sufficient for the monthly CORMIX assessments defined above. As an alternative, ambient lake velocity data was derived from predicted current

3. According to US Army Corps of Engineers (Reference 5.3-8), water depth = mean water level (MWL) – datum elevation + depth according to a recent navigation map.

velocity generated by the LEOFS model. LEOFS operates within 20 vertical layers. The values for all layers were averaged to determine the mean velocity of the entire water column. The eight observations for each day (one observation every three hours) were averaged to provide daily mean current velocity and direction values. The daily dataset supplied the statistics required for Model Set 1 (the 10^{th} percentile and maximum current speed values, Table 5.3-2) for each of the twelve months. Mean direction for a given month was calculated as a simple average of modeled current direction. These values are presented in Table 5.3-6 and Figure 5.3-6.

As previously noted, Lake Erie is affected by seiche events, wind-driven changes in water level. These events are relatively infrequent and short-lived but they do affect water velocity over short periods. Current speed and direction at the outfall location were analyzed to determine the prevalence of westward current flow and potential for plume intrusion on the plant's intake and shoreline wetlands area. The current rose in Figure 5.3-7 was developed using the entire 26-month LEOFS dataset. The figure indicates that the predominant flow directions are generally parallel to the shore, in the due north and south-southwest direction. The figure also indicates that westward flow does occur, likely following the relaxation of a wind-driven seiche (i.e., water level rebound as winds from the west cease). Flow in a westerly direction is predicted to occur with low frequency (i.e., far less than 10 percent of the record) and at low velocities (less than 0.13 fps). The effect of such flow conditions are assessed in Model Set 3.

Ambient Wind Velocity

The CORMIX model incorporates wind as an input for use in predicting thermal plume behavior or heat dissipation to the atmosphere in the far field. Used for heat transfer and ambient mixing only, wind in CORMIX is non-directional. Ambient wind data was downloaded from the Weather Underground historical meteorological database for the Gross Ile, Michigan, Airport, located approximately four miles from the Fermi site. The database provides the average monthly wind velocity for every month over the last ten years (Reference 5.3-10); these values were averaged to provide a mean velocity for every month. The results are shown in Table 5.3-7. It should be noted that given the small nature of the thermal plumes predicted for the Fermi 3 discharge, heat dissipation to the atmosphere is not likely to be an important process in limiting the area of the plume above the WQS.

Water Quality Standards

The Michigan Water Quality Standards, Section R 323.1070, define two temperature criteria applicable to thermal discharge into Lake Erie:

1. The Great Lakes and connecting waters shall not receive a heat load which would warm the receiving water at the edge of the mixing zone more than 3°F above the existing natural water temperature.
2. The Great Lakes and connecting waters shall not receive a heat load which would warm the receiving water at the edge of the mixing zone to temperatures in degrees Fahrenheit higher than the following monthly maximum temperature. (Table 5.3-8)

The thermal plume modeling scenarios described in Table 5.3-2 were developed to evaluate the predicted thermal plume relative to these WQS. The first WQS criterion, maximum temperature rise, is evaluated using Scenarios 1 and 2, while the second criterion, maximum absolute temperature, is evaluated using Scenarios 3 and 4.

5.3.2.1.1.4 **Discharge Configuration**

A conceptual diffuser design was developed to provide efficient mixing of the thermal plume. The simulated discharge outfall enters Lake Erie from the western bank of the lake. Discharge ports are aligned perpendicular to the ambient lake current direction and directed twenty degrees above the horizontal of the lake bed. The multiport diffuser consists of three individual ports spaced evenly over 32.8 ft. Each port is 16.5 inches in diameter and located 19.7 inches above the lakebed (Table 5.3-9). Ports were designed to achieve desired exit velocity and direction. Module 2 of CORMIX v.5 for a submerged multiport diffuser discharge was used for modeling of the mixing zone.

5.3.2.1.1.5 **Effluent Data**

Table 5.3-10 shows the projected discharge parameters and rates for Fermi 3. The effluent flow rate varies by month, ranging from 12,000 gpm to 17,000 gpm. A single effluent flow rate was used for all four modeling scenarios within a single month. Both the effluent flow rate and temperature values are anticipated to be monthly maximum values, allowing evaluation of maximum potential temperature impacts.

The CORMIX model requires the initial effluent temperature to be input as ΔT, the difference between the effluent temperature and the ambient water temperature. This value varies by month because of the monthly changes in ambient temperature (Table 5.3-4) and effluent (Table 5.3-10).

A complete summary of the monthly-variable CORMIX input parameters is presented in Table 5.3-11.

5.3.2.1.1.6 **Results of Thermal Plume Analysis**

Model Set 1: Monthly Model Runs

Summaries of the predicted thermal plume dimensions are presented in Table 5.3-12 and Table 5.3-13 for Model Set 1, evaluating the two WQS. Predicted plume dimensions are defined in Table 5.3-12 as the estimated location of the 3°F ΔT isotherm, which indicates the maximum extent of the discharge plume above the WQS for temperature increase above ambient. The May scenario with low ambient lake temperature and high ambient lake velocity (Scenario 2 in Table 5.3-12) produced the plume that extended furthest eastward into Lake Erie from the discharge point for the ΔT WQS. The largest mixing zone of the proposed thermal discharge was predicted to extend 130.2 feet in the eastward direction and was 226.4 feet wide in the north/south direction, with an approximate plume area of 29,486 ft^2 (Figure 5.3-8).

Table 5.3-13 shows the resulting plume dimensions when evaluated for the absolute temperature WQS, which specifies that water temperature outside of the mixing zone not exceed a month-specific maximum value (Table 5.3-8). This standard was assessed by evaluating the plume temperature, including the influence of ambient temperatures, relative to the WQS. The maximum ambient lake temperature during this time is assumed to be the 90th percentile of observed monthly temperatures for the 2-year period of record. The largest plume in this analysis is produced by the January conditions using low ambient lake temperature and high ambient lake velocity (Scenario 4 in Table 5.3-2). The mixing zone under these conditions is predicted to be 23.1 feet long in the eastward direction from the discharge location and 8.1 feet wide in the north/south direction, for an approximate plume area of 188 ft^2.

The worst-case plume scenario from Model Set 1 was used for subsequent analyses in Model Sets 2 and 3 that address specific concerns related to lake bathymetry and variability in local depth and current direction.

Model Set 2: Depth Sensitivity Analysis

By producing the largest plume area in the month-specific temperature rise evaluation, the specific conditions of May Scenario 2 are expected to provide a worst-case scenario of the effects of variable depth. In order to address worst-case conditions, lower (and less frequently occurring) water depths were used with the monthly scenario that produced the largest plume with respect to the temperature increase standard in Model Set 1. The values used for the depth-related sensitivity analysis represent depths that recur with 1 percent, 5 percent, and 20 percent frequency within the month of May (7.0 ft, 7.6 ft, and 8.0 ft, respectively). Summaries of the predicted thermal plume dimensions are presented in Table 5.3-14. The length of the plume's eastward extent increases from 130.2 feet to 159.4 feet at the lowest modeled depth, increasing in approximate area from 29,486 ft^2 to 55,347 ft^2. Even under rare conditions of decreased depth, the plume is expected to disperse within a small fraction of the local lake area (over 35 billion ft^2).

Model Set 3: Westward Current Flow

The specific conditions of May Scenario 2 are also expected to provide a worst-case scenario of the effects of current flow directly towards the western shore. For this analysis, the May scenario was duplicated with ambient currents to the west-northwest direction (directly into the shore) and velocity equal to 1.0 fps, 1.5 times the maximum observed current velocity in any direction. All other parameters such as water depth, ambient temperature, and discharge flowrate were equal to those used in the May scenario with low ambient lake temperature and high ambient lake velocity (Scenario 2).

The results of this model run indicated very little risk of the thermal plume impinging upon the shoreline wetlands and intake areas. This analysis, using wintertime ice-free temperature conditions, ambient cross-flow directed towards the shore, and a single port discharge without a diffuser, predicted that the thermal plume will extend approximately 26 feet towards the shore (Table 5.3-15). Since the center of the discharge port is located approximately1300 feet from the shoreline, the plume dissipates approximately 1300 feet away from the shore in this worst-case scenario. It poses no threat of impinging on the western shore located 1300 feet from the discharge outfall location.

5.3.2.1.1.7 **Summary of Thermal Plume Analysis**

CORMIX v.5 Module 2 was used to define the area of the western basin of Lake Erie in which the temperature is likely to be elevated above the relevant WQS due to the blowdown discharge by Fermi 3. The predicted mixing zone was conservatively estimated using accepted techniques. Several separate scenarios were evaluated in order to illustrate seasonal changes in currents, water depths, temperatures, effluent characteristics, and the WQS. The potential importance of seiche-related events was evaluated through a sensitivity analysis. The predicted mixing zone affects a very small section of the western lake and was not predicted to impinge on the shore, interact with the cooling water intakes, or interact with the existing Fermi 2 outfall. The impacts of the Fermi 3 thermal discharge are expected to be SMALL, and no mitigation measures are warranted.

5.3.2.1.2 **Other Physical Impacts**

Potential physical impacts associated with discharge from the Fermi 3 site include shoreline erosion, impact on lake stratification, and bottom scour in the location of the diffuser, which could result in increased turbidity and siltation. As discussed above, the plume is not predicted to interact with the shoreline, and is not expected to result in any shoreline erosion.

There is a potential for benthic scouring in the direct vicinity of the discharge outfall. Scouring damage at this location will be minimized by design measures such as the presence of riprap around the submerged discharge port as well as the orientation of the discharge ports in an upward direction. Due to the shallow water depth in the western basin and wind-driven mixing, thermal stratification is essentially non-existent (Reference 5.3-5). Therefore, the diffuser is not expected to disrupt stratification.

5.3.2.2 **Aquatic Ecosystems**

Impacts associated with Fermi 3 discharges into the western basin of Lake Erie could include changes in the benthic ecosystems in the immediate area of the discharge and cold shock to aquatic organisms associated with the immediate area surrounding the discharge during periods of unit shutdown. Additional potential impacts relate to chemical effluent and the physical effects of the Fermi 3 discharge. These areas are addressed in the following subsections.

5.3.2.2.1 **Thermal Impacts**

The discharge rate for the combined discharge for Fermi 3 will be 24.4 million gallons per day (MGD). Small discharges such as this that use a high rate diffuser would be expected to rapidly mix with ambient lake water, resulting in a small thermal plume, as demonstrated in Subsection 5.3.2.1. The thermal plume is unlikely to hinder fish migration or spawning efforts; although, some species may avoid the area altogether in the summer when maximum lake temperatures are reached. Alternatively, the thermal plume may act as an aggregation point for species that prefer warmer water temperatures during the winter months, as the heated effluent would warm water temperatures to a more desirable range. Discharge ΔT (water temperature change) would be highest during wintertime when ambient lake water temperatures decline. The maximum absolute lake water temperature, however, would occur in summer months. Water temperatures at this time of year have been documented to reaching excess of 76°F. Even under these conditions, the 3°F isotherm is extremely small, and impacts to aquatic organisms would still be SMALL in this scenario.

Table 5.3-16 illustrates the lethal upper and lower temperature limits for important aquatic species of Lake Erie found near the Fermi site. Several of these species, such as the gizzard shad, emerald shiner, channel catfish, common carp, and bluegill, are widely distributed. As such, these species tend to exhibit a higher range of temperature tolerances and, overall, are more robust and capable of withstanding fluctuations in habitat parameters. Other species listed in Table 5.3-16, such as the walleye, brown trout, and rainbow trout, have been classified by the USFWS as cool or cold-water dependent species[4]. It would be expected that these species would avoid the thermal plume, as fishes tend to migrate away from temperature stressors. Additionally, there is a potential for permit conditions that will require gradual reduction of effluent discharge to lake during winter months to prevent fish mortality due to cold shock. As demonstrated in Subsection 5.3.2.1, the resulting thermal plume in Lake Erie from Fermi 3 will be small, and little displacement of localized cool and coldwater fish congregations is expected (Reference 5.3-11, Reference 5.3-12, and Reference 5.3-13). Therefore, no significant thermal impacts to local fish species are expected to occur.

The NRC previously ruled that there would be 'no impacts' to aquatic organisms associated with Fermi 2 discharge (Reference 5.3-14). As demonstrated in Subsection 5.3.2.1, the thermal plume resulting from the operation of Fermi 3 would be minimal when compared with the breadth of the western basin of Lake Erie. Even under rare conditions of decreased depth, the plume at its maximum size of 55,347 ft^2 is expected to disperse within a small fraction of the local lake area (over 35 billion ft^2). Therefore, impacts to organisms resulting from additional thermal discharges associated with Fermi 3 are expected to be SMALL, with no mitigation measures needed.

Additionally, NRC studies have "evaluated the potential impacts of the discharge of heated water to an aquatic system including: (1) thermal discharge effects; (2) cold shock; (3) effects on movement and distribution of aquatic biota; (4) premature emergence of aquatic insects; (5) stimulation of nuisance organisms; (6) losses from predation; (7) parasitism and disease; (8) gas supersaturation of low dissolved oxygen in the discharge; and (9) accumulation of contaminants in sediments or biota. In general, for plants employing cooling tower systems, the impacts were found to be minor." (Reference 5.3-15) Future operational plans for Fermi 3 include use of a cooling tower system; thereby, substantiating the conclusion that impacts to aquatic resources related to thermal discharges would be SMALL.

No thermal impacts to wetlands are expected. The thermal discharge from Fermi 3 will be released at approximately 1300 feet from the shore and will use a high rate diffuser. As demonstrated in Subsection 5.3.2.1, no thermal plume in excess of the relevant Water Quality Standards is predicted to persist beyond a maximum length or width of 350 feet. Under all circumstances, the plume of elevated temperature is predicted to dissipate well before approaching the lake's edge.

4. Cool and coldwater species – USFWS guidance for evaluating temperature limits indicates that these fishes are commonly found in waters with a mean high temperature of 84°F and 72°F, respectively (Reference 5.3-10).

5.3.2.2.2 **Chemical Impacts**

Impacts to aquatic ecosystems at Fermi associated with the chemical components of effluents for Fermi 3 will be limited to those constituents listed in NPDES permit, as detailed in Section 2.3. Importantly, MDEQ, the delegated NPDES authority, will review the proposed discharge and regulate the on-going discharge to ensure protection of the water quality of Lake Erie. A current NPDES permit is held by Fermi 2 that became effective on September 30, 2005. Given the common source water and similar facility processes, the current NPDES permit for the existing unit provides a reasonable model for the future NPDES permit for Fermi 3[5]. In particular, the constituents of potential concern to MDEQ relative to water quality impacts are reflected in the effluent limitations contained in the NPDES permit for Fermi 2 (Reference 5.3-16). These parameters include (outfalls are shown on Figure 2.3-47):

- For Outfall 001A (to Lake Erie at a maximum of 45.1 MGD): total residual chlorine, two specific water treatment chemicals, pH, and net mercury loadings. Monitoring of these constituents is required[6] by the permit;
- For Outfall 001B (to Lake Erie at a maximum of 1.44 MGD): a water treatment chemical;
- For Outfall 001D (to Lake Erie at a maximum of 0.216 MGD): Total Suspended Solids, Oil & Grease;
- For Outfall 001E (to Lake Erie at a maximum of 0.5 MGD): Total Suspended Solids, Oil & Grease, total copper, and total iron;
- For Outfall 009A (to Swan Creek at a maximum of 0.72 MGD): Total Suspended Solids, Oil & Grease, total copper, total iron, total boron, total residual chlorine, dechlorination reagent, and pH; and
- For Outfall 011A (to Swan Creek at a maximum of 1.8 MGD): Net mercury loadings, total selenium, and pH.

Fermi 2 has maintained consistent compliance with this suite of effluent limits and the relevant regulatory parties have been satisfied that they are consistent with the relevant rules and the protection of water quality of both Swan Creek and Lake Erie.

The water balance for Fermi 3 is simpler than the one for Fermi 2 in some respects. In particular, only one outfall to the environment is planned (although internal outfalls to facilitate monitoring of particular waste streams may be necessary). That outfall will be a high rate diffuser located approximately 1300 feet offshore of the facility. Based on the combination of internal waste streams to one outfall with a high rate diffuser in Lake Erie, it is very likely that some of effluent limitations included for Fermi 2 will not be necessary as greater dilution will be achieved prior to discharge as well as rapidly within the receiving water. While no adverse effects from chemicals in effluent are anticipated, MDEQ will provide a rigorous review of the impacts to water quality as part of the

5. While this discussion assumes that a separate NPDES permit will be issued for Fermi 3, it is equally likely, and essentially equivalent, that a major modification of the existing permit will made to accommodate the new unit.
6. Monitoring of a broader suite of effluent characteristics is also required as part of the NPDES permit renewal process.

NPDES permitting process and opportunities will be available to mitigate any potential adverse impacts by measures such as changes in metallurgy, treatment chemicals, and outfall configuration.

Monitoring of chemicals that present a potential concern has been required by the NPDES permit for Fermi 2 (Reference 5.3-16) and will be required for the NPDES permit for Fermi 3. It is important to note that MDEQ has defined the current effluent limits after repeated characterization of the quality of the effluent from Fermi 2. This has included evaluation of the full suite of Priority Pollutants. During this process, MDEQ determined that none of the priority pollutants (beyond those listed above – and several of those are included based on Categorical Effluent Limitations) had a reasonable potential to cause an exceedance of Michigan Water Quality Standards in the Lake Erie. For this reason, none of the other priority pollutants were the subject of an effluent limitation.

Effluent limits outlined in the NPDES permit are developed in accordance with EPA ambient water quality criteria documents. These criteria documents have assessed numerous toxicity studies to aid in determining appropriate limit levels to prevent facility effluents from harming natural resources, including aquatic biota. The levels outlined in the NPDES permit are set well below documented lethal levels for indicator organisms, thus ensuring the health and continuity of the natural processes of any organisms in the receiving water body. By monitoring discharges in accordance with current and future NPDES permits, Fermi 3 will ensure that any chemical components contained in its effluent would not adversely affect aquatic resources within the western basin of Lake Erie.

5.3.2.2.3 **Physical Impacts**

As detailed in Subsection 2.4.2, benthic productivity in the western basin of Lake Erie is limited; the minor loss of substrate in the small area associated with the discharge outfall would only minimally impact those aquatic organisms residing in the direct vicinity of the discharge structure. As discussed in Subsection 5.3.2.1.2, the physical impacts (shoreline erosion, bottom scouring and subsequent turbidity and siltation) on Lake Erie are not significant. Physical impacts to aquatic resources and important aquatic species associated with thermal discharges from Fermi 3 are expected to be SMALL.

The closed-cycle cooling system employed at Fermi 3 will minimize the potential effects of heated water discharge, as the majority of the waste heat is dissipated to the atmosphere during the cooling process. The analysis provided in this section indicates that impacts to aquatic resources within the western basin of Lake Erie at Fermi 3 would be limited to those in a small area in the direct vicinity of the discharge pipeline. Therefore, it is concluded that impacts to these resources would be SMALL and no mitigation for impacts would be warranted.

5.3.3 **Heat-Discharge System**

Operation of Fermi 3 will influence the local climatology and terrestrial ecosystems through its heat-discharge system of cooling towers by introducing increased moisture and chemical content into the atmosphere. Therefore, the discussion in this subsection is aimed at an evaluation of cooling tower plume effects. To that end, this subsection gives consideration to the potential atmospheric phenomena resulting from operation of the heat-discharge system and the significance of its potential environmental impacts on terrestrial ecosystems and activities.

5.3.3.1 **Heat Dissipation to the Atmosphere**

Fermi Unit 3 Cooling Systems

Cooling systems which depend on evaporation of water for a major portion of the heat dissipation can be expected to create visible vapor plumes. These vapor plumes cause shadowing of nearby lands, salt deposition, and can increase the potential for fogging or icing. Each of these phenomena, including the potential for vapor plume interaction and increases to ground-level humidity, is addressed below.

As discussed in Section 3.4, the Circulating Water System (CIRC) provides cooling water during startup, normal plant operations, and hot shutdown for removal of power cycle heat from the main condenser and rejects this heat to the normal power heat sink (NPHS). The NPHS is comprised of a hyperbolic natural draft cooling tower (NDCT). Cooling towers take heat, which was transferred to the cooling water via a condenser, and dissipate it to the atmosphere by evaporation. It is this evaporation which can create vapor plumes that have the potential to impact the existing environment.

Water pumped from the Lake Erie intake bay would be used to replace water lost by evaporation, drift, and blowdown from the cooling towers. Blowdown water is returned to Lake Erie via an outfall located in the lake. A portion of the waste heat is thus dissipated to Lake Erie through the blowdown process. A discussion of the thermal plume predictions in Lake Erie is contained in Subsection 5.3.2.1.

The Fermi 3 design does not require an external source of safety-related cooling water. The Ultimate Heat Sink (UHS) function is provided by safety systems integral and interior to the reactor plant. These systems have no cooling towers, basins, or cooling water intake/discharge structures external to the reactor plant. Thus, no environmental impact is expected from the operation of the UHS. In addition to the UHS and NPHS, Fermi 3 will include an Auxiliary Heat Sink (AHS) which will utilize small linear mechanical draft cooling towers to dissipate heat from the Plant Service Water System typically during plant shutdown conditions. However, the heat dissipated by the significantly smaller AHS cooling towers would be orders of magnitude less than the heat dissipated by the NPHS cooling tower. Accordingly, the environmental impact associated with the AHS cooling towers operating in conjunction with the NPHS cooling tower or alone is bounded by the NPHS cooling tower analysis presented in the remainder of this subsection. The NPHS cooling tower analysis uses design conditions which produce the most limiting heat-discharge system environmental impacts.

Plume Prediction Code

The NRC has identified several plume-related codes as acceptable methodologies. A model endorsed by NUREG-1555, Section 5.3.3.1, was Carhart and Policastro (Reference 5.3-23). In NUREG-1555, the NRC accepted Carhart and Policastro's conclusion that their code predicts the plume rise within a factor of 2 approximately 75 percent of the time and visible plume length within a factor of 2.5 approximately 70 percent of the time. This model was embedded into the Electric Power Research Institute's (EPRI) Seasonal/Annual Cooling Tower Impact Prediction Code (SACTI) in 1991, and later modified in accordance with Reference 5.3-24 and Reference 5.3-9. The current version of the SACTI plume modeling code (Reference 5.3-25) was used to develop the model for the evaluation of potential plumes from the Fermi 3 NDCT.

In order to determine the potential impacts of the cooling tower vapor plumes, the SACTI cooling tower model requires as input certain site-specific, tower-specific, and circulating water-specific data. Input data used in the SACTI cooling tower model are discussed below.

Site-Specific Data

Site-specific data includes the site's latitude and longitude, time zone, surface roughness height, monthly clearness indices, daily solar insolation values, representative hourly recorded surface meteorological data, and average morning and afternoon mixing heights. The site's location is a given data point and, as such, was input directly to the model. The surface roughness (100 cm) was selected based on the general obstruction profile typical of industrial facilities. The monthly clearness indices and solar insolation values were obtained from Appendix B of the User's Manual for the SACTI Computer Code (Reference 5.3-25) for Detroit, MI; the most representative location provided in the manual.

Onsite meteorological data from the Fermi meteorological tower was used for the most recently available 5-year data period of 2003 through 2007 (discussed in detail in Section 2.7). The onsite data contains wind direction, wind speed, dry bulb temperature, and dew point temperature measurements at 10 meter (32.8 ft) and 60 meter (196.8 ft) heights. As discussed in Subsection 2.7.4.2, the meteorological tower is located east of a grove of trees that is located less than ten times the obstruction height recommended in Regulatory Guide 1.23. The potential impact of the trees, for upwind sectors, is to reduce the indicated wind speed at the 10 meter elevation. Very little impact to the wind speed has been observed at the 60 meter elevation. Because the cooling tower proposed is a 600 foot natural draft tower, the 60 meter meteorological measurements are the most representative of the release height and as such, were utilized in the SACTI modeling analysis. Thus, the SACTI modeling analysis is not impacted by the presence of the trees.

Because the onsite meteorological tower does not record atmospheric pressure, ceiling height, or cloud cover, data commensurate with the onsite data, was taken from the Detroit Metro Airport, located in Detroit, MI, only 17 miles from the Fermi site. Using dry bulb and dew point temperature from Fermi, along with air pressure from Detroit Metro Airport, the required wet bulb temperature and relative humidity values were calculated. These data elements (from onsite and Detroit Metro Airport) were then combined into the appropriate CD-144 format required by the SACTI cooling tower model. When CD-144 format is used as the meteorological input to SACTI, the model determines stability class based on measured wind speed, ceiling height, cloud cover, solar elevation angle, and time of day.

The mixing height data for the SACTI cooling tower model was taken from Table 2.7-7 (data in table from Reference 5.3-26). This table contains average mixing heights for the morning and afternoon by month as calculated by the National Climatic Data Center (NCDC) using Detroit Metro Airport surface data and White Lake upper air balloon data. These are the closest, most representative reporting stations for data of this kind to the Fermi site. A discussion of this data and the resulting tabled values are presented in Subsection 2.7.2.4.

Tower-Specific Data

Tower-specific data includes information pertaining to the type of cooling tower, dimensions of the tower housing, cell exhaust diameter, heat load, drift rate, design air flow, and orientation of the cooling tower cells with respect to the 16 available representative wind directions. Tower-specific data included in the SACTI cooling tower model are provided in Table 5.3-17.

Water-Specific Data

Water-specific data includes the CIRC total dissolved solids (TDS) concentration, salt density, and the size distribution of the water droplets in the cooling tower drift. The cooling water is expected to go through two cycles of concentration before requiring blowdown. Multiplying the Lake Erie water TDS of 210 ppm by two cycles of concentration yields a cycled TDS concentration of 420 ppm or 0.00042 g salt/g solution.

5.3.3.1.1 **Length and Frequency of Elevated Plumes**

Cooling tower plume lengths are calculated by the SACTI cooling tower model as the frequency of occurrence of a given plume length from the cooling tower for each of 16 wind directions.

Table 5.3-18 describes the expected plume lengths by wind direction for the NDCT on an annual and seasonal basis. The longest average plume lengths are predicted to occur during the winter months and the shortest are predicted to occur during the summer months. Considering all wind directions, the model predicts an average length of approximately 1.5 miles in winter and 0.24 miles in the summer.

On an annual frequency basis, as presented in Table 5.3-19, the SACTI cooling tower model predicts the plume lengths from the NDCT to be less than approximately 1000 m (3281 ft) roughly 50 percent of the year considering all wind directions of plume travel. This length is also known as the median plume length (i.e., that length which the plume is predicted to be longer or shorter than for 50 percent of the year). The median plume length, which is predicted to occur approximately 50 percent of the year, only extends past the nearest property boundary (843 m) by less than 200 m. Additionally, the highest probability of a visible plume over a particular location is approximately 11 percent of the year in an area 100 to 300 m (328 to 984 ft) east of the NDCT. The highest probability plume will not reach offsite as the nearest property boundary to the new tower is approximately 843 m (2766 ft). At a distance equal to the closest point of the property boundary to the proposed tower (843 m) the highest probability of a visible plume from the NDCT is only 7.33 percent in any particular direction. The above model output indicates that the percent frequency of occurrence of long cooling tower plumes in any particular direction is very SMALL and, as such, does not warrant mitigation.

5.3.3.1.2 **Frequency and Extent of Ground Level Fogging and Icing In the Site Vicinity**

Cooling Tower Plume-Induced Fogging

Ground level fogging occurs when the visible plume from a cooling tower contacts the ground. Studies conducted by Broehl (Reference 5.3-27), Zeller (Reference 5.3-28), and Hosler (Reference 5.3-29) indicate that surface fogging from natural draft towers does not present a significant problem. Broehl and Zeller found no cases of cooling tower plumes reaching the ground, while Hosler noted only one in a two year study at the Keystone Power Plant, near Shelcota, in western Pennsylvania. As such, the SACTI cooling tower model assumes that the occurrence of fogging from natural draft towers is an insignificant event and thus does not predict estimates of plume induced, ground level fogging from such towers (Reference 5.3-25).

While the SACTI model assumes no occurrences of fogging hours from the NDCT, sometimes the meteorological conditions that are favorable for the occurrence of natural fog events can be conducive to cooling tower plume-induced fogging as well. As such, should the NDCT produce an induced fog, it may likely occur simultaneously with a natural fog event and thereby further alleviate the relative impact potentially caused by cooling tower plume-induced events (of which the model assumes to be insignificant as previously discussed). Climatologically, natural fog (that which restricts visibility to less than ¼ of a mile) occurs an average of 17.7 days per year in the Fermi region based on meteorological data from Detroit Metro Airport (Reference 5.3-30). This means a minimum of 17.7 hours of naturally occurring fog in the vicinity of Fermi (conservatively assuming that reported fogging events last for only one hour per day). Any cooling tower plume-induced fogging event that may occur would be a fraction of fog events that occur naturally.

For the reasons described above, it is predicted that the operation of the NDCT will result in no increased fogging at the site. Any event that may occur is likely to be coincident with a natural fog event and transient in nature similar to the existing NDCTs, which currently do not disrupt onsite operations. Any impact should only be aesthetic in nature. Therefore, the impacts of cooling tower plume-induced fogging are anticipated to be negligible to SMALL, and do not warrant mitigation.

Cooling Tower Plume-Induced Icing

Ground level plume icing is a coating of small granules of ice formed when small water droplets in the cooling tower plume-induced fogging (discussed above) freeze rapidly on the ground during periods of below freezing temperatures. Temperature measurements at nearby Detroit Metro Airport indicate that, on average, the area experiences 129.8 days per year where the minimum ambient temperature drops below freezing (Reference 5.3-30).

However, as discussed previously, the SACTI cooling tower model assumes that natural draft towers do not produce ground level plume-induced fogging. Thus, ground level icing from natural draft cooling towers is not predicted by SACTI. Icing may be possible from the operation of the AHS, but given their small size impacts are expected to be contained on site and SMALL.

Therefore, impacts from the new cooling towers are anticipated to be negligible to SMALL, and do not warrant mitigation.

5.3.3.1.3 Solids Deposition (i.e., Drift Deposition) in the Site Vicinity

As discussed in Subsection 3.4.1.6, the NDCT will use drift eliminators to minimize the amount of water lost from the tower via drift. Some droplets are, nevertheless, swept out of the top of the cooling tower in the moving air stream. Initially, these droplets rise in the plume's updraft, but due to their high settling velocity, they eventually break away from the plume, and then evaporate, settle downward, and are dispersed by atmospheric turbulence. This drift essentially has the same concentrations of dissolved and suspended solids as the water in the cooling tower basin. The maximum expected TDS (due to two cycles of concentration) in the circulating water system were discussed and given above in Subsection 5.3.3.1.

NUREG-1555, Section 5.3.3.2, provides the following guidance on analyzing operational impacts from salt drift:

- Deposition of salt drift (NaCl) at rates of 1 to 2 kg/ha/mo (0.9 to 1.8 lb/acre/mo) is generally not damaging to plants.
- Deposition rates approaching or exceeding 10 kg/ha/mo (9 lb/acre/mo) in any month during the growing season could cause leaf damage in many species.
- Deposition rates of hundreds or thousands of kg/ha/yr could cause damage sufficient to suggest the need for changes of tower-basin salinities or a re-evaluation of tower design, depending on the amount of land impacted and the uniqueness of the terrestrial ecosystems expected to be exposed to drift deposition.

The solids deposition analysis conservatively assumed that all TDS was salt. The results are discussed below.

Table 5.3-20 through Table 5.3-24 present the annual and seasonal SACTI cooling tower model predicted average monthly salt deposition rates for the NDCT. The maximum predicted annual salt deposition rate is 0.01 $kg/km^2/mo$ and occurs between 4200 and 9400 meters (13,779 and 30,840 ft) east-northeast of the NDCT. Due to the high initial plume of the NDCT, no solids are deposited within 4100 meters (13,451 ft) of the NDCT. Because of the low drift loss, low solids concentrations in the water, and small number of cycles of concentration, the average salt deposition within the radius containing the maximum value (i.e., 4500 meters) is below the models predicting threshold and registers as 0.00 $kg/km^2/mo$. The maximum seasonal impact occurs during the winter (Table 5.3-21) with 0.02 $kg/km^2/mo$ predicted to occur between 4400 and 9400 meters (14,436 and 30,840 ft) east-northeast of the NDCT. These maximum predicted impacts are well within the NUREG-1555 acceptable levels and generally not damaging to plants. Average annual salt deposition isopleths from the NDCT are shown in Figure 5.3-9.

Additionally, no salt deposition is predicted at the existing Fermi 2 switchyard, the planned location of the new Fermi 3 switchyard, or the planned Fermi 3 main transformer area as these areas lie within 4100 meters of the NDCT. The only other electrical equipment associated with the operation of Fermi 3 existing beyond 4100 meters are the transmission lines that run offsite and traverse the surrounding area. The Transformers Committee of the IEEE Power Engineering Society sponsored an "IEEE Guide for Application of Power Apparatus Bushings" which provides ranges of salt deposition density levels for various types of contaminated environments ranging from light contamination environments to extra heavy contamination environments. The maximum predicted impact values given above are well below the lowest bound equivalent salt deposit density level associated with even the lightest contaminated environments which is given in the reference as 300 kg/km^2 (0.03 mg/cm^2) (Reference 5.3-44). This indicates that the operation of the NDCT for Fermi 3 will not produce a contaminated environment on power apparatus bushings which are incorporated as part of transformers, power circuit breakers, and isolated phases bus. It is also reasonable to assume that cumulative salt deposition buildup would not cause a contaminated environment as the maximum monthly deposition rates are orders of magnitude below the light contamination level and natural precipitation events would wash off and reduce salt deposition long before any significant buildup could occur.

According to NUREG-1555 Section 5.3.3.2, the risk of soil salinization from cooling towers is generally considered to be low. Soil salinization is of most concern in arid areas (deserts) where salts could accumulate in soils over long time intervals. The Fermi location is not located in an arid area.

The use of drift eliminators to minimize drift directly results in the minimization of salt deposition impacts given above. In sum, the impacts from salt deposition are anticipated to be SMALL, and do not require mitigation.

The predicted minimal impact due to salt deposition from the Fermi 3 NDCT is further substantiated by historical data from the operation for the Fermi 2 NDCTs. Fermi 2 uses two NDCTs which are located North of Fermi 3. Studies have been performed to determine if the operation of the Fermi 2 NDCTs have had an adverse impact to the vegetation in the vicinity of the site. These studies concluded that the emissions from the NDCTs have not previously contributed to adverse impacts to the vegetation.

5.3.3.1.4 **Cloud Formation, Plume Shadowing, and Additional Precipitation**

<u>Cloud Formation and Plume Shadowing</u>

The potential for cloud development and plume shadowing due to the operation of cooling towers exists. Natural draft cooling tower plumes at several power plant sites have been observed to cause broken cloud decks to become overcast, make thin clouds thicker, and create separate cloud formations several thousand feet above ground (Reference 5.3-31). Although the plumes from natural draft cooling towers at several power plants have been observed to increase cloud cover several thousand feet above the ground, mechanical draft cooling towers, such as that proposed for the AHS are not known to produce such cloud development effects (Reference 5.3-32).

Regardless of whether from cloud development or from the cooling tower plume itself, plume shadowing is an important phenomenon especially for agricultural areas. Because there are agricultural areas in the vicinity of the Fermi site, an analysis of plume shadowing is presented here.

Cooling tower plume shadowing is determined by the SACTI cooling tower plume model by calculating the average number of hours the cooling tower visible plume causes shadowing of the sun on the ground.

Table 5.3-25 presents the five-year total hours of predicted shadowing caused by the visible plume associated with the NDCT. The SACTI model predicts that maximum shadowing will occur 200 m (656 ft) north of the NDCT for an average of 348 hours per year. Beyond a radius of 800 m (2625 ft) from the NDCT, the SACTI model predicted that the average annual hours of shadowing (considering all directions of plume travel) would be less than 100 hours, or approximately less than 2.3 percent of the daylight hours per year. Additionally, the average hours per year of plume shadowing beyond 843 m (nearest property boundary distance) is predicted to be 92 hours per year (2.1 percent of the daylight hours per year) from the NDCT (considering all plume directions in the table).

The resulting hours per year of shadowing (especially at the nearest property boundary) are predicted to be an insignificant fraction of the total daylight hours for agricultural purposes. Additionally shadowing events are not expected to occur at significantly far downwind locations reaching agricultural areas. Thus, the plume shadowing impacts are expected to be SMALL, and do not warrant mitigation.

Additional Precipitation

As presented by Huff, light drizzle and snow occasionally have been noted within a few hundred meters downwind from cooling towers, but these phenomena are very localized and should have no effect outside the site boundary. From this it can be concluded that the occurrence of freezing drizzle associated with operation of the NDCT would be an even rarer event as the surface temperatures would have to be at or below freezing. Huff compared the flux of water vapor and air from natural draft cooling towers with those occurring in natural convective showers. His results indicate that some enhancement of small rain showers might be expected, as tower fluxes are within an order of magnitude of the shower fluxes (Reference 5.3-33). This implies that large thunderstorms, with their much greater flux values, should not be significantly affected.

In addition to triggering additional precipitation events, another potential environmental impact resulting from the discharge of cooling tower moisture is the regional augmentation of natural precipitation. In estimates made by Huff, the total contribution to surface precipitation from cooling towers, based on a 2200 MWe station, was found to be only 0.4 inches annually (Reference 5.3-34). Precipitation augmentation from a cooling tower is assessed in SACTI as water deposition. Water deposition from a cooling tower occurs when the airborne water droplets coalesce and precipitate out downwind of a cooling tower. The pattern of water deposition and the distance of maximum water deposition from the cooling tower are a function of the physical size of the water droplets in the drift, prevailing wind direction, orientation of the cells, and the airflow rate through the cooling tower.

As shown in Table 5.3-26, the SACTI cooling tower plume model predicted that the maximum cooling tower water deposition from the NDCT will occur approximately 4500 to 9300 m (15,000 ft to 31,000) east northeast of the NDCT at a rate of 5.9 $kg/km^2/mo$. The average water deposition within the largest radius containing the maximum impact (9300 m) is predicted to be 2.2 $kg/km^2/mo$ (considering all wind directions or plume travel).

A potential effect of water deposition on vegetation species is the increased threat of plant fungal diseases associated with the increased precipitation. Based on historical meteorological data for Detroit Metro Airport, the average monthly rainfalls for the driest month (February) and the wettest month (June) are 48 mm and 90 mm, respectively. Conservatively assuming no evaporation of the falling cooling tower drift droplets, the precipitation rate equivalent of the maximum SACTI model predicted water deposition rate (5.9 $kg/km^2/mo$) is approximately 0.00001 mm per month. By comparison, this precipitation rate is less than 0.0001 percent of the average monthly rainfall of even the driest month. Further, when considering freezing conditions and associated precipitation events, potential drizzle ice accumulation from operation of the NDCT is immeasurable as evidenced by taking the maximum 0.0001 percent fraction of the highest monthly average precipitation value (of any month having recorded an icing event) of 3.05 inches (April), as displayed in Table 2.7-2, which results in 0.000003 hundredths of an inch accumulation assuming it is cold enough to result in freezing drizzle conditions. Thus, impacts due to water deposition (additional precipitation) are expected to be SMALL, and do not warrant mitigation.

Induced snowfall due to operating cooling towers has been observed. However, the accumulation was found to be less than one inch of very light, fluffy snow. Other documented induced snowfall occurrences generally preceded actual snowfall occurrences. An investigation into the climatic conditions conducive to induced snowfall indicated that a very cold, stable atmosphere with light winds optimized this situation (Reference 5.3-35). While this type of meteorological condition occurs at the Fermi site, literature indicates that snow amounts are light (less than one inch) and would be only a small fraction of the typical snowfalls the area receives. There is no reason to expect the Fermi 3 cooling tower to significantly alter local meteorology, especially because the site and surrounding area are not adversely affected by the existing natural draft cooling towers.

5.3.3.1.5 **Interaction of Vapor Plume with Existing Pollutant Sources Located Within 1.25 Miles of the Site**

The existing NDCTs at the Fermi site are located approximately 0.58 and 0.73 miles to the northeast of the planned location for the Fermi 3 cooling tower on opposite sides of the central power block. The interaction between the plumes from the existing NDCTs and that for the Fermi 3 cooling tower is expected to be insignificant because usually the plumes will travel in parallel, non-intersecting directions. Given this distance and the fact that the cooling towers will not be situated in line as to additively affect plant operations (i.e., the towers are situated such that only one set of towers (new or existing) can impact the facility operations on the main power block during a given wind direction), there is expected to be little concern for cumulative effects with existing operations. As for the potential offsite cumulative interaction of new and existing cooling tower plumes, the large separation distance means that only a very discrete and narrow set of wind directions/angles (on the order of 10 degrees or less of the possible 360 degrees of potential wind angles) would allow the plumes to overlap.

There is also the potential for vapor plume interaction with existing and proposed combustion sources such as diesel generators, auxiliary boilers, diesel fire pumps, etc. However, these sources are typically low level stack point source releases that operate infrequently (i.e., not typically during normal plant operation). Additionally, they do not typically contain the same pollutants within their exhaust streams (e.g., NO_x, SO_2, CO) as the cooling tower vapor plumes (particulates). There are no other pollutant sources of significance located within 1.25 miles of the site. Therefore, interaction effects are expected to be SMALL, and do not warrant mitigation.

5.3.3.1.6 **Data and Information on Similar Heat Dissipation Systems**

The nearest and thus most representative similar heat dissipation systems are the existing NDCTs at the Fermi site located just north of the main power block approximately 0.58 and 0.37 miles from the Fermi 3 NDCT. The predicted minimal impact due to salt deposition from the Fermi 3 NDCT is further substantiated by historical data from the operation for the Fermi 2 NDCTs. Fermi 2 uses two NDCTs which are located North of Fermi 3. Studies have been performed to determine if the operation of the Fermi 2 NDCTs have had an adverse impact to the vegetation in the vicinity of the site. These studies concluded that the emissions from the NDCTs have not previously contributed to adverse impacts to the vegetation.

The NRC described impacts from mechanical and natural draft cooling towers in the GEIS (Reference 5.3-1). The analyses in the GEIS encompass all operating light-water power reactors. For each type of environmental impact, the GEIS attempts to establish generic finding covering as many plants as possible. This document generally concludes that continued operation of similar heat dissipations systems at various facilities is of little concern for impacts upon plants and birds (discussed herein in Subsection 5.3.3.2). Additionally, there are no apparent special circumstances of the site or the design of the Fermi 3 NDCT that invalidates the generic conclusions related to environmental effects of heat dissipation systems on the atmosphere in the GEIS.

5.3.3.1.7 **Ground Level Humidity Increase in the Site Vicinity**

In the vicinity of the NDCT vapor plume, both the absolute and relative humidity aloft is increased as evidenced by model-predicted frequency of visible plume occurrence. As discussed in Subsection 5.3.3.1.1, the impacts from the occurrence of visible plumes are expected to be SMALL. Thus, absolute humidity at the surface would be increased only slightly. However, relative humidity near the tower may be increased more during colder months due to relatively low moisture-bearing capacities of cold air. However, any increases in humidity during cold periods is likely to be localized and short-lived as air masses move and further mix with surrounding drier air which is immensely more voluminous than the air flow from the NDCT. For an overwhelming majority of the time, contribution of water vapor from the cooling tower is insignificant when compared with the humidity values that are naturally experienced in the region (Subsection 2.7.1.2.3). Therefore, increases in ground level humidity are expected to be SMALL, and do not warrant mitigation.

5.3.3.2 **Terrestrial Ecosystems**

NUREG-1555 Table 2.4.1.1 defines important species and habitats. There are no records of occurrence of any Federally-listed species in the area. However, three species listed as

State-threatened are known to occur on the Fermi site; two animals (the bald eagle and Eastern fox snake) and one plant (the American lotus). While the USFWS delisted the bald eagle as Federally-threatened under the Endangered Species Act, effective August 8, 2007, it is protected by other Federal acts and is listed as State-threatened. The American lotus is also listed as State-threatened and is abundant in the South and North Lagoons on the Fermi site. However, because the species is so common, the impact of the project to the overall population present on the Fermi site is expected to be SMALL. Other animal and plant species listed as State-threatened are potentially in the area of the project site, but have not been observed on the Fermi site. Additionally, no critical habitats are currently known to occur on the Fermi site or in the vicinity (presented in more detail in Subsection 2.4.1).

Although no Federally-listed terrestrial species or critical habitat exists at the Fermi site or in the vicinity, an analysis of the NDCT's potential impacts upon terrestrial ecosystems is presented here to assure minimal impacts to any existing species. Cooling towers can potentially impact terrestrial ecosystems through salt drift, vapor plumes, icing, shadowing, precipitation augmentation, noise, and bird collisions with the cooling towers themselves.

5.3.3.2.1 **Salt Drift**

Vegetation in the vicinity of the NDCT may experience salt deposition due to plume drift. As salinity levels increase, growth of intolerant plants declines, and yields are reduced. Some plant families tend to show either high or low limits of salt survival. Growth suppression is sometimes accompanied by leaf injury.

As discussed in Subsection 3.3.1.6, the tower will use drift eliminators to minimize the amount of water lost from the tower via drift. Some droplets are, nevertheless, swept out of the tops of the cooling tower in the moving air stream. Initially, these droplets rise in the plume's updraft, but due to their high settling velocity, they eventually break away from the plume, and then evaporate, settle downward, and are dispersed by atmospheric turbulence. This drift essentially has the same concentrations of dissolved and suspended solids as the water in the cooling tower basin and is thus the source of the potential salt deposition onto vegetation. An analysis of potential salt drift from the cooling tower was discussed and presented in Subsection 5.3.3.1.3.

As discussed in detail in Subsection 5.3.3.1.3, NUREG-1555, Section 5.3.3.2, provides the following guidance on analyzing operational impacts from salt drift:

- Deposition of salt drift (NaCl) at rates of 1 to 2 kg/ha/mo (0.9 to 1.8 lb/acre/mo) is generally not damaging to plants.
- Deposition rates approaching or exceeding 10 kg/ha/mo (9 lb/acre/mo) in any month during the growing season could cause leaf damage in many species.
- Deposition rates of hundreds or thousands of kg/ha/yr could cause damage sufficient to suggest the need for changes of tower-basin salinities or a re-evaluation of tower design, depending on the amount of land impacted and the uniqueness of the terrestrial ecosystems expected to be exposed to drift deposition.

The solids deposition analysis conservatively assumed that all TDS was salt. As given in Subsection 5.3.3.1.3, the maximum predicted annual salt deposition rate is 0.01 kg/km^2/mo. This value is well within (i.e., several orders of magnitude less than) the NUREG-1555 acceptable levels of generally not damaging to plants.

Additionally, monitoring results from a sample of nuclear plants, in conjunction with the literature review and information provided by the natural resource agency and agricultural agencies in all states with nuclear power plants, have revealed no instances where cooling tower operation has resulted in measurable degradation of the health of natural plant communities (Reference 5.3-1).

According to NUREG-1555, Section 5.3.3.2, the risk of soil salinization from cooling towers is generally considered to be low. Soil salinization is of most concern in arid areas (deserts) where salts could accumulate in soils over long time intervals. The Fermi site is not located in an arid area.

The use of drift eliminators to minimize drift directly results in the minimization of salt deposition impacts given above. In sum, the impacts from salt deposition are anticipated to be SMALL, and do not warrant mitigation.

5.3.3.2.2 **Vapor Plumes**

As concluded in Subsection 5.3.3.1.1, on a frequency basis, the SACTI cooling tower model predicts the plume lengths from the NDCT to be less than 1000 m (3281 ft) for 50 percent of the year, considering all wind directions of plume travel. Additionally, the highest probability of a visible plume over a particular location is approximately 11 percent of the year in an area 100 to 300 m (328 to 984 ft) east of the NDCT.

The median plume length, which is predicted to occur approximately 50 percent of the year, only extends past the nearest property boundary (843 m) by less than 200 m. The highest probability plume will not reach offsite as the nearest property boundary to the new tower is approximately 843 m (2766 ft). In fact, at a distance equal to the closest point of the property boundary to the proposed tower (843 m), the highest probability of a visible plume from the NDCT is only 7.33 percent in any particular direction. The above model output indicates that the percent frequency of occurrence of long cooling tower plumes in any particular direction is SMALL and, as such, does not warrant mitigation.

5.3.3.2.3 **Icing**

Ground level plume icing is discussed in detail in Subsection 5.3.3.1.2. As discussed previously, the SACTI cooling tower model assumes that natural draft towers do not produce ground level plume-induced fogging. Thus, ground level icing from natural draft cooling towers is not predicted by SACTI. Therefore, impacts are anticipated to be SMALL, and do not warrant mitigation.

5.3.3.2.4 **Plume Shadowing**

Plume shadowing is an important phenomenon especially for agricultural areas. Because there are agricultural areas near the Fermi site, an analysis of plume shadowing is presented in detail in Subsection 5.3.3.1.4.

As presented in Subsection 5.3.3.1.4, the SACTI model predicts that maximum shadowing will occur 200 m (656 ft) north of the NDCT for an average of 348 hours per year. Beyond a radius of 800 m (2625 ft) from the NDCT, the SACTI model predicted that the average annual hours of shadowing (considering all directions of plume travel) would be less than 100 hours, or approximately less than 2.3 percent of the daylight hours per year. Additionally, the average hours per year of plume shadowing beyond 843 m (nearest property boundary distance) is predicted to be 92 hours per year (2.1 percent of the daylight hours per year) from the NDCT (considering all plume directions in the table).

The resulting hours per year of shadowing (especially at the nearest property boundary) are predicted to an insignificant fraction of the total daylight hours for agricultural purposes. Thus, the plume shadowing impacts are expected to be SMALL, and do not warrant mitigation.

5.3.3.2.5 **Precipitation Augmentation**

In addition to triggering additional precipitation events, another potential environmental impact resulting from the discharge of cooling tower moisture is the regional augmentation of natural precipitation. An analysis of this phenomenon is presented in detail in Subsection 5.3.3.1.4.

As given in Subsection 5.3.3.1.4, the SACTI cooling tower plume model predicted that the maximum cooling tower water deposition from the NDCT will occur approximately 4500 to 9300 m (15,000 ft to 31,000) east northeast of the NDCT at a rate of 5.9 kg/km^2/mo. The average water deposition within the largest radius containing the maximum impact (9300 m) is predicted to be 2.2 kg/km^2/mo (considering all wind directions or plume travel).

A potential effect of water deposition on vegetation species is the increased threat of plant fungal diseases associated with the increased precipitation. Based on historical meteorological data for Detroit Metro Airport, the average monthly rainfalls for the driest month (February) and the wettest month (June) are 48 mm and 90 mm, respectively. Conservatively assuming no evaporation of the falling cooling tower drift droplets, the precipitation rate equivalent of the maximum SACTI model predicted water deposition rate (5.9 kg/km^2/mo) is approximately 0.00001 mm per month. By comparison, this precipitation rate is less than 0.0001 percent of the average monthly rainfall of even the driest month. Thus, impacts due to water deposition (additional precipitation) are expected to be SMALL, and do not warrant mitigation.

5.3.3.2.6 **Noise**

Information related to the estimated noise impacts associated with the cooling system components is included in Subsection 5.8.1.3. As presented in Subsection 5.8.1.3, the predicted noise emissions from normal station operation conform to NRC and EPA sound level guidelines for minimizing noise impact. The maximum expected increase in ambient sound level of 3 dB is a barely perceptible change in ambient sound level during the quietest nighttime hours based on the existing conditions detailed in Subsection 2.5.4. The potential noise impacts due to the operation of Fermi 3 are, therefore, expected to be similar to background and to current noise levels to which local species are adapted. Accordingly, noise impacts to terrestrial ecosystems are expected to be SMALL, and do not warrant mitigation.

5.3.3.2.7 **Avian Collisions**

The potential for avian collisions increases as structure heights and broad dimensions increase. The mechanical draft cooling towers are of little concern due to their relatively low height compared to existing and proposed structures on site. The natural draft cooling tower, however, will be 600 feet high. The NRC concluded in the GEIS (Reference 5.3-1) that effects of bird collisions with existing cooling towers are minimal. Therefore, impacts to bird species from collisions with the cooling tower are expected to be SMALL, and do not warrant mitigation.

5.3.4 **Impacts to Members of the Public**

This section describes the potential health impacts associated with the thermal discharges from the Fermi 3 cooling systems on the environment. Specifically, the potential impacts to human health are from etiological agents such as microorganisms, parasites, and thermo-stable viruses (formerly referred to collectively as thermophilic microorganisms), and from noise resulting from the operation of the cooling systems.

5.3.4.1 **Etiological Agents**

Etiological agents associated with cooling tower reservoirs and thermal discharges can impair human health. These agents may include microorganisms, thermophilic fungi, parasites, and viruses whose presence or numbers can be affected by the addition of heat. While the growth rate of some etiological agents can be increased by the addition of heat, others can resist moderately high temperatures long enough to be released into a cooler body of water for growth. Therefore, cooling tower reservoirs and thermal discharges can act to harbor or accelerate some etiologic agents that ultimately affect human health once released into the environment.

These etiological agents include, but are not limited to, the enteric pathogens *Salmonella* spp., *Vibrio* spp. and *Shigella* spp., and *Plesiomonas shigelloides*, as well as *Pseudomonas* spp., toxin-producing algae such as *Karenia brevis*, noroviruses, and thermophilic fungi. Etiological agents also include the bacteria *Legionella* spp., which causes Legionnaires' disease, and free-living amoebae of the genera *Naegleria*, *Acanthamoeba,* and *Cryptosporidium*. Exposure to these microorganisms, or in some cases the endotoxins or exotoxins produced by the organisms, can cause illness or death. Thermo-stable viruses are also considered etiological agents and are subject to review for this impact analysis.

A study regarding thermophilic and thermotolerant fungi isolated specimens from the thermal effluent of nuclear power generating reactors examined the dispersal of human opportunistic and veterinary pathogenic fungi (Reference 5.3-36). The following excerpt is taken from the study which concludes that thermal discharges from power plants do not significantly affect human health:

> Over a period of a year, samples of water, foam, microbial mat, soil and air were obtained from areas associated with the cooling canal of a nuclear power station. The seventeen sample sites included water in the cooling canal that was thermally enriched and soil and water adjacent to, upstream, downstream and at a distance from the generator. Air samples were taken at the plant and at various distances from the plant. Fifty-two species of thermotolerant and thermophilic fungi were isolated. Of these, eleven species are grouped as opportunistic *Mucorales* or opportunistic *Aspergillus* species. One veterinary pathogen was also isolated (*Dactylaria gallopava*). The opportunistic/pathogenic fungi were found primarily in the intake bay, the discharge bay and the cooling canal. Smaller numbers were obtained at both upstream and downstream locations. Soil samples near the cooling canal reflected an enrichment of thermophilous organisms, the previously mentioned opportunistic *Mucorales* and *Aspergillus* spp. Their numbers were found to be greater than that usually encountered in a mesophilic environment. However, air and soil samples taken at various distances from the power station indicated no greater abundance of these thermophilous fungi than would be expected from a thermal enriched environment. The results indicate that there was no significant dissemination of thermophilous fungi from the thermal enriched effluents to the adjacent environment. These findings are consistent with the results of other investigators.

The operation of an additional cooling tower for Fermi 3 is not anticipated to significantly increase thermal discharges into areas surrounding the Fermi site. Discharged blowdown from the cooling tower basin is expected to be released directly into Lake Erie in accordance with MDEQ NPDES permits. Lake Erie provides a significant mixing source thus preventing etiological agents from developing or becoming prolific.

No streams, ponds, or other small water resources will be influenced by the Fermi 3 thermal discharge, thus eliminating the potential for heated effluent retention to lead to increased abundance of thermophilic etiological agents.

The heated effluent for Fermi 3 results in a limited thermal discharge plume into Lake Erie within a small mixing zone. This small mixing zone will limit the area of conditions necessary for optimal growth of these etiological agents. Even during worst case scenario operational conditions (maximum operations, effluent discharge into Lake Erie during the spring time when ambient water temperatures are low, and a low ambient lake depth), the total plume surface area is only approximately 55,300 ft^2. Additionally, ambient water temperature increases under these conditions will remain within the MDEQ required 3°F ΔT standard, as further detailed in Subsection 5.3.2.2.1.

Heated effluent is expected to rapidly mix with ambient lake waters, presenting limited opportunity for rapid growth and population increases of etiological agents. While small scale increases of thermophilic microorganisms within the cooling towers themselves, and within aquatic and soil environments in the vicinity of the Fermi site could result, impacts to humans associated with increase in disease outbreaks are expected to be minimal. It is also important to note that diseases caused by etiological agents associated with warm waters are typically contracted via nasal passageway contact with contaminated water (i.e., swimming, diving, and other water sports). The point of discharge of heated effluent from the Fermi site is not typically utilized for primary contact recreation (restricted industrial area). It is highly unlikely that a disease caused by an etiological agent would be contracted as a result of human interaction with the thermal plume.

Certain freshwater algal blooms can present issues to human health. Algal species such as *Microcystis* spp., *Anabaena* spp., *Nodularia* spp., *Nostoc* spp., and *Oscillatoria* spp. produce neuro- and hepa-totoxins that, when present in high numbers, can damage neurological systems and cause hepatic tumors. While increases in water temperature can be a causative factor in triggering algal blooms, temperature increases in Lake Erie due to increased thermal discharges will be limited to a small area, as previously detailed. To date, no harmful algal blooms have been documented as a result of Fermi 2 thermal discharges. The Fermi 2 discharge is located along the shoreline of Lake Erie, north of Fermi 2, due east of the Fermi 2 cooling towers. The Fermi 3 discharge pipe will be located southeast of Fermi 2 extending approximately 1300 feet into Lake Erie. Based on the plume analysis in Subsection 5.3.2.1, no mixing of Fermi 2 and Fermi 3 thermal discharges are anticipated which would contribute to an additive thermal increase that would act as a causative agent in triggering algal blooms in Lake Erie.

These factors indicate that additional thermal discharges associated with Fermi 3 would result in limited increases in etiological agents at the Fermi site and human impacts would be SMALL with no mitigative measures needed.

5.3.4.1.1 **Health Effects to Public**

The MDEQ reports information associated with beach closures and monitoring effects. In Monroe County, eleven public beaches and/or waterbodies are monitored. During 2007, no beach closures were documented for the Monroe County public beaches and/or waterbodies under study.

A review of data from the Center for Disease Control (CDC) and the Michigan Department of Community Health indicates that there have been no waterborne disease outbreaks in the vicinity of the Fermi site within the last 10 years.

Additionally, the Lake Erie Lakewide Management Plan (LaMP) has designated the drinking water use of Lake Erie as unimpaired (Reference 5.3-37). The closest potable water intake utilizing water from Lake Erie is the Frenchtown Township water intake located south of the Fermi site which draws water approximately one mile offshore through two intake lines. The distance of the nearest residence is approximately 0.2 miles from the southwest boundary of the Fermi site.

Therefore, the risk to public health from etiological agents resulting from additional thermal discharges to Lake Erie at the Fermi site would be SMALL, and no mitigation measures associated with etiological agents are necessary.

5.3.4.1.2 **Health Effects to Workers**

Several reported cases, recorded prior to 1990, of fatal *Naegleria* infections in association with cooling towers have lead to the extensive study of free-living amoebae in power plant environments. In response to these cases, many electric utilities require workers to utilize respiratory protection when cleaning cooling towers and condensers. In the case of Fermi 2, biocides are utilized to help reduce the levels of harmful microbial populations. This treatment has prevented the need for respiratory protection when cleaning cooling towers and condensers. Fermi 3 will utilize biocides as described in Subsection 5.2.2.2.1. There have been no reportable cases of Legionnaires Disease, *Naegleria* infections, or any other diseases associated with the operation of cooling towers (including the heated effluent associated with cooling tower discharge) at Fermi 2. Although no Occupational Safety and Health Administration (OSHA) standard currently exists for the exposure to microorganisms, Detroit Edison would comply with all relevant OSHA standards measures for reducing worker exposure to the adverse impacts associated with microorganisms for Fermi 3 as are currently employed for Fermi 2. The NRC has stated that it is anticipated that all plants will continue to employ proven industrial hygiene principles so that adverse occupational health effects associated with microorganisms will be of small significance at all sites, and no mitigation measures beyond those currently implemented for Fermi 2 would be necessary.

The operations of Fermi 3 will comply with all relevant OSHA regulations. In summary, the risk to site workers, such as maintenance personnel, from etiological agents resulting from Fermi 3 cooling tower operation is expected to be SMALL.

5.3.4.2 **Noise**

Fermi 3 produces noise from the operation of pumps, cooling towers, transformers, turbines, generators, switchyard equipment, and loudspeakers. Most of this equipment, except for transformers, loudspeakers, the natural draft and mechanical draft cooling towers and pumps that supply the cooling water, are located inside structures, thus reducing the noise impacts associated with the equipment on the outdoor ambient noise level. Of these four sources, only the natural draft cooling tower and pumps that supply the cooling water are principal sources of continuous noise.

The cooling tower systems will include a natural draft cooling tower and two mechanical draft cooling towers. The sound level for the natural draft cooling tower is expected to be between 55 and 60 db(A) at 1000 feet (Reference 5.3-38). Normal conversations typically have a decibel measurement of 60 db(A). The primary sources of mechanical draft cooling tower noise are the fans (including motors and gearboxes) and water splash. Information related to the estimated noise impacts associated with the cooling system components is included in Subsection 5.8.1.

Day-night noise levels from the Fermi 3 cooling towers are anticipated to be less than 65 db(A) at the nearest noise-sensitive receptor, which is considered to be of SMALL significance to the public. Thus, no mitigation alternatives are necessary. Similarly, the resulting operational noise level from the addition of Fermi 3 would not significantly increase the noise level at the Fermi site boundary. Therefore, the noise level at the Fermi site boundary is expected to remain below the limit of 65 db(A) recommended in NUREG-1555.

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Table 5.3-1 Model Sets Used in CORMIX Thermal Plume Analysis

Name	Number of CORMIX Runs	Objective
Model Set 1	48	Evaluate extent of mixing zone resulting from additional unit for the applicable water quality standards criteria; identify worst case conditions for use in other model sets
Model Set 2	3	Evaluate effects of depth variation (seiche-driven) on plume dimension
Model Set 3	1	Evaluate effects of extreme westward flow (seiche-driven) on plume dimension

Table 5.3-2 The Four Modeling Scenarios Performed for Each Month in Model Set 1

Scenario	Ambient Temperature Condition	Ambient Velocity Condition
1	10^{th} percentile	10^{th} percentile
2	10^{th} percentile	Maximum
3	90^{th} percentile	10^{th} percentile
4	90^{th} percentile	Maximum

Table 5.3-3 Ambient Conditions Time Series and Additional Data Sources

Data	Range of Record	Frequency	Count
Ambient Lake Temperature	2/1/2006 – 2/29/2008	Every 3 hours	6328
	Source: Reference 5.3-4		
Ambient Lake Current	2/1/2006 – 2/29/2008	Every 3 hours	6328
	Source: Reference 5.3-4		
Ambient Lake Depth			
- Water Level	1/1964-12/1969, 9/1996-11/2007	Monthly	211
	1/1996-2/2008	Hourly	99,111
	Source: Reference 5.3-6		
- Navigational Chart Depth	Source: Reference 5.3-7		
-Datum	Source: Reference 5.3-6		
Wind Velocity	1/1997- 12/2007	Monthly	132
	Source: Reference 5.3-10		

Table 5.3-4 Monthly Statistics of Ambient Water Temperature Near the Discharge, LEOFS

	LEOFS Water Temperature, °F		
Month	**Mean**	**10th Percentile**	**90th Percentile**
January	35.5	32.1	38.7
February	32.9	32.0	34.1
March	35.8	33.2	38.8
April	43.2	39.3	47.0
May	53.6	47.8	60.5
June	64.1	59.0	68.5
July	68.6	64.8	72.8
August	73.1	69.4	76.4
September	70.0	66.4	74.9
October	61.5	53.1	70.0
November	49.7	46.9	53.0
December	39.6	36.7	41.7

Table 5.3-5 Mean Monthly Water Depth at NOAA GLIN Buoy 9063090, Fermi 2, 1964-1969 and 1996-2008

Month	Water Depth, ft
January	7.4
February	7.5
March	7.8
April	8.3
May	8.5
June	8.6
July	8.5
August	8.3
September	8.1
October	7.7
November	7.3
December	7.4

Table 5.3-6 Monthly Statistics of Ambient Current Speed near the Discharge, LEOFS

LEOFS Current Velocity, fps				
Month	**Mean**	**10^{th} Percentile**	**Maximum**	**Direction of Flow**
January	0.152	0.039	0.390	North
February	0.148	0.041	0.444	North
March	0.139	0.034	0.509	South
April	0.138	0.036	0.406	South
May	0.116	0.035	0.349	South
June	0.118	0.044	0.270	South
July	0.086	0.030	0.227	South
August	0.124	0.034	0.328	South
September	0.114	0.024	0.381	South
October	0.143	0.028	0.473	North
November	0.119	0.025	0.452	North
December	0.165	0.029	0.473	North

Table 5.3-7 Average Monthly Wind Velocity at Gross Ile, Michigan, Airport

Month	Mean Wind Velocity, fps
January	12.3
February	10.8
March	11.5
April	10.4
May	8.7
June	7.2
July	6.8
August	7.1
September	7.7
October	9.5
November	11.2
December	12.0

Table 5.3-8 Michigan Water Quality Standards, Maximum Allowable Monthly Water Temperatures

Month	Monthly Maximum, °F
January	45
February	45
March	45
April	60
May	70
June	75
July	80
August	85
September	80
October	70
November	60
December	50

Table 5.3-9 Diffuser Configuration Parameters for CORMIX Modeling

Parameter	Value	Source
Effluent flowrate, MGD	Variable by month	Section 3.4
Effluent temperature, °F	Variable by month	Section 3.4
Port type	Staged diffuser	Conceptual design
Diffuser length, ft	33	Conceptual design
Distance to bank, ft	1312	Conceptual design
Port height, ft	1.6	Conceptual design
Port diameter, ft	1.4	Conceptual design
Number of ports	3	Conceptual design
Discharge pipe relation to ambient current	perpendicular	Conceptual design
Port discharge relation to ambient current	perpendicular	Conceptual design
Discharge angle above horizontal, degree	20	Conceptual design

Table 5.3-10 Monthly Discharge Rates and Temperatures

Month	Flow Rate, Gallons per Minute	Temperature, °F
January	12,035	55.0
February	12,360	55.3
March	13,260	59.4
April	14,460	66.0
May	15,560	72.7
June	16,460	78.4
July	16,910	81.5
August	16,860	80.8
September	16,260	76.3
October	14,960	68.8
November	13,910	62.7
December	12,660	56.6

Table 5.3-11 Monthly-Variable CORMIX Input Parameters

Month	Ambient Current Direction	Ambient Current Speed: 10th Percentile, fps	Ambient Current Speed: Maximum, fps	Average Depth at Discharge, ft	Ambient Water Temp: 10th percentile, °F[1]	Ambient Water Temp: 90th percentile, °F[1]	Wind Speed, ft/s	Maximum Allowable Water Temp °F	Effluent Flowrate, MGD	Effluent Temp, °F	Heat Exchange Coefficient, W/m^2 °C
January	North	0.039	0.390	7.37	39	39	12.3	45	17.3	55	21
February	North	0.041	0.444	7.54	39	39	10.8	45	17.8	55	21
March	South	0.034	0.509	7.85	39	39	11.5	45	19.1	59	21
April	South	0.036	0.406	8.33	39	47	10.4	60	20.8	66	19
May	South	0.035	0.349	8.55	48	61	8.7	70	22.4	73	20
June	South	0.044	0.270	8.63	59	68	7.2	75	23.7	78	18
July	South	0.030	0.227	8.51	65	73	6.8	80	24.4	82	20
August	South	0.034	0.328	8.31	69	76	7.1	85	24.3	81	21
September	South	0.024	0.381	8.11	66	75	7.7	80	23.4	76	22
October	North	0.028	0.473	7.67	53	70	9.5	70	21.5	69	22
November	North	0.025	0.452	7.32	47	53	11.2	60	20.0	63	21
December	North	0.029	0.473	7.41	39	42	12.0	50	18.2	57	22

1. In order to incorporate effects of water density on plume behavior, CORMIX restricts ambient water temperature to values greater than or equal to 4 °C (39 °F). For wintertime conditions in which observed temperatures are between 0-4 °C (32-39 °F), plume dimensions are not expected to be significantly affected.

Table 5.3-12 Monthly CORMIX Results for Model Set 1, Scenarios 1 and 2: Evaluation of the Maximum Allowable Temperature Rise Standard

Month	Ambient Current Velocity	Scenario (Table 5.3-2)	Length of Eastward Plume , ft	North / South Plume Width, ft	Approximate Plume Planview Area, ft^2	Plume Vertical Thickness, ft
January	low	1	169.0	33.1	5599	7.5
	high	2	53.8	38.7	2083	5.2
February	low	1	169.6	33.1	5621	7.5
	high	2	41.7	33.1	1381	4.9
March	low	1	123.0	30.8	3794	7.9
	high	2	44.9	47.6	2138	7.5
April	low	1	178.8	42.3	7568	8.2
	high	2	84.0	203.7	17112	3.3
May	low	1	145.3	35.4	5150	8.5
	high	2	130.2	226.4	29486	3.6
June	low	1	80.1	22.0	1760	8.5
	high	2	78.4	18.7	1466	8.5
July	low	1	56.1	17.1	957	8.5
	high	2	53.5	14.8	790	8.5
August	low	1	12.1	8.5	104	5.6
	high	2	12.1	8.5	104	5.6
September	low	1	3.6	5.9	21	3.9
	high	2	13.5	15.7	212	2.3
October	low	1	103.0	20.0	2062	7.5
	high	2	51.8	36.4	1888	5.2
November	low	1	125.0	24.6	3076	7.2
	high	2	54.1	39.4	2131	5.2
December	low	1	177.2	35.4	6278	7.5
	high	2	44.6	39.4	1757	5.9

Note: Shading indicates maximum predicted plume

Table 5.3-13 Monthly CORMIX Results for Model Set 2, Scenarios 3 and 4: Evaluation of the Maximum Allowable Absolute Temperature Standard

Month	Ambient Current Velocity	Scenario (Table 5.3-1)	Length of Eastward Plume, ft	North / South Plume Width, ft	Approximate Plume Planview Area, ft^2	Plume Vertical Thickness, ft
January	low	3	30.4	4.2	128	2.8
	high	4	23.1	8.1	188	1.5
February	low	3	30.5	4.3	130	2.8
	high	4	21.1	3.7	79	1.5
March	low	3	9.9	7.9	78	5.2
	high	4	4.0	10.7	43	2.1
April	low	3	14.8	0.5	7	0.3
	high	4	12.7	3.5	45	1.0
May	low	3	15.5	0.3	4	0.2
	high	4	12.6	3.1	40	0.9
June	low	3	14.7	0.5	8	0.4
	high	4	14.7	0.5	8	0.4
July	low	3	15.6	0.3	4	0.2
	high	4	15.6	0.3	4	0.2
August	low	3	16.4	1.4	23	0.7
	high	4	16.4	1.4	23	0.7
September	low	3	16.4	1.4	23	0.7
	high	4	16.4	1.4	23	0.7
October	low	3	0.0	0.0	0	0.0
	high	4	0.0	0.0	0	0.0
November	low	3	16.4	1.4	23	0.7
	high	4	16.4	1.4	23	0.7
December	low	3	19.5	0.9	18	0.6
	high	4	18.3	3.9	72	1.0

Note: Shading indicates maximum predicted plume

Table 5.3-14 Plume Dimensions For May Scenario with Varying Depth

Month	Ambient Velocity	Ambient Temperature	Ambient Depth, ft	Depth Statistic	Length of Eastward Plume, ft	North / South Plume Width, ft	Approximate Plume Area, ft^2
May	high	low	7.0	1st Percentile	159.4	347.1	55,347
			7.6	5th Percentile	146.0	294.0	42,918
			8.0	20th Percentile	138.8	263.1	36,516
			8.5	Mean	130.2	226.4	29,486

Table 5.3-15 Plume Length Resulting from Westward Ambient Flow

Month	Velocity	Extent of Plume Travel Towards Shore (ft)
May	1.0 fps Directly Towards Shore	25.8

Table 5.3-16 Temperature Tolerance Ranges of Selected Principal Aquatic Species

Scientific Name	Common Name	Temperature Tolerance Range (°C)[1]
Dorosoma cepedianum	Gizzard shad	(3.0-9.0)-(31.5-35)
Carassius auratus	Goldfish	(0.3-12.6)-(30.8-43.6)[2]
Cyprinus carpio	Common carp	35.8, u[3]
Notropis atherinoides	Emerald shiner	37.6, u[3]
Pimephales notatus	Bluntnose minnow	6.4 - 34.6(avg)[3]
Carpiodes cyprinus	Quillback	38.8, u[3]
Ictiobus bubalus	Smallmouth buffalo	31.3, u[3]
Ictalurus punctatus	Channel catfish	10.0-32.0
Oncorhynchus mykiss	Rainbow trout	0.8 (avg) - 28.7 (avg)[3]
Salmo trutta	Brown trout	29.7 (avg), u[3]
Morone saxatilis	Striped bass[4]	31.6, u[3]
Lepomis macrochirus	Bluegill	1.0-36.0
Sander vitreus	Walleye[5]	(31.6-34.1)
Aplodinotus grunniens	Freshwater drum	32.4, u

u-upper limit, l – lower limit

1. Reference 5.3-17 through Reference 5.3-22 were utilized to compile temperature ranges listed in this table.
2. Ranges of temperature limits presented are based on temperatures of the ambient water body (acclimation temperature), ranging from 5-35°C.
3. Critical thermal methodology (CTM) - a laboratory approach to characterizing temperature tolerances (Reference 5.3-17).
4. While the striped bass is not considered to be a principal species of Lake Erie, its habitat preferences are similar to both the white bass and the white perch (principal species).
5. Temperature ranges documented for juvenile and subjuvenile walleye, respectively (Reference 5.3-22).

Table 5.3-17 SACTI Input Parameters

Parameter	Natural Draft Cooling Tower	
Number of Towers	1	
Number of Cells/Fans per Tower	N/A	
Tower Height [1]	600 ft (note 2)	
Total Circulating Water Flow Rate	720,000 gpm (highest expected operation)	
Total Drift Loss Rate	3603 lb/hr - based on 0.001% of total water flow as drift	
Total Exit Air Flow Rate	229,211,402 lb/hr - highest expected operation	
Total Heat Rejection Rate	3142 MW (highest expected operation)	
Top Exit Diameter	292 ft	
Drift Droplet Spectrum	Drop Size (m)	Mass Fraction
	10	0.12
	15	0.08
	35	0.20
	65	0.20
	115	0.20
	170	0.10
	230	0.05
	375	0.04
	525	0.008

1. Base elevation of tower is approximately 583 ft (presented in Figure 2.7-58).
2. Section 1.2 addresses the need for Federal Aviation Administration (FAA) approval prior to erecting the natural draft cooling tower.

Table 5.3-18 Average Plume Lengths during NDCT Operation

	Winter		Spring		Summer		Fall		Annual	
Direction	**Miles**	**km**	**Miles**	**km**	**Miles**	**km**	**Miles**	**km**	**Miles**	**km**
S	1.72	2.77	0.78	1.25	0.29	0.47	1.19	1.92	1.22	1.97
SSW	1.68	2.70	0.64	1.03	0.26	0.42	1.38	2.22	1.19	1.91
SW	1.72	2.76	0.55	0.89	0.27	0.44	1.22	1.96	1.21	1.95
WSW	1.66	2.66	0.65	1.04	0.34	0.56	1.10	1.78	1.24	1.99
W	1.57	2.53	0.96	1.55	0.20	0.32	1.24	2.00	1.27	2.04
WNW	1.41	2.28	0.92	1.48	0.19	0.31	0.98	1.58	1.04	1.68
NW	1.15	1.86	0.61	0.98	0.18	0.29	0.99	1.59	0.85	1.37
NNW	1.27	2.05	0.75	1.21	0.18	0.29	0.75	1.21	0.86	1.38
N	1.21	1.95	0.38	0.61	0.19	0.30	0.72	1.16	0.84	1.35
NNE	1.22	1.97	0.38	0.61	0.19	0.31	0.79	1.27	0.89	1.43
NE	1.42	2.29	0.39	0.62	0.19	0.30	1.15	1.84	1.17	1.89
ENE	1.66	2.67	0.50	0.81	0.21	0.34	1.27	2.04	1.42	2.28
E	1.40	2.26	0.75	1.21	0.23	0.37	1.03	1.67	1.16	1.86
ESE	1.35	2.17	0.85	1.37	0.32	0.52	0.97	1.56	1.10	1.77
SE	1.35	2.17	0.87	1.39	0.27	0.43	1.12	1.81	1.15	1.86
SSE	1.48	2.38	0.79	1.28	0.30	0.48	1.13	1.81	1.17	1.89
All	1.47	2.37	0.73	1.18	0.24	0.39	1.07	1.73	1.15	1.85

Notes:
1. Plume moving in the indicated direction.

Table 5.3-19 Annual Plume Length Frequency during NDCT Operation (Sheet 1 of 2)

Values in %

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	SUM
100	4.24	3.25	4.79	4.63	7.19	4.82	4.39	4.15	7.94	8.17	8.10	9.25	11.27	7.08	5.66	5.07	100.00
200	4.24	3.25	4.79	4.63	7.19	4.82	4.39	4.15	7.94	8.17	8.10	9.25	11.27	7.08	5.66	5.07	100.00
300	4.24	3.25	4.79	4.63	7.19	4.82	4.39	4.15	7.94	8.17	8.10	9.25	11.27	7.08	5.66	5.07	100.00
400	4.11	3.18	4.73	4.49	7.00	4.63	4.12	3.69	7.24	7.76	7.66	8.89	10.72	6.76	5.45	4.89	95.34
500	3.73	2.94	4.28	3.83	6.12	3.79	3.01	2.76	5.61	5.82	5.96	7.52	9.13	5.89	4.90	4.46	79.77
600	3.35	2.60	3.68	3.41	5.52	3.15	2.42	2.18	4.71	4.89	5.27	6.96	8.45	5.46	4.49	4.09	70.62
700	2.90	2.17	3.10	3.04	4.95	2.65	2.02	1.81	4.01	4.18	4.72	6.48	7.81	4.94	4.05	3.61	62.43
800	2.55	1.83	2.73	2.70	4.47	2.35	1.77	1.53	3.56	3.60	4.34	6.10	7.33	4.57	3.73	3.32	56.46
900	2.38	1.72	2.54	2.52	4.23	2.21	1.63	1.43	3.36	3.40	4.12	5.89	7.03	4.35	3.55	3.15	53.51
1000	2.18	1.61	2.36	2.37	4.04	2.06	1.53	1.33	3.13	3.17	3.95	5.71	6.77	4.14	3.41	2.97	50.71
1100	1.83	1.37	2.04	2.11	3.63	1.79	1.30	1.13	2.59	2.73	3.53	5.35	6.22	3.74	3.11	2.65	45.11
1200	1.83	1.37	2.04	2.11	3.63	1.79	1.30	1.13	2.59	2.73	3.53	5.35	6.22	3.74	3.11	2.65	45.11
1300	1.68	1.26	1.84	1.99	3.37	1.65	1.18	1.05	2.28	2.49	3.31	5.12	5.84	3.48	2.93	2.48	41.93
1400	1.55	1.17	1.70	1.88	3.11	1.50	1.09	0.96	2.04	2.27	3.06	4.92	5.47	3.31	2.77	2.31	39.10
1500	1.55	1.17	1.70	1.88	3.11	1.50	1.09	0.96	2.04	2.27	3.06	4.92	5.47	3.31	2.77	2.31	39.10
1600	1.41	1.06	1.58	1.76	2.90	1.35	0.99	0.85	1.81	2.07	2.88	4.67	5.02	3.11	2.62	2.18	36.27
1700	1.41	1.06	1.58	1.76	2.90	1.35	0.99	0.85	1.81	2.07	2.88	4.67	5.02	3.11	2.62	2.18	36.27
1800	1.41	1.06	1.58	1.76	2.90	1.35	0.99	0.85	1.81	2.07	2.88	4.67	5.02	3.11	2.62	2.18	36.27
1900	1.29	0.95	1.46	1.66	2.76	1.22	0.89	0.75	1.61	1.84	2.63	4.42	4.64	2.94	2.45	2.04	33.56
2000	1.03	0.78	1.17	1.39	2.39	0.99	0.67	0.52	1.20	1.42	2.23	3.90	3.76	2.49	2.01	1.75	27.70
2100	0.90	0.66	1.06	1.27	2.21	0.85	0.56	0.40	1.02	1.21	2.03	3.68	3.42	2.19	1.81	1.58	24.84
2200	0.90	0.66	1.06	1.27	2.21	0.85	0.56	0.40	1.02	1.21	2.03	3.68	3.42	2.19	1.81	1.58	24.84
2300	0.78	0.61	0.95	1.14	2.03	0.72	0.47	0.33	0.85	1.02	1.81	3.36	3.06	1.93	1.62	1.39	22.06
2400	0.78	0.61	0.95	1.14	2.03	0.72	0.47	0.33	0.85	1.02	1.81	3.36	3.06	1.93	1.62	1.39	22.06
2500	0.68	0.55	0.83	1.01	1.82	0.62	0.41	0.29	0.70	0.88	1.55	2.99	2.65	1.65	1.43	1.17	19.22
2600	0.68	0.55	0.83	1.01	1.82	0.62	0.41	0.29	0.70	0.88	1.55	2.99	2.65	1.65	1.43	1.17	19.22
2700	0.68	0.55	0.83	1.01	1.82	0.62	0.41	0.29	0.70	0.88	1.55	2.99	2.65	1.65	1.43	1.17	19.22

Table 5.3-19 Annual Plume Length Frequency during NDCT Operation (Sheet 2 of 2)

Values in %

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	SUM
2800	0.60	0.45	0.68	0.86	1.62	0.50	0.33	0.23	0.57	0.72	1.29	2.67	2.26	1.35	1.21	0.97	16.32
2900	0.60	0.45	0.68	0.86	1.62	0.50	0.33	0.23	0.57	0.72	1.29	2.67	2.26	1.35	1.21	0.97	16.32
3000	0.60	0.45	0.68	0.86	1.62	0.50	0.33	0.23	0.57	0.72	1.29	2.67	2.26	1.35	1.21	0.97	16.32
3100	0.60	0.45	0.68	0.86	1.62	0.50	0.33	0.23	0.57	0.72	1.29	2.67	2.26	1.35	1.21	0.97	16.32
3200	0.60	0.45	0.68	0.86	1.62	0.50	0.33	0.23	0.57	0.72	1.29	2.67	2.26	1.35	1.21	0.97	16.32
3300	0.60	0.45	0.68	0.86	1.62	0.50	0.33	0.23	0.57	0.72	1.29	2.67	2.26	1.35	1.21	0.97	16.32
3400	0.50	0.39	0.59	0.67	1.30	0.40	0.27	0.20	0.47	0.56	1.03	2.21	1.78	1.05	1.00	0.78	13.20
3500	0.50	0.39	0.59	0.67	1.30	0.40	0.27	0.20	0.47	0.56	1.03	2.21	1.78	1.05	1.00	0.78	13.20
3600	0.50	0.39	0.59	0.67	1.30	0.40	0.27	0.20	0.47	0.56	1.03	2.21	1.78	1.05	1.00	0.78	13.20
3700	0.50	0.39	0.59	0.67	1.30	0.40	0.27	0.20	0.47	0.56	1.03	2.21	1.78	1.05	1.00	0.78	13.20
3800	0.50	0.39	0.59	0.67	1.30	0.40	0.27	0.20	0.47	0.56	1.03	2.21	1.78	1.05	1.00	0.78	13.20
3900	0.50	0.39	0.59	0.67	1.30	0.40	0.27	0.20	0.47	0.56	1.03	2.21	1.78	1.05	1.00	0.78	13.20
4000	0.50	0.39	0.59	0.67	1.30	0.40	0.27	0.20	0.47	0.56	1.03	2.21	1.78	1.05	1.00	0.78	13.20
4100	0.50	0.39	0.59	0.67	1.30	0.40	0.27	0.20	0.47	0.56	1.03	2.21	1.78	1.05	1.00	0.78	13.20
4200	0.50	0.39	0.59	0.67	1.30	0.40	0.27	0.20	0.47	0.56	1.03	2.21	1.78	1.05	1.00	0.78	13.20
4300	0.50	0.39	0.59	0.67	1.30	0.40	0.27	0.20	0.47	0.56	1.03	2.21	1.78	1.05	1.00	0.78	13.20
4400	0.41	0.31	0.49	0.51	1.03	0.29	0.17	0.16	0.32	0.37	0.82	1.74	1.34	0.80	0.73	0.59	10.09
4500	0.41	0.31	0.49	0.51	1.03	0.29	0.17	0.16	0.32	0.37	0.82	1.74	1.34	0.80	0.73	0.59	10.09
4600	0.41	0.31	0.49	0.51	1.03	0.29	0.17	0.16	0.32	0.37	0.82	1.74	1.34	0.80	0.73	0.59	10.09
4700	0.41	0.31	0.49	0.51	1.03	0.29	0.17	0.16	0.32	0.37	0.82	1.74	1.34	0.80	0.73	0.59	10.09
4800	0.41	0.31	0.49	0.51	1.03	0.29	0.17	0.16	0.32	0.37	0.82	1.74	1.34	0.80	0.73	0.59	10.09
4900	0.41	0.31	0.49	0.51	1.03	0.29	0.17	0.16	0.32	0.37	0.82	1.74	1.34	0.80	0.73	0.59	10.09
5000	0.41	0.31	0.49	0.51	1.03	0.29	0.17	0.16	0.32	0.37	0.82	1.74	1.34	0.80	0.73	0.59	10.09

Notes:

Plume moving in the indicated direction

Table 5.3-20 Annual Salt Deposition during NDCT Operation (Sheet 1 of 3)

Values in kg/km^2/mo

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
4100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00

Table 5.3-20 Annual Salt Deposition during NDCT Operation (Sheet 2 of 3)

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
	Values in kg/km^2/mo																
6800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
9000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
9100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
9200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
9300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
9400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00

Table 5.3-20 Annual Salt Deposition during NDCT Operation (Sheet 3 of 3)

	Values in $kg/km^2/mo$																
Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
9500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes:

1. Due to high initial plume from the NDCT, no salt is deposited within 4100 m of the tower center.
2. Plume moving in the indicated direction.

Table 5.3-21 Winter Salt Deposition during NDCT Operation (Sheet 1 of 3)

Values in $kg/km^2/mo$

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
3800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3900	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4000	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
4100	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
4200	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4300	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4400	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
4500	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
4600	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
4700	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
4800	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
4900	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
5000	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
5100	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
5200	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
5300	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
5400	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
5500	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
5600	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
5700	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
5800	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
5900	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
6000	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
6100	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
6200	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
6300	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
6400	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01

Table 5.3-21 Winter Salt Deposition during NDCT Operation (Sheet 2 of 3)

Distance from Tower (m)	Values in kg/km^2/mo																
	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
6500	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
6600	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
6700	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
6800	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
6900	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
7000	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
7100	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
7200	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
7300	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
7400	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
7500	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
7600	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
7700	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
7800	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
7900	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
8000	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
8100	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
8200	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
8300	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
8400	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
8500	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
8600	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
8700	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
8800	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
8900	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
9000	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
9100	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01

Table 5.3-21 Winter Salt Deposition during NDCT Operation (Sheet 3 of 3)

Values in $kg/km^2/mo$

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
9200	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
9300	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
9400	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01
9500	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
9600	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00
9700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
9800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes:

1. Due to high initial plume from the NDCT, no salt is deposited within 3800 m of the tower center.
2. Plume moving in the indicated direction.

Table 5.3-22 Spring Salt Deposition during NDCT Operation (Sheet 1 of 2)

Values in $kg/km^2/mo$

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
5000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5.3-22 Spring Salt Deposition during NDCT Operation (Sheet 2 of 2)

Values in $kg/km^2/mo$

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
7700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes:

1. Due to high initial plume from the NDCT, no salt is deposited within 10,000 m of the tower center.
2. Plume moving in the indicated direction.

Table 5.3-23 Summer Salt Deposition during NDCT Operation (Sheet 1 of 2)

Values in kg/km^2/mo

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
5000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5.3-23 Summer Salt Deposition during NDCT Operation (Sheet 2 of 2)

	Values in kg/km²/mo																
Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
7700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes:

1. Due to high initial plume from the NDCT, no salt is deposited within 10,000 m of the tower center.
2. Plume moving in the indicated direction.

Table 5.3-24 Fall Salt Deposition during NDCT Operation (Sheet 1 of 3)

Values in kg/km^2/mo

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
3900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
4100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
4200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
4900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
5900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00

Table 5.3-24 Fall Salt Deposition during NDCT Operation (Sheet 2 of 3)

Values in kg/km^2/mo

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
6600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
6900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
7900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
8900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
9000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
9100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
9200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00

Table 5.3-24 Fall Salt Deposition during NDCT Operation (Sheet 3 of 3)

	Values in kg/km²/mo																
Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
9300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
9400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
9500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
9600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes:

1. Due to high initial plume from the NDCT, no salt is deposited within 3900 m of the tower center.
2. Plume moving in the indicated direction.

Table 5.3-25 5-Year Total Hours of Plume Induced Shadowing during NDCT Operation (Sheet 1 of 2)

	Values in Hours																
Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
200	300.5	318.5	376.0	453.0	629.0	1034.0	1385.0	1644.5	1742.0	1670.0	1381.0	937.9	557.9	398.4	332.5	288.5	840.5
400	154.0	187.4	276.4	488.4	866.9	1100.5	1209.5	1508.5	1682.5	1701.5	1457.5	1145.9	818.4	323.4	170.5	140.5	827.0
600	81.4	114.4	236.4	480.4	673.9	786.4	875.5	1115.0	1168.4	1287.4	1179.4	946.9	634.0	278.0	128.5	90.5	629.8
800	57.4	83.4	197.0	403.0	596.3	601.9	603.0	694.4	722.9	740.4	854.9	716.8	620.9	260.9	109.5	70.0	458.3
1000	48.4	74.0	170.0	320.9	477.9	443.2	473.9	485.3	488.9	528.3	687.8	574.2	496.7	270.0	83.4	45.0	354.3
1200	41.4	61.0	144.5	323.4	402.9	349.8	447.2	382.0	404.3	432.8	614.1	482.0	382.1	273.6	67.4	35.9	302.8
1400	31.0	49.0	112.4	369.6	337.5	273.4	361.8	307.3	346.0	349.9	511.5	436.2	312.1	227.6	49.9	28.9	256.5
1600	24.0	43.0	94.3	317.9	262.8	229.0	304.4	274.3	283.0	289.3	432.8	393.3	253.5	173.7	48.9	24.9	215.6
1800	23.0	35.5	71.9	274.8	208.4	208.9	225.2	227.9	238.0	256.8	348.7	351.6	201.1	132.8	40.5	23.9	179.3
2000	19.0	30.5	63.4	230.6	180.9	197.5	157.7	211.6	204.0	223.6	294.1	315.8	165.3	106.7	33.5	20.9	153.4
2200	16.0	25.5	55.3	183.0	149.8	174.1	128.5	182.6	184.5	183.4	251.7	275.4	144.2	82.6	30.8	20.9	130.5
2400	11.5	21.7	47.3	159.6	133.4	151.7	110.0	168.1	157.0	181.8	244.9	254.1	127.8	67.2	32.3	20.9	118.1
2600	11.5	17.7	32.4	139.7	123.1	125.7	102.9	154.2	139.5	163.9	213.6	221.4	103.5	58.1	31.3	17.9	103.5
2800	10.5	16.7	25.8	118.6	118.7	109.3	90.3	124.7	115.5	134.4	189.9	193.2	92.2	54.3	27.3	17.9	89.9
3000	8.5	15.7	27.7	107.1	96.6	104.8	86.9	115.6	109.0	125.5	159.2	170.6	79.7	53.4	23.3	15.9	81.2
3200	7.5	14.7	27.1	97.5	87.7	94.4	78.8	106.4	90.3	97.7	143.2	159.7	72.1	44.9	20.0	11.5	72.1
3400	9.5	14.1	23.7	84.0	78.3	83.6	76.7	102.3	77.8	87.4	130.3	145.0	67.0	43.4	19.0	9.5	65.7
3600	8.5	14.1	22.7	81.3	71.4	73.2	66.4	88.4	68.3	83.4	116.2	137.1	62.7	39.4	17.0	8.0	59.9
3800	7.5	12.9	20.2	69.7	66.1	65.8	60.2	84.0	67.3	80.4	113.5	119.5	56.5	34.9	15.5	7.0	55.1
4000	7.5	10.9	21.2	68.1	62.7	55.5	54.9	76.7	67.9	70.4	109.6	120.8	46.1	30.1	14.5	5.0	51.4
4200	7.5	10.9	16.9	68.5	54.0	55.2	53.0	69.3	65.9	61.9	102.5	109.7	46.2	27.7	13.5	4.0	47.9
4400	7.5	10.9	13.6	55.4	58.9	48.5	48.2	51.9	59.9	56.1	96.5	101.3	46.2	22.3	12.5	4.0	43.4
4600	7.5	10.9	13.6	56.8	53.1	45.5	47.8	37.3	57.9	52.6	92.2	95.1	36.2	21.3	11.0	4.0	40.2
4800	7.5	6.4	13.6	51.4	47.2	42.3	44.8	36.3	52.4	47.6	92.2	88.7	32.1	19.3	7.0	4.0	37.0
5000	8.5	6.4	11.3	48.2	48.7	39.0	41.7	31.9	50.4	38.6	84.0	87.0	25.3	16.3	7.0	4.0	34.3
5200	5.5	6.4	10.3	43.2	46.4	35.8	35.4	28.8	45.4	39.6	68.9	82.0	24.3	13.1	7.0	2.0	30.9
5400	5.5	6.4	10.3	40.1	43.1	30.6	29.3	21.0	46.9	39.1	67.9	73.5	19.2	12.1	6.0	2.0	28.3
5600	5.0	5.4	8.9	38.0	39.3	26.5	24.5	17.5	48.9	37.1	64.9	63.5	19.1	12.1	5.0	2.0	26.1

Table 5.3-25 5-Year Total Hours of Plume Induced Shadowing during NDCT Operation (Sheet 2 of 2)

	Values in Hours															
Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
5800	5.0	5.4	8.9	35.7	36.0	21.5	25.5	14.7	46.8	35.1	53.0	58.1	18.1	11.0	5.0	2.0	23.9
6000	6.0	5.4	7.9	30.5	36.3	22.2	26.2	12.3	45.8	31.9	43.6	58.9	15.1	9.0	4.0	2.0	22.3
6200	5.0	5.4	7.9	28.5	36.0	19.4	23.1	9.9	45.3	30.9	38.6	51.0	13.1	6.1	3.0	2.0	20.3
6400	5.0	5.4	6.9	25.9	34.0	20.4	24.0	9.9	41.5	26.9	30.6	51.8	13.0	4.1	3.0	2.0	19.0
6600	5.0	5.4	6.9	24.0	32.3	20.4	22.9	8.9	33.6	21.9	27.6	39.5	10.5	5.0	3.0	2.0	16.8
6800	5.0	4.4	6.9	22.0	30.1	19.4	21.7	8.9	25.6	21.9	24.6	36.7	10.3	5.0	3.0	2.0	15.5
7000	4.0	4.4	5.9	20.3	28.3	20.0	22.2	8.5	23.2	19.9	23.2	34.4	10.3	4.1	3.0	1.0	14.5
7200	4.0	3.4	5.9	18.4	29.1	19.3	19.2	4.9	16.8	16.5	23.2	32.2	9.3	3.1	2.0	1.0	13.0
7400	4.0	3.4	4.9	17.6	27.4	19.3	19.2	4.9	11.8	16.5	23.2	31.2	6.8	3.1	2.0	1.0	12.3
7600	4.0	2.4	4.9	16.6	25.6	17.0	19.8	4.9	10.8	16.5	21.4	31.4	6.8	3.9	2.0	1.0	11.8
7800	4.0	2.4	3.9	17.3	24.6	17.0	16.9	4.9	9.9	16.5	21.8	29.3	6.8	1.8	2.0	1.0	11.3
8000	2.0	2.4	3.9	13.7	23.5	17.6	13.1	4.9	7.9	16.5	18.2	28.5	6.8	1.8	0.0	1.0	10.1

Notes:

1. Total hours of shadowing over 5 years Average annual hours of cooling tower induced shadowing is obtained by dividing the table value by 5.
2. Plume moving in the indicated direction.

Table 5.3-26 Annual Plume Water Deposition during NDCT Operation (Sheet 1 of 3)

Values in $kg/km^2/mo$

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
2800	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2900	0.37E-04	0.33E-04	0.41E-04	0.26E-04	0.48E-04	0.32E-04	0.29E-04	0.26E-04	0.44E-04	0.51E-04	0.41E-04	0.34E-04	0.49E-04	0.35E-04	0.34E-04	0.41E-04	0.38E-04
3000	0.64E-03	0.48E-03	0.66E-03	0.59E-03	0.83E-03	0.52E-03	0.44E-03	0.43E-03	0.82E-03	0.86E-03	0.70E-03	0.67E-03	0.96E-03	0.71E-03	0.57E-03	0.61E-03	0.66E-03
3100	0.15E-02	0.10E-02	0.14E-02	0.12E-02	0.18E-02	0.12E-02	0.98E-03	0.89E-03	0.20E-02	0.19E-02	0.17E-02	0.15E-02	0.22E-02	0.17E-02	0.13E-02	0.13E-02	0.15E-02
3200	0.19E-02	0.14E-02	0.20E-02	0.15E-02	0.25E-02	0.16E-02	0.13E-02	0.11E-02	0.29E-02	0.26E-02	0.23E-02	0.22E-02	0.33E-02	0.24E-02	0.18E-02	0.18E-02	0.20E-02
3300	0.26E-02	0.19E-02	0.27E-02	0.21E-02	0.38E-02	0.24E-02	0.18E-02	0.16E-02	0.42E-02	0.38E-02	0.36E-02	0.33E-02	0.53E-02	0.34E-02	0.26E-02	0.27E-02	0.30E-02
3400	0.41E-02	0.30E-02	0.40E-02	0.33E-02	0.59E-02	0.39E-02	0.29E-02	0.27E-02	0.63E-02	0.59E-02	0.55E-02	0.57E-02	0.93E-02	0.60E-02	0.45E-02	0.42E-02	0.48E-02
3500	0.61E-02	0.47E-02	0.61E-02	0.52E-02	0.85E-02	0.60E-02	0.46E-02	0.45E-02	0.96E-02	0.95E-02	0.94E-02	0.98E-02	0.16E-01	0.92E-02	0.77E-02	0.66E-02	0.77E-02
3600	0.10E-01	0.72E-02	0.10E-01	0.98E-02	0.14E-01	0.98E-02	0.81E-02	0.80E-02	0.16E-01	0.16E-01	0.16E-01	0.19E-01	0.30E-01	0.17E-01	0.14E-01	0.12E-01	0.14E-01
3700	0.15E-01	0.12E-01	0.18E-01	0.18E-01	0.25E-01	0.16E-01	0.13E-01	0.11E-01	0.24E-01	0.26E-01	0.30E-01	0.37E-01	0.51E-01	0.33E-01	0.26E-01	0.23E-01	0.24E-01
3800	0.30E-01	0.23E-01	0.37E-01	0.41E-01	0.64E-01	0.34E-01	0.26E-01	0.19E-01	0.48E-01	0.53E-01	0.69E-01	0.10E+00	0.12E+00	0.77E-01	0.64E-01	0.56E-01	0.54E-01
3900	0.40E+00	0.27E+00	0.46E+00	0.61E+00	0.12E+01	0.34E+00	0.25E+00	0.17E+00	0.42E+00	0.56E+00	0.95E+00	0.18E+01	0.18E+01	0.11E+01	0.95E+00	0.71E+00	0.75E+00
4000	0.62E+00	0.44E+00	0.74E+00	0.94E+00	0.19E+01	0.50E+00	0.38E+00	0.27E+00	0.65E+00	0.84E+00	0.15E+01	0.28E+01	0.28E+01	0.17E+01	0.15E+01	0.11E+01	0.12E+01
4100	0.68E+00	0.50E+00	0.82E+00	0.10E+01	0.21E+01	0.54E+00	0.40E+00	0.29E+00	0.71E+00	0.90E+00	0.16E+01	0.32E+01	0.30E+01	0.19E+01	0.16E+01	0.12E+01	0.13E+01
4200	0.93E+00	0.73E+00	0.11E+01	0.14E+01	0.28E+01	0.72E+00	0.49E+00	0.37E+00	0.96E+00	0.11E+01	0.22E+01	0.45E+01	0.39E+01	0.24E+01	0.22E+01	0.17E+01	0.17E+01
4300	0.93E+00	0.73E+00	0.11E+01	0.14E+01	0.28E+01	0.72E+00	0.49E+00	0.37E+00	0.96E+00	0.11E+01	0.22E+01	0.45E+01	0.39E+01	0.24E+01	0.22E+01	0.17E+01	0.17E+01
4400	0.13E+01	0.95E+00	0.14E+01	0.17E+01	0.32E+01	0.92E+00	0.56E+00	0.47E+00	0.11E+01	0.12E+01	0.26E+01	0.54E+01	0.43E+01	0.26E+01	0.23E+01	0.19E+01	0.20E+01
4500	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
4600	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
4700	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
4800	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
4900	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
5000	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
5100	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
5200	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
5300	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
5400	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
5500	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
5600	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
5700	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01

Table 5.3-26 Annual Plume Water Deposition during NDCT Operation (Sheet 2 of 3)

Values in kg/km^2/mo

Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
5800	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
5900	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
6000	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
6100	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
6200	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
6300	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
6400	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
6500	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
6600	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
6700	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
6800	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
6900	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
7000	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
7100	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
7200	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
7300	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
7400	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
7500	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
7600	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
7700	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
7800	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
7900	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
8000	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
8100	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
8200	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
8300	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
8400	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
8500	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
8600	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
8700	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
8800	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01

Table 5.3-26 Annual Plume Water Deposition during NDCT Operation (Sheet 3 of 3)

Values in $kg/km^2/mo$

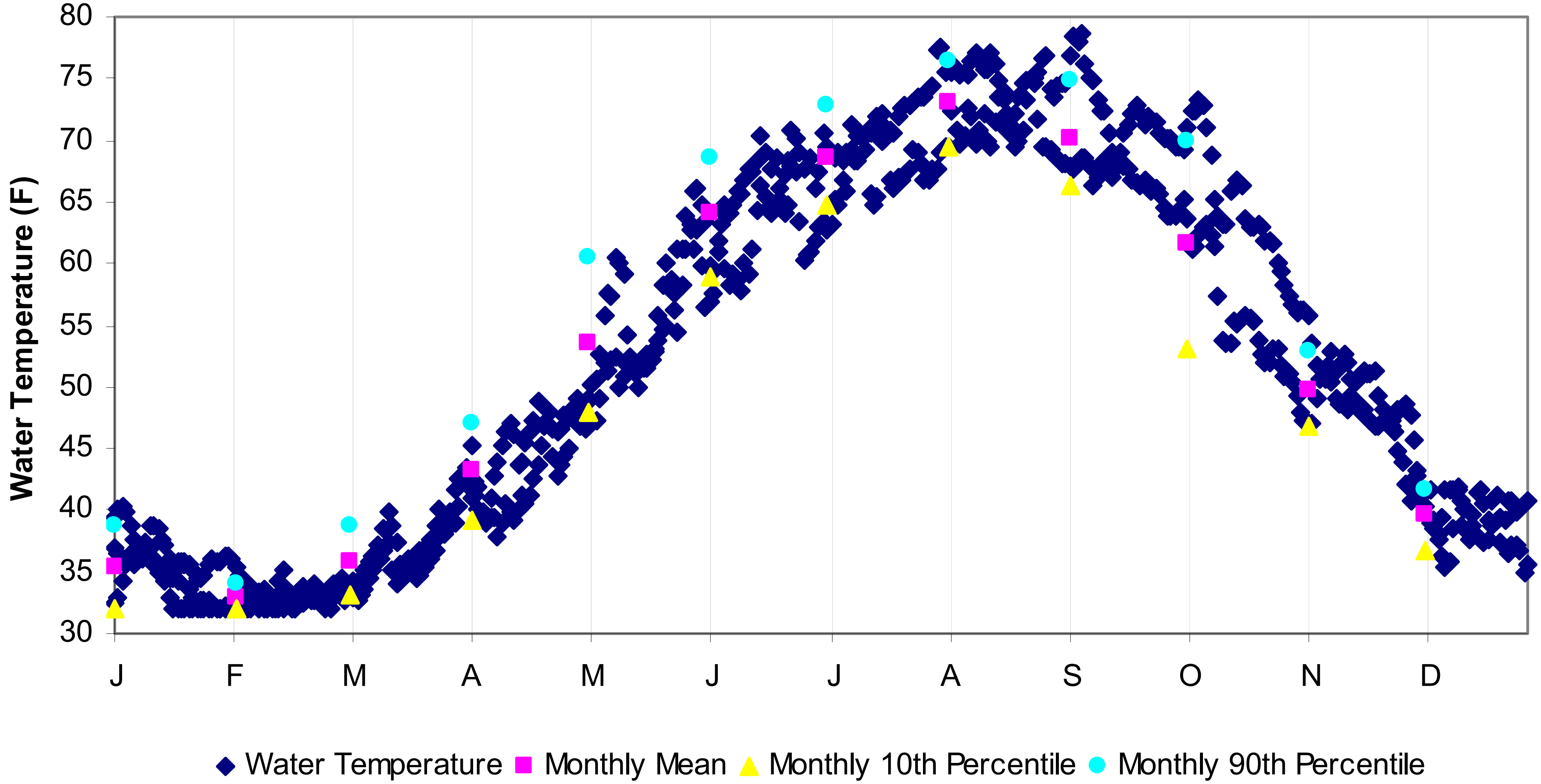
Distance from Tower (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
8900	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
9000	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
9100	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
9200	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
9300	0.15E+01	0.11E+01	0.16E+01	0.18E+01	0.35E+01	0.11E+01	0.60E+00	0.53E+00	0.11E+01	0.13E+01	0.28E+01	0.59E+01	0.46E+01	0.27E+01	0.24E+01	0.21E+01	0.22E+01
9400	0.13E+01	0.93E+00	0.14E+01	0.16E+01	0.29E+01	0.93E+00	0.51E+00	0.43E+00	0.94E+00	0.11E+01	0.24E+01	0.51E+01	0.38E+01	0.22E+01	0.19E+01	0.17E+01	0.18E+01
9500	0.11E+01	0.83E+00	0.12E+01	0.14E+01	0.25E+01	0.83E+00	0.42E+00	0.36E+00	0.80E+00	0.94E+00	0.21E+01	0.44E+01	0.32E+01	0.18E+01	0.16E+01	0.15E+01	0.16E+01
9600	0.10E+01	0.76E+00	0.11E+01	0.12E+01	0.20E+01	0.72E+00	0.33E+00	0.31E+00	0.68E+00	0.77E+00	0.17E+01	0.39E+01	0.26E+01	0.15E+01	0.13E+01	0.13E+01	0.13E+01
9700	0.89E+00	0.69E+00	0.96E+00	0.98E+00	0.17E+01	0.61E+00	0.27E+00	0.28E+00	0.57E+00	0.59E+00	0.15E+01	0.33E+01	0.20E+01	0.11E+01	0.10E+01	0.11E+01	0.11E+01
9800	0.58E+00	0.40E+00	0.60E+00	0.56E+00	0.83E+00	0.40E+00	0.15E+00	0.19E+00	0.26E+00	0.33E+00	0.78E+00	0.16E+01	0.89E+00	0.42E+00	0.37E+00	0.49E+00	0.56E+00
9900	0.58E+00	0.40E+00	0.60E+00	0.56E+00	0.83E+00	0.40E+00	0.15E+00	0.19E+00	0.26E+00	0.33E+00	0.78E+00	0.16E+01	0.89E+00	0.42E+00	0.37E+00	0.49E+00	0.56E+00
10000	0.50E-01	0.40E-01	0.62E-01	0.78E-01	0.12E+00	0.60E-01	0.47E-01	0.29E-01	0.83E-01	0.95E-01	0.12E+00	0.21E+00	0.22E+00	0.14E+00	0.12E+00	0.10E+00	0.99E-01

Notes:

1. Due to high initial plume from the NDCT, no water deposition is deposited with 2800 meters of the tower center.
2. Plume moving in the indicated direction.

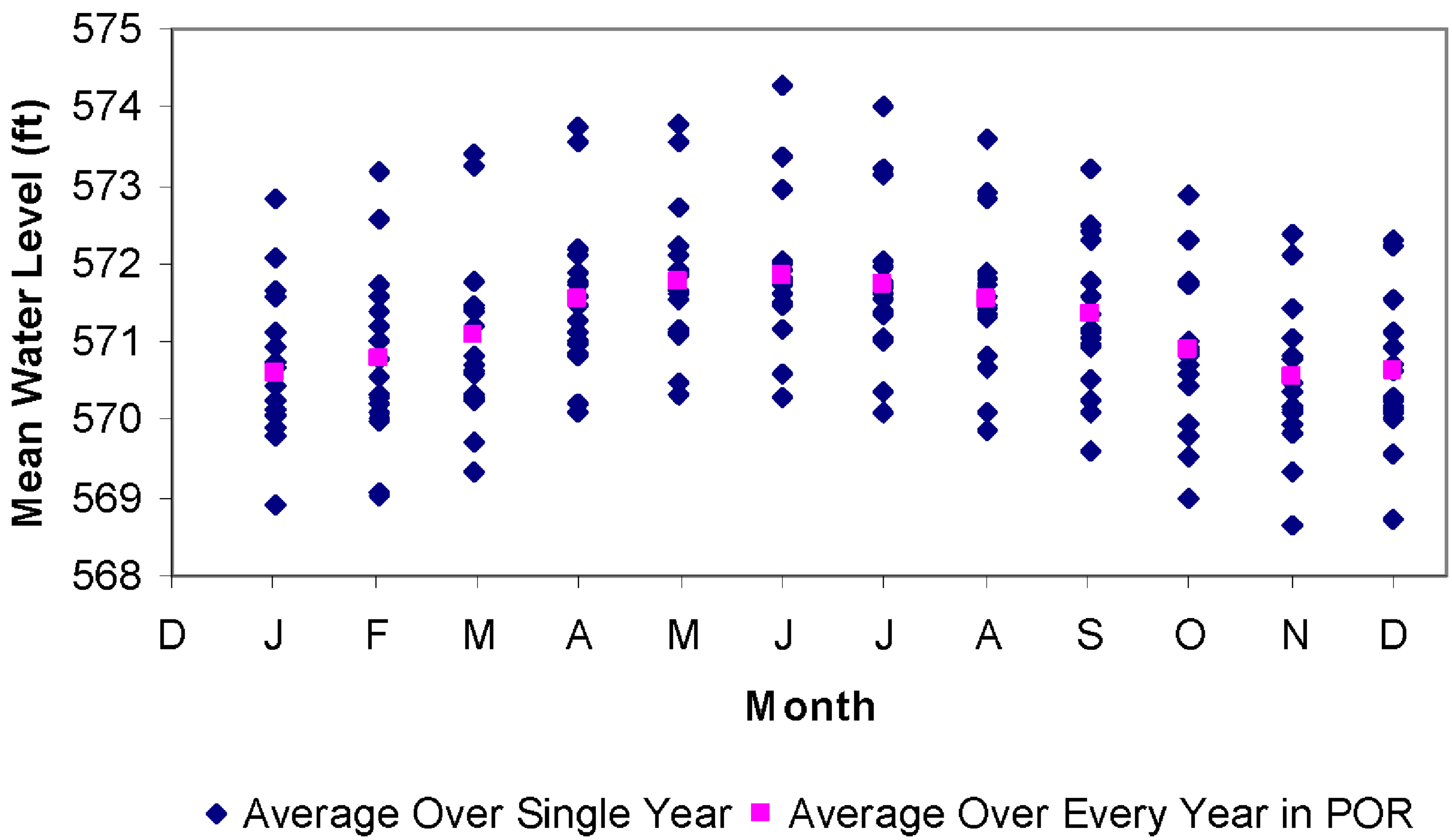
Figure 5.3-1 Station Layout with Intake, Discharge and Outfalls

Figure 5.3-2 Daily Average Water Temperature near the Discharge, LEOFS



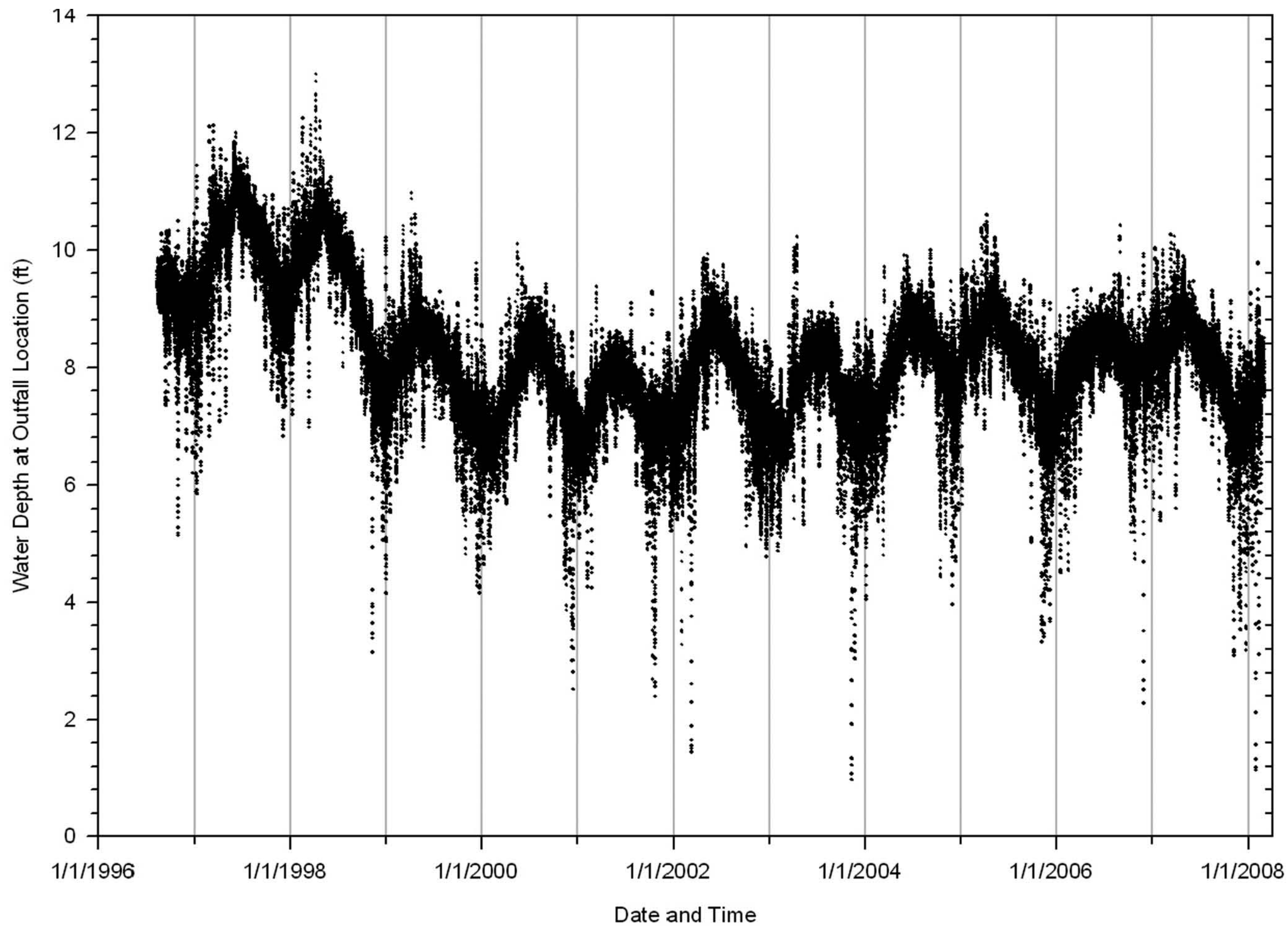
Source: Reference 5.3-4

Figure 5.3-3 Monthly Mean Water Levels for the Period of Record at NOAA GLIN Buoy



Source: Reference 5.3-6

Figure 5.3-4 Observed Hourly Water Depth Time Series, January 1996-February 2008 Period of Record, Proposed Fermi 3 Outfall Location



Source: Reference 5.3-6

Figure 5.3-5 Observed Hourly Water Depth Probability Plot, January 1996-February 2008 Period of Record Vicinity of Proposed Fermi 3 Outfall Location

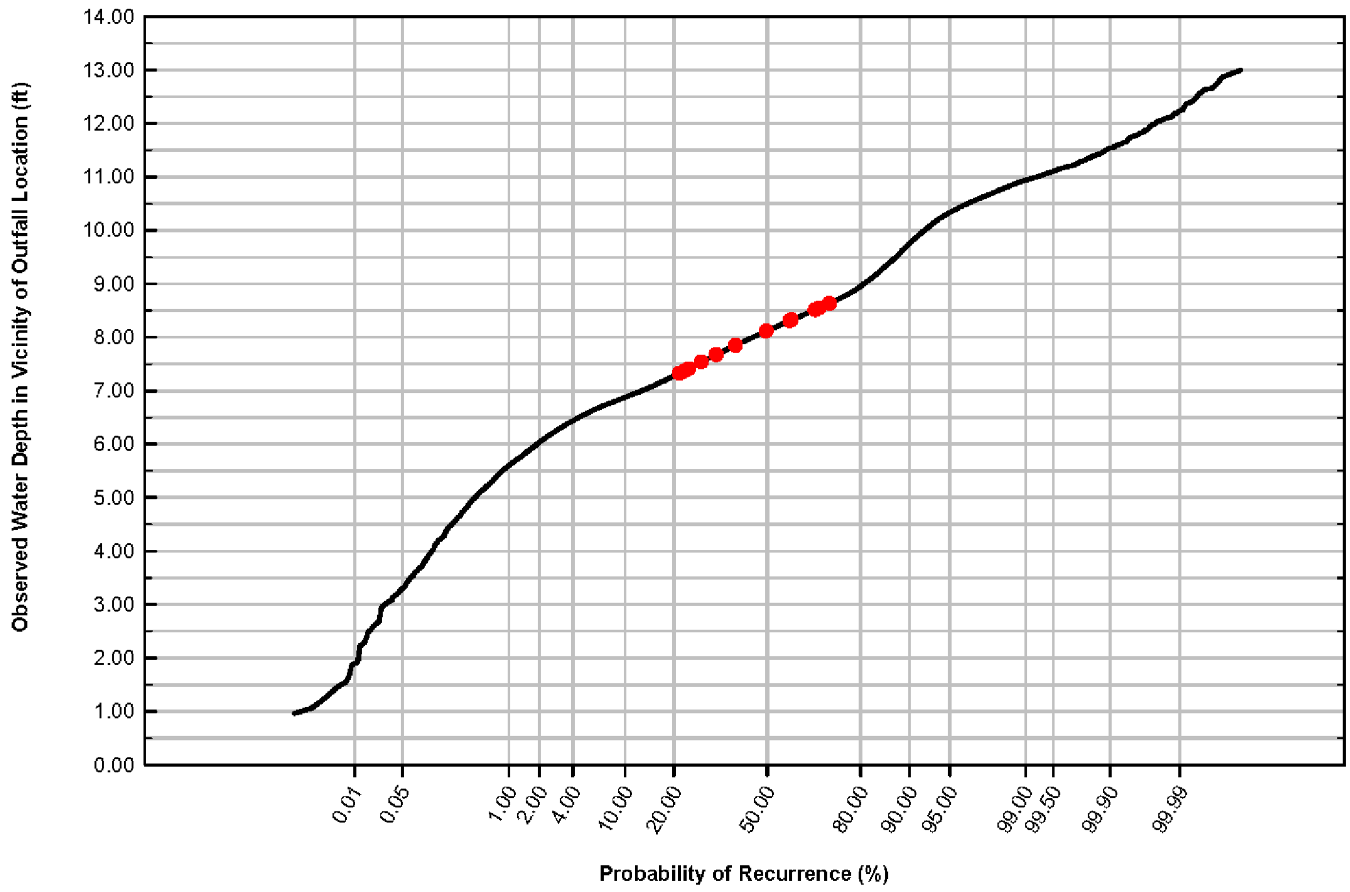
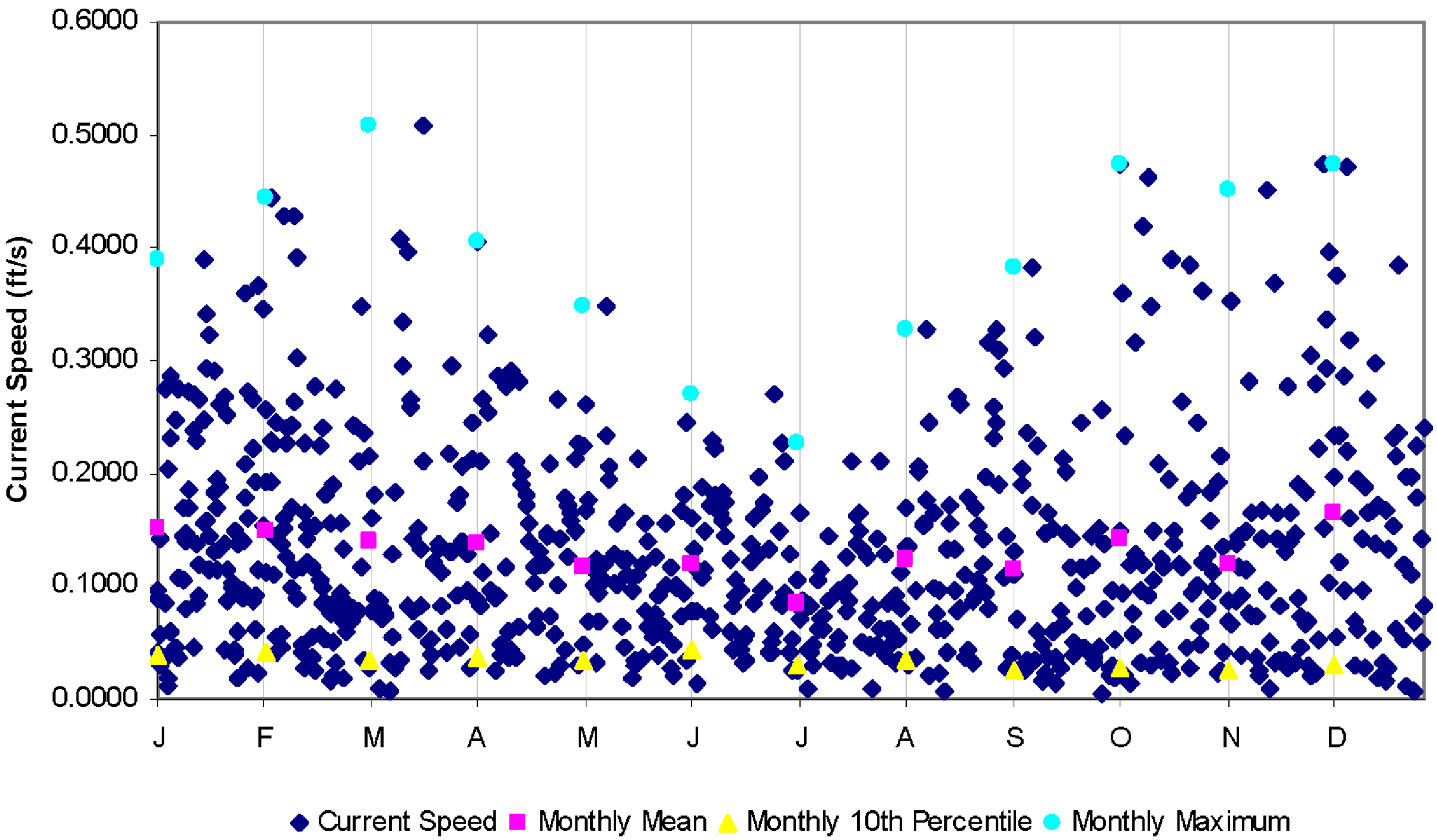
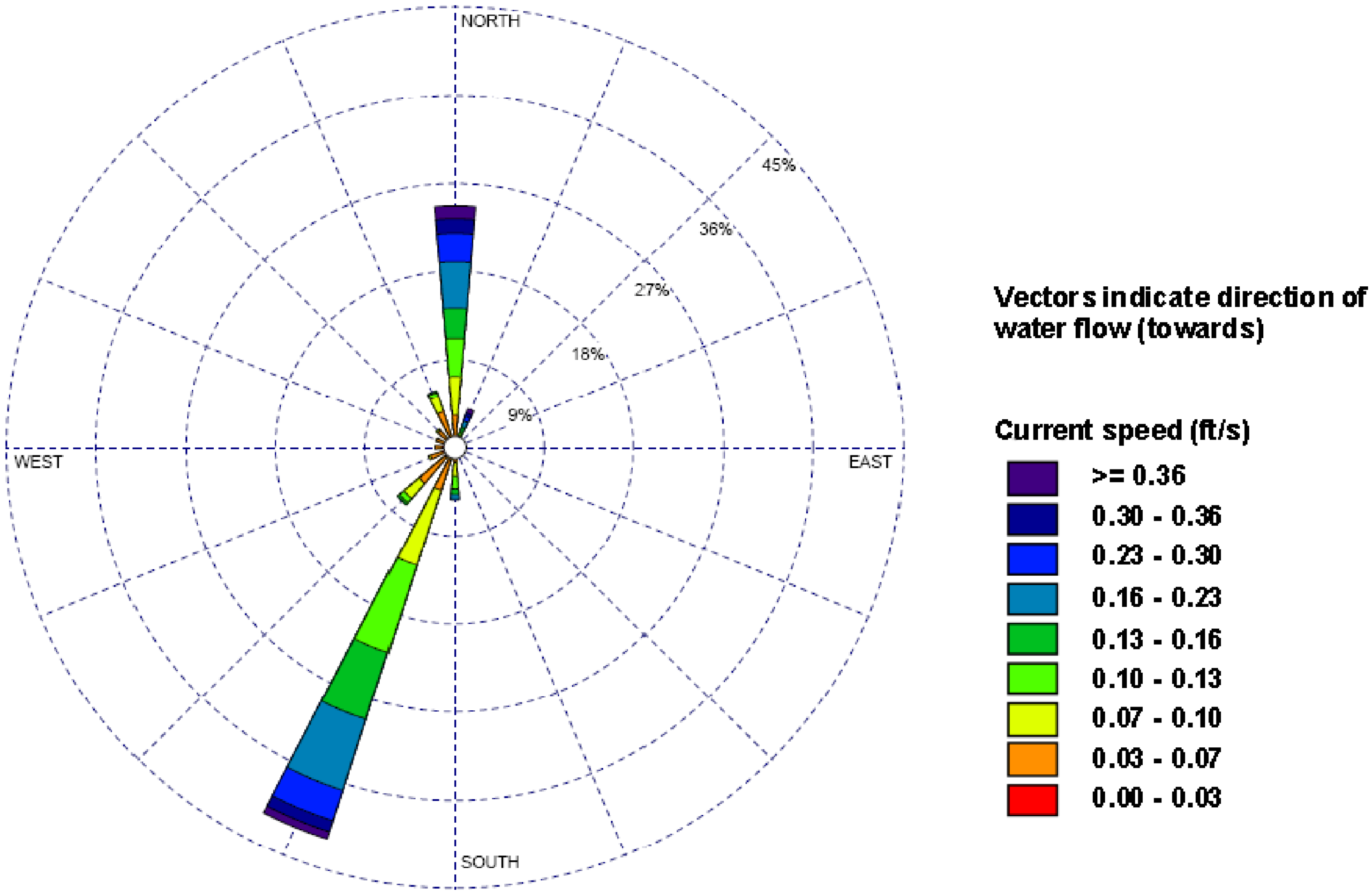


Figure 5.3-6 Daily Average Current Speed near the Discharge, LEOFS



Source: Reference 5.3-4

Figure 5.3-7 Modeled Current Speed and Direction at Outfall Location, LEOFS, January 2006-February 2008



Source: Reference 5.3-4

Figure 5.3-8 Fermi 3 Maximum Predicted Worst-Case Thermal Plume

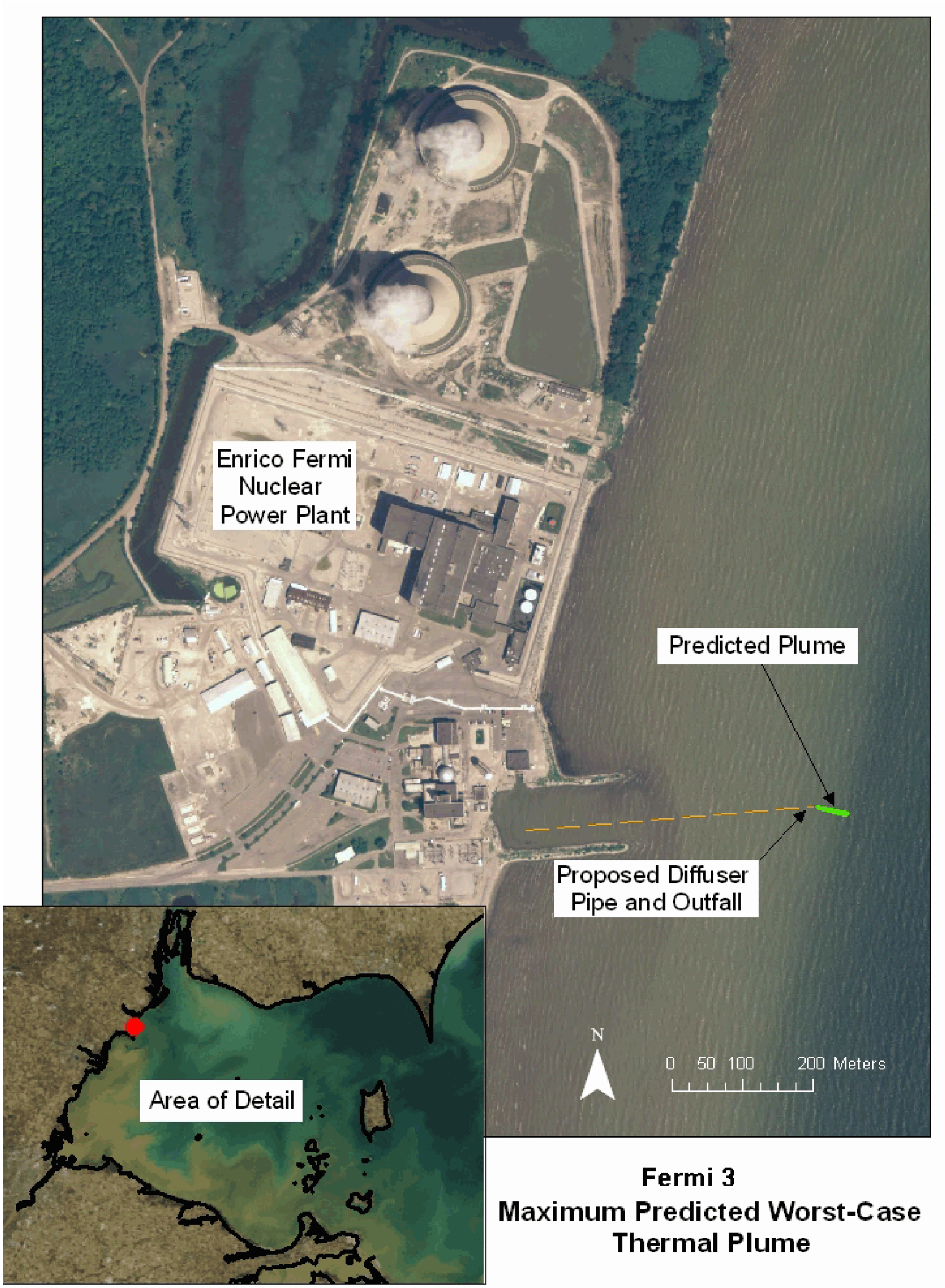
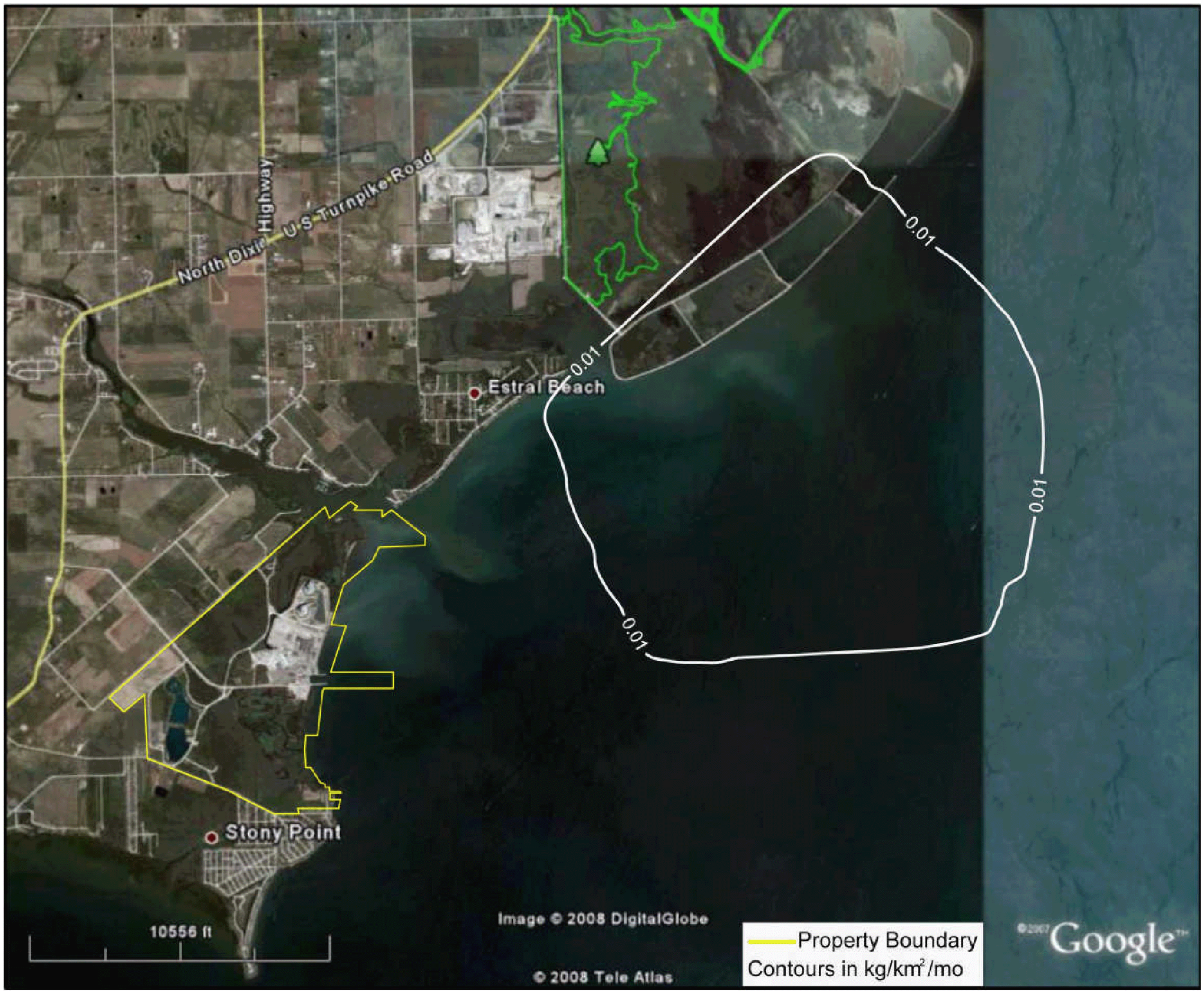


Figure 5.3-9 Annual Salt Deposition Isopleths from NDCT Operation



5.4 Radiological Impacts of Normal Operation

This section describes the radiological impacts of normal plant operation on members of the public, plant workers, and biota. A 50-mile region of interest is chosen for determining impacts to the general public although maximum impacts to individuals are calculated for the immediate plant environs. Subsection 5.4.1 describes the exposure pathways by which radiation and radioactive effluents could be transmitted from Fermi 3 to organisms living near the plant. Subsection 5.4.2 estimates the maximum doses to the public from the operation of Fermi 3. Subsection 5.4.3 evaluates the impacts of these doses by comparing them to regulatory limits. In addition, the impact of Fermi 3 in conjunction with Fermi 2 is compared to the corresponding regulatory limit. Subsection 5.4.4 considers the impact to non-human biota.

5.4.1 Exposure Pathways

Radioactive gases would be discharged to the environment during normal operation of Fermi 3. Fermi 3 is planned to be operated as a zero liquid effluent discharge plant. However, the analyses discussed herein conservatively assume that liquid effluents are discharged as part of normal operation. The released quantities have been estimated in ESBWR DCD Tables 12.2-16 (noble gas and other fission products), FSAR Table 12.2-206 (iodines) and 12.2-19b (liquids) (Reference 5.4-10). The impact of these releases and any direct radiation to individuals, population groups, and biota in the vicinity of Fermi 3 was evaluated by considering the most important pathways from the release to the receptors of interest. The major pathways are those that could yield the highest radiological doses for a given receptor. The relative importance of a pathway is based on the type and amount of radioactivity released, the environmental transport mechanism, and the consumption or usage factors of the receptor.

The exposure pathways considered and the analytical methods used to estimate doses to the maximally exposed individual (MEI) and to the population surrounding the new unit are based on Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I" (Reference 5.4-1) and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," (Reference 5.4-2). An MEI is a member of the public located to receive the maximum possible calculated dose. The annual dose to each nearby receptor indicated in Section 2.7 from the estimated releases from Fermi 3 was calculated, and the maximum of those was denoted the MEI. The use of the MEI allows comparisons with established dose criteria to the public.

5.4.1.1 Liquid Pathways

As noted above, Fermi 3 is designed for zero liquid effluent discharge during normal operation. However, the analyses discussed herein conservatively assume that liquid effluents are discharged as part of normal operation. For this analysis, the liquid effluents would be released through the Circulating Water (CIRC) blowdown line, approximately 1300 feet into Lake Erie. Dilution would occur due to mixing of the liquid effluent with the normal CIRC blowdown. Additional dilution would occur in Lake Erie. The dilution factors in Lake Erie are determined as part of the thermal analysis. The LADTAP II computer program (Reference 5.4-4) was used to calculate these doses with parameters specific to Lake Erie. This program implements the radiological exposure models described in Regulatory Guide 1.109 for radioactivity releases in liquid effluent. The following exposure pathways are considered in LADTAP II:

- Ingestion of drinking water from Lake Erie
- Ingestion of aquatic organisms as food
- External exposure to contaminated sediments deposited along the shoreline (shoreline exposure)

Although less important, as determined by LADTAP II calculations, the swimming and boating exposure pathways are also considered in the analysis. The program also considers ingestion of food sources that use the affected water for irrigation. However, as discussed in Subsection 2.3.2, water from Lake Erie in the vicinity of Fermi 3 is not used for irrigation. The site-specific input parameters for the liquid pathway are presented in Table 5.4-1.

5.4.1.2 **Gaseous Pathways**

The GASPAR II computer program (Reference 5.4-11) was used to calculate the doses to offsite receptors (the general public within 50 miles and the nearest individual receptors in various directions) from Fermi 3. This program implements the radiological exposure models described in Regulatory Guide 1.109 to estimate the doses resulting from radioactive releases in gaseous effluent. The atmospheric dispersion component of the analysis was calculated with the XOQDOQ computer program (Reference 5.4-5). Dispersion and deposition factors were calculated from validated onsite meteorological parameters (wind speed, wind direction, stability class) for the combined years 2002 through 2007 (and 1985 through 1989) as described in Section 2.7.

Section 2.7 describes the meteorological data, gives the dispersion and deposition factors, and gives the locations of the individual receptors (distance and direction) relative to Fermi 3.

The following exposure pathways are considered in GASPAR II:

- External exposure to contaminated ground
- External exposure to gases in air
- Inhalation of airborne activity
- Ingestion of contaminated meat and milk
- Ingestion of contaminated garden vegetables

The spatial distribution of population was discussed in Section 2.5. The agricultural production for the 50 miles surrounding the site was developed from information in Section 2.2. The input parameters for the gaseous pathway are presented in Table 5.4-3.

5.4.1.3 Direct Radiation from Fermi 3

The primary objective of radiation shielding is to protect operating personnel and the general public from radiation emanating from the reactor, power conversion systems, radwaste process systems and auxiliary systems.

Figure 4.5-2 shows the locations of thermoluminescent dosimeter (TLD) measurements at Fermi 2. Measurements show that the direct dose levels at the site boundary are at background levels.

Shielding in Fermi 3 is provided to protect the general public outside the controlled area. The direct dose contribution from Fermi 3 is provided at two distances in DCD Table 12.2-21. The DCD annual dose at 800 meters is 5.93E-04 mrem/year. The distance from Fermi 3 (Reactor Building centerline) to the site boundary is at least 890 meters. Therefore, the value from DCD Table 12.2-21 is conservative. This annual dose is considered to be negligible.

5.4.2 Radiation Doses to Members of the Public (Individuals)

Doses to MEIs residing near Fermi 3, from liquid and gaseous effluents are estimated using the methodologies and parameters specified in Subsection 5.4.1. Collective doses to the general public from Fermi 3 are described in Subsection 5.4.3.

Doses from the ISFSI to Fermi 3 construction workers are discussed in Section 4.5. These dose values are representative of doses anticipated during Fermi 3 operations.

It is noted that radiation is naturally present in the environment. It comes from outer space (cosmic), the ground (terrestrial), and even from our own bodies. It is present in the air breathed, the food and water consumed, and in the construction materials used to build homes. The average annual radiation exposure from natural sources to an individual in the United States is about 300 mrem (Reference 5.4-3).

5.4.2.1 Liquid Pathway Doses

Based on the parameters shown in Table 5.4-1, the LADTAP II computer program was used to calculate the important doses to the MEI via the following activities:

- Drinking contaminated water
- Eating fish and invertebrates caught in Lake Erie
- Shoreline exposure

The liquid activity releases (source terms) for each radionuclide in the discharge are described in Subsection 3.5.1. The MEI for the total body dose is determined to be an adult. The maximum organ dose occurs to the bone for a child. The maximum annual doses to the total body and organs from all pathways for all age groups calculated by the LADTAP program are presented in Table 5.4-4.

5.4.2.2 Gaseous Pathway Doses

Based on the parameters in Table 5.4-3, the GASPAR II computer program was used to calculate doses to the MEI child, who represents the bounding age group for total body and all organs. GASPAR determined that a child was the MEI because of the greater sensitivity of that age group to internal exposure from vegetables and meat. The gaseous activity releases (source terms) for each radionuclide are described in Subsection 3.5.1. The annual pathway components for the total body, thyroid, and other organ doses calculated by the GASPAR computer program for this individual are presented in Table 5.4-5.

As part of the analysis, several sensitivities were performed to account for potentially limiting combinations of atmospheric dispersion, deposition and ingestion pathways. The NNW direction provides the limiting plume dose. The NW direction at the site boundary provides the limiting dose for ground exposure. The NW direction provides the limiting dose for residents and consumption of vegetables. The WNW direction provides the dose contribution due to milk consumption. The NNW direction provides the limiting dose due to meat consumption. The total dose is the sum of these applicable individual contributions.

As shown in Table 5.4-5, the annual total body dose to the MEI is 0.98 mrem to a child, and the maximum annual thyroid dose of 11.3 mrem to a child. Experience at Fermi 2 (Reference 5.4-6) indicates that these calculations are likely very conservative.

5.4.2.3 Summary

The maximum doses due to the liquid and gaseous effluents are summarized in Table 5.4-5. As shown, all results are well within the 10 CFR 50, Appendix I limits. Therefore, the impacts are SMALL and no mitigation actions are necessary.

5.4.3 Impacts to Members of the Public (Individual and Collective Dose to the Public and Comparison with Regulations)

The radiological impacts to individuals and population groups from liquid and gaseous effluents are presented using the methodologies and parameters specified in Subsection 5.4.1. Table 5.4-5 estimates the total body and organ doses to the MEI from liquid effluents and gaseous releases from Fermi 3 for analytical endpoints prescribed in 10 CFR 50, Appendix I. The MEI receptor age group and location are those described in Subsection 5.4.2. As Table 5.4-5 indicates, the predicted doses are below Appendix I limits. These results are discussed in Subsection 5.4.2.3, above.

The total site liquid and gaseous effluent doses from Fermi 2 plus Fermi 3 would be well within the regulatory limits of 40 CFR 190 (Table 5.4-8). As indicated in NUREG-1555, demonstration of compliance with the limits of 40 CFR 190 is considered to be in compliance with the 0.1 rem limit of 10 CFR 20.1301.

Table 5.4-6 and Table 5.4-7 show the total body dose to the population within 50 miles that would be attributable to Fermi 3. Based on the information in these tables, the total whole body dose due to liquid and gaseous effluents from Fermi 3 is 21.6 person-rem/year. As discussed above, the average annual radiation exposure from natural sources to an individual in the United States is about 300 mrem (Reference 5.4-3). Multiplying this by the population of 7,713,709 (Table 5.4-1), results in 2,300,000 person-rem/year. Thus, the dose from Fermi 3 is less than 0.001 percent of that received by the population from natural causes. Impacts to members of the public from operation of Fermi 3 would be SMALL and would not warrant mitigation.

Occupational exposure to Fermi 3 workers from Fermi 3 sources are described in the ESBWR DCD Section 12.4 (Reference 5.4-10). After consideration of shielding provided by the Fermi 3 facilities, occupational exposure from other sources on-site are relatively insignificant. As described in the Fermi 3 FSAR Appendix 12AA, occupational exposure at Fermi 3 will be maintained as low as reasonably achievable (ALARA).

5.4.4 Impacts to Biota Other than Members of the Public

Subsection 2.4.1 and Subsection 2.4.2 identify the relevant species within the site area. Radiation exposure pathways to biota are expected to be the same as those to humans, i.e., inhalation, external (from ground, airborne plume, water submersion, and shoreline), drinking water and ingestion. These pathways were examined to determine if they could result in doses to biota significantly greater than those predicted for humans from operation of Fermi 3. This assessment used surrogate species that provide representative information about the various dose pathways potentially affecting broader classes of living organisms. The gaseous pathway doses for muskrats, raccoons, herons and ducks were taken as equivalent to human doses for the inhalation (child), plume (adult), and twice the ground (adult) pathways, conservatively adjusted based on the assumption that the affected biota are located at 0.25 miles from the facility. The doubling of doses from ground deposition reflects the closer proximity of these organisms to the ground. Doses to those same species plus fish, invertebrate and algae are calculated by the LADTAP II computer program.

Doses to biota from liquid and gaseous effluents from Fermi 3 are shown in Table 5.4-9. The total dose is taken as the sum of the internal and external dose. Annual doses to five of the surrogates meet the criteria of 40 CFR 190. The Bald Eagle, a species of significance known to inhabit the site, is represented by the surrogate species of Table 5.4-9. The Heron is a representative surrogate for the Bald Eagle. Estimated dose to two of the surrogates (duck and muskrat) are slightly greater than the criteria in 40 CFR 190.

Use of exposure guidelines, such as 40 CFR 190, which apply to members of the public in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. The International Council on Radiation Protection states that "…if man is adequately protected then other living things are also likely to be sufficiently protected," and uses human protection to infer environmental protection from the effects of ionizing radiation (Reference 5.4-7 and Reference 5.4-8). This assumption is appropriate in cases where humans and other biota inhabit the same environment and have common routes of exposure. It is less appropriate in cases where human access is restricted or pathways exist that are much more important for biota than for humans. NUREG 155, Section 5.4.4, indicates that if the doses are approximately the same order of magnitude as the criteria in 40 CFR 190, no further review is necessary. Thus, as the results for the duck and muskrat are of the same order of magnitude as 40 CFR 190, the results are considered to be acceptable.

Species in most ecosystems experience dramatically higher mortality rates from natural causes than man, as witnessed by their lesser life spans. From an ecological viewpoint, population stability is considered more important to the survival of the species than the survival of individual organisms. Thus, higher dose limits could be permitted. In addition, no biota has been discovered that show significant changes in morbidity or mortality due to radiation exposures predicted from nuclear power plants.

An international consensus has been developing with respect to permissible dose exposures to biota. The International Atomic Energy Agency (IAEA) (Reference 5.4-9) evaluated available evidence including the “Recommendations of the International Commission on Radiological Protection” (Reference 5.4-7). The IAEA found that appreciable effects in aquatic populations will not be expected at doses lower than 1 rad per day and that limiting the dose to the maximally exposed individual organisms to less than 1 rad per day will provide adequate protection of the population. The IAEA also concluded that chronic dose rates of 0.1 rad per day or less do not appear to cause observable changes in terrestrial animal populations. The assumed lower threshold occurs for terrestrial rather than for aquatic animals primarily because some species of mammals and reptiles are considered more radiosensitive than aquatic organisms. The permissible dose rates are considered screening levels and higher species-specific dose rates could be acceptable with additional study or data. This gives further confidence that if the screening levels are met, such as they are here, then biota are protected.

A rad (radiation absorbed dose) is the absorption of 100 ergs per gram of, in this case, biological mass. The absorbed dose can be related to the biological effects on humans through the unit of rem (roentgen equivalent man). For many types of radiation, including almost all of those normally released by nuclear power plants (gamma and beta emitters), one rem is equivalent to the absorption of one rad.

The calculated total doses in Table 5.4-9 can be compared to the 1 rad per day dose criteria for aquatic species and the 0.1 rad per day dose criteria for terrestrial species evaluated in the “Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards” (Reference 5.4-9). The biota doses meet these dose guidelines by a large margin. In these cases, the annual dose to biota is much less than the daily allowable doses to aquatic and terrestrial organisms. Impacts to biota other than members of the public from exposure to sources of radiation would be SMALL and would not warrant mitigation.

5.4.5 References

5.4-1 U.S. Nuclear Regulatory Commission, “Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I,” Regulatory Guide 1.109, Revision 1, October 1977.

5.4-2 U.S. Nuclear Regulatory Commission, “Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors,” Regulatory Guide 1.111, Revision 1, July 1977.

5.4-3 U.S. Nuclear Regulatory Commission, Fact Sheet, Biological Effects of Radiation, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html, accessed 4 June 2008.

5.4-4 U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, “LADTAP II Technical Reference and User Guide,” NUREG/CR-4013, April 1986.

5.4-5 U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, “XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations Final Report,” NUREG/CR-2919, September 1982.

5.4-6 Detroit Edison, “Fermi 2 – 2006 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2006 through December 31, 2006.

5.4-7 International Council on Radiation Protection, “Recommendations of the International Commission on Radiological Protection,” Publication 26, 1977.

5.4-8 International Council on Radiation Protection, “Recommendations of the International Commission on Radiological Protection,” Publication 60, 1991.

5.4-9 International Atomic Energy Agency, “Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards,” Report Series No. 332, 1992.

5.4-10 GE-Hitachi Nuclear Energy, “ESBWR Design Control Document – Tier 2,” Revision 7, March 2010.

5.4-11 U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, “GASPAR II Technical Reference and User Guide,” NUREG/CR-4653, March 1987.

Table 5.4-1 Liquid Pathway Input Parameters

Parameter	Value
Release Source Term	Refer to Subsection 3.5.1
Liquid Effluent Discharge Flow Rate	0.234 ft^3/sec (1)
Impoundment Reconcentration Model	None
Dilution Factor for MEI Pathways	115 – (minimum to discharge location) (2) Additional dilution factors after discharge: 45 – Nearest shoreline Northeast (1770 meters) 67 – Nearest shoreline South (1530 meters) – closest drinking water supply 77 – South (3200 meters) 100 – Distances greater than 3200 meters
Transit Time for MEI Pathways (3)	22.6 hours – closest drinking water 24 hours – drinking water for general population 10.6 hours – boating, swimming
Consumption/Usage Rates	Table 5.4-2
Population Distribution 50-mile Population	Section 2.5 7,713,709 (4)
Shoreline Recreation Usage	450,000 individuals (10)
50-mile Sport Fish Catch	11.45E6 kg/yr (5)
50-mile Commercial Fish Catch	2.07E6 kg/yr (6)
50-Mile Invertebrate Catch	3.3E7 kg/yr(11)
Dilution Factor for Fish and Invertebrate Catches	115 - minimum to discharge location (2) 100 – additional dilution factor after discharge
Transit Time for Fish and Invertebrate Catches	24 hours (7)
Population Served by Nearest Drinking Water Source	900,000 (8)
Dilution Factor for Population Drinking Water	100
Transit Time for Population Drinking Water	24 hours (9)

Notes:
1. Discharge flow rate is 105 gpm, from Section 3.3
2. Blowdown flowrate (from Section 3.3) divided by discharge flow rate
3. Transit times include time for transit from discharge location to source and the internal LADTAP default values, depending on pathway.
4. Estimated population for the year 2060, from Section 2.5
5. Total sport fish catch from Lake Erie for states of Michigan and Ohio (Subsection 2.4.2), assuming an average of three pounds per fish.
6. Total commercial fish catch from Lake Erie for states of Michigan and Ohio (Subsection 2.4.2)
7. The transit time for both fish and invertebrate harvests are set to a total of 24 hours.
8. Population within 50 mile radius near Lake Erie shoreline (Subsection 2.5.1) not including the City of Detroit. The City of Detroit obtains drinking water up-river from Lake Erie.
9. Includes LADTAP default value of 24 hours
10. Assumed as 50 percent of the total population within 50-mile radius of Fermi 3 that lives in sectors near the lake shore.
11. Total Invertebrate catch is determined based on population distribution, population fractions, and annual consumptions in Table 5.4-2. This is considered to be very conservative as only minimal quantities of invertebrates from Lake Erie are ingested.

Table 5.4-2 Annual Consumption/Usage Rates for MEI and Average Individual Liquid and Gaseous Pathways

MEI Pathway Annual Consumption/Usage (1)	Infant	Child	Teen	Adult
Fruits, Vegetables & grain (kg/yr)	0	520	630	520
Leafy Vegetables (kg/yr)	0	26	42	64
Milk (l/yr)	330	330	400	310
Meat & Poultry (kg/yr)	0	41	65	110
Fish (kg/yr)	0	6.9	16	21
Invertebrates (kg/yr)	0	1.7	3.8	5
Drinking Water (l/yr)	330	510	510	730
Shoreline Recreation (hr/yr)	0	14	67	12
Inhalation (m^3/yr)	1400	3700	8000	8000

Average Individual Annual Consumption/Usage (2)	Child	Teen	Adult
Fruits, Vegetables & grain (kg/yr)	200	240	190
Milk (l/yr)	170	200	110
Meat & Poultry (kg/yr)	37	59	95
Fish (kg/yr)	2.2	5.2	6.9
Invertebrates (kg/yr)	0.33	0.75	1.0
Drinking Water (l/yr)	260	260	370
Shoreline Recreation (hr/yr)	9.5	47	8.3
Inhalation (m^3/yr)	3700	8000	8000

Notes:
1. Data obtained from RG 1.109, Table E-5.
2. Data obtained from RG 1.109, Table E-4.

Table 5.4-3 Gaseous Pathway Input Parameters

Parameter	Value
Release Source Term	Refer to Subsection 3.5.1
Agricultural Production within 50 mile radius Meat Production Milk Production Vegetable Production (grain, tomatoes, potatoes)	Developed from Section 2.2 1.919E+07 kg/year 6.043E+08 liter/year 9.689E+09 kg/year
Fraction of the year that leafy vegetables are grown	0.33
Fraction of a maximum individual's vegetable intake from own garden	0.76
Fraction of the year milk cows are on pasture	0.58
Fraction of milk cow feed intake from pasture while on pasture	1.0
Fraction of year goats are on pasture	0.67
Fraction of goat feed intake from pasture while on pasture	1.0
Fraction of year meat cows are on pasture	0.58
Fraction of meat cow feed intake from pasture while on pasture	1.0
Consumption/Usage Rates	Table 5.4-2
Population Distribution 50-mile Population	Refer to Section 2.5 7,713,709 (1)
Distance and Direction to Receptors and Associated Atmospheric Dispersion Factors	Refer to Section 2.7
Humidity	11 g/m^3

Notes:
1. Estimated population for the year 2060, from Section 2.5

Table 5.4-4 Liquid Pathway Doses for Maximally Exposed Individual

Dose (mrem/yr)							
Skin (1)	Bone (2)	Liver (1)	Total Body (3)	Thyroid (4)	Kidney (1)	Lung (2)	GI-LLI (3)
1.19E-04	8.77E-02	1.00E-02	6.48E-03	2.63E-02	2.49E-03	1.11E-03	8.40E-03

Notes:
1. Total of all pathways for Teen
2. Total of all pathways for Child
3. Total of all pathways for Adult
4. Total of all pathways for Infant

Table 5.4-5 Comparison of Annual Maximally Exposed Individual Doses with 10 CFR 50, Appendix I Limits

	Annual Dose	
Type of Dose	**Fermi 3**	**Limit**
Liquid Effluents		
Total Body (mrem/yr)	0.006 (1)	3
Max Organ – Bone (mrem/yr)	0.088 (2)	10
Gaseous Effluents		
Total External Body (mrem/yr)	0.98	5
Skin (mrem/yr)	1.15	15
Beta Air Dose (mrem/yr)	0.26	20
Gamma Air Dose (mrem/yr)	0.22	10
Max Organ – Thyroid (mrem/yr) Child	11.3	15

Notes:

1. Total dose from all pathways for an adult
2. Total dose from all pathways for a child

Table 5.4-6 50-mile Population Doses from Liquid Effluents

Pathway	Dose person-rem/yr
Fish	
Total Body	2.27
Max Organ – Bone	28.9
Invertebrates	
Total Body	11.3
Max Organ – Bone	74.6
Drinking Water	
Total Body	1.35
Max Organ – Thyroid	25.3
Shoreline Recreation	
Total Body	4.16E-03
Max Organ – Thyroid	4.16E-03
50-Mile Total Dose	
Total Body	14.9
Bone	104.2
Thyroid	30.1

Table 5.4-7 50-mile Population Doses from Gaseous Effluents

Pathway	Dose person-rem/yr
Plume	
Total Body	1.20
Max Organ – Skin	3.58
Ground	
Total Body	2.25
Max Organ – Skin	2.63
Inhalation	
Total Body	0.07
Max Organ – Thyroid	5.13
Vegetable	
Total Body	2.39
Max Organ – Bone	10.1
Cow Milk	
Total Body	0.75
Max Organ – Thyroid	16.1
Meat Cow	
Total Body	0.03
Max Organ – Bone	0.14
50-Mile Total Dose	
Total Body	6.7
Max Organ – Thyroid	27.1

Table 5.4-8 Comparison of Maximally Exposed Individual Doses with 40 CFR 190 Criteria

Type of Dose	Fermi 3 (ESBWR)			Fermi 2	Site Total (1)	40 CFR 190 Limit
	Liquid	Gaseous	Total			
Total Body (mrem/yr)	0.006	0.976	0.98	4.68	5.66	25
Thyroid (mrem/yr)	0.026	11.3	11.33	2.66	13.99	75
Bone (mrem/yr)	0.088	2.18	2.27	0.05	2.32	25

Table 5.4-9 Doses to Biota from Liquid and Gaseous Effluents

Biota	Dose (mrem per year)			40 CFR 190 Limit
	Liquid Effluents	Gaseous Effluents (1)	Total	
Fish	2.31	0	2.31	25
Invertebrate	7.65	0	7.65	25
Algae	11.9	0	11.9	25
Muskrat	14.8	11.15	25.95	25
Raccoon	0.43	11.15	11.58	25
Heron	6.87	11.15	18.02	25
Duck	14.8	11.15	25.95	25

Notes:

1. Dose from gaseous effluents determined based on whole body inhalation dose for child + whole body ground and plume exposure at 0.25 miles from the facility. Ground exposures increased by a factor of two to account for ground proximity.

5.5 Environmental Impacts of Waste

This section describes the environmental impacts that could result from the operation of the non-radioactive waste systems and the storage and disposal of mixed wastes. Mixed wastes contain both radioactive and chemically active wastes. Federal regulations governing generation, management, handling, storage, treatment, disposal, and protection requirements associated with these wastes are contained in Title 10 (NRC regulations) and Title 40 (EPA regulations) of the Code of Federal Regulations (CFR).

The Fermi site generates EPA “hazardous waste” as defined in the implementing regulations for the Resource Conservation and Recovery Act (RCRA) in 40 CFR 239-299. At the Fermi site these wastes include such non-radioactive sources as laboratory solvent waste, paint waste, and aerosol residues. Waste minimization programs at the Fermi site have tended to minimize the generation of these types of wastes when practical and possible through hazardous materials substitution (such as the use of citrus-based non-hazardous solvents and the use of water-based epoxy paints) and the use of waste minimization strategies (such as using paints with high solids and low volatile organic content). Most hazardous wastes are accumulated in satellite accumulation areas, transferred to the onsite hazardous waste storage area, and are transported to approved licensed RCRA waste management facilities in accordance with Michigan hazardous waste regulations.

Mixed waste contains hazardous waste and a low-level radioactive source, special nuclear material, or byproduct material. This may include such contaminated items as waste oil, chlorinated fluorocarbons, organic solvents, metals and metal-contaminated materials, or aqueous corrosives. Mixed wastes are discussed further in Subsection 5.5.2.

The Fermi site has a written procedure in place for Hazardous and Mixed Waste Management. The procedure provides administrative controls assuring that plant activities involving potential or actual hazardous or mixed wastes are conducted in accordance with applicable requirements and good practices. According to the administrative controls, only authorized trained staff can approve manifests for shipping hazardous or mixed waste offsite.

Additionally, the Fermi site has dumpsters for typical facility solid wastes (non-hazardous, non-radioactive) such as office waste, packaging and other warehouse waste, and maintenance waste. This “dumpster waste” is managed with local waste haulers. Other selected materials are recycled such as used batteries, scrap metal, lubricating oils, paper, and fluorescent and incandescent bulbs.

This section is divided into two subsections: non-radioactive waste system impacts and mixed waste impacts.

5.5.1 Non-Radioactive Waste System Impacts

Descriptions of the Fermi 3 non-radioactive waste systems are presented in Section 3.6.

Non-radioactive wastes generated at the Fermi site, including those from Fermi 3 (i.e., solid wastes, liquid wastes, air/gaseous emissions), are managed in accordance with applicable Federal, State and local laws and regulations, and permit requirements. Fermi 3 management practices will be similar to those implemented at Fermi 2 and include the following:

- Non-radioactive solid waste is collected and stored temporarily on the Fermi site and disposed of offsite only at authorized licensed commercial waste disposal site(s) or recovered at an offsite permitted recycling or a recovery facility, as appropriate. Waste includes typical dumpster waste from offices and facility support activities and EPA RCRA hazardous wastes as noted in Section 5.5.
- Debris (e.g., vegetation) collected on trash screens at the water intake structure(s) is disposed of offsite as solid waste, in accordance with state regulations.
- Dredge spoils resulting from periodic maintenance of the intake area may be used as onsite fill material, as in the past for Fermi 2 (see Subsection 5.5.1.2.1 below).
- Scrap metal, lead acid batteries, and paper on the Fermi site are recycled.
- Water discharges from cooling and auxiliary systems are discharged directly and indirectly to Lake Erie through the permitted outfalls as discussed in Subsection 5.2.2.
- Sanitary waste is delivered to the Frenchtown Township Sewage Treatment Facility for treatment.

For further descriptions of plant systems generating non-radioactive wastes, refer to Section 3.6. No other site-specific waste disposal activities unique to Fermi 3 are anticipated. The assessment of potential impacts resulting from the discharge of non-radioactive wastes is presented in the following subsections.

5.5.1.1 **Impacts of Discharges to Water**

Non-radioactive waste water discharges to surface water increases as a result of certain aspects of Fermi 3 operation. Discharges include additional chemically-treated Circulating Water System (CIRC) blowdown and stormwater runoff from new impervious surfaces including roof drains and surface runoff.

Wastewater discharge sources included in the Fermi 2 NPDES permit (which is expected to be included in a permit for Fermi 3) include cooling tower blowdown, chemical metal cleaning waste, non-chemical metal cleaning wastes, service water screen back wash, stormwater runoff, settled water from the dredged material storage basin, and the use of zebra mussel control chemicals (Reference 5.5-1).

As discussed in Subsection 5.2.2, waste water effluents discharge to Lake Erie through NPDES permitted outfalls are subject to constituent permitted levels summarized in Subsection 5.2.2. Ambient or baseline water quality conditions are discussed in Subsection 2.3.3. Additional site background information presented in other sections includes site hydrology (Subsection 2.3.1), water use in the area (Subsection 2.3.2), terrestrial/aquatic ecology (Section 2.4), and chemicals used (Section 3.6).

Subsection 5.2.2 addresses planned water treatment chemicals and biocides to be used for Fermi 3 and the monitoring of the discharges based upon current usage and the NPDES permit for Fermi 2. Ongoing monitoring of chemicals and biocides is discussed in Section 6.6. The Fermi 2 NPDES permit (Reference 5.5-1) requires prior approval by the MDEQ of any new or increased use of water treatment additives at the Fermi site. As discussed in Subsection 2.3.3 and Subsection 5.2.2:

- Lake Erie water has been monitored extensively for such parameters as temperature, solids, inorganic constituents, and related parameters potentially impacted by use of the water by power generation and other industrial users.
- The impact of the water discharged to Lake Erie from Fermi 2 has been minimal based upon the results of ongoing monitoring programs.
- Based upon the Fermi 3 design plans, the impact of the discharge of water from Fermi 3 is projected to be minimal.
- Limits included in the Fermi 2 wastewater discharge permit are those determined by the MDEQ to be protective of Lake Erie water quality and the streams receiving stormwater based upon an evaluation of facility operations, facility wastewater discharges, and Michigan and Federal water quality regulations and guidance, as discussed in Subsection 5.2.2.
- Fermi 3 operations do not include additional or different potential impact issues beyond those evaluated and regulated for Fermi 2. Both are similar operations with similarities in the technologies used, chemicals used, etc.
- The assimilation ability of Lake Erie for discharge wastewater parameters from Fermi 3 is expected to remain the same as demonstrated by the temperature plume modeling results for Fermi 3.
- Since the Fermi site uses only authorized licensed offsite disposal sites, impact to critical habitat or toxic material dispersion is bounded by those licenses.

As discussed in Subsection 5.2.2, the primary discharge of CIRC and wastewater from Fermi 3 is released directly to Lake Erie, and concentrations of constituents in the Fermi 3 discharge are estimated to be minimal or undetectable in Lake Erie. Evaluations considered variations in total discharge flow rate, such as thermal monitoring shown in Subsection 5.2.2. Therefore, potential impacts from constituents in the CIRC and plant auxiliary system discharges from Fermi 3 are SMALL, and do not warrant mitigation.

The Fermi 2 SWPPP provides the basis for management of stormwater runoff at Fermi 3. The SWPPP prevents or minimizes the discharge of harmful quantities of pollutants with the stormwater discharge, including paved areas, facilities, and drainage patterns as discussed in Subsection 4.2.2 and Subsection 5.2.2. Best Management Practices initiated throughout the Fermi site in the SWPPP are employed to control stormwater runoff. Therefore, potential impacts from increases in volume or pollutants in the stormwater discharge are SMALL.

5.5.1.1.1 **Sanitary Waste**

Sanitary waste is collected onsite and pumped to the Frenchtown Township Sewage Treatment Facility for treatment in accordance with the Frenchtown treatment and discharge program under an NPDES permit and federal sanitary waste treatment limits (40 CFR 133 limits). The Fermi site has limits on the following parameters to meet the requirements of the Frenchtown facility industrial/non-domestic user discharge permit:

- pH range
- Grease and oil
- Cd, Cu, Hg, Pb, and Zn
- Alpha & beta radioactivity
- Total suspended solids
- Biological oxygen demand

The Fermi site is required to stay within the limits of the above parameters as established by the site sanitary industrial user permit. Accordingly, potential impacts associated with increases in sanitary waste from the operation of Fermi 3 are SMALL, and do not warrant mitigation.

5.5.1.2 **Impacts of Discharges to Land**

Operation of Fermi 3 results in an increase in the total volume of solid waste generated at the Fermi site. The types of solid waste generated are summarized in Section 5.5. In addition to normal facility trash dumpster waste, Fermi 3 may generate additional non-radioactive solid waste from periodic plant maintenance projects that vary from year to year. However, no fundamental change in the characteristics of these wastes or the way they are currently managed at the Fermi site is expected. The Fermi site has standard procedures in place for waste segregation, appropriate management of waste, and worker training for waste management.

The applicable Federal, State, and local requirements and standards are met with regard to handling, transportation, and offsite land disposal of the solid waste at authorized licensed commercial facilities. Detroit Edison and the Fermi site use a formal waste facility selection and audit procedure to approve licensed facilities that can receive wastes from the Fermi site. Wastes are only sent to approved facilities. Since the Fermi site uses only authorized licensed offsite disposal sites, impact to critical habitat or toxic material dispersion is bounded by those licenses.

The Fermi site has a recycling and waste minimization program in place. Non-radioactive solid waste from Fermi 3 is reused or recycled according to current Fermi 2 plans to the extent practicable. Solid wastes appropriate for recycling or recovery (e.g., used oil, antifreeze, scrap metal, paper) are managed through the use of approved and appropriately licensed contractors. Non-radioactive solid waste destined for offsite land disposal is disposed of at approved and licensed offsite commercial waste disposal site(s). Therefore, potential impacts from land disposal of non-radioactive solid wastes are SMALL.

5.5.1.2.1 **Other Waste Disposal Activities**

The Fermi site accumulates “spoils” from periodic dredging activities. Detroit Edison contracts the dredging of the water intake canal on approximately a four year cycle depending on actual conditions. Spoils accumulate in an onsite Spoil Disposal Pond. Additional spoils are generated by yearly cleaning of pump house intakes with approximately 1000 yd^3 of spoils generated every year.

Dredged material may either be used onsite as fill or sold for use as topsoil. In the past, dredge material had been removed from the basin periodically and used onsite as fill material under case-by-case approval of the Office of Monroe County Drain Commissioner. Because other dredging projects in the area have been able to sell the dredge material as prime topsoil, Detroit Edison is considering options to sell spoils in the future if they are not needed for onsite fill purposes.

5.5.1.3 **Impacts of Discharges to Air**

Operation of Fermi 3 increases small amounts of gaseous emissions to the air, primarily from equipment associated with plant auxiliary systems (e.g., auxiliary boilers, standby diesel generators, and diesel-driven fire pumps). These emissions are intermittent since they are associated with auxiliary and backup systems. Projected emissions from the diesel-fueled equipment are provided in Section 3.6. Cooling tower impacts on terrestrial ecosystems are addressed in Subsection 5.3.3.

Air emission sources associated with Fermi 3 are managed in accordance with Federal, State, and local air quality control laws and regulations. Based on the amount of potential air emissions, and the intermittent nature of the potential emissions, potential impacts to air quality are SMALL, and do not warrant mitigation.

5.5.1.4 **Conclusions**

Based upon the above information, the operation of Fermi 3 results in the discharge of minimal chemical constituents and/or wastes to the water, land, or air. Constituents discharged directly or indirectly to Lake Erie are estimated at or below NPDES permitted levels. Discharges to land are minimal based on the current waste discharges at Fermi 2 and the current waste minimization and recycling activities. Finally, air emissions are minimal based on the estimated equipment emissions and the intermittent nature of these emissions.

As stated, no new/additional types of waste streams are generated. Potential impacts of non-radioactive waste generation are SMALL.

5.5.2 **Mixed Waste Impacts**

The term ‘’mixed waste’’ refers specifically to waste that is regulated as both radioactive waste and hazardous waste. Radioactive materials at nuclear power plants are regulated by the NRC under the Atomic Energy Act (AEA) of 1954. Hazardous wastes are regulated by the State of Michigan, which is authorized by the EPA to regulate those portions of the Federal Act. An EPA authorized state may regulate under RCRA.

Mixed waste generated onsite is assessed based on the following laws and regulations:

1. The radioactive component of mixed waste must satisfy the definition of Low-Level Waste (LLW) in the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985.
2. The hazardous component must exhibit at least one of the hazardous waste characteristics identified in 40 CFR 261, Subpart C, or be listed as a hazardous waste under 40 CFR 261, Subpart D.
3. Entities that generate, treat, store, or dispose of mixed wastes are subject to the requirements of the AEA, the Solid Waste Disposal Act of 1965, as amended by the RCRA in 1976, and the Federal Hazardous and Solid Waste Amendment (HSWA) to RCRA in 1984.

The Federal agencies responsible for ensuring compliance with these statutes are the NRC and the EPA.

5.5.2.1 **Plant Systems Producing Mixed Waste**

Mixed waste contains hazardous waste and a low-level radioactive source, special nuclear material, or byproduct material. A 1990 survey by the NRC identifies the following types of low-level mixed waste at nuclear power plants which are representative of the types of waste expected at Fermi 3 (Reference 5.5-2):

- Waste oil from pumps and other equipment
- Chlorinated fluorocarbons resulting from cleaning, refrigeration, degreasing, and decontamination activities
- Organic solvents, reagents, compounds, and associated materials such as rags and wipes
- Metals such as lead from shielding applications and chromium from solutions and acids
- Metal-contaminated organic sludge and other chemicals
- Aqueous corrosives consisting of organic and inorganic acids

Nuclear power plants are not large generators of mixed waste. Proper chemical handling techniques and pre-job planning ensure that only small quantities of mixed waste are expected to be generated by Fermi 3. The specific types and quantities of mixed waste generated in a new operating nuclear power plant are not available. Background engineering indicates that each nuclear power plant is estimated to produce potentially 0.5 m^3/year of mixed waste. Based upon Fermi 2 operation in recent years, mixed waste generation can range from 200 to 2000 pounds per year.

5.5.2.2 **Mixed Waste Storage and Disposal Plans**

Fermi 3 manages mixed wastes in accordance with existing Fermi site programs. If an authorized licensed offsite disposal site is not available for the mixed waste disposal, the Fermi site containerizes, segregates, and stores the waste at a remote monitored structure within the site boundary to minimize possible exposure to employees and the public.

The volume of mixed waste is reduced or eliminated by one or more of the following treatments before disposal: decay, stabilization, neutralization, filtration, chemical decontamination or treatment performed by an offsite vendor.

Some small quantities of mixed waste may be temporarily stored onsite due to the lack of treatment options or disposal sites, if necessary as noted in Subsection 5.5.2.1. For this reason, impacts resulting from occupational exposure to chemical hazards and radiological doses could be higher than otherwise expected. Occupational chemical and radiological exposures could occur during the testing of mixed wastes to determine if the constituents are chemically hazardous. In those cases, appropriate hazardous chemical control and radiological control measures are applied.

Fermi 2 operates under a State of Michigan low level mixed waste exemption (under Michigan Administrative Code R299.9822) that allows mixed wastes generated as a result of activities conducted in accordance with the Fermi 2 NRC operating license to be exempt from hazardous waste status requirements. The waste is managed as low level radioactive waste under the terms of the NRC license. This allows for unlimited quantity and time of storage as long as the mixed waste exemption conditions are observed. Fermi 3 will also claim the exemption.

5.5.2.3 **Waste Minimization Plan**

Primary importance is placed on source reduction efforts to prevent pollution and to eliminate or reduce the generation of hazardous waste. Reducing the quantity, toxicity, or mobility of the hazardous waste before accumulation or disposal is considered when prevention or recycling is not possible or practical. The Fermi Site Waste Minimization Plan includes such plan goals as source reduction, source control, and recycling.

The Fermi Site Waste Minimization Plan is linked to an Environmental Management System (EMS) and hazardous and mixed waste procedures. The minimization plan focuses on material control, process management to minimize leaks and malfunctions, appropriate segregation of waste streams, and continuous feedback/improvement. The EMS includes such key procedures as employee environmental awareness training and internal environmental audits which increase the focus on environmental program effectiveness and continuous improvement.

The existing Fermi 2 procedure for hazardous and mixed waste management includes administrative controls to assure that plant activities involving potential or actual mixed or hazardous waste are conducted in accordance with applicable requirements and good practices. Unidentified waste is assumed to be hazardous until identified otherwise.

Waste minimization considerations are an integral part of work planning and implementation at Fermi. As part of that effort, the Fermi hazardous and mixed waste management procedure specifies that individuals planning or performing work expected to generate waste in the scope of the procedure must make specified consultations and plans for appropriate collection and disposition of the waste including proper packaging, labeling, storage, and notifications. Waste disposition, inspections, and reports are defined by the procedure to assure appropriate management and status documentation.

5.5.2.4 Environmental Impacts

Minimal environmental impacts result from storage or shipment of the mixed wastes generated at Fermi. The existing procedures for the management of low level mixed waste at Fermi 2 provides the basis for the handling of mixed wastes at Fermi 3. The procedures address such items as storage, personnel qualifications, inspection and inventory, records, and working with mixed waste.

Emergency operating procedures are implemented to limit any onsite impacts, in accordance with the Fermi Comprehensive Emergency Response Plan. Properly trained emergency response personnel maintain a current facility inventory on the types of waste, volumes, locations, hazards, control measures, and precautionary measures to be taken.

Generation and temporary storage of mixed waste can expose workers to hazards associated with the chemical component(s) of the mixed waste matrix from potential leaks and spills. Fermi 3 procedures include topics such as proper labeling of containers, installation of fire detection and suppression equipment (if required), use of fences and locked gates, availability of emergency shower and eyewash facilities, posting of hazard signs, and regular inspections.

The existing emergency procedures limit any onsite impacts. Isolation of the waste storage and exposure monitoring programs at the storage area for any potential occupational doses associated with mixed waste generation and storage minimize the possibility of impacts.

Offsite shipment, treatment, and disposal options depend on the hazard levels and radiological characteristics of the mixed waste. Because personnel performing packaging and shipping could be exposed to radiation from the mixed waste, appropriate controls are implemented to ensure that as low as reasonably achievable (ALARA) goals are not exceeded. The EPA mandates that waste storage containers in temporary storage be inspected weekly and certain above-ground portions of hazardous waste storage tanks be inspected daily. The purpose of these inspections is to detect leakage from, or deterioration of containers (40 CFR 264). Waste inspection methods could include direct visual monitoring or remote monitoring for detecting leakage or deterioration. In addition, measures are provided to promptly locate, segregate, and manage the leaking containers to minimize the effects of mixed waste hazards.

The amount and activity of material allowed in a storage facility and the shielding used also is controlled by the dose rate criteria for both the occupational exposures at the site boundary and any adjacent offsite areas. Direct radiation and effluent limits are restricted by 10 CFR 20 and 40 CFR 190. The exposure limits given in 10 CFR 20.1301 apply to unrestricted areas.

Based upon the information presented in this subsection, the potential impacts from the treatment, storage, and disposal of mixed wastes generated by Fermi 3 are SMALL.

5.5.3 **Conclusions**

Unavoidable impacts, due to non-radioactive waste water discharges to surface water, the total volume of solid waste, gaseous emissions to the air, and potential generation of mixed waste all increase as a result of Fermi 3 operation. Also, some small quantities of mixed waste can be temporarily stored onsite due to the lack of treatment options or disposal sites, if necessary. For this reason, impacts resulting from occupational exposure to chemical hazards and radiological doses could be higher than otherwise expected. Occupational chemical and radiological exposures could occur during the testing of mixed wastes to determine if the constituents are chemically hazardous. In those cases, appropriate hazardous chemical control and radiological control measures are applied.

Despite the addition of Fermi 3, minimal chemical constituents and/or wastes are expected to be discharged to the water, land, or air from operation of Fermi 3. Constituents discharged directly or indirectly to Lake Erie are expected be at or below NPDES permitted levels. Discharges to land are projected to be minimal based on the current waste discharges at Fermi 2 and the current waste minimization and recycling. Finally, air emissions are minimal based on the estimated equipment emissions and the intermittent nature of these emissions.

As stated previously, no new/additional types of waste streams are generated, and the impacts of waste generation (non-radioactive and mixed waste) are SMALL. Accordingly, the environmental impact of non-radioactive waste systems and the storage and disposal of mixed wastes is SMALL, and mitigation is not required.

5.5.4 **References**

5.5-1 Michigan Department of Environmental Quality, “National Pollutant Discharge Elimination System (NPDES) Permit – Detroit Edison Company Fermi 2 Power Plant,” NPDES Permit No. MI0037028, September 30, 2005.

5.5-2 U.S. Nuclear Regulatory Commission, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” NUREG-1437, May 1996.

5.6 Transmission System Impacts

This section discusses the possible environmental impacts of the transmission system during the operation of Fermi 3. Potential impacts from transmission system operation and maintenance, which include transmission corridor maintenance and transmission line use, are discussed relative to terrestrial and aquatic ecosystems and members of the public.

The 345 kV transmission system and associated corridors are exclusively owned and operated by ITC*Transmission*. The Applicant has no control over the construction or operation of the transmission system. Accordingly, the operation impacts are based on publicly available information and reasonable expectations of the configurations and controls that ITC*Transmission* would likely follow based on standard industry practice. However, the information described in this subsection does not infer commitments made by ITC*Transmission* or Detroit Edison, unless specifically noted.

5.6.1 Terrestrial Ecosystems

The 345 kV transmission system associated with Fermi 3 is owned, operated and maintained by ITC*Transmission*, which includes the rights-of-way from Fermi 3 to Milan Substation. Accordingly, the potential operational impacts discussed are based on publicly available information and reasonable expectations of the applicable regulatory processes and approvals that ITC*Transmission* would likely follow based on standard industry practice.

ITC*Transmission* operates within the Midwest ISO regional reliability area, a FERC –approved regional transmission organization. The Midwest ISO and ITC*Transmission* determine necessary upgrades to the transmission system. This process has been followed for the proposed connection of Fermi 3 to the ITC*Transmission* system.

Baseline terrestrial ecosystem information on the proposed transmission corridor is provided in Subsection 2.4.1.9. The effects of transmission line corridor construction were evaluated in Subsection 4.3.1. Impacts due to the operation of the transmission system are discussed as outlined in ESRP Section 5.6.1. The ESRP considers the effects of right-of-way maintenance and an assessment of impacts to important terrestrial species and habitats. The new onsite transmission lines are expected to be constructed in a short new corridor through the western portion of the site using new towers. The new Fermi 3 switchyard is expected to be constructed at the intersection of Fermi Drive and Toll Road. The new offsite transmission lines are expected to be constructed in existing corridors both by the re-configuration of existing towers and conductors as well as the installation of new towers/poles and conductors in selected segments. The Milan Substation may also be expanded into a previously disturbed area.

As discussed in the following subsections, impacts due to the project and cumulative impacts to the terrestrial ecosystem from the operation of the new transmission lines are expected to be SMALL.

5.6.1.1 Vegetation

Operation of onsite and offsite portions of the transmission system is expected to have no significant effects on vegetation. In the offsite portion, existing corridors and towers are planned to be used for the majority of the new lines, and the proposed substation addition is located on previously disturbed land. Access to sensitive areas, such as wetlands, that may be needed is expected to be accomplished using matting to avoid soil disturbance and minimize damage to plants.

Maintenance of the right-of-way is expected to be scheduled in accordance with ITC*Transmission's* vegetation management plan. The work will likely consist of periodic removal of trees to provide adequate clearance from the lines. Pesticides and herbicides may also be used selectively as needed to maintain the right-of-way. Selective removal of undesirable species by hand cutting and/or mowing as needed will likely be the practice routinely used; this would encourage the growth of vegetation types that provide desirable low-growing ground cover, erosion control, improved appearance, treatment of invasive species (as defined in Executive Order 13112), and wildlife habitat. Maintenance of the right-of-way is discussed further in Subsection 5.1.2.

The right-of-way is typically inspected by helicopter and ground patrolled periodically to ensure that the corridor is in proper condition for safe operation of the transmission line.

5.6.1.2 **Wildlife**

A minimal increase in impacts to wildlife (e.g., bird collisions and habitat loss) would be expected from the addition of the new lines to the existing towers and potential new towers in the existing offsite corridor and the new onsite corridor. NUREG-1437, Section 4.5.6.2, provides a thorough discussion of the topic and concludes that bird collisions associated with the operation of transmission lines will not cause long-term reductions in bird populations. In this instance, the new lines are expected to be installed largely on existing towers in about two-thirds of the offsite route and on new towers in the short onsite route. The remaining third of the offsite route is located in a partly established right-of-way on a combination of new towers and/or steel poles. The overall effect of the new line on wildlife is expected to be minor, since most of the corridor is previously develop or impacted, and in less maintained areas there are existing disturbances, such as farming, neighboring residences, and roadways. Because of these local conditions, it is not anticipated that ITC*Transmission* will implement any new wildlife management practices with the right-of-way.

The operation of the new Fermi 3 switchyard onsite and the expanded offsite substation at Milan would be expected to have an insignificant effect on wildlife in the area due to the use of the site as a power generation facility and the presence of an existing offsite substation (to which area wildlife has adjusted), the relatively small area of new onsite switchyard and offsite substation expansion, and the degraded nature of the forest, wetland, maintained grass, and cropland habitat in the surrounding vicinity.

5.6.1.3 **Important Terrestrial Species and Habitats**

No important terrestrial species or habitats (including critical habitats), as discussed in Subsection 2.4.1.2 and Subsection 2.4.1.9, are known to occur within the onsite or offsite portions of the transmission system. Therefore, the operation of the transmission system is expected to have no impact on these resources and no mitigation is anticipated.

5.6.1.4 **Wetlands and Floodplains**

In the short new portion of the transmission corridor onsite, minimal impacts to wetlands and floodplains are anticipated. The portion of the onsite transmission corridor parallel to Toll Road will permanently impact approximately 1.53 acres of palustrine forested wetland. During operation, this area will be maintained as a wetland with lower-height vegetation more typical of an emergent wetland. No transmission towers are expected to be located in the central portion of the drainage area of the onsite transmission corridor. Operation of the onsite transmission corridor is not expected to affect any other wetland areas.

According to Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map 26115C0259D, the area surrounding the majority of the onsite transmission corridor near the onsite drainage area (Berns Drain) is within Zone AE, a special flood hazard area inundated by a 100-year flood (Reference 5.6-9). There is also a portion of the onsite transmission corridor parallel to Toll Road that would fall within Zone X, an area of either 500-year flood or 100-year flood with shallow depth, limited drainage area, or protected by levees. The small areas occupied by the transmission towers in the floodplain would not impact the carrying capacity of the drainage area or the floodplain, and the towers and foundations would be in place as designed for corrosion resistance in periodically flooded conditions in that area of the site.

Maintenance of the onsite corridor is anticipated to be very similar to the offsite corridor maintenance detailed below.

In the offsite portion, minimal impacts to wetlands and floodplains are anticipated from the operation of the new transmission lines or Milan Substation. Areas within the corridor that have the potential to regenerate in forest vegetation are expected to be periodically hand cleared of woody vegetation for line safety clearance. Access to these areas for maintenance would likely be on foot or by the use of matting for vehicle equipment, so as not to disturb the soil. As noted in Subsection 5.6.1.1, there should be only selected and occasional pesticide or herbicide use in specific areas where needed in the corridor. It is expected that the use of such chemicals in the right-of-way would be minimized to the greatest extent possible in wetlands areas to protect these important resources.

5.6.1.5 **Impact of Electromagnetic Fields on Flora and Fauna**

Electromagnetic fields (EMF) are unlike other agents that have an adverse impact (e.g., toxic chemicals) in that dramatic acute effects cannot be demonstrated and long-term effects, if they exist, are subtle, according to the NRC's Generic Environmental Impact Statement for License Renewal (GEIS) conclusions (Reference 5.6-7). As discussed in the GEIS, a careful review of biological and physical studies of EMFs did not reveal consistent evidence linking harmful effects with field exposures. Thus the conclusion presented in the GEIS was that the impacts of EMFs on terrestrial flora and fauna were of small significance at operating nuclear power plants, including transmission systems variable numbers of power lines. On this basis, it is concluded that the incremental EMF impacts posed by possible additions of new power lines for the Fermi 3 project would be minimal and mitigation is not anticipated.

5.6.1.6 Other Projects within the Area with Potential Impacts

Other projects that may be affected by the operation of the transmission line are not known to the Applicant at this time.

5.6.1.7 Consultation

No direct consultation has been made with Federal, State, or local agencies at this time regarding the transmission line routing, new switchyard construction, and substation expansion; however, the USFWS and MDNR were consulted for information on known occurrences of federal and state listed protected species in the project vicinity (Subsection 2.4.1.9.6). Although no regulatory consultation has occurred for the transmission route, Federal and State web sites have been consulted. As the transmission system design is formalized, it is expected that agency consultations would be initiated to ensure the protection of terrestrial resources. It is the desire of the Applicant to avoid or minimize impacts to natural resources through the use of existing corridors along the entire route and existing towers in most segments of the route.

5.6.1.8 Mitigation

Impacts to terrestrial ecosystems resulting from transmission activities are expected to be minor, and no mitigation is anticipated at this time.

5.6.2 Aquatic Ecosystems

Baseline aquatic ecosystem information on the proposed transmission corridors are provided in Subsection 2.5.2.9. The effects of transmission line corridor construction on aquatic ecosystems were evaluated in Subsection 4.3.2. Impacts that were considered due to the operation of the transmission system are outlined in ESRP Section 5.6.2. The ESRP considers the effects of right-of-way maintenance and an assessment of impacts to important species and habitats (defined in ESRP Table 2.4.1-1). No important aquatic species or habitats would be affected by operation of the transmission system. Based on anticipated maintenance plans for the transmission systems as discussed in Subsection 5.6.1.1, no impacts are expected due to maintenance activities. Therefore, impacts to the aquatic ecosystem due to operation of the transmission system are expected to be SMALL, and no mitigation is anticipated.

5.6.3 Impacts to Members of the Public

As described in Section 3.7, three new transmission lines and a separate switchyard will be needed for Fermi 3 per System Impact Study Report (MISO G867) performed by ITC*Transmission* (Reference 5.6-8). These enhancements to the ITC*Transmission* system will be used to transport power generated from Fermi 3 to local distribution systems as well as the Eastern Interconnection.

Upon completion of the new transmission lines, no additional land disturbances other than routine right-of-way maintenance is likely to occur. Impacts to members of the public are not expected for the portions of the new transmission system within the Fermi site because members of the public are not permitted access to the site.

Potential impacts to members of the public from the expanded ITC*Transmission* system would be minimal. Anticipated operational and maintenance impacts of the expanded transmission system may result in visual impacts, electric shock hazards, electromagnetic field exposure, noise impacts, and radio and television interference.

Interference with wireless Internet services and cellular phones is possible, but would only occur in the unlikely event that use of these devices by members of the public occurred directly under the transmission line or within the corridor area.

5.6.3.1 **Visual Impacts**

Existing transmission lines for Fermi 2 were designed with consideration given to minimizing impacts on environmental resources and visual values. These considerations would be continued throughout the proposed transmission system modifications described in Section 3.7. The visual impacts of the onsite transmission system would not change significantly as a result of the addition of new transmission lines because the onsite transmission structures would be visible from the majority of vantage points only on the Fermi site. Members of the public would be able to see parts of the transmission structures from the limited viewpoints just outside the Fermi entrance or from Toll Road and Langton Road where the view is not obstructed by forested areas. The appearance of the new structures and conductors in the existing offsite corridor would be consistent with the present structures and conductors and result in very little visual change. Based on the proposed design, the visual impacts to members of the public from the transmission system operation are considered SMALL, and no mitigative measures are anticipated.

5.6.3.2 **Electric Shock Potential**

Objects located near transmission lines can become electrically charged because of their immersion in the lines' electrical field. This charge results in a current that flows through the object to the ground. This is called an induced current because there is no direct connection between the line and the object. Induced current can also flow to the ground through the body of a person who touches the charged object.

Transmission line electrical fields can cause an induced current in nearby grounded objects, as well as buildup of voltage on nearby ungrounded objects such as automobiles, electric or non-electric fences, railroad tracks, and rain gutters.

An object that is insulated from the ground can store an electrical charge, becoming capacitively charged. A person standing on the ground and touching a vehicle or a fence receives an electric shock because of the sudden discharge of the capacitive charge through the person's body to the ground. After the initial discharge, a steady-state current can develop, the magnitude of which depends on several factors, including the following:

- The strength of the electrical field, which depends on the transmission line voltage
- The height and geometry of the individual transmission wires
- The size of the object on the ground
- The extent to which the object is grounded

The National Electric Safety Code (NESC) (Reference 5.6-1) has a provision that describes how to establish minimum vertical clearances to the ground for electrical lines having voltages exceeding 98 kV. The clearance must limit the induced current due to electrostatic effects to five mA, if the largest anticipated truck, vehicle, or equipment were short-circuited to ground.

To reduce the potential for vehicle-to-ground short-circuit shock to vehicles parked beneath the lines, existing transmission lines are currently designed to provide clearances consistent with the NESC 5 mA rule. The proposed new offsite structures and lines would likely change the geometry of the power lines because the new conductors could sag differently. All transmission lines would continue to comply with applicable regulatory standards. Operation and maintenance of all onsite and offsite transmission lines would continue to comply with the NESC provisions in order to minimize potential for electric shock.

Analysis of this area of impact, detailed in the NUREG-1437, concludes that “potential electric shock impacts are of small significance for transmission lines that are operated in adherence with the NESC.” ITC*Transmission* will ensure that electric field strength under the new transmission lines will conform to the NESC guidelines (less than 7.5 kV/m maximum within the right-of-way, and less than 2.6 kV/m maximum at the edge of the right-of-way). Therefore, potential electric shock impacts will be SMALL for both onsite and offsite transmission lines, and no mitigative measures are anticipated.

5.6.3.3 **Electromagnetic Field Exposure (EMF)**

The existing ITC*Transmission* system meets NESC criteria for induced currents. Modifications to the existing system will comply with ITC*Transmission* design specifications as well as applicable regulatory standards, including the NESC. ITC*Transmission* has developed engineering and construction design control documents pertaining to transmission systems. These design control documents establish company requirements to comply with current applicable NESC criteria. The transmission lines meet these standards, which provide appropriate assurance that impacts to the public attributable to the acute effects of EMF will be minimized.

In 1992, Congress established a research and educational program designed to determine whether exposure to extremely low frequency electric and magnetic fields (ELF-EMF) was harmful to humans. The research and information compilation effort was conducted by the National Institute of Environmental Health Sciences (NIEHS) and the U.S. Department of Energy. Their findings (Reference 5.6-2) state that, “The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak.” Nevertheless, the NIEHS concluded that such exposure could not be ruled entirely safe, but that the evidence was insufficient to warrant aggressive regulatory concern. In a subsequent 2002 bulletin, the NIEHS provided an overview of recent scientific studies and summarized various expert review panel evaluations of the body of evidence regarding EMF (Reference 5.6-3). This bulletin reiterated and accepted the conclusions provided in the 1999 study report.

Acute and chronic effects of transmission line operation to members of the public appear to be minimal and unknown, respectively, according to the body of scientific research on the subject. Most EMF research studies call attention to the need for further research because of the adverse effects reported in some studies. EMF experts recommend a policy of "prudent avoidance," or reducing EMF exposure whenever possible without excessive cost or inconvenience (Reference 5.6-3). ITC*Transmission* has not encountered significant environmental problems associated with EMF from its transmission system. If problems arise, it is likely that they can be eliminated by modifications of the lines or right-of-way (Reference 5.6-4). Accordingly, impacts to members of the public from EMF associated with the transmission system operation are considered SMALL, and no mitigative measures are expected.

5.6.3.4 **Noise**

High-voltage transmission lines can emit noise when the electrical field strength surrounding them is greater than the breakdown threshold of the surrounding air, creating a discharge of energy. This energy loss, known as corona discharge, is affected by ambient weather conditions such as humidity, air density, wind, and precipitation, and by irregularities on the energized surfaces. The transmission lines that provide service to the Fermi site are designed with hardware and conductors that have features to eliminate corona discharge and to ensure that they are corona free up to their maximum operating voltage. Nevertheless, during wet weather, the potential for corona loss increases, and it could occur if insulators or other hardware have any defects. NUREG-1437 explains that corona discharge results in audible noise, radio and television interference, energy losses, and the production of ozone, but is generally not a problem.

Potential noise sources for transmission systems include transformers and transmission line conductor corona discharge. Typical worst-case noise levels from corona discharge (i.e., during periods of heavy rain) are below 70 dB(A) at ground level directly below the transmission lines.

Corona-induced noise along the existing transmission lines is very low, except possibly directly below the line on a quiet, humid day. Accordingly, complaints are not expected on nuisance noise from the onsite transmission lines, or from nuisance noise from the expanded offsite transmission corridor. Any additional noise from the new onsite or offsite structures and lines would not be readily discernible from noise associated with the existing transmission corridor that the public has become accustomed to. Since transmission line corona noise does not have adverse effects on humans (except as a potential minor annoyance) and the noise produced is at a low level, impacts are expected to be SMALL, and no mitigative measures are expected.

5.6.3.5 **Radio, Television, Cellular Phone, and Wireless Internet Interference**

Generally, the cause of radio and television interference from transmission lines is a result of corona discharge from defective insulators or hardware. Corona increases with voltage, adverse weather conditions (e.g., high humidity or fog), and the number of surface irregularities (e.g., scratches, dirt particles) on the conductors. Radio interference from corona discharge is most likely to affect the amplitude modulation (AM) broadcast band (535 to 1605 kilohertz); frequency modulation (FM) radio is rarely affected. AM receivers would have to be located in very close proximity to transmission lines to experience potential radio interference effects. During damp or rainy weather, potential interference from corona effects is more likely.

There is a very small potential that the transmission lines could interfere with pacemakers or defibrillators, if this kind of equipment was being used by people in direct proximity to or directly below the lines (Reference 5.6-5). It is highly unlikely that this kind of interference would occur since the transmission corridor has been sited as far from residences as practical and because the transmission lines are suspended at a height tall enough to be distant from people on the ground. Also, people using this kind of equipment would likely be aware of possible interference effects and would thereby remain in areas away from the transmission corridor.

Although radio and television interference can occur, it is not a common or widespread phenomenon along transmission lines. The radio and television interference can vary from static sounds on AM radios to distorted TV reception, and magnetic fields can cause flickering in computer monitors. The majority of radio and television interference problems result from local, lower voltage electrical distribution lines that serve residences and businesses, not high voltage transmission lines. When radio and television interference is generated by a transmission line, it does attenuate with lateral distance from transmission lines and is typically not an issue beyond a few hundred feet out from the line. As such, emergency and business operations would not experience large impacts with the appropriate distance from the transmission corridor.

Wireless Internet services usually are not affected by high-voltage transmission lines unless the home or business attempting to use these services is directly under the transmission line or immediately adjacent to the corridor edge or right-of-way. Similarly, transmission line interference with cellular telephones would be very unlikely to occur unless phone use was attempted directly under the transmission line. Difficulties with Internet or cell phone interference would likely be resolved by the user moving out from under the transmission lines and out of the corridor (Reference 5.6-6).

Should complaints about electromagnetic interference with radio, television, cellular phone, wireless Internet reception, or other electrical devices occur, ITC*Transmission* would investigate the cause and, if necessary, replace the defective component to correct the problem. As described in Subsection 5.6.3.4, the transmission lines associated with the Fermi site are designed to be corona-free up to their maximum operating voltage. ITC*Transmission* expects that radio, television, cellular phone, and wireless Internet interference from the proposed new transmission corridor would be SMALL, and no mitigative measures are expected.

5.6.4 **References**

5.6-1 Institute of Electrical and Electronics Engineers, “National Electrical Safety Code,” C2-2007, Part 2, Rules 232C1 and 232D3c, 2007.

5.6-2 National Institutes of Health, National Institute of Environmental Health Sciences, "NIEHS Report on Health Effects from Exposure to Power-Line Frequency and Electric and Magnetic Fields", Publication No. 99-4493, May 1999.

5.6-3 National Institutes of Health, National Institute of Environmental Health Sciences, "EMF Questions & Answers, Electric and Magnetic Fields Associated with the Use of Electric Power", June 2002.

5.6-4 Neuert Electromagnetic Services, “FAQs webpage,” http://www.emfcenter.com/faqs.htm, accessed 27 March 2008.

5.6-5 Medtronic Guideline, “Tachyrrhythmia, Home and Work, Guidelines,” 2008, http://www.medtronic.com/servlet/ContentServer?pagename=Medtronic/Website/StageArticle&ConditionName=Tachyarrhythmia&Stage=Treatment&Article=tachy_art_home_and_work, accessed 27 March 2008.

5.6-6 Southern California Edison, “Antelope-Pardee 500-kV Transmission Project Final Environmental Impact Report/Environmental Impact Statement, Appendix 8, Draft EIR/EIS Comments and Responses, Comment Set C.189: Laurie De Santis-Staschik and Family,” December 2006, http://www.cpuc.ca.gov/environment/info/aspen/antelopepardee/EIR/Appendices/Appendix%208-Comments%20and%20Responses/C.%20Individuals/C-189_LaurieDeSantis-Staschik.pdf, accessed 27 March 2008.

5.6-7 U.S. Nuclear Regulatory Commission, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” NUREG-1437, 1996.

5.6-8 ITC*Transmission*, “System Impact Study Report (MISO G867),” Generation Interconnection in Monroe County, MI, July 21, 2008.

5.6-9 Federal Emergency Management Agency National Flood Insurance Program, Flood Insurance Rate Map, Monroe County, Michigan (All Jurisdictions), Panel 259 of 510, Map Number 26115C0259D, effective date: April 20, 2000.

5.7 Uranium Fuel Cycle and Transportation Impacts

This section discusses the impacts of the uranium fuel cycle and transportation of radioactive materials. Environmental impacts from the uranium fuel cycle (UFC) for Fermi 3 are discussed in Subsection 5.7.1. Subsection 5.7.2 provides a detailed description and analysis of the environmental impacts of transporting fuel and waste to and from Fermi 3.

5.7.1 Uranium Fuel Cycle Impacts

This subsection discusses the environmental impacts from the UFC for Fermi 3. This subsection is prepared in accordance with the guidance provided in NUREG-1555, Environmental Standard Review Plan, Section 5.7.1, Uranium Fuel Cycle Impacts, Revision 1. The UFC is defined as the total of those operations and processes associated with provision, utilization, and ultimate disposal of fuel for nuclear power reactors.

The regulations in 10 CFR 51.51(a) state that:

> Every environmental report prepared for the construction permit stage of a light water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low level wastes and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor. Table S-3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility.

The latest values of 10 CFR 51.51(a) Table S-3 (NRC Table S-3) are used to assess environmental impacts. The values are normalized for a reference 1000 MWe LWR at 80 percent capacity factor. NRC Table S-3 values are reproduced as the “Reference LWR” column in Table 5.7-2. One ESBWR unit with a net electrical output of 1535 megawatts electric (MWe) operating at 93 percent capacity factor is analyzed for Fermi 3. Operating under these constraints yields an effective electric output of 1428 MWe for Fermi 3. A ratio of the generation values of 1428 MWe and 800 MWe provides a scaling factor of 1.79 (Table 5.7-1) to convert the reference LWR values to Fermi 3 specific values. The approximately 79 percent increase in power level for Fermi 3 has been considered in the evaluation of the estimated environmental impacts relative to the reference LWR in Table 5.7-2. However, it is important to recognize that the higher power level impact on the UFC is in the same order of magnitude as for the Normalized Model LWR Annual Fuel Requirement table in WASH-1248 or reference reactor-year in NUREG-0116. Therefore, the values for the maximum effect per annum fuel total reactor year of the reference 1000 MWe LWR of NUREG-1555 are comparable to Fermi 3.

Specific categories of natural resource use are included in NRC Table S-3 (and duplicated in Table 5.7-2). These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high and low-level wastes, and radiation doses from transportation and occupational exposures. In developing Table S-3, the NRC considered two fuel cycle options that differed in the treatment of spent fuel removed from a reactor. "No recycle" treats all spent fuel as waste to be stored at a Federal waste repository, "uranium only recycle" involves reprocessing spent fuel to recover unused uranium and return it to the system. Neither cycle involves the recovery of plutonium. The contributions in NRC Table S-3 resulting from reprocessing, waste management, and transportation of wastes are maximized for both of the two fuel cycles (uranium only and no recycle); that is, the identified environmental impacts are based on the cycle that results in the greater impact.

Because the U.S. does not currently reprocess spent fuel, only the “no recycle” option is considered here. Natural uranium is extracted from the earth through either open-pit or underground mines or by an in situ leaching (ISL) process. ISL involves injecting a solvent solution into the underground uranium ore to dissolve uranium, and then pumping the solution to the surface for further processing. The ore or leaching solution is moved to mills where it is processed to produce uranium oxide (U_3O_8). The uranium oxide is then converted to uranium hexafluoride (UF_6) in preparation for the enrichment process. The UF_6 is then transported to an enrichment facility. The process of enrichment increases the percentage of the more fissile isotope, uranium-235 (U-235), and decreases the percentage of uranium-238 (U-238). Natural uranium is approximately 0.7 percent U-235. The enrichment process exploits the slight differences in atomic weights of the two isotopes. A feature common to large-scale enrichment schemes is that they employ a number of identical stages, which use a cascading process to produce successively higher concentrations of U-235. Each stage concentrates the product of the previous stage further before being sent to the next stage. Similarly, the tailings from each stage are returned to the previous stage for further processing. At a fuel-fabrication facility, the enriched uranium is then converted from UF_6 to uranium dioxide (UO_2). The UO_2 is formed into pellets, inserted into tubes, and loaded into fuel assemblies. The fuel assemblies are placed in the reactor to produce power. After most of the U-235 has fissioned, the concentration reaches a point where the nuclear fission process becomes inefficient. The fuel assemblies are then withdrawn from the reactor. After onsite storage for sufficient time to allow for short-lived fission product decay and to reduce the heat generation rate, the fuel assemblies are transferred to a waste repository for interment. Storing the spent fuel elements in a repository constitutes the final step in the “no-recycle” option.

The following assessment of the environmental impacts of the UFC for an ESBWR at the Fermi 3 site is based on the values in NRC Table S-3 and NRC's analysis of the radiological impacts from radon-222 and technetium-99 in the GEIS. Detroit Edison has utilized these impacts for this analysis. The GEIS and Addendum 1 to NUREG-1437 provide a detailed analysis of the environmental impacts from the UFC. Although these references are specific to impacts related to license renewal, the information is relevant to this review because the ESBWR design considered here is also a LWR and uses the same type of fuel.

The NRC calculated the values in NRC Table S-3 from industry averages for the performance of each type of facility or operation associated with the UFC. The NRC chose assumptions so that the calculated values will not be underestimated. This approach was intended to ensure that the actual values will be less than the quantities shown in NRC Table S-3 for all LWR nuclear power plants within the widest range of operating conditions. Changes in the UFC and reactor operations have occurred since NRC Table S-3 was promulgated. For example, the estimated quantity of fuel required for a year's operation of a nuclear power plant can now reasonably be calculated assuming a 60 year lifetime (40 years of initial operation plus a 20 year license renewal term). This was done in the GEIS for both BWRs and PWRs, and the highest annual requirement (35 metric tonnes [MT] of uranium made into fuel for a BWR) was used in the GEIS as the basis for the reference reactor-year. A number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and enrichment requirements, reducing annual fuel requirements. Therefore, NRC Table S-3 remains a conservative estimate of the environmental impacts of the fuel cycle fueling nuclear power reactors operating today.

5.7.1.1 **Land Use**

The total annual land requirement for the fuel cycle supporting Fermi 3 is approximately 200 acres. Approximately 23 acres are permanently committed land, and 179 acres are temporarily committed. A “temporary” land commitment is a commitment for the life of the specific fuel cycle plant, (e.g., mill, enrichment plant, or succeeding plants). Following decommissioning, such land can be used for unrestricted use. “Permanent” commitments represent land that may not be released for use after plant shutdown and/or decommissioning because decommissioning activities do not result in removal of sufficient radioactive material to meet the limits in 10 CFR 20, Subpart E, for release of land for unrestricted use. Of the 179 acres per year of temporarily committed land, 141 acres are undisturbed and 39 acres are disturbed. In comparison, a coal-fired power plant with the same output as Fermi 3 and that uses using strip-mined coal requires the disturbance of approximately 360 acres per year for fuel alone.

If the quality and opportunity cost of the land is equivalent, then it is reasonable to say the land requirements are minor. Accordingly, the impact on land use to support Fermi 3 is SMALL, and does not warrant mitigation.

5.7.1.2 **Water Use**

The principal water use for the fuel cycle supporting Fermi 3 is that required to remove waste heat from the power stations supplying electricity to the enrichment step of this cycle. Scaling from NRC Table S-3 shows that of the total annual water use of 2.04×10^{10} gallons for the Fermi 3 fuel cycle approximately 2.0×10^{10} gallons are required for the removal of waste heat, assuming that these plants use once-through cooling. Fermi 3 uses a cooling tower; therefore, these values are very conservative. Other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of approximately 2.9×10^8 gallons per year and water discharged to ground (e.g., mine drainage) of approximately 2.3×10^8 gallons per year.

Given that the water discharged to water bodies and to the ground from other fuel cycle facilities for a reference reactor-year is only a small fraction of the discharge from a LWR; therefore, the impact on water use to support Fermi 3 is SMALL, and does not warrant mitigation.

5.7.1.3 **Fossil Fuel Impacts**

Electric energy and process heat are required during various phases of the fuel cycle process. The electric energy is usually produced by the combustion of fossil fuel at conventional power plants. Electric energy associated with the fuel cycle represents approximately 9.0 percent of the annual electric power production of Fermi 3. The original analysis in WASH-1248 shows that the environmental impacts are almost totally from the electrical generation needed for the gaseous diffusion process. These impacts result from the emissions from the electrical generation that is assumed to be from coal plants, the water needed to cool the coal plants, and the water needed to cool the gaseous diffusion plant equipment. However, the process used for enrichment is undergoing a transition from gaseous diffusion to centrifuge enrichment. Centrifuge enrichment technology requires less than 10 percent of the energy need for the gaseous diffusion process. In the U.S., Louisiana Energy Services (LES) and the United States Enrichment Corporation (USEC) are in the process of construction new centrifuge enrichment plants. By the time enrichment services are required for Fermi 3, it is possible that the majority of United States supplied enrichment services will utilize centrifuge technology. As such, the environmental impacts associated with fossil fuel electrical generation would be correspondingly less for Fermi 3.

Process heat is primarily generated by the combustion of natural gas. As concluded in the GEIS, this gas consumption, if used to generate electricity, represents less that 0.72 percent of the annual electric power production of Fermi 3.

Therefore, the fossil fuel impact from the consumption of electrical energy for UFC operations to support Fermi 3 is SMALL relative to the net power production of Fermi 3.

5.7.1.4 **Chemical Effluents**

The quantities of liquid, gaseous, and particulate discharges associated with the fuel cycle processes are shown in Table 5.7-2 for the reference 1000 MWe LWR and Fermi 3. The quantities of effluents for Fermi 3 will be approximately 79 percent greater than the reference 1000 MWe LWR. The principal effluents are SOx, NOx, and particulates. Based on data in the Seventh Annual Report of the Council on Environmental Quality (Reference 5.7-1), these emissions constitute a SMALL additional atmospheric loading in comparison with these emissions from the stationary fuel combustion and transportation sectors in the United States, which is approximately 0.036 percent of the annual national releases for each of these species.

Liquid chemical effluents produced in fuel cycle processes are related to fuel enrichment and fabrication operations and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table 5.7-2 specifies the amount of dilution water required for specific constituents for the reference 1000 MWe LWR and Fermi 3. All liquid discharges into the navigable waters of the United States from facilities associated with UFC operations are subject to requirements and limitations set by a NPDES permit issued by an appropriate Federal, State, regional, local, or tribal regulatory agency, thus assuring minimum impact.

As concluded in NUREG-1555, tailing solutions and solids are generated during the milling process, but are not released in quantities sufficient to have a significant impact on the environment.

As discussed above, the impact from chemical effluents from UFC operations to support Fermi 3 is SMALL, and does not warrant mitigation.

5.7.1.5 **Radioactive Effluents**

Radioactive gaseous effluents estimated to be released to the environment from reprocessing and waste management activities and certain other phases of the fuel cycle process are shown in Table 5.7-2 for the reference 1000 MWe LWR and Fermi 3. Using NRC Table S-3 data, Subsection 6.2.2.1 of the GEIS calculates the 100-year involuntary environmental dose commitment to the United States population from the fuel cycle (excluding reactor releases and dose commitments due to radon-222 and technetium-99) to be approximately 400 person-rem per reference reactor-year. The estimated dose commitment to the U.S. population is 716 person-rem per reactor-year of operation for Fermi 3 based on scaling the reference 1000 MWe LWR value. Subsection 6.2.2.1 of the GEIS calculates the additional whole body dose commitment to the U.S. population from radioactive liquid wastes effluents due to all fuel cycle operations (other than reactor operation) to be approximately 200 person-rem per reference reactor-year. The estimated dose commitment to the U.S. population is 358 person-rem per reactor-year of operation for Fermi 3. Thus, the estimated 100-year involuntary environmental dose commitment to the United States population from radioactive gaseous and liquid releases from UFC operations is 1074 person-rem to the whole body per reactor-year for Fermi 3.

Currently, the radiological impacts associated with radon-222 releases and technetium-99 releases are not addressed in NRC Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings. Principal technetium-99 releases occur as releases from the gaseous diffusion enrichment process. The NRC provided an evaluation of these technetium-99 and radon-222 releases in the GEIS.

Section 6.2 of the GEIS, the NRC estimated the radon-222 releases from mining and milling operation, and from mill tailings for each year of operations of the reference 1000 MWe LWR. The estimated releases of radon-222 for the reference reactor-year for the reference 1000 MWe LWR is approximately 5200 Ci. The estimated releases of radon-222 for Fermi 3 are 9308 Ci per reactor-year. Of this total, approximately 78 percent would be from mining, 15 percent from milling operations, 7 percent from inactive tails prior to stabilization. For radon releases from stabilized tailings, the NRC assumed that the reference 1000 MWe LWR would result in an emission of 1 Ci per year which yields an estimated 1.79 Ci release for Fermi 3. The major risks from radon-222 are from exposure to the bone and the lung, although there is a small risk from exposure to the whole body. The organ-specific dose weighting factors from 10 CFR 20 were applied to the bone and lung doses to estimate the 100-year dose commitment from radon-222 to the whole body. The estimated population dose commitment from mining, milling, and tailings before stabilization for each reactor-year of operation for the reference 1000 MWe LWR would be approximately 920 person-rem to the whole body and an estimated 1647 person-rem for Fermi 3. From stabilized tailings piles, the estimated 100-year environmental dose commitment would be approximately 18 person-rem to the whole body for the reference 1000 MWe LWR and an estimated 32 person-rem for Fermi 3.

Also in the GEIS, the NRC considered the potential health effects associated with the releases of technetium-99. The estimated releases of technetium-99 for the reference 1000 MWe LWR is approximately 0.007 Ci per reactor-year from chemical processing of recycled UF6 before it enters the isotope enrichment cascade and 0.005 Ci into the groundwater from a candidate repository. The estimated releases of technetium-99 for the referrence reactor are a total of 0.012 Ci per reactor-year which yields an estimated 0.022 Ci per reactor year for Fermi 3. The major risks from technetium-99 are from exposure of the gastrointestinal tract and kidney, although there is a small risk from exposure to the whole body. Applying the organ-specific dose weighting factors from 10 CFR 20 to the gastrointestinal tract and kidney doses, the total-body 100-year dose commitment from technetium-99 was estimated to be 100 person-rem for the reference 1000 MWe LWR and an estimated 179 person-rem for Fermi 3.

As stated in NUREG-1555, radiation may cause cancers at high doses and high dose rates, but currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses and dose rates, below approximately 10,000 mrem. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response model is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council, the BEIR VII report, supports the linear, no-threshold dose response model. 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.

Based on this model, the NRC estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment 730 fatal cancers, nonfatal cancers, and severe hereditary effects per 1,000,000 person-rem from International Commission on Radiation Protection (ICRP) Publication 60). For Fermi 3, this coefficient was multiplied by the sum of the estimated whole body population doses discussed above, approximately 2936 person-rem/yr, to calculate that the U.S. population would incur a total of approximately 2.1 fatal cancers, nonfatal cancers, and severe hereditary effects annually. This risk is quite small compared to the number of fatal cancers, nonfatal cancers, and severe hereditary effects that would be estimated to the U.S. population annually from exposure to natural sources of radiation using the same risk estimation method.

Radon releases from tailings are indistinguishable from background radiation levels at a few kilometers from the tailings pile (at less than 1 km in some cases). The public dose limit specified by EPA regulations in 40 CFR 190, is 25 mrem/yr to the whole body from the entire fuel cycle.

In addition, at the request of the U.S. Congress, the National Cancer Institute (NCI) conducted a study and published Cancer in Populations Living Near Nuclear Facilities in 1990

(Reference 5.7-2). This report included an evaluation of health statistics around all nuclear power plants, as well as several other nuclear fuel cycle facilities, in operation in the U.S. in 1981 and found “no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities.” The contribution to the annual average dose received by an individual from the fuel cycle-related radiation and other sources as reported in National Council on Radiation Protection and Measurements (NCRP) Report 93 (Reference 5.7-3) is shown in Table 5.7-3. The nuclear fuel cycle contribution to an individual’s annual average radiation dose is extremely small (less than 1 mrem per year).

Based on these analyses, the environmental impact of radioactive effluents from the UFC is SMALL and does not warrant mitigation.

5.7.1.6 **Radioactive Waste**

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in NRC Table S–3. For low-level waste disposal at land burial facilities, the NRC notes in Table S–3 that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, the NRC notes that these are to be buried at a repository and that no release to the environment is expected to be associated with such disposal because the gaseous and volatile radionuclides contained in the spent fuel would have been released and monitored before the disposal. NUREG-0116, which provides background and context for the high-level and transuranic NRC Table S–3 values, indicates that these high-level and transuranic wastes will be buried and will not be released to the environment.

For the reasons stated above, the environmental impact of radioactive waste disposal is SMALL, and does not warrant mitigation.

5.7.1.7 **Occupational Dose**

The estimated annual occupational dose attributable to all phases of the UFC is approximately 1074 person-rem per reactor-year for Fermi 3. This is based on a 600 person-rem per reactor-year occupational dose estimate attributable to all phases of the UFC for the reference 1000 MWe LWR. Occupational doses would be maintained to meet the dose limit of 5 rem/yr in 10 CFR 20. The environmental impact from this occupational dose is SMALL.

For the reasons stated above, the environmental impact from this occupational dose is SMALL, and does not warrant mitigation.

5.7.1.8 **Transportation**

The transportation dose to workers and the public totals approximately 2.5 person-rem annually for the reference 1000 MWe LWR as presented in Table 5.7-2. This corresponds to a dose of 4.5 person-rem per reactor-year for Fermi 3. Estimated dose to workers is below established safe limit.

On the basis of this comparison, the environmental impact of transportation from the UFC is SMALL, and does not warrant mitigation.

5.7.1.9 **Summary**

The environmental impacts of the UFC, as given in NRC Table S-3, have been evaluated considering the effects of radon-222 and technetium-99 releases based on the information presented in the GEIS. For determination of "small radiological impact" compliance with dose and release levels were utilized. Arguments based on comparison with natural background radiation were used only where dose and release levels cannot be established without great uncertainty, e.g., for large populations. The GEIS, Vol. 1, Section 6.2.4, Conclusions, states that "The aggregate nonradiological impact of the UFC resulting from the renewal of an operating license on any plant is small". Based on this evaluation, the impacts associated with the UFC are SMALL, and mitigation would not be warranted.

5.7.2 **Transportation of Radioactive Materials**

The description and analysis of the environmental impacts of transporting fuel and waste to and from Fermi 3 are discussed in Section 3.8.

5.7.3 **References**

5.7-1 Council on Environmental Quality, "The Seventh Annual Report of the Council on Environmental Quality," Executive Office of the President, Administrative Operations Branch, 1976.

5.7-2 National Cancer Institute, "Cancer in Populations Living Near Nuclear Facilities," National Institutes of Health, Publication 90-874, 1990.

5.7-3 U.S. Nuclear Regulatory Commission, "Reactor Concepts Manual, Natural and Man-Made Radiation Sources," www.nrc.gov/reading-rm/basic-ref/teachers/06.pdf, accessed 18 April 2008.

Table 5.7-1 Scaling Factor - Reference LWR and Fermi 3

	10 CFR 51.51 Reference LWR	**Fermi 3 ESBWR**
Electric Output	1000 MWe	1535 MWe
Capacity Factor	80%	93%
Effective Electric Output	800 MWe	1428 MWe
Scaling Factor	1.00	1.79

Table 5.7-2 Summary Table S-3 – Uranium Fuel Cycle Environmental Data[1][2] (Sheet 1 of 3)

Environmental Considerations	Reference LWR	Fermi 3
Natural Resource Use		
Land (acres):		
Temporarily committed [3]	100	179
Undisturbed area	79	141
Disturbed area	22	39
Permanently committed	13	23
Overburden moved (millions of MT)	2.8	5.0
Water (millions of gallons):		
Discharged to air	160	286
Discharged to water bodies	11,090	19,851
Discharged to ground	127	227
Total	11,377	20,365
Fossil fuel:		
Electrical energy (thousands of MWh)	323	578
Equivalent coal (thousands of MT)	118	211
Natural gas (millions of scf)	135	242
Effluents - Chemical (MT)		
Gases (including entrainment): [4]		
SO_x	4400	7876
NO_x [5]	1190	2130
Hydrocarbons	14	25
CO	29.6	53.0
Particulates	1154	2066
Other gases:		
F	0.67	1.20
HCl	0.014	0.025
Liquids:		
$SO_4^{=}$	9.9	17.7
NO_3^-	25.8	46.2
NO_3 dilution water (cfs)	20	36
Fluoride	12.9	23.1
Fluoride dilution water (cfs)	70	125
Ca^{++}	5.4	9.7

Table 5.7-2 Summary Table S-3 – Uranium Fuel Cycle Environmental Data(1)(2) (Sheet 2 of 3)

Environmental Considerations	Reference LWR	Fermi 3
Liquids: (continued)		
Cl^-	8.5	15.2
Na^+	12.1	21.7
NH_3	10.0	18
NH_3 dilution water (cfs)	600	1074
Fe	0.4	0.7
Tailings solutions (thousands of MT)	240	430
Solids	91,000	162,890
Effluents—Radiological (Curies)		
Gases (including entrainment):		
Rn-222	5200	9308
Ra-226	0.02	0.04
Th-230	0.02	0.04
Uranium	0.034	0.061
Tritium (thousands)	18.1	32.4
C-14	24	43
Kr-85 (thousands)	400	716
Ru-106	0.14	0.25
I-129	1.3	2.3
I-131	0.83	1.49
Tc-99	0.012	0.021
Fission products and transuranics	0.203	0.363
Liquids:		
Uranium and daughters	2.1	3.8
Ra-226	0.0034	0.0061
Th-230	0.0015	0.0027
Th-234	0.01	0.02
Fission and activation products	5.9×10^{-6}	1.1×10^{-5}
Solids (buried onsite):		
Other than high level (shallow)	11,300	20,227
TRU and HLW (deep)	1.1×10^{7}	2.0×10^{7}
Other		
Effluents—thermal (billions of BTU)	4063	7273

Table 5.7-2 Summary Table S-3 – Uranium Fuel Cycle Environmental Data(1)(2) (Sheet 3 of 3)

Environmental Considerations	Reference LWR	Fermi 3
Transportation (person-rem)		
Exposure of workers and general public	2.5	4.5
Occupational exposure	22.6	40.5

Notes:

1. Reference LWR column is normalized to model LWR annual fuel requirement in WASH-1248 or reference reactor-year in NUREG-0116 as listed in NRC Table S-3.
2. NRC Table S-3 does not include estimates of releases of radon-222 from the uranium fuel cycle or estimates of technetium-99 released from waste management or reprocessing activities. Radiological impacts of these two radionuclides are addressed in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," and it was concluded that the health effects from these two radionuclides posed a small significance.
3. The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.
4. Estimated effluents based on combustion of coal for equivalent power generation
5. 1.2% from natural gas use and process

Table 5.7-3 Comparison of Annual Average Dose Received by an Individual from All Sources

Source	Dose (mrem/yr)	Percent of Total
Natural		
Radon	200	55
Cosmic	27	8
Terrestrial	28	8
Internal (body)	39	11
Total natural sources	300	82
Artificial		
Medical x-ray	39	11
Nuclear medicine	14	4
Consumer products	10	3
Total artificial sources	63	18
Other		
Occupational	0.9	<0.30
Nuclear fuel cycle	<1	<0.03
Fallout	<1	<0.03
Miscellaneous sources	<1	<0.03

Source: Reference 5.7-3

5.8 Socioeconomic Impacts

This section addresses the socioeconomic impacts of Fermi 3 operation on the region and, in particular, the primary impact area consisting of Monroe, Wayne, and Lucas counties. The impacts discussed are arranged according to physical impacts (Subsection 5.8.1), social and economic impacts (Subsection 5.8.2), and environmental justice impacts (Subsection 5.8.3).

The operational impacts of Fermi 3 are discussed below using the same general approach used to evaluate construction impacts in Section 4.4. The impact analysis in this subsection is based on an assumed operating workforce size of 900 full time and contract employees, which is slightly below the Fermi 2 workforce (800 employees plus 150 contract employees). These workers will be divided into multiple shifts such that the plant will be staffed 24 hours per day, all days of the year.

A 2004 study prepared for the Department of Energy titled: “Study of Construction Technologies and Schedules, O&M Staffing and Cost, Decommissioning Costs and Funding Requirements for Advanced Reactor Designs (Volume 1)”, called the DOE Staffing Study herein, has a list of staffing job categories for a number of nuclear technologies, including the ESBWR technology. Section 3 of the DOE Staffing Study lists more than 200 position categories organized into several staffing departments. The primary departments are listed below, and a summary listing of some of the key job categories is also provided:

- Management – includes director positions over O&M and safety, plus various corporate services such as financial support.
- Operations – includes manager of operations positions and support, shift licensed and non-licensed operators, shift supervisors, operations engineers, refueling operators, clerks and administrative support.
- Engineering – includes the engineering manager and administrative support, systems engineers, reactor engineers, component engineers, civil and mechanical engineers, and records clerks.
- Maintenance – includes the maintenance manager and administrative support, electricians and electrical supervisors, mechanics and supervisors, I&C technicians, outage scheduling personnel, outage inspectors, and maintenance procurement workers.
- Outage and Planning – includes the outage and planning manager and administrative support, the nuclear scheduling supervisor, electrical schedulers and planners, mechanical schedulers and planners, I&C schedulers and planners, unit outage coordinator, and turbine maintenance specialists.
- Major Modification and Site Support – includes the nuclear support services manager and administrative support, the construction engineering supervisor, construction engineers, quality inspectors, electrical construction specialists and supervisors, civil/mechanical construction specialists and supervisors, project controls specialists and supervisors, labor support and supervisors, and construction equipment management.

- Organizational Effectiveness – includes the licensing supervisor and engineers, nuclear safety supervisor, and corrective action coordinators.
- Radiation Protection – includes radiation protection manager and administrative support, health physicist technicians and supervisors, radwaste technicians and supervisor, and chemistry technicians and supervisor.
- Training – includes the nuclear training manager and administrative support, operations initial training supervisor and staff, operations continuing training supervisor and staff, and maintenance/rad protection training supervisor and staff.
- Security – includes the protection services manager and administrative support, security supervisors, security officers, safety and loss prevention personnel, and the site emergency planning personnel.
- Supply Chain Management – includes the supply chain manager and administrative support, the warehouse supervisor and storekeepers, receiving and inspection workers, and emergent sourcing specialists.
- Telecommunications – includes the IT manager, business analysts, local area network field services workers, and telecommunications services.

The analysis in Section 5.8 assumes a commercial operation date of 2020 and assumes a settlement pattern for the Fermi 3 operating staff that reflects the Fermi 2 staff settlement pattern, whereby most of the employees reside in Monroe County (58 percent), Wayne County, (19 percent), and Lucas County (10 percent), with the remaining 13 percent of employees disbursed among at least eight other counties including Washtenaw (3 percent), Oakland (3 percent), Wood (2 percent), Lenawee (1 percent), and others (4 percent but no single county above 1 percent). The approximate Michigan and Ohio percentages are 87 percent and 13 percent, respectively.

In addition to the full time work force, additional personnel will work at the Fermi site during scheduled maintenance and forced outages. The maintenance and outage workforce peaks during refueling outages that would be expected to occur every 24 months. Based on Fermi 2 experience, the additional temporary maintenance staff onsite during the refueling will be between 1200 and 1500 workers.

5.8.1 Physical Impacts of Station Operation

Physical impacts of station operation on the region and nearby communities could potentially include impacts on nearby populations, buildings, roads and cultural or recreational facilities. The potential for such impacts are discussed below and are based on the Fermi 3 layout described in Section 2.1. Transportation impacts are discussed in Subsection 5.8.2.4.2.

5.8.1.1 People

According to the Census data summarized in Table 2.5-2, approximately 3500 people live within five miles of the Fermi site. There are nearby full-time residences adjacent to the southwest and southeast portion of the Fermi site, with the nearest residence located approximately 660 feet west of the site on Langton Road. Most nearby residences are buffered by trees and undeveloped land on the site. People who could be impacted by noise, fugitive dust, and gaseous emission resulting from operation activities include the Fermi 3 operational staff, people living adjacent to the site, and transient populations near the site.

The Fermi 3 staff will be trained regarding the need to wear protective noise equipment in designated areas and will be required to do so. Additional activities taken to reduce noise impacts may include the restriction of certain noise producing activities to the daytime, the routing of project traffic, and the use of low vibration equipment onsite and equipment that is operated and maintained according to recommended practices. Additional safety procedures are described in Subsection 5.8.2.4.3. Populations living near the site will be protected due to their distance from the Fermi 3 facilities, the minimal increase in noise, and the existence of tree buffers between the Fermi 3 facilities and offsite residences. As a result of these practices and of the low increase in noise levels from operation (see Table 5.8-1 and Table 5.8-2), those staff working onsite or living near the Fermi site should not experience physical impacts from noise during operation of Fermi 3. As explained in Subsection 5.8.1.3, air emissions during operation are also not expected to have a significant impact on onsite or offsite populations. Consequently, any physical impacts to people from operational activities should be SMALL, and would not require mitigation activities over and above normal operational practices.

5.8.1.2 **Buildings and Recreational/Cultural Facilities**

Operational activities should not impact any offsite buildings and residences due to the geographic separation between Fermi 3 and such structures. Onsite buildings are designed and constructed to safely withstand possible impacts from operational activities associated with the proposed project. Table 5.8-1 and Table 5.8-2 present data on attenuated noise levels at nearby noise receptors expected from the operation of Fermi 3. As indicated in these tables, the change in noise levels at nearby receptors will be hardly noticeable by populations; also, noise at the levels indicated will not adversely affect building structures.

Figure 2.5-16 shows several recreational facilities within the vicinity of Fermi 3, including wildlife conservation areas that provide hiking, fishing, and other recreation opportunities. The closest recreation areas to Fermi 3 are along the Lake Erie shore and are associated with the resort communities at Stony Point Beach, approximately 2 miles south, and Estral Beach, approximately two miles northeast. The DRIWR extends along the shore of Lake Erie from the River Raisin to the south of the Fermi site to southern Detroit north of the Fermi site. The area encompasses 656 acres of the Fermi site as part of the refuge; however, the DRIWR on the Fermi site is not open to the public (Subsection 2.5.2). In addition, the following areas in the Fermi 3 vicinity are available for recreation (utilization of these facilities is not tracked):

1. Swan Creek: 0.52 mile north of the Fermi site
2. Pointe Mouillee State Game Area: 3.1 miles northeast
3. William C. Sterling State Park: 4.8 miles south-southwest
4. Captain Norman Heck Park: 5.5 miles southwest
5. Raisin River Golf Club: 5.4 miles southwest

6. Lake Erie Metropark (Wayne County): 6.6 miles north-northeast
7. Monroe Multi-Sport Complex: 7 miles southwest in Monroe

Although there are cultural and recreational resources located within the 10-mile radius of the site, all are located at least half a mile from the site and the potential for noise or air emission impacts during Fermi 3 operation will be minimal due to this distance and the natural buffers on the site. Therefore, no significant impacts due to Fermi 3 operation are expected.

Accordingly, the effects of physical impacts to buildings and recreational/cultural resources from operational activities are anticipated to be SMALL, and should not warrant mitigation.

5.8.1.3 **Noise**

5.8.1.3.1 **Applicable Regulations and Criteria**

Fermi 3 is located in unincorporated Frenchtown Township, in Monroe County. There are neither applicable township noise regulations, nor extant county or State regulations regarding noise emissions. The GEIS (Reference 5.8-1) provides the following regarding noise impact and sound levels:

> When noise levels are below the levels that result in hearing loss, impacts have been judged primarily in terms of adverse public reactions to the noise. Generally, power plant sites do not result in offsite levels more than 10 dB(A) above background. However, some sites have calculated impacts to critical receptors at this level and above. Noise level increases larger than 10 dB(A) would be expected to lead to interference with outdoor speech communication, particularly in rural areas or low-population areas where the day-night background noise level is in the range of 45-55 dB(A). Generally, surveys around major sources of noise such as large highways and airports have found that, when the day-night level increases beyond 60 to 65 dB(A) (FICN 1992), noise complaints increase significantly. Noise levels below 60 to 65 dB(A) are considered to be of small significance.

The EPA identifies yearly day-night average sound levels (L_{dn}), sufficient to protect public health and welfare from the effects of environmental noise (Reference 5.8-2). According to the EPA, yearly levels are sufficient to protect public health and welfare if they do not exceed an L_{dn} of 55 dB(A) outdoors in sensitive areas such as residences, schools, churches, and hospitals. The day-night sound level, L_{dn}, is the 24-hour average sound level with a penalty weighting applied to the nighttime sound levels to account for increased sensitivity to noise during nighttime hours. The EPA guideline equates to a daytime sound level (L_d) of 55 dB(A) and a night-time sound level (L_n) of 45 dB(A). The EPA emphasizes that because the protective sound levels were derived without concern for technical or economic feasibility, and contain a margin of safety to ensure their protective value, they must not be viewed as standards, criteria, regulations, or goals. Rather, they should be viewed as levels below which there are no reasons to suspect that the general population will be at risk from any of the identified effects of noise. Notwithstanding the above guidance, the EPA has no authority to regulate ambient noise levels.

Human response to sound is highly individualized. Annoyance is the most common issue regarding community noise. The percentage of people claiming to be annoyed by noise will generally increase as environmental sound levels increase. Various references (Reference 5.8-3 through Reference 5.8-6) discuss the subjectivity of changes in sound level. Based on these, a three dB change in a continuous broadband noise is generally considered "just barely perceptible" to the average listener. A five dB change is generally considered "clearly noticeable" and a 10 dB change is generally considered a doubling (or halving) of the apparent loudness.

The Occupational Safety and Health Administration (OSHA) has established worker noise exposure limits (Reference 5.8-7). The OSHA worker noise exposure limits are based on a worker's noise exposure over a specific time period. When worker noise exposure exceeds the permissible noise exposure, feasible engineering or administrative controls must be implemented to reduce the noise exposure. Fermi 3 will comply with OSHA requirements for personnel hearing protection.

5.8.1.3.2 **Facility Noise Sources**

Primary audible noise sources associated with normal station operation include the transformers, the cooling systems (natural draft cooling tower), and transmission lines.

Noise emissions from cooling systems equipment are discussed in Subsection 3.4.1.6.

The IEEE C57.12.00 (Reference 5.8-8) sound levels (near field at 1-3 feet from the equipment) for the transformers are expected to be 90 dB(A) for the main transformers and 86 dB(A) for the unit and reserve auxiliary transformers.

Noise emissions from the transmission line are discussed in Subsection 3.7.4.

5.8.1.3.3 **Operational Noise Emissions**

Environmental noise emissions for normal station operation are modeled in accordance with ISO 9613, Parts 1 and 2 (Reference 5.8-9 and Reference 5.8-10), using noise prediction software (Cadna/A version 3.6.119). The model simulates the outdoor propagation of sound from each noise source and accounts for sound wave divergence; absorption from the atmosphere, the ground, and areas of dense foliage; sound directivity; and shielding due to interceding barriers and topography. A database is developed which specifies the location, octave band sound levels, and sound directivity of each noise source. A receptor grid is specified which covers the entire area of interest. The model calculates the overall A-weighted sound pressure levels within the receptor grid based on the octave band sound level contribution of each noise source. Finally, a noise contour plot is produced based on the overall sound pressure levels within the receptor grid, including specific receptor locations.

The estimated sound levels from normal station operation (Fermi 3 equipment only) are shown graphically on the noise contour plot of Figure 5.8-1. Sound levels at the nearest noise sensitive receptors (see Subsection 2.5.5) resulting from normal station operation are provided in Table 5.8-1 and Table 5.8-2.

5.8.1.3.4 **Potential Impacts**

Table 5.8-1 provides the lowest ambient sound level with Fermi 2 (only) in operation based on the results of the ambient sound level survey presented in Subsection 2.5.5. As stated in Subsection 2.5.5, the Noise Monitoring Locations (NML) represent the nearest noise-sensitive receptors within a 5-mile radius of the Fermi facility. The expected ambient sound levels, as well as the increases in ambient sound levels, resulting from Fermi 3 operation are also presented in Table 5.8-1. The maximum expected increase in ambient sound level of 6 dB is expected to occur at receptor NML-2. This increase is a generally noticeable change in ambient sound level that will only occur during the quietest nighttime hours. During other times of day and night, the existing acoustical environment is not expected to change significantly as a result of the operation of Fermi 3.

Table 5.8-2 provides the existing and predicted future day-night sound levels (L_{dn}) at three of the nearest noise-sensitive receptors. No significant change in L_{dn} at the nearest receptors is expected to occur due to the operation of Fermi 3. Based on the results in Table 5.8-1 and Table 5.8-2 and the accompanying discussion above, the potential noise impacts due to the operation of Fermi 3 are expected to be SMALL, and no mitigation measures are necessary.

5.8.1.4 **Background Air Quality**

The Fermi site is located in the northeastern tip of Monroe County and along the western shoreline of Lake Erie. Air quality at the Fermi site is heavily influenced by the Detroit and Toledo Metropolitan areas and surrounding emission sources. The MDEQ evaluates the air quality in the Detroit Metropolitan area with a network of monitors mostly located in Wayne County, north of the Fermi site. The MDEQ routinely monitors USEPA criteria pollutants of NO_2, SO_2, CO, $PM_{2.5}$, PM_{10}, and Ozone. Monroe County and the counties that include the Detroit metropolitan area are ruled by USEPA as a non-attainment area for the annual $PM_{2.5}$ standard and a maintenance area for the 8-hour ozone standard (Reference 5.8-11). The USEPA as of March 12, 2008 strengthened the definition of ozone non-attainment areas as those that record a 3-year average of the fourth highest daily maximum 8-hour average ozone concentration of 0.075 ppm or higher (Reference 5.8-12). For $PM_{2.5}$ the USEPA considers areas in violation of the standard when the 3-year average of the weighted annual mean $PM_{2.5}$ concentration is equal to or exceeds 15 $\mu g/m^3$. Detroit Edison intends to comply with the USEPA ambient air quality standards and pollutant levels during the construction and operation of Fermi 3.

Class I Areas as defined by the Clean Air Act are national parks greater than 6,000 acres, wilderness areas and national memorial parks greater than 5,000 acres, and international parks that have stringent protection from air pollution damage. There are no Class I Areas that are located within 186 miles of the Fermi site (Reference 5.8-13). Given the minor nature of air emissions associated with operations of the facility (discussed below), this distance is sufficiently far as to not warrant a concern.

5.8.1.5 **Projected Air Quality**

Criteria Pollutants

Air emissions of criteria pollutants will be minor given the nature of a nuclear facility and its lack of significant gaseous exhausts or effluents to the air. Sources of air emissions for the proposed facility include two standby diesel generators, two ancillary diesel generators, an auxiliary boiler, and two diesel-driven fire pumps, as well as a natural draft cooling tower (NDCT). A 4-cell mechanical draft cooling tower will serve as the auxiliary heat sink (AHS), but will only be operated during limited normal operating scenarios and shutdown of Fermi 3. The combustion sources mentioned above will be designed for efficiency and operated with good combustion practices on a limited basis throughout the year (often only for testing). Given their small magnitude of size and infrequent operation, these emissions will not only have little effect on the nearby ozone maintenance and $PM_{2.5}$ non-attainment areas, but will have minimal impact on the local and regional air quality as well. The estimated emissions of criteria pollutants from fossil fuel combustion in the standby diesel generators, ancillary diesel generators, auxiliary boiler, and diesel-driven fire pumps during Fermi 3 operation are provided in Table 3.6-3, Table 3.6-4, Table 3.6-5, and Table 3.6-6, respectively, of Subsection 3.6.3.1. Final emissions will depend upon the specific equipment selected for implementation, but emissions from all equipment will be within regulatory guidelines set by Federal and State agencies to be protective of air quality in the Fermi region. The air emissions from all equipment are regulated by the MDEQ.

The proposed NDCT will not be a source of the typical combustion-related criteria pollutants or other toxic emissions. They will, however, emit small amounts of particulate matter as drift. The tower will be equipped with drift eliminators designed to limit drift to 0.001 percent or less of total water flow. The height of the tower will allow for good dispersion of the drift and not allow localized concentrations of particulate matter to be realized. The estimated emissions of $PM_{2.5}$ and PM_{10} during Fermi 3 operation are provided in Subsection 3.6.3.1. The minor nature of the effects of the new cooling tower on visibility and air quality, including potential for increases in ambient temperature and moisture, icing, fogging, and salt deposition, are discussed in further detail in Subsection 5.3.3.1. As discussed in Subsection 5.3.3.1, the impacts of the cooling towers' operation are expected to be localized and minor in nature.

During operation, no impacts associated with dust are expected to exist outside the Fermi site because it is relatively isolated and has a significant buffer between the operations area and offsite permanent populations and structures. Additional measures to limit airborne dust such as watering, reseeding, or paving areas used for construction can be used if necessary. Combustion sources burning fossil fuels are not typically sources of odor emissions as they do not process or treat effluent streams rich in odorous compounds such as hydrogen sulfide. Additionally, no open burning will occur during the operational phase. Accordingly, the potential air impacts due to the operation of Fermi 3 are expected to be SMALL, and no mitigative measures are needed.

<u>Carbon Dioxide</u>

Various types of mobile vehicles will emit carbon dioxide (CO_2) during Fermi 3 onsite operational activities. The expected mobile vehicle activities include worker arrivals and dismissals, deliveries of materials and fuel, and disposal of wastes each making one daily round-trip between the Fermi site front security gate and the proposed Fermi site parking garage. Additional emissions will come from the operation of heavy equipment and support vehicles on the Fermi site.

The annual emissions estimate of CO_2 associated with the operation of Fermi 3 is based on the following assumptions:

- Certain data for Fermi 3, such as the number and frequency of worker vehicles arriving at the site, mobile vehicle fuel usage, and total annual shipments/exports of fuels, materials, and wastes, are the same as those historically recorded for Fermi 2.
- Estimates of emissions from worker vehicles use a split of 50% passenger cars and 50% light-duty trucks.
- Appropriate CO_2 factors are available from documents published by the US Environmental Protection Agency (USEPA).

The following paragraphs provide a practical estimate of CO_2 emissions from mobile sources during the operation of Fermi 3.

Worker Vehicles

In order to estimate emissions of CO_2 from worker vehicles during operation of Fermi 3, CO_2 vehicle emission factors were obtained from published USEPA documentation for both passenger cars and light-duty trucks. The analysis also utilized data on the number and frequency of worker vehicles by operational mode (e.g., normal operations - weekday, normal operation – weekend, outage – weekday, and outage – weekend) recorded for the operation of Fermi 2 assuming similar traffic will be experienced during the operation of Fermi 3. By taking the product of the CO_2 emission factors for worker vehicles, the Fermi 2 recorded number of workers onsite during various operational modes, and the round trip distance a worker vehicle travels between the front security gate and the parking garage, the annual emissions of CO_2 from worker vehicles during operation of Fermi 3 is estimated as shown in Table 5.8-3.

On-Site Support Vehicles and Heavy Equipment

On-site support vehicles and any other mobile heavy equipment used at the Fermi site are currently operated using fuel dispensed at the facility. Therefore, CO_2 emissions from the use of on-site support vehicles and mobile heavy equipment were derived using USEPA published factors of emissions per gallon of fuel consumed and historical annual fuel dispensing records for the operation of Fermi 2 assuming similar usage of this type of equipment during the operation of Fermi 3. The annual emissions of CO_2 from on-site support vehicles and heavy mobile equipment during operation of Fermi 3 is estimated as shown in Table 5.8-4.

Deliveries of Materials and Fuels and Disposal of Wastes

CO_2 emissions from deliveries of various materials and fuel and disposal of radioactive wastes are derived using USEPA published factors which require the weight of material transported and a transport distance as inputs. Weights of materials required by the emission factor were obtained from various resources and assumptions such as Fermi 3 project design elements for fuel requirements, historical radioactive waste generation values for the state of Michigan, and the assumption that all materials disposed of by Fermi 2 are equivalent to the deliveries of materials necessary for the operation of Fermi 3. By taking the product of the selected CO_2 emission factor, the shipping weights, and the distance the vehicle travels between the front security gate and the proposed Fermi site parking garage, the annual emissions of CO_2 from deliveries of materials and fuels and disposal of wastes are estimated as shown in Table 5.8-5.

The total estimate of CO_2 emissions resulting from worker vehicles, onsite support vehicles and heavy equipment, as well as deliveries and removal of materials and fuels is 853.2 tons/year. This estimate of CO2 emissions from mobile sources is insignificant compared to the estimated 7,734 tons/year of CO2 emitted annually from stationary sources presented in ER Subsection 3.6.3.1.

5.8.2 Social and Economic Impacts of Station Operation

This section discusses the social and economic impacts of Fermi 3 operation. The analysis is based, in part, on the socioeconomic information contained in Subsection 2.5.1 and Subsection 2.5.2.

5.8.2.1 Demography

The social and economic impacts during Fermi 3 operation will primarily be a function of the number of operational and maintenance workers and their place of residence within the primary impact area. Of the projected Fermi 3 operational workforce of 900, it is reasonable to assume that approximately two-thirds, or 600 workers will be hired from within the primary impact area and that, due to the specialized nature of the jobs, up to 300 workers will be hired from outside the primary impact area and will relocate on a long-term basis. Table 5.8-7 indicates the settlement pattern projected for the Fermi 3 workforce based on the assumptions made at the beginning of Section 5.8. Thus, based on the settlement pattern for Fermi 2, Monroe County is assumed to be the home for 174 of the relocating operations staff, followed by Wayne County (57) and Lucas County (30).

The population impact from relocating workers and families is calculated based on the weighted average household size for the primary impact area counties of 2.6 persons per household (based on data from Table 2.5-18). Table 5.8-7 indicates that 261 workers (out of 300 total relocating workers to the region) and a total of 678 persons would be added to the primary impact area population when the Fermi 3 operations staff relocates prior to commercial operation. The projected population increase includes 452 persons in Monroe County, 148 persons in Wayne County, and 78 persons in Lucas County. Given that the combined population of these three counties is projected to be nearly 2.5 million in 2020, the increase of 678 persons will be a SMALL population impact, and no mitigation measures are needed.

5.8.2.2 Local Housing

The Fermi 3 operating staff relocating to the primary impact area counties will have some impact on the local housing market. It is assumed that 261 of the 300 relocating Fermi 3 operational workforce will establish a household in the counties of Monroe (174 new households), Wayne (57 new households), and Lucas (30 new households). In total, these 261 new households would represent less than a one percent (0.03 percent) increase in the 1,005,059 households in the primary impact area counties in 2000 (from Table 2.5-18), and 0.4 percent of the 73,816 vacant housing units in 2000. This small percentage increase would have only a SMALL impact on the primary impact area housing market.

Within the individual primary impact area counties, the largest impact would be expected in Monroe County, where 174 new households are forecast. This number of new households would represent 0.3 percent of the total housing units in 2000, 6.4 percent of vacant units in 2000, and 3.7 percent of the 4685 vacant units in 2006. The projected 57 new households in Wayne County would represent an insignificant percentage (< 0.01 percent) of the 826,145 housing units in 2000, 0.1 percent of vacant units in 2000, and 0.05 percent of the vacant units in 2006. In Lucas County, the 30 new households would represent 0.02 percent of the total housing units in 2000, 0.2 percent of vacant units in 2000, and 0.1percent of the vacant units in 2006. These percentages, while a SMALL impact, likely overstate the impact as new staff may choose to construct a new house, and because there will otherwise be more housing units constructed by 2020.

5.8.2.3 **Tax Payments**

Tax payments from the operation of Fermi 3 will be generated from property taxes paid by Detroit Edison, from property taxes paid on real estate and personal property owned by operational staff, and by sales tax on goods and services purchased by Detroit Edison and by operational staff. Attempting to estimate the amount of taxes collected from Fermi 3 staff and from Detroit Edison purchases of local materials and supplies during operation is very difficult. However, these revenues are expected to be similar to those resulting from Fermi 2 operation.

By far the most important source of taxes is expected to be the property taxes or payments in lieu of taxes for Fermi 3 that are collected by Monroe County. As seen in Table 2.5-31, Detroit Edison had a taxable assessed value of over $822 million in 2006, and this comprised 12.62 percent of the total county tax levy. Also in looking at Table 2.5-70, the total amount of property taxes paid by Fermi 2 has declined by approximately $10 million from 2002 to 2007. With the addition of Fermi 3, a significant new asset will be added to the tax base and this will help offset the decrease in taxable value from Fermi 2. The addition of Fermi 3 will help address the issue identified in the Frenchtown Township Master Plan, which stated:

> In 1989, the Fermi plant (building and land alone) represented fully 74% of the property tax base in the Township. While this represented a windfall for the Township, it is in fact a temporary condition…beginning around the year 2000, the taxable value of the Fermi plant began to decline and will continue to decline in coming years. By 2002, the Fermi plant represented only 49% of the property tax base in the Township (Reference 5.8-14).

The addition of Fermi 3 will significantly increase the local revenues over the long-term and will result in a much smaller cost burden for residents compared to a scenario in which Fermi 3 is not placed in service.

In addition to the taxes collected directly from the Fermi plant there is also the additional taxes gained from the operating staff via property, sales and other taxes. Projecting the increase in various taxes that will arise from Fermi 3 operation will depend on many factors that are not known at this time with certainty such as the residential location of the workforce, whether they purchase existing homes or build new homes, and changes in various sales tax rates. However, an order of magnitude impact assessment can be developed based on the information in Table 2.5-36, which lists various forms of taxation, including property and sales tax, stated on a per capita and per $1000 of personal income basis for Michigan and Ohio.

Based on the taxes per $1000 of personal income in Table 2.5-36, applied to the estimated total annual income ($66,868 per employee in 2008 dollars, see Subsection 5.8.2.7) for the 900 permanent and contract workers, Table 5.8-6 projects the various categories of taxes that could reasonably accrue, based on the assumed distribution of worker residence in Michigan (87 percent) and Ohio (13 percent). Results in the table indicate that, in 2008 dollars, it is reasonable to assume that the project would generate $52.3 million in annual income to Michigan-based employees, and $7.8 million to Ohio-based employees. From these amounts, approximately $5.4 million in total Michigan taxes associated with worker personal income, with $2.1 million in property taxes and $1.3 million in general sales taxes comprising the largest categories, followed by $1.0 million in individual income taxes and $0.5 million in selective sales taxes. In Ohio, a total of $0.8 million would be expected annually, with individual income taxes comprising the largest category. These figures do not include the impacts of the periodic temporary maintenance staff that will be needed at the site during refueling and other outages or maintenance periods.

By far the most important source of taxes is expected to be the property taxes or payments in lieu of taxes for Fermi 3. Property tax payments will be the subject of negotiations, but will be a significant contributor to the county's revenue. The addition of Fermi 3 will significantly increase the local revenues over the long-term and will result in a much smaller cost burden for residents compared to a scenario in which Fermi 3 is not placed in-service.

5.8.2.4 **Local Public Services**

There is the potential that the demand for a number of local public services in the primary impact area counties will be impacted by the operation of Fermi 3. On the positive side, an increase in the population base will increase taxes and user fees for the continued funding of facilities and services. This is especially important for Wayne County and Lucas County, which have experienced population decreases since 1990 (see Table 2.5-9). The potential for negative impacts is also present, however, and could arise if the relocation of workers occurred rapidly and out paced the ability of a county or community to provide for the sudden increase in demand for these services.

The potential for a significant increase in the demand for public services is primarily a function of the number of relocating worker and family populations as a percentage of the overall county population. By comparing the 2020 population projections for each county with the Fermi 3-related increase in population shown in Table 5.8-7, it is determined that the largest population increase in the primary impact area would be 0.26 percent of the projected 2020 county population in Monroe

County. This growth, however, would be well within the projected 0.94 percent annual average growth rate projection for the county, which is equal to the historical growth rate from 1990 through 2005. Therefore, the inflow of Fermi 3-related populations should not present an unexpected increase in the demand for local public services.

In Wayne and Lucas counties, the long-term population trend has consisted of a slow population decline, and the influx of Fermi 3-related populations would not be large enough to impact the overall trend of population decline. This suggests that the influx of Fermi 3-related populations would not create a surge in the demand for community facilities and services. It is also important to note that the operational workforce assumed to relocate into the primary impact area for operation will do so gradually before the Fermi 3 commercial operation date, thereby avoiding a sudden increase in the demand for local public services.

The factors above support the conclusion that the overall impact on public services and facilities would be SMALL. Accordingly, there is no need to adjust public facilities and services during the transition period from construction to operation phases.

5.8.2.4.1 **Education**

Based on the assumed settlement pattern of 261 Fermi 3 operating staff in the primary impact area, applied to the average number of students per occupied household (Monroe County 0.44 students per occupied household, Wayne County 0.5 students per occupied household, and Lucas County 0.4 students per occupied household), a net increase of 118 students would be expected in the primary impact area. Of this total, 77 new students would be expected in Monroe County, 29 new students would be expected in Wayne County, and 12 new students would be expected in Lucas County.

The largest impact from new Fermi 3-related student populations would be in Monroe County, although the increase would comprise only 0.3 percent of the 2005-2006 enrollment level of 25,963 (per Table 2.5-43) in the county schools. Discussions with personnel in Monroe County indicated that no significant difficulties in accommodating the new student population would be expected, assuming the county is informed of the general Fermi 3 schedule

The increase in student populations would also be insignificant in Wayne County (2005-2006 enrollment of 359,643 students, per Table 2.5-44) and Lucas County (2005-2006 enrollment of 73,146 students, per Table 2.5-45). Further, considering the long-term negative population trend in these two counties, enrollment levels in 2020 are likely to be below the 2005-2006 levels, and additional student populations will likely be seen as a positive impact that could help avoid the closure of some schools. Therefore, for all three counties, the impact on education would be a SMALL impact, and no mitigative measures are needed.

5.8.2.4.2 **Transportation**

Transportation impacts due to Fermi 3 operation will include those arising from the estimated 900 member Fermi 3 operational workforce, deliveries that will be dispersed throughout the day, and the periodic need for maintenance workers that may peak at 1200 to 1500 workers during the refueling outages that are expected to occur every 24 months. Impacts will be especially concentrated on North Dixie Highway near Fermi Drive as vehicles slow down to enter the site. Based on the average daily traffic count of 5,580 shown on Figure 2.5-25 on North Dixie Highway just south of Fermi Drive, the impact of Fermi 3 operation could increase the traffic volume on this road by nearly 50 percent during refueling periods every 24 months, and would otherwise increase the traffic volumes by approximately 20 percent over the 2006 levels. However, because Fermi 2 and Fermi 3 would not typically be in a refueling outage concurrently, the Fermi 3 outage traffic would be comparable to Fermi 2 outages. Additionally the expansion of Fermi Drive during Fermi 3 construction (see Subsection 4.4.2.4.2) is a permanent improvement that will help ease congestion during the Fermi 3 operational phase.

The transportation impact of the operational workforce will be a function of multiple factors such as the number of workers and the workforce commuting pattern, including average distance traveled to the Fermi site. It is reasonable to assume that the Fermi 3 operational workforce will be reflective of the Fermi 2 operational workforce in terms of the dispersion of residences in the project region. Therefore, an idea of the average commuting distance of the Fermi 3 workforce can be estimated from collecting data on the residential location of the Fermi 2 workforce, assigning an average commuting distance to the workers located in various regional counties, and then calculating a weighted average commuting distance for the workforce.

In Table 5.8-4-(A), the counties of residence for the Fermi 2 operations workforce are presented, based on residential zip code data. The data indicate that Monroe County is home to 58 percent of the Fermi 2 operational workforce, followed by Wayne County (19 percent) and Lucas County (10 percent). Since it is reasonable to assume that the Fermi 2 workforce residential distribution will be a good indicator of the Fermi 3 operational workforce residential distribution, the second column of the table is titled “Fermi 2 and Projected Fermi 3 Operational Workforce Distribution.” To determine the average distance to the Fermi 3 site, the distance from the Fermi site to the approximate middle of the largest city in each county was estimated, and a weighted average distance was then calculated based on the percent of workforce by county. The result of the process indicates that the Fermi 3 operational workforce is projected to have an average commuting distance to the Fermi 3 site of 23.5 miles.

Low cost or no cost measures will be implemented to lessen transportation impacts, such as staggering the shift start time for the two unit operating staff and encouraging car pooling. Even so, there is the clear potential for MODERATE to LARGE traffic impacts near the site during refueling operations. Refer to Subsection 4.4.2.4.2 for discussion of the Level of Service (LOS) analysis to be conducted regarding the performance of traffic studies and mitigation activities, if required.

5.8.2.4.3 **Public Safety**

In addition to traffic, other safety impacts could potentially include impacts on the demand for safety and emergency services at the Fermi site and by workers and families relocating to the primary impact area. This could include demands on police, fire, ambulance, and hospital services. For each of these services, the impact created in the primary impact area counties by relocating population is a function of the percentage increase in population. As indicated previously, the 678 population increase in the primary impact area attributed to the relocation of a portion of the Fermi 3 workforce is only 0.03 percent of the projected 2020 population. The largest impact will be in Monroe County, where the projected population increase of 452 persons will be only 0.3 percent of the projected 2020 population and well within the 0.94 percent historical and projected average annual growth rate. Consequently, the impact on public safety arising from relocating workers and families will be SMALL.

The onsite demand for local public safety services should be SMALL as Fermi 3 design and operational practices will be undertaken with the specific intent to minimize or eliminate negative impacts, and to make Fermi 3 largely self-sufficient in these areas. An operational safety plan is to be developed for the site that conforms to industry requirements and regulations. This plan will facilitate a safe working environment for the operating workforce. The safety plan will comply with OSHA requirements, workers will undergo training to familiarize themselves with the safety plan, and the members of the workforce will be required to adhere to the requirements.

In addition, there will be limited access to the Fermi site, with security guards posted on site and a badge system to control personnel access. The site will include security lighting and fire suppression equipment. First aid stations will be established and maintained throughout the Fermi site. First aid training will also be provided to selected individuals in the workforce. Standard procedures will be adopted for spill prevention and containment, injury response, and requests for assistance from local police, fire, and ambulance services.

Should outside fire fighting and medical assistance be required, nearby emergency responders can be called upon and transportation to the Mercy Hospital in the City of Monroe can be provided, as well as transportation to other regional hospitals. Should fire fighting equipment be required and exceed the onsite capabilities, the Frenchtown Township fire station personnel in Fire Station No. 4, which is located at 6335 Point Aux Peaux Road, can be contacted. Assistance can also be requested from other stations in Frenchtown Township and all other departments in Monroe County, based on the mutual aid agreement that dates to 1986. Similarly, should Fermi onsite security require assistance, the Monroe County Sheriff's Office can be contacted. If additional support is needed, the Sheriff's Department can utilize its cooperative agreement with other regional departments. It is expected that the normal demand for such emergency and public safety services will be SMALL, and no mitigative measures are necessary.

5.8.2.4.4 **Public Utilities**

The impact on public utilities within the primary impact area associated with the relocation of operating personnel and families will be SMALL due to the disbursed settlement pattern and considering that in Monroe County, which will experience the largest percentage increase in population, the growth in population and households attributed to Fermi 3 operation will be well within the historical growth rates.

While the operation of Fermi 3 will require electricity, water, and waste facilities, Fermi 3 will be a net provider of electricity, and will have contracted for water and waste water facilities years in advance such that local providers can plan to have sufficient capacity available to meet the project needs and the demands of other customers in their jurisdiction. Detroit Edison will pay for all water and wastewater treatment used and, because the plant will be base loaded, Detroit Edison will help improve the utilization factor of facilities to the benefit of other users on the system. It is anticipated that Fermi 3 will route an average of 35 gpm of water and sanitary waste to the city of Monroe Wastewater Treatment Facility. Consequently, the impact on public utilities arising from relocating workers and families will be SMALL.

5.8.2.5 **Tourism and Recreation**

The impacts on recreation and tourism will primarily be limited to possible delays in traveling to recreational or tourist sights that require patrons to pass by Fermi on Dixie Highway at shift change. Consequently, the impact on public utilities arising from relocating workers and families will be SMALL.

5.8.2.6 **Land Use and Aesthetics**

The operation of Fermi 3 will be consistent with the land use pattern set forth in the Frenchtown Master Plan, which acknowledges the on-going use of the site for utility use (Reference 5.8-14). As discussed in Section 3.1, the only on-going aesthetic and visual impact anticipated during operation will be the visibility of the Fermi 3 natural draft cooling tower that, along with the steam plume, will be visible from offsite locations; this is similar in kind to the viewscape currently existing with Fermi 2. Thus, the land use and aesthetic impact are expected to be SMALL, and no mitigative measures are required.

5.8.2.7 **Local Employment**

The 900 full-time operating positions for Fermi 3 will create direct economic benefits to the region, as these will be stable, high paying positions that will be much sought after. In addition, the periodic maintenance staff needed to support the refueling and maintenance requirements will provide additional direct employment and wage benefits to the primary impact area. Based on an estimated peak refueling staff of 1200 to 1500 workers required every 24 months, plus the recognition that there will be additional and on-going maintenance staff required during scheduled and forced outages, a levelized, full-time equivalent maintenance staff of 100 workers, over and above the 900 full-time Fermi 3 plus contract staff, is assumed for in this section. Based on wage data from the U.S. Bureau of Labor Statistics, an average direct salary for the Fermi 3 operational and workforce staff of $66,868 in 2008 dollars is assumed (Reference 5.8-15). This estimate is consistent with data in Table 3-7 of the DOE Staffing Study[1], which estimated the average direct cost for an ESBWR unit (added to an existing site) to be $65,733 (2008 dollars) per staff member, not including anticipated overtime. When including anticipated overtime, the direct per person salary increased to $70,664 (2008 dollars).

To calculate the operational impacts, the general process developed for the construction impact analysis was followed. Table 5.8-8 shows the calculation process that produces the total operational employment and income impact estimate for the region and for the primary impact area counties of Monroe, Wayne, and Lucas. The analysis is based on the assumption that 300 of the 900 Fermi 3 operating staff would be hired from outside the region and that 87 percent of the 300 relocating workers will relocate to the primary impact area counties, based on current Fermi 2 residential information. For purposes of the impact analysis, the employment and earnings of the

[1]This study provided wages in 2004 dollars and they were updated to 2008 dollars using the Bureau of Labors Statistics inflation calculator.

outage workers is counted as a direct impact, but the earnings and employment multipliers have notbeen applied due to the difficulty of estimating the amount of income sent out of the region to their permanent households. Thus, the multiplier is 1 for the outage workers and worker earnings in the analysis.

In terms of calculating total employment impacts for the primary impact area counties, a multiplier is applied to the assumed 261 operational workforce that are assumed to relocate to the primary impact area (87 percent of the 300 workforce moving to the region, see row A). In addition, based upon current unemployment rates for Michigan, it is assumed in row B that 9 percent of the 600 workers hired from the primary impact area will be from the ranks of the unemployed and should be counted in the multiplier impact analysis. Thus, row C in Table 5.8-8 indicates that there are 9,450 man-years of employment subject to the utility sector employment multiplier. Applying the RIMS II utility sector multiplier of 2.3549 results in 22,254 man-years as indicated in row E. In row G, the primary impact area man-years during operation is shown to be 41,634 manyears, and this consists of the 22,254 man-years associated with employment subject to the multiplier, and 19,380 man-years of primary impact area employment not subject to the multiplier (because they are assumed to be already employed in the area when they are hired, or are short-time residents during outages). Finally, when the regional many years of operational staff not assumed to reside in the primary impact area are added, the total regional impact of 42,804 man-years of employment is shown in row I.

Following a similar methodology for calculating earnings impacts, Table 5.8-8 indicates that total direct earnings over the 30 year period for all staff will surpass $2 billion in 2008 dollars. Of this amount, more than $631 million of this total will be subject to the earnings multiplier and after applying the RIMS II utility sector earnings multiplier results in earnings of $963.5 million, as indicated in row N. When adding in the primary impact area earnings not subject to the multiplier (row O), it is seen in row P that the total primary impact area earnings from the Fermi 3 operational workforce are projected to be $2.26 billion in 2008 dollars. The total impact raises to $2.34 billion on a regional basis (row R).

5.8.3 Environmental Justice Impacts

The purpose of this environmental justice review is to determine if low income or minority populations would bear a disproportionate amount of environmental impacts from the operation of Fermi 3. Potential areas of impact that deserve special attention include cultural, economic, and human health impacts. Logically, for there to be a significant concern that the culture, economy, or human health of low income or minority populations may be harmed due to the operation of Fermi, or receive a disproportionate share of negative impacts: 1) a low income or minority populations in close proximity to the site would need to be present (because the impacts will be limited to areas near the Fermi site), 2) negative cultural, economic, or health impacts on such populations would need to be expected, and 3) the low income areas would need to encounter a disproportionate share of negative impacts from the operation of Fermi 3.

As explained in Subsection 2.5.4, a low-income population is defined to exist if the percentage of households within an environmental impact area or Census Block Group (CBG) living below the poverty level exceeds the percentage of low-income households within the State by 20 percentage points, or if the percentage of low-income households in the impact area or CBG is 50 percent or greater. A “minority population” is defined to exist if the percentage of minorities within a county, CBG, or environmental impact area exceeds the percentage of minorities in the State in which the impact area or CBGs are located, by 20 percentage points or more, or if the percentage of minorities in the impact area or CBGs is 50 percent or greater.

Based on the analysis in Subsection 2.5.4, no county in the region qualifies as a low income area based on the appropriate criteria for this category, although multiple CBGs within certain counties do qualify as low income. These low income areas are indicated on Figure 2.5-30. In Monroe County, only one CBG out of 126 qualifies as low income, and this is located in the city of Monroe, approximately 8 miles from the Fermi site.

U.S. Census data also indicate that, within the region, only Wayne County is a minority county (see Figure 2.5-28). Monroe County is not a minority county, and only one CBG in the city of Monroe qualifies as minority (see Figure 2.5-29).

Combined, the low income and minority information at the CBG level leads to the conclusion that there are no populations near the site that would create environmental justice concerns. While there is the possibility that sub-populations even smaller than the CBG could be present and give rise to environmental justice concerns, interviews with Monroe County officials and non-government residents indicate that no subsistence living activities occur near the site and, therefore, there would be a lack of impacts due to operational activities.

Based on the above information, it is reasonable to conclude that the three conditions required for environmental justice impacts are absent for Fermi 3. Namely, 1) low income or minority populations are not in close proximity to the site, 2) during operation, only SMALL negative cultural, economic, or health impacts are expected, other than traffic impacts near the Fermi site, and 3) low income and minority populations would not encounter a disproportionate share of any negative impacts from the operation of Fermi 3 because low income, minority, or subsistence populations are not located near the site.

5.8.4 **Summary**

In summary, the negative impacts of Fermi 3 operation on the primary impact area should be SMALL in most impact categories. The lack of significant and negative impacts is due to the disbursement of the population and housing impacts over a large and populated area that already has a well developed infrastructure.

The operation of Fermi 3 will create a significant direct and indirect socioeconomic benefits in Monroe County while maintaining consistency with the Frenchtown Township Plan. The potential for negative impacts arising from the demand for local facilities and services will be controlled through appropriate operating practices at the site (security, fire, safety measures), and Detroit Edison will coordinate with local schools and providers of water and waste water services to ensure that needs are known well in advance. Negative traffic impacts in Monroe County have the potential to be MODERATE during operation, especially during the refueling outages, though a staggering of work times would help reduce the severity of impacts. As discussed in Subsection 5.8.2.4.2, traffic impacts on the level of service near the Fermi site will be studied in the future and in cooperation with the Michigan Department of Transportation and the Monroe County Road Commission, once a number of project decisions affecting traffic impacts have been made. Given the location of the Fermi site in a CBG that is neither low income nor minority, and in a county having only one minority and one low income CBG, there is no reason to expect that any low income or minority areas within the county or region would be disproportionately affected by negative impacts from the project. Subsistence living activities on or near the site are also not an issue.

5.8.5 References

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5.8-6 Bolt, Beranek and Newman, Inc., “Fundamentals and Abatement of Highway Traffic Noise,” Report No. PB-222-703, prepared for the Federal Highway Administration, 1973.

5.8-7 Occupational Safety and Health Administration, “Occupational Noise Exposure,” 29 CFR 1910.95, 2007.

5.8-8 Institute of Electrical and Electronics Engineers, “Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers,” C57.12.00, Chapter 13, 2000.

5.8-9 International Organization for Standardization, “Acoustics — Attenuation of Sound during Propagation Outdoors — Part 1: Calculation of the Absorption of Sound by the Atmosphere,” 9613-1,1993.

5.8-10 International Organization for Standardization, “Acoustics — Attenuation of Sound during Propagation Outdoors — Part 2: General Method of Calculation,” 9613-1,1993.

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5.8-15 U.S. Department of Labor, “Occupational Employment and Wages, May 2007,” http://www.bls.gov/oes/current/oes518012.htm, accessed 26 March 2008.

5.8-16 Citizens Research Council (CRC) Memorandum, “Tax Revenue Comparison: Michigan and the U.S. Average,” June 2004.

5.8-17 U.S. Bureau of Labor Statistics Data, “Labor Force Data by County 2000 Annual Average,” ftp://ftp.bls.gov/pub/special.requests/la/laucnty00.txt, accessed 26 July 2007.

5.8-18 U.S. Bureau of Economic Analysis, RIMS II Multiplier, “DTE Primary Impact Area,” March 2008.

5.8-19 U.S. Environmental Protection Agency (USEPA), “Greenhouse Gas Inventory Protocol Core Module Guidance,” EPA430-R-08-006, Tables 1 and 6, May 2008.

5.8-20 U.S. Environmental Protection Agency (USEPA), “Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel,” EPA420-F-05-001, p. 2, February 2005.

5.8-21 Michigan Department of Environmental Quality (MDEQ), “Low-Level Radioactive Waste in Michigan,” Table 2, December 2008.

Table 5.8-1 Estimated Facility Noise Impacts – Increase in Ambient Sound Level (Cooling Systems and Transformers)

Receptor[1]	Predicted Fermi 3 Sound Level (dB(A)) Includes Cooling Systems and Transformer Noise Contributions	Lowest Nighttime Ambient Hourly Sound Level (dB(A))	Predicted Future Ambient Sound Level (dB(A)) during Fermi 3 Operation	Predicted Increase in Ambient Sound Level (dB) due to Fermi 3 Operation
NML-1	29	34	35	1
NML-2	37	32	38	6
NML-3	26	32	33	1
NML-4	31	40	41	1
NML-5	35	39	41	2
NML-6	31	42	42	0
NML-7	27	37	38	1

1. See Figure 2.5-32 for Receptor Locations.

Table 5.8-2 Estimated Facility Noise Impacts – Increase in Day-Night Sound Level (L_{dn}) (Cooling Systems and Transformers)

Receptor	Existing L_{dn} (dB(A))	Predicted Future L_{dn} (dB(A)) during Fermi 3 Operation	Predicted Increase (dB)
NML-1	54	54	0
NML-2	62	62	0
NML-3	63	63	0

Table 5.8-3 Estimated Emissions of CO_2 from Fermi 3 Worker Vehicles

	Vehicles per Day	Days per Year	Round Trip Miles[5]	CO_2 Emission Factor (kg/vehicle-mile)	CO_2 Annual Emissions[8] (tons/year)
Normal Operations (Weekday)	1,189[1]	241	1.7	0.519[6]	278.69
				0.364[7]	195.46
Normal Operations (Weekend)	306[2]	94	1.7	0.519[6]	27.97
				0.364[7]	19.62
Outage (Weekday)	2,187[3]	20	1.7	0.519[6]	42.54
				0.364[7]	29.84
Outage (Weekend)	1,827[4]	10	1.7	0.519[6]	17.77
				0.364[7]	12.46
Total Estimated Emissions from Worker Vehicles					624.35

Notes:

1. Half the May 2009 average weekday vehicle count (2,378) during Fermi 2 normal operations.
2. Half the May 2009 average weekend vehicle count (611) during Fermi 2 normal operations.
3. Half the April 2009 average weekday vehicle count (4,373) during Fermi 2 scheduled outage.
4. Half the April 2009 average weekend vehicle count (3,654) during Fermi 2 scheduled outage.
5. Distance from the Fermi front security gate to the proposed Fermi site parking garage and back.
6. CO_2 Emission Factor for light-duty trucks as listed in Reference 5.8-19.
7. CO_2 Emission Factor for passenger cars as listed in Reference 5.8-19.
8. Estimated CO_2 emissions listed in final column assumes that 50% of the vehicles per day are passenger cars and 50% of the vehicles per day are light-duty trucks.

Table 5.8-4 Estimated Emissions of CO_2 from Fermi 3 On-site Support Vehicles and Heavy Equipment

Fuel Type	Annual Fuel Consumption (gal/year)	CO_2 Emission Factor (kg/gal)	CO_2 Annual Emissions (tons/year)
Gasoline Consumption	18,562[1]	8.80[3]	180.05
Diesel Consumption	4,300[2]	10.1[4]	47.87
Total Estimated Emissions from Onsite Support Vehicles and Heavy Equipment			227.92

Notes:

1. Total volume of gasoline dispensed for Fermi 2 operations during 2008.
2. Total volume of diesel dispensed for Fermi 2 operations during 2008.
3. CO_2 Emission Factor based on carbon content of gasoline as listed in Reference 5.8-20.
4. CO_2 Emission Factor based on carbon content of diesel fuel as listed in Reference 5.8-20.

Table 5.8-4-(A)Projected Fermi 3 Operations Workforce Residence and Commuting Distance

County	Fermi 2 and Projected Fermi 3 Operations Workforce Distribution	Major City	Distance to Fermi (miles)	Average Derivation
Monroe County (MI)	58%	Monroe City	10.0	5.8
Wayne County (MI)	19%	Detroit	35.7	6.8
Lucas County (OH)	10%	Toledo	30.3	3.0
Washtenaw County (MI)	3%	Ann Arbor	43.1	1.3
Oakland County (MI)	3%	Pontiac	64.1	1.9
Wood County (OH)	2%	Bowling Green	53.5	1.1
Lenawee County (MI)	1%	Adrian	63.8	0.6
Other Counties	4%	Various	75.0	3.0
	Average Commuting Distance (miles)			23.5

Table 5.8-5 Estimated Emissions of CO_2 from Fermi 3 Deliveries and Removal of Fuel and Materials

Delivery Type	Annual Shipment Weight (ton/year)	Round Trip Miles[5]	CO_2 Emission Factor[6] (kg/ton-mile)	CO_2 Annual Emissions (tons/year)
New Fuel Delivery	202[1]	1.7	0.297	0.11
Materials Delivery	514[2]	1.7	0.297	0.29
Materials Removal	514[2]	1.7	0.297	0.29
Class A Radioactive Waste Removal	437[3]	1.7	0.297	0.24
Radioactive Waste Cask Delivery	32[4]	1.7	0.297	0.02
Total Estimated Emissions from Deliveries of Fuel and Materials				0.95

Notes:

1. Per ESBWR DCD Rev. 5, Section 9.1.2.3, 475 new fuel elements will be shipped every 2 years. 2 fuel elements will be delivered in one ANF-10 transport container that has a gross weight of 3,410 lbs.
2. Total weight of waste, refuse, and materials disposed of by Fermi 2 as indicated in the DTE Energy 2008 Goals for Michigan Pollution Prevention Partnership (MBP3).
3. Weight of one fourth of the total Class A waste (76,187 cubic feet) generated by utilities in Michigan during 2007 (Reference 5.8-21) plus the weight of one 20’ DOT IP-1 cargo container. The density of the Class A waste is assumed to be 41 lbs per cubic foot. The cargo container has a 7,200 lbs tare weight and 1,162 cubic foot internal volume.
4. Weight of one Chem-Nuclear Systems 8-120B radioactive waste cask (gross weight of 63,980 lbs).
5. Distance from the Fermi front security gate to the proposed Fermi site parking garage and back.
6. CO_2 Emission Factor for on-road truck product transport as listed in Reference 5.8-19.

Table 5.8-6 Approximate Annual Tax Impact Attributed to the Increase in Personal Income Associated with Fermi 3 Permanent Staff (2008 dollars)

Tax Category	Tax Per $1000 Personal Income	Annual Tax Impact, Michigan, Assuming 87% of Staff Resides in Michigan	Tax Per $1000 Personal Income	Annual Tax Impact, Ohio, Assuming 13% of Staff Resides in Ohio
Property Taxes	$39.96	$2.1 million	$31.48	$0.2 million
General Sales Taxes	$24.36	$1.3 million	$25.95	$0.2 million
Selective Sales Taxes	$9.78	$0.5 million	$8.58	$0.1 million
Individual Income Taxes	$19.63	$1.0 million	$34.15	$0.3 million
Corporate Income Taxes	$5.68	$0.3 million	$2.97	$0.02 million
Motor Fuel Taxes	$3.34	$0.2 million	$4.34	$0.03 million
Tobacco Product Taxes	$3.08	$0.2 million	$1.57	$0.01 million
Sum of the Above	$105.83	$5.4 million	$109.04	$0.8 million

Note: The individual taxes may not add to the total taxes due to minor tax categories not included in the table.

Source: Reference 5.8-16

Table 5.8-7 2020 Population and the Assumed Residence of Relocating Fermi 3 Operating Staff in the Primary Impact Area*

Regional County	Population, 2020	Assumed Relocating Staff to Each County	Population Increase from Relocating Staff
Monroe	176,990	174	452
Wayne	1,877,082	57	148
Lucas	432,942	30	78
Total	2,487,014	261	678

Note: population numbers have been rounded to yield the correct total

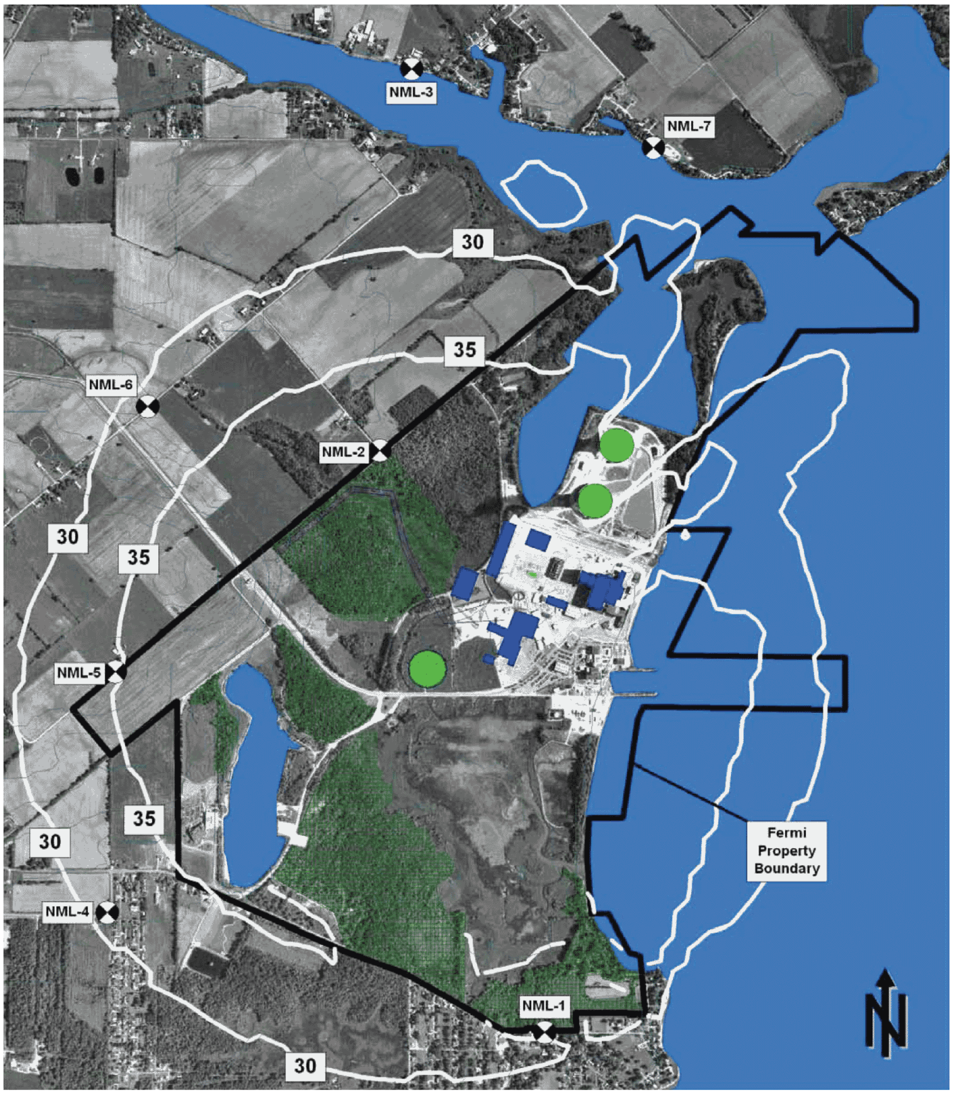
Source: Reference 5.8-17

Table 5.8-8 Fermi 3 Operations Workforce Employment and Earnings Impacts

Estimated Employment Benefits with Multiplier Impacts	
Total Man-years of Employment (1000 jobs, levelized, for 30 years)	30,000
A) PIA In-migrant Oper. Man-years (300*0.87*30)	7,830
B) PIA Resident Unemployed Man-years (600*0.09*30)	1,620
C) PIA Man-years Multiplier Applicable (A+B)	9,450
D) Employment Multiplier, Utility Sector	2.3549
E) PIA Man-years, Multiplier Applicable (C*D)	22,254
F) PIA Man-years not Multiplier Applicable (600*0.91*30)+(100*30)	19,380
G) Total Man-years of Employment in PIA (E+F)	41,634
H) Regional Man-years not in PIA ((300*0.13*30)	1,170
I) Total Regional Impact, with PIA multiplier impact (H + G)	42,804
Estimated Earnings Benefits with Multiplier Impacts, $2008	
Total Earnings Estimate (1000*30*$66,868)	$2,006,040,000
J) PIA In-migrant operations earnings (300*0.87*30*$66,868)	$523,576,440
K) PIA Resident Unemployed Earnings (600*0.09*30*$66,868)	$108,326,160
L) PIA Earnings Multiplier Applicable (J+K)	$631,902,600
M) Earnings Multiplier	1.5247
N) PIA Earnings, Multiplier Applicable (L*M)	$963,461,894
O) PIA Earnings Not Multiplier Applicable (600*0.91*30*$66,868)+(100*$66,868*30)	$1,295,901,840
P) Total Earnings in PIA (N+O)	$2,259,363,734
Q) Regional Earnings not in PIA (300*0.13*30*$66,868)	$78,235,560
R) Total Regional Impact, with PIA multiplier impact (P+Q)	$2,337,599,294

Note: The formulas shown in parentheses may differ slightly from the corresponding result due to rounding.

Figure 5.8-1 Estimated Environmental Noise Emissions—A-Weighted Sound Pressure Level Contours (dB(A))—Resulting from Normal Operation (Fermi 3 Cooling Systems and Transformers)



5.9 Decommissioning

Decommissioning is defined as permanently removing a nuclear facility from service and reducing radioactive materials on the licensed site to levels that would permit termination of the NRC license.

5.9.1 Financial Assurance

A report and certification, per the specifications outlined in 10 CFR 50.75, is included in the Decommissioning Funding Assurance Report in COLA Part 1. In accordance with 10 CFR 50.75(c), Fermi 3 meets the minimum requirement for decommissioning expenses.

5.9.2 Environmental Impact

According to NUREG-1555, Section 5.9, studies of social and environmental effects of decommissioning large commercial power generating units have not identified any significant impacts beyond those considered in the Final Generic Environmental Impact Statement (GEIS) on decommissioning (Reference 5.9-2). The GEIS evaluates the environmental impact of the following three decommissioning methods:

DECON – The equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.

SAFSTOR – The facility is placed in a safe stable condition and maintained in that state until it is subsequently decontaminated and dismantled to levels that permit license termination. During SAFSTOR, a facility is left intact, but the fuel has been removed from the reactor vessel, and radioactive liquids have been drained from systems and components and processed. Radioactive decay occurs during the SAFSTOR period, thus reducing the quantity of contaminated and radioactive material that must be disposed of during the decontamination and dismantlement.

ENTOMB – This alternative involves encasing radioactive structures, systems, and components in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license.

NRC regulations do not require a COL applicant to select one of these decommissioning alternatives or to prepare definite plans for decommissioning at the time of the COL. Pursuant to 10 CFR 50.82, planned decommissioning activities would be described after a decision has been made by the licensee to cease operations. Further, the choice of decommissioning methods, the identification of disposal sites for waste, and other pertinent information required to develop definitive plans would be determined by the conditions at the time. Therefore, at this stage, a general assessment of decommissioning environmental impacts is provided.

Decommissioning of a nuclear facility that has reached the end of its useful life is in essence an environmental remediation and therefore has an overall positive environmental impact. The main adverse environmental impact, regardless of the specific decommissioning option selected, is the commitment of relatively small amounts of land for waste burial in exchange for the potential re-use of the land where the facility is located.

NUREG-0586 indicates that the NRC has evaluated environmental impacts from decommissioning. NRC-evaluated impacts presented in this report include: 1) occupational and population doses; 2) impacts of waste management; 3) impacts to air and water quality; and 4) ecological, economic, and socioeconomic impacts. NRC also indicated (Reference 5.9-3) that the environmental effects of greatest concern (i.e., radiation dose and releases to the environment) are substantially less than the same effects resulting from reactor operations. As such, Detroit Edison adopts by reference the NRC conclusions regarding environmental impacts of decommissioning presented in NUREG-0586.

In addition, a DOE study (Reference 5.9-4) indicated that projected physical plant inventories associated with the ESBWR design would generally be less than those for currently operating power reactors. This is due to the advances in technology and the use of passive support systems that have significantly simplified and reduced inventories of electrical cabling, piping, pumps, motors, instrumentation and controls wiring, building size and concrete volume typically used in contemporary power plants. (Reference 5.9-1) This ultimately reduces the overall quantity of contaminated and non-contaminated waste required for disposal, along with transportation to and from disposal sites. Additionally, the ESBWR is designed to reduce accumulation of radioactivity in plant components (DCD Section 12.1.2.2.3). Unlike existing BWRs, the ESBWR has only one significant source of radiation in the containment post operation—the reactor core (DCD Section 12.2.1.1). It also includes a number of design features as described in DCD Section 12.1.2.1 to maintain low occupational doses during decommissioning. Further, the new facility is situated on the existing Fermi site and is contained within the original site boundaries, not requiring encroachment onto additional property that is not already designated for use in power production. Therefore, the estimated environmental impacts of decommissioning presented in NUREG-0586 are reasonably expected to bound the impacts of decommissioning an ESBWR at Fermi.

Regardless of the option chosen in the future, decommissioning must be completed within 60 years of permanent cessation of plant operations per 10 CFR 50.82(a)(3). Fermi 3 would be operated until the approved combined license expires and then decommissioning activities would be initiated in accordance with NRC requirements. In accordance with 10 CFR 50.82, these decommissioning activities would include the following submissions:

1. Written certification to the NRC within 30 days of the decision to permanently cease operations per 10 CFR 50.4(b)(8);
2. Written certification to the NRC once the fuel has been permanently removed from the reactor vessel per 10 CFR 50.4(b)(9);
3. A post-shutdown decommissioning activities report (PSDAR) to the NRC within two years after permanent cessation of operations per 10 CFR 50.82(a)(4), detailing planned decommissioning activities, schedule for the accomplishment of significant milestones, estimated decommissioning costs, and documentation showing that the

environmental impacts associated with the site-specific decommissioning activities are bounded by appropriate previously issued environmental impact statements and;

4. A license termination plan at least two years before termination of the license date, per 10 CFR 50.82(a)(9), which includes: site characterization, identification of remaining dismantlement activities, plans for site remediation, detailed plans for the final radiation survey, a description of the end use of the site (if restricted), an updated site-specific estimate of remaining decommissioning costs and a supplement to the environmental report describing any new information or significant environmental change associated with the proposed termination activities.

During decommissioning of Fermi 3 facilities, radiological doses would be controlled with appropriate work procedures, shielding, and other control measures similar to those used during plant operations. Experience with decommissioned power plants has shown that the occupational exposures during the decommissioning period are comparable to those associated with refueling and plant maintenance of an operational unit (Reference 5.9-2). Each decommissioning alternative has radiological impacts resulting from the transport of materials to disposal sites. The expected impact from this transportation activity would not be significantly different from that associated with normal operations.

Based on the factors described above, it can be reasonably concluded that the environmental impacts resulting from decommissioning proposed Fermi 3, after it ceases operations, are bounded by those presented in NUREG-0586. Pursuant to 10 CFR 50.82(a)(4), a further analysis would be provided at the time of decommissioning, when the activities and schedule are known, to demonstrate that the previously estimated impacts are still bounding.

5.9.3 **References**

5.9-1 GE-Hitachi Nuclear Energy, “ESBWR Design Control Document – Tier 2,” Revision 6, August 2009.

5.9-2 U.S. Nuclear Regulatory Commission, “Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities,” NUREG-0586, Supplement 1, November 2002.

5.9-3 U.S. Nuclear Regulatory Commission, “Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities,” NUREG-0586, August 1988.

5.9-4 U.S. Department of Energy, “Study of Construction Technologies and Schedules, O&M Staffing and Cost, Decommissioning Costs and Funding Requirements for Advanced Reactor Designs,” Volume 1, May 27, 2004.

5.10 Measures and Controls to Limit Adverse Impacts During Operation

This section summarizes adverse environmental impacts of operation, as well as controls to limit these impacts. Table 5.10-1 shows the cause-and-effect relationships between operation environmental impacts and actions and affected environmental resources. Significance levels SMALL (S), MODERATE (M), and LARGE (L) are determined assuming that measures and controls are implemented for each impact. If a range of effect is expected, then two significance levels are assigned, such as M-L, meaning a MODERATE to LARGE impact. The levels of impact significance (S, M, and L) are defined below:

SMALL Environmental effects are not detectable or are so minor that they neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the NRC's regulations are considered small.

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.

Table 5.10-1 also summarizes specific measures and controls (both preventative and mitigative) to alleviate operation impacts. Each "Impact Description or Action" attribute is assigned a number, and each "Specific Measures and Controls" attribute is assigned a number that corresponds to the respective "Impact Description or Action." The assignment of significance levels (S, M, and L) in Table 5.10-1 is based on the assumption that the corresponding measures and controls have been taken for each impact. The measures and controls described in Table 5.10-1 are considered reasonable from practical, engineering, and economic standpoints. The measures and controls are generally accepted practices within the utility industry, and stem from guiding statutes and regulatory requirements. These measures and controls, therefore, are appropriate and not expected to create a hardship for Detroit Edison.

5.10.1 References

None.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 1 of 19)

	Impact Category and Level of Impact															
Environmental Resource Categories	**Noise**	**Erosion/Sediment**	**Air Quality/Dust**	**Traffic**	**Effluents and wastes**	**Surface-water Impacts**	**Groundwater Impacts**	**Land Use protection/restoration**	**Water-use protection/restoration**	**Terrestrial Ecosystem Impacts**	**Aquatic Ecosystem Impacts**	**Socioeconomic Impacts**	**Radiation Exposure to**	**Other Site-Specific Impacts**	**Impact Description or Action**	**Specific Measures and Controls**
5.1 Land-Use Impacts																
5.1.1 Site and Vicinity	S	S		S	S			S							1) Erosion 2) Traffic 3) Noise 4) Plant operation may affect nearby agricultural lands through salt deposition.	1) Limit disturbance of vegetation to the impact area within the site designated for Fermi 3 construction. 1 and 2) Minimize potential impacts through use of BMPs and compliance with SWPPP requirements. 2) Use of existing roads will minimize traffic impacts to land use. Heavy traffic during plant outage shift changes is a short-term duration activity. 3) Noise from Fermi 3 is expected to be similar to ambient noise levels. Mitigation measures for noise are not required. 4) The deposition rates are well within the NUREG-1555 acceptable levels that would generally not be damaging to plants. 4) Drift eliminators are incorporated into the design of the cooling towers to minimize the potential for salt deposition, especially to nearby agricultural lands. Mitigation beyond the proposed drift eliminators is not required. 4) Natural draft and mechanical draft cooling towers and the heat dissipation system will be monitored during operation under rules and regulations governing these systems.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 2 of 19)

	Impact Category and Level of Impact															
Environmental Resource Categories	**Noise**	**Erosion/Sediment**	**Air Quality/Dust**	**Traffic**	**Effluents and wastes**	**Surface-water Impacts**	**Groundwater Impacts**	**Land Use protection/restoration**	**Water-use protection/restoration**	**Terrestrial Ecosystem Impacts**	**Aquatic Ecosystem Impacts**	**Socioeconomic Impacts**	**Radiation Exposure to**	**Other Site-Specific Impacts**	**Impact Description or Action**	**Specific Measures and Controls**
5.1.2 Transmission Corridors and Offsite Areas (not within control of Detroit Edison)		S						S							1) Project implementation restricts use of land for most purposes other than utility projects. 2) Maintenance on the existing transmission line corridors continues to impact land. 3) Erosion and compaction of soils from construction vehicles when maintaining corridor.	Since the transmission corridors are controlled and operated by ITC*Transmission*, the following measures are considered as typical. 1) To the extent feasible, avoid disturbances on critical or sensitive habitats/species. 1 and 2) ITC*Transmission* is expected to consider maintenance decision impacts and tailor maintenance to the environment of each portion of the line before performing the work. 2) Limit vegetation removal to the minimal amount needed to ensure safe operation of the transmission lines within the corridors or rights-of-way. 3) Use existing access roads, postpone work during wet ground conditions, use BMPs from the SWPPP, maintain grass cover in the corridor to avoid bare areas and erosion, and restrict vehicles to within the corridor. 3) Use helicopter to conduct transmission corridor maintenance inspections. This will reduce traffic on the access roads and reduce the need to cut vegetation along the entire corridor at one time.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 3 of 19)

Environmental Resource Categories	Impact Category and Level of Impact														Impact Description or Action	Specific Measures and Controls
	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts		
5.1.3 Historic Properties	S	S						S						S	1) Noise produced from normal station operations could affect nearby historic resources. 2) Erosion or silting-over of shoreline archaeological sites. 3) Damage to archaeological sites through onsite ground disturbing activities. 4) Visual impacts to site and vicinity above-ground resources.	1) The closest above-ground historic resource is located 0.5 mile from the construction site, and all others are located 2 to 3 miles distant. Noise-related impacts are not substantial, and no measures or controls are necessary. 2) Surveys onsite shoreline did not identify any archaeological resources. Shoreline stabilization may be required if NRHP-eligible archaeological resources are encountered during station operation. 3) The site exhibits low potential for containing archaeological sites in an undisturbed context. Station operation is unlikely to impact significant archaeological sites. Appropriate controls will be used during post-construction excavation activities to ensure compliance with the Native American Graves Protection and Repatriation Act. 4) Fermi 3 project area contains an existing power plant with two cooling towers. Station operation would not introduce a new element that would contribute to the loss of historic integrity of site-vicinity historic above-ground resources, and no measures or controls are necessary.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 4 of 19)

	Impact Category and Level of Impact															
Environmental Resource Categories	**Noise**	**Erosion/Sediment**	**Air Quality/Dust**	**Traffic**	**Effluents and wastes**	**Surface-water Impacts**	**Groundwater Impacts**	**Land Use protection/restoration**	**Water-use protection/restoration**	**Terrestrial Ecosystem Impacts**	**Aquatic Ecosystem Impacts**	**Socioeconomic Impacts**	**Radiation Exposure to**	**Other Site-Specific Impacts**	**Impact Description or Action**	**Specific Measures and Controls**
5.2 Water Related Impacts																
5.2.1 Hydrologic Alterations and Plant Water Supply									S						1) Impact on water in Lake Erie.	1) Primary hydrologic alteration from operation of Fermi 3 is reduction in water levels during drought. The volume of water used by Fermi 3 is very minimal compared to other neighboring uses and the size of Lake Erie.
5.2.2 Water Use Impacts									S						1) Fermi 3 water use could affect other water users.	1) Water users would not be affected because there is adequate water supply for users and Fermi 3. No mitigation measures are expected to be necessary.
5.2.3 Water Quality Impacts		S			S	S	S				S				1) Discharge wastewater/thermal effluent. 2) Turbidity from dredging.	1) Effluent limitations and controls for Fermi 3 are expected to be similar to those required under the NPDES permit for operation of Fermi 2. 1) Fermi 3 operations will comply with permits issued under the Federal Water Pollution Control Act Sections 401 and 402, as administered by the MDEQ. These permits define allowable discharges and actions required to minimize impacts.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 5 of 19)

Environmental Resource Categories	Impact Category and Level of Impact														Impact Description or Action	Specific Measures and Controls
	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts		
5.3 Cooling System Impacts																
5.3.1 Intake System																
5.3.1.1 Hydrodynamic Impact and Physical Impacts		S				S					S				1) Turbidity may temporarily increase in Lake Erie due to periodic dredging and scouring at the intake structure. 2) Silt buildup.	1) Short-term duration activity. Rock groins limit turbidity to the intake bay. 2) No mitigation measures are practical.
5.3.1.2 Aquatic Ecosystems		S				S					S				1) Some species are killed by impingement, entrapment, or entrainment by the intake system.	1) The closed-cycle cooling system will significantly reduce adverse effects from impingement and entrapment. 1) Maintain a low intake velocity ($\leq$ 0.5 fps). 1) Design intake screens with appropriate mesh size and include a trash rack. Regular washing of the intake screens will minimize impingement. 1) Location of Fermi 2 and Fermi 3 intakes in the same area will reduce entrapment.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 6 of 19)

Environmental Resource Categories	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts	Impact Description or Action	Specific Measures and Controls
5.3.2 Discharge System																
5.3.2.1 Thermal Description and Physical Impacts		S			S	S									1) Thermal. 2) Turbidity. 3) Scouring. 4) Siltation.	1) The diffuser will be designed to minimize the size of the thermal mixing zone, in both lateral and vertical extent. 2 and 3) The diffuser will be designed to minimize bottom scour and associated turbidity. Localized armoring may be required to reduce bottom scour. 4) Discharge location and orientation of discharge ports would minimize siltation resulting from turbidity at the diffuser ports. Diffuser design would reduce concentrated silt buildup through discharge points spaced approximately 17 feet apart. No additional mitigation is expected to be necessary.
5.3.2.2 Aquatic Ecosystems											S				1) Thermal. 2) Chemical. 3) Physical.	1) The diffuser will be designed to minimize the size of the thermal mixing zone, in both lateral and vertical extent. No additional mitigation measures are expected to be necessary. 2) Compliance with NPDES permit effluent limits and use of one Lake Erie outfall for Fermi 3 will minimize chemical impacts. 3) Minimization of scouring may be achieved through the use of riprap around the submerged discharge port as well as upward orientation of discharge ports.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 7 of 19)

Environmental Resource Categories	Impact Category and Level of Impact														Impact Description or Action	Specific Measures and Controls
	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts		
5.3.3 Heat-Discharge System																
5.3.3.1 Heat Dissipation to the Atmosphere			S												1) Cooling towers may produce steam plumes, fogging/icing, cloud formation, plume shadowing, humidity, and additional precipitation. 2) Small quantities of waste salts and chemicals are discharged into the atmosphere.	1) Analyses indicate low occurrence of plumes and fogging. Cooling tower design uses Best Available Technology to reduce evaporative losses. Impacts are anticipated to be small and mitigation measures are not required. 2) Cooling water is treated prior to discharge to reduce salt concentration. Implementation of measures and controls 1 and 2 provides adequate mitigation. No additional mitigation is expected to be necessary.
5.3.3.2 Terrestrial Ecosystems	S		S							S					1) Operating noise has minor impact to wildlife. 2) Small quantities of waste salts and chemicals are discharged into the atmosphere. 3) Minor impact from avian collisions with towers or power lines.	1) No mitigation measures are expected to be necessary. 2) Concentrations are not high enough to adversely impact soil, air, or vegetation. No mitigation measures are expected to be necessary. 3) No mitigation measures are expected to be necessary.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 8 of 19)

Environmental Resource Categories	Impact Category and Level of Impact: Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts	Impact Description or Action	Specific Measures and Controls
5.3.4 Impacts to the Public	S		S			S								S	1) Etiological agents associated with cooling towers and thermal discharges can impair human health. 2) Risk to site workers, such as maintenance personnel, from etiological agents resulting from additional thermal discharges to the Fermi site cooling towers. 3) The sound level for the natural draft cooling tower is expected to be between 55 and 60 dB(A) at 1000 feet.	1) Temperature increases in Lake Erie due to increased thermal discharges will be limited to a small area. Centers for Disease Control documents through 2006 indicates no outbreaks of waterborne diseases in Monroe County associated with Lake Erie and existing Fermi facility operation. 2) The operations of the Fermi 3 would comply with all relevant OSHA regulations. 3) The noise level at the property line is expected to remain below the limit of 65 dB(A) recommended in NUREG-1555. Implementation of measures and controls 1 through 3 provides adequate mitigation. No additional mitigation is expected to be necessary.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 9 of 19)

Environmental Resource Categories	Impact Category and Level of Impact														Impact Description or Action	Specific Measures and Controls
	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts		
5.4 Radiological Impacts of Normal Operation																
5.4.1 Exposure Pathways										S	S			S	1) Discharges of radioactive gases to the environment. 2) Potential exposure of humans to low doses of radiation. 3) Relatively small planned discharges of radioactive liquids to Lake Erie. 4) Exposure of humans and biota to radioactive liquid through ingestion, immersion or contact with contaminated water or shoreline soil, and ingestion of contaminated food chain components. 5) Exposure to radioactive gases through airborne radioactivity, deposited activity, ingestion of contaminated agricultural products, and direct radiation from the facility during operation.	1-5) Planned releases of radiation are within dose limits prescribed under 10 CFR 20. 1-5) Detroit Edison has a comprehensive plan for routinely periodically monitoring of radiation pathways and releases on receptors. 3) Effluent discharges must comply with requirements specified in 10 CFR 20. No additional mitigation is required.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 10 of 19)

	Impact Category and Level of Impact															
Environmental Resource Categories	**Noise**	**Erosion/Sediment**	**Air Quality/Dust**	**Traffic**	**Effluents and wastes**	**Surface-water Impacts**	**Groundwater Impacts**	**Land Use protection/restoration**	**Water-use protection/restoration**	**Terrestrial Ecosystem Impacts**	**Aquatic Ecosystem Impacts**	**Socioeconomic Impacts**	**Radiation Exposure to**	**Other Site-Specific Impacts**	**Impact Description or Action**	**Specific Measures and Controls**
5.4.2 Radiation Doses to members of the Public														S	Refer to impacts listed for 5.4.1.	Refer to mitigations listed for 5.4.1.
5.4.3 Impacts to Members of the Public														S	Refer to impacts listed for 5.4.1.	Refer to mitigations listed for 5.4.1.
5.4.4 Impacts to Biota Other than Members of the Public										S	S				1) Potential doses to biota originate from liquid and gaseous effluents. 2) Biota can receive radioactive doses via contact with contaminated water or soil and through ingestion.	1 and 2) Calculated doses are within regulatory limits of 40 CFR 190. No mitigation is required. No additional mitigation is required.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 11 of 19)

Environmental Resource Categories	Impact Category and Level of Impact														Impact Description or Action	Specific Measures and Controls
	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts		
5.5 Environmental Impacts of Waste																
5.5.1 Non-radioactive Waste System Impacts			S		S	S	S	S	S						1) Management of Non-radioactive waste including discharges of air emissions and wastewater. 2) Management of Non-radioactive waste including non-hazardous dumpster waste, debris, dredge spoils, and recyclable supplies. 3) Management of Non-radioactive hazardous waste	1) All releases from Fermi 3 including discharges to waste and discharges to air are in compliance with applicable regulations, permits, and procedures. The activity does not warrant mitigation. 2) All wastes transferred offsite are managed in licensed facilities and in compliance with applicable regulations, permits, and procedures. The activity does not warrant mitigation. 3) All hazardous wastes are accumulated on site in accordance with all applicable regulations and transferred offsite to licensed/permitted facilities in compliance with applicable regulations, permits, and procedures. The activity does not warrant mitigation. Implementation of measures and controls 1 through 3 provides adequate mitigation. No additional mitigation is expected to be necessary.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 12 of 19)

	Impact Category and Level of Impact															
Environmental Resource Categories	**Noise**	**Erosion/Sediment**	**Air Quality/Dust**	**Traffic**	**Effluents and wastes**	**Surface-water Impacts**	**Groundwater Impacts**	**Land Use protection/restoration**	**Water-use protection/restoration**	**Terrestrial Ecosystem Impacts**	**Aquatic Ecosystem Impacts**	**Socioeconomic Impacts**	**Radiation Exposure to**	**Other Site-Specific Impacts**	**Impact Description or Action**	**Specific Measures and Controls**
5.5.2 Mixed Waste Impacts					S								S		1) Management of mixed waste including temporary onsite storage. 2) Management of mixed waste including offsite disposal.	1) All onsite management will be in compliance with applicable regulations and procedures. Exposure to employees and the public is minimized through isolated storage and monitored in accordance with all applicable regulations and procedures. The activity does not warrant mitigation. 2) Offsite shipment, treatment, and disposal of mixed wastes will be in compliance with applicable regulations and procedures. The activity does not warrant mitigation. Implementation of measures and controls 1 and 2 provides adequate mitigation. No additional mitigation is expected to be necessary.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 13 of 19)

	Impact Category and Level of Impact															
Environmental Resource Categories	**Noise**	**Erosion/Sediment**	**Air Quality/Dust**	**Traffic**	**Effluents and wastes**	**Surface-water Impacts**	**Groundwater Impacts**	**Land Use protection/restoration**	**Water-use protection/restoration**	**Terrestrial Ecosystem Impacts**	**Aquatic Ecosystem Impacts**	**Socioeconomic Impacts**	**Radiation Exposure to**	**Other Site-Specific Impacts**	**Impact Description or Action**	**Specific Measures and Controls**
5.6 Transmission System Impacts																
5.6.1 Terrestrial Ecosystems										S					1) Right-of-way maintenance impacts on important terrestrial species or habitats.	Since the transmission corridors are controlled and operated by ITC*Transmission*, the following measures are considered as typical. 1) Existing corridor and towers would be used and the proposed substation addition is located on previously disturbed land. 1) No pesticides or herbicides is expected to be minimized to manage ROW vegetation. 1) ROW inspections mainly completed by airplane. 1) No important species or habitats would be affected by the transmission system. The new lines will be installed on the same towers as the existing line, where possible, so will be incidental to existing conditions. Area wildlife already has adjusted to the existing line and substation so a new line and a new or expanded substation will not have a long-term effect. The species and habitat along the new transmission route are similar to the existing route, and so would similarly be expected to be unaffected long-term. Implementation of the above measures and controls provides adequate mitigation. No additional mitigation is expected to be necessary.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 14 of 19)

Environmental Resource Categories	Impact Category and Level of Impact														Impact Description or Action	Specific Measures and Controls
	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts		
5.6.2 Aquatic Ecosystems		S						S			S				1) Right-of-way impacts on wetlands and other waterbodies.	1) Line construction will be designed to avoid wetlands or other waterbodies to the maximum extent possible. Any unavoidable impacts would be subject to regulatory permit conditions.
5.6.3 Impacts to Members of the Public	S													S	1) The operation and maintenance of the new transmission system may result in visual impacts, electric shock hazards, electromagnetic field exposure, noise impacts, and radio and television interference.	1) To reduce the potential for vehicle-to-ground short-circuit shock to vehicles parked beneath the lines, the existing transmission lines are currently designed to provide clearances consistent with the NESC 5 mA rule. 1) The transmission lines associated with Fermi 3 are designed to be corona-free up to their maximum operating voltage. Implementation of the above measures and controls provides adequate mitigation. No additional mitigation is expected to be necessary.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 15 of 19)

Environmental Resource Categories	Impact Category and Level of Impact														Impact Description or Action	Specific Measures and Controls
	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts		
5.7 Uranium Fuel Cycle and Transportation Impacts																
5.7.1 Uranium Fuel Cycle and Transportation Impacts			S			S		S	S				S		1) Operation of the plant will render some offsite land (at waste disposal facilities) unusable for other purposes because of accumulated radioactive material. 2) Water discharged to waterbodies or ground. 3) Fossil fuel used. 4) Chemical releases into surface waters. 5) Radioactive gas releases. 6) Radioactive waste disposal. 7) Worker exposure to radiation.	1) Land use relative to other power generation technologies is small enough that mitigation to recover quality and opportunity land cost would be uneconomical and likely ineffective. 2) Water discharged is only a small fraction of other power generation technologies, and normal controls are sufficient to manage the minimal impacts. 3) Fossil fuel used for uranium fuel shipment and waste transport is small relative to net production of fossil fuels. 4) Chemical discharges into navigable waters are subject to NPDES regulatory discharge permit requirements, thus assuring minimum impact. 5) Prior studies indicate that existing controls reduce exposure to acceptable levels. 6) Existing storage controls limit potential exposure. 7) Existing controls limit worker exposure to acceptable levels. Transportation of reactor fuel closely monitored and exposure potential is minor.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 16 of 19)

Environmental Resource Categories	Impact Category and Level of Impact														Impact Description or Action	Specific Measures and Controls
	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts		
5.7.2 Transportation of Radioactive Materials													S		1) Exposure to fuel transported to plant or spent fuel to storage.	1) The ESBWR technology meets the conditions delineated in 10 CFR 51.52 and worker or public exposures are within regulated safe limits.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 17 of 19)

Environmental Resource Categories	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts	Impact Description or Action	Specific Measures and Controls
5.8 Socioeconomic Impacts																
5.8.1 Physical Impacts of Station Operation	S		S	M	S									S	1) Potential for increased traffic and accidents with increased operational-related traffic on North Dixie Highway near Fermi Drive. 2) Air pollution, emissions, and effluents can affect humans in the primary impact area. 3) Potential noise impacts (some noises are temporary, others will be permanent) to Fermi 3 workers and residents near the transmission corridor and Fermi 3.	1) Detroit Edison will pursue level of service analysis at the appropriate time and in conjunction with the Michigan Department of Transportation (MDOT), the Monroe County Road Commission, and other appropriate agencies. Once completed, the appropriate mitigation measures will be determined. 1) Stagger shifts, encourage carpooling, and schedule deliveries to avoid shift changes or commute times. 2) Monitor the release of waste emissions & effluents. 3) Although most operational noise is expected to be similar to ambient noise levels, train and appropriately protect Fermi 3 employees as needed to reduce their risk of noise exposure. Noise mitigation measures are not required. 3) Sound attenuation measures as part of the standard mechanical draft cooling tower should be sufficient to limit the noise impact. Infrequent operation of the mechanical draft cooling towers would further reduce noise impacts. 3) Transmission lines are typically designed to be corona free up to their maximum operating voltage. No additional mitigation measures are necessary.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 18 of 19)

Environmental Resource Categories	Impact Category and Level of Impact														Impact Description or Action	Specific Measures and Controls
	Noise	Erosion/Sediment	Air Quality/Dust	Traffic	Effluents and wastes	Surface-water Impacts	Groundwater Impacts	Land Use protection/restoration	Water-use protection/restoration	Terrestrial Ecosystem Impacts	Aquatic Ecosystem Impacts	Socioeconomic Impacts	Radiation Exposure to	Other Site-Specific Impacts		
5.8.2 Social and Economic Impacts								S				S		S	1) Population will increase as operational workers move in to the primary impact area, creating a small increase in demand for housing in Monroe, Wayne, and Lucas counties. 2) Beneficial impact to regional economy and tax revenue. 3) Increased operational-related populations may affect provision of public services, tourism/recreation, and public utilities. 4) A net increase of 305 students would be expected to attend schools in the primary impact area. 5) Beneficial impact on local employment as Fermi 3 becomes operational.	1) No mitigation measures are deemed necessary. 2) The impact will be beneficial and therefore no mitigation required. 3 and 4) Services supported by user fees. No further mitigation measures are deemed necessary. 5) Beneficial impact, so no mitigation is necessary.
5.8.3 Environmental Justice Impacts	S		S	S				S				S			1) No disproportionately high, adverse impacts have been identified in the primary impact area.	1) No mitigation measures are deemed necessary.

Table 5.10-1 Summary of Measures and Controls to Limit Adverse Impacts During Operation (Sheet 19 of 19)

	Impact Category and Level of Impact															
Environmental Resource Categories	**Noise**	**Erosion/Sediment**	**Air Quality/Dust**	**Traffic**	**Effluents and wastes**	**Surface-water Impacts**	**Groundwater Impacts**	**Land Use protection/restoration**	**Water-use protection/restoration**	**Terrestrial Ecosystem Impacts**	**Aquatic Ecosystem Impacts**	**Socioeconomic Impacts**	**Radiation Exposure to**	**Other Site-Specific Impacts**	**Impact Description or Action**	**Specific Measures and Controls**
5.9 Decommissioning																
5.9 Decommissioning					S										1) Disposal of contaminated wastes.	1) Required procedures outlined in 10 CFR 50.82 reduce potential impacts to acceptable levels.

5.11 Cumulative Impacts Related to Station Operation

A cumulative impact is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time" (40 CFR 1508.7). This section examines the cumulative environmental effects from Fermi 3 operation along with impacts from past, current, and anticipated future activities at the Fermi site and the surrounding area. This section also considers renewal of the operating licenses for Fermi 2 and Fermi 3 and the cumulative impacts from operating both units on the affected environment.

Impacts from Fermi 3 operation categorized as SMALL when considered alone could result in MODERATE or LARGE impacts when considered in combination with the impacts of other actions that could affect each resource area. For resources of concern in the area, SMALL individual impacts cumulatively have greater importance if they contribute to the decline of existing resources.

Potential cumulative impacts of operating an additional facility at the Fermi site were considered for this analysis. Past actions are limited to those related to the existing Fermi 2. Present actions are defined as major projects in progress at the time of the Fermi 3 COL application until the projected finish of Fermi 3 construction. Future actions are those major projects reasonably foreseeable during construction and subsequent operation of Fermi 3. The geographical area over which past, present, and future actions could contribute to cumulative impacts depends on the resource area being analyzed and is discussed in each section of the ER.

Most of the past environmental impacts that occurred at the Fermi site were associated with the construction and operation of the existing Fermi 2 and the decommissioned prototype Fermi 1. These actions include the construction and operation of the two nuclear reactors and associated facilities.

Following Fermi 3 construction, the site configuration at Fermi will consist of a Protected Area shared by both Fermi 2 and Fermi 3. Structures from the decommissioned Fermi 1 will be removed from the site and the reclaimed area will support construction and operation of Fermi 3. The new Fermi Drive will be used as the main site access; the existing Fermi Drive may be retained as a secondary access road or abandoned.

The vicinity of the Fermi site is used primarily for cropland and pasture. Land use onsite and within the 7.5-mile vicinity is discussed in Subsection 2.2.1. Most of the Fermi site (roughly 52 percent before construction) is dedicated to the DRIWR, with the remainder containing the Fermi 2 and Fermi 3 facilities, access and service roads and related outbuildings.

The Fermi 3 cooling system is discussed in Subsection 3.4.1. Heat dissipation to the atmosphere from operation of the Fermi cooling tower and the effects of the cooling tower plumes and drift are discussed in detail in Subsection 5.3.3.1. The impacts of the cooling tower plumes regarding salts, fogging, and icing on the Fermi site are discussed in Subsection 5.3.3.2. Salt deposition is not likely to be a concern for agricultural producers because most cooling tower drift impacts will be confined to the site, with minimal drift reaching beyond the site property boundary.

5.11.1 **Land Use**

The geographic area considered for potential cumulative impacts to land use from Fermi 3 operation encompasses a 7.5-mile area centered on the Fermi site (Figure 2.1-2).

Cumulative impacts to land use include new development to accommodate workers and worker-related services. Development would result in land conversion from forested and agricultural land to various development types, such as housing, gas stations and shopping centers. Impacts from general work force changes are expected to be minor since the operations work force is expected to relocate from a wider area than Monroe County, which may include the metro regions of Detroit, Michigan and Toledo, Ohio. Because the work force will be dispersed over these larger cities in the labor supply region, the induced impacts on land use (from operations of a new unit at the Fermi site) can be easily absorbed within the surrounding region. The exception is the vicinity of the Fermi site. Historically, the area contained within the Fermi site was agricultural and undeveloped lands undergoing slow development. Therefore, cumulative impacts would accrue with more effect, positive or negative, within Frenchtown Township nearest the Fermi site.

As discussed in Subsection 4.1.1, approximately 155 acres of the Fermi site will be permanently occupied by facilities associated with Fermi 3 until the unit is decommissioned. The existing Fermi 2 facility occupies 172 acres, including the remaining Fermi 1 structures. Proposed operation of Fermi 3 will contribute to changing land use within the Fermi site. Fermi 3 operation is not likely to encourage offsite industrial or urban development on a scale similar to Fermi 2, in part because of county and township zoning, which favors preservation of agricultural and rural land use. No large-scale industrial or commercial projects are planned near the Fermi site. Following construction of Fermi 2, Monroe Country did not experience increased development and similar results are expected for Fermi 3. Fermi 3 has a projected commercial in-operation date of 2020, which will spread any projected impacts over a greater length of time, making it less likely to have any discernible cumulative impacts. Because Fermi 3 construction will comply with all applicable county and township land use and zoning regulations, the cumulative impacts from Fermi 3 operation are anticipated to be SMALL.

As noted in Subsection 2.2.2.2, an ITC*Transmission* study has indicated that a separate switchyard and three new transmission lines will be needed for power output from the proposed Fermi 3. It is assumed that the existing Milan Substation may be expanded from its current size of 350 by 500 feet to an area approximately 1,000 by 1,000 feet to accommodate the addition of the three new transmission lines. This expansion would be into maintained grass and agricultural areas. The proposed expansion of the transmission corridor would affect predominately agricultural or forested land along the approximate 29.4-mile route.

The new transmission route would pass through Monroe, southwest Wayne, and southeast Washtenaw Counties along an assumed 300-foot wide corridor currently used or previously characterized for transmission purposes, thereby avoiding environmentally sensitive areas, such as population concentrations, National Forest lands, military installations, large bodies of water, wildlife preserves and refuges, state parks, state commemorative areas and major transportation facilities. The transmission upgrades within the previously developed eastern 18.6 miles of corridor are expected to be minimal, since the reconfiguration of existing conductors would largely allow for the use of existing infrastructure to create the new lines, access for installing additional lines is good, and the ROW is maintained. Impacts from construction are primarily limited to the western 10.8 miles of the corridor where both tower and steel pole installation could occur and some clearing will be required. Potential impacts are limited to wetlands within the assumed 300-foot wide ROW during construction, and SMALL operational impacts to the offsite transmission corridor are anticipated.

The operational impact of Fermi 2 was found to be small in previous studies. All known planned major projects, principally Fermi 3 and the offsite transmission corridor, would be subject to applicable state or federal environmental review and compliance requirements. Only minor impacts to land use in Monroe County were identified from past Fermi activities and land use impacts projected into the future in Monroe, Wayne and Washtenaw Counties are expected to be SMALL. Mitigation for unavoidable impacts will be subject to permit and regulatory compliance requirements.

5.11.2 **Air Quality**

This analysis focuses on air impacts to Fermi site and contributions to the region by Fermi 3 operation. The Fermi site is located in an attainment area for all EPA listed criteria pollutants. Impacts to air quality would primarily be from backup and emergency equipment (e.g. diesel generators and fire fighting equipment) and the cooling tower. Combustion sources burning fossil fuels are not typically sources of odor emissions as effluent streams rich in odorous compounds such as hydrogen sulfide are not processed. Additionally, no open burning will occur during the operational phase. Vehicle traffic would contribute to emissions, both directly from vehicle operation and from fugitive dust on unpaved surfaces, but these emissions are considered temporary and negligible.

Air emissions of criteria pollutants from Fermi 2 and Fermi 3 will be minor given the lack of significant gaseous exhausts of effluents to the atmosphere by nuclear facilities under normal operating conditions. Sources of air emissions for the proposed Fermi 3 facility are two standby diesel generators, an auxiliary boiler, a diesel fire pump, a natural-draft cooling tower, and a mechanical draft cooling tower. The combustion sources used are selected for efficiency and operated with good combustion practices on a limited basis throughout the year (often only for testing). Given their small size and infrequent operation, these emissions will not only have little effect on the Fermi vicinity, but will have minimal impact on local and regional air quality. Final emissions will depend on specific equipment selected for implementation, but emissions from all equipment will be within air quality regulatory guidelines set by federal and state agencies. Emissions of criteria pollutants from Fermi 3 will be cumulative with the impacts of the similar equipment of Fermi 2. Since such equipment is operated intermittently, the cumulative impact is considered SMALL.

The proposed cooling tower for Fermi 3 will not be a source of typical combustion-related criteria pollutants or other toxic emissions. However, small amounts of salt and particulate matter will be emitted as drift. The tower will be equipped with drift eliminators designed to limit drift to levels low enough to avoid adverse effects to vegetation, including crops. The height of the tower will allow for good drift dispersion and prohibit localized concentrations of particulate matter. The minor nature of cooling tower effects on visibility and air quality, including potential for increases in ambient temperature and moisture, icing, fogging and salt deposition, are discussed in further detail in Subsection 5.3.3.

During Fermi 3 operation, no impacts associated with fugitive dust are expected near the Fermi site. Access and maintenance roads within the site are infrequently traveled and any fugitive dust is a temporary and limited discharge that will not affect regional air quality or result in non-attainment.

Air emissions at Fermi 3 will be controlled in accordance with local, state and federal laws. Emissions are also subject to the compliance requirements and conditions of the Fermi 3 air permit issued by the MDEQ. Cooling tower salt deposition and drift impacts would not significantly affect surrounding agricultural lands or vegetation since most such material would be contained within the site.

Similarly, impacts from future potential industrial expansion in the Fermi vicinity would be SMALL due to the restrictions under MDEQ and EPA new facility air permitting programs and associated control and modeling criteria. Operational impacts to air quality at the site and in the vicinity would not affect land use on the site or near Fermi 3; therefore, cumulative impacts to air quality from Fermi 3 operation would be SMALL and further mitigation is not warranted.

5.11.3 **Water Use and Quality**

This section focuses on water usage from Lake Erie as the primary surface waterbody supplying and receiving Fermi water, and as the body of water that provides liquid pathways for both radiological and non-radiological effluents. Groundwater impacts also are discussed.

The geographical area for surface water in this analysis is the Lake Erie segment immediately adjacent to Fermi. The evaluation area for groundwater is Monroe County.

5.11.3.1 **Surface Water Use**

Michigan State law was amended effective February 28, 2006, to better manage water withdrawals. The amendments changed reporting, registration, environmental protection standards and permitting requirements for large quantity withdrawals from groundwater and surface water, including the Great Lakes. A large quantity withdrawal generally is a withdrawal greater than 100,000 gallons per day (GPD) averaged over a consecutive 30-day period. New or increased large quantity withdrawals are prohibited from causing an “adverse resource impact.” An adverse resource impact is defined as altering the ability of a waterbody to support a characteristic fish population, as determined by comparing the groundwater contribution to stream flow against the size of the watershed. In general, taking too much water from a waterbody changes the types of fish expected to be found in that waterbody.

The amended law requires development of a water withdrawal assessment tool, which has not yet been completed. Until this tool is available, there is a rebuttable presumption that a new or increased large quantity withdrawal will not cause an adverse resource impact if the withdrawal location is farther than 1320 feet from the banks of a designated trout stream or if the withdrawal depth of the well is at least 150 feet. There must be strong evidence that a new or increased large quantity withdrawal has caused or is likely to cause an adverse resource impact.

The Fermi 3 withdrawal for cooling water will qualify as a large quantity withdrawal from Lake Erie (greater than 100,000 GPD withdrawn from a Great Lake) and a permit from MDEQ for the new intake installation will be required. In addition, because the water withdrawal assessment tool is not available and the Fermi 3 site is not near a designated trout stream segment, adverse resource impacts from Fermi 3 withdrawals are not likely. All water withdrawn (less consumptive use) will be returned to Lake Erie.

Lake Erie will be the primary source of water for Fermi 3, including an estimated maximum makeup flow withdrawal of approximately 34,000 gpm (Subsection 3.3.1.1). Discharge to Lake Erie would be approximately 17,000 gpm during normal operations and much reduced when on standby (Subsection 5.2.1).

The nearest user of Lake Erie water is the Frenchtown Township municipal water system. However, because of the immense volume of water in Lake Erie and the extremely small proportion of Lake Erie water that would be utilized, use conflicts are unlikely.

The cumulative impacts of Fermi 3 and other water withdrawal on Lake Erie water use will be SMALL.

5.11.3.2 **Surface Water Quality**

Western Lake Erie receives major inflows from the Detroit River, Huron River, River Raisin and Rouge River and from smaller drainages including Swan Creek and Stony Creek. The River Raisin, Huron River and Rouge River drain into the western basin of Lake Erie, affecting western basin water quality near the Fermi site. However, Fermi does not impact the water quality in these streams (Subsection 2.3.3). Lake Erie and Swan Creek are the two waterbodies most likely to be directly affected by Fermi 3 operation (Subsection 2.3.1.1.3.1). Swan Creek receives discharges from the Fermi 2 plant which then enter Lake Erie, while Fermi 3 will discharge directly to Lake Erie.

The Fermi site lies within the Swan Creek Watershed. Land use and human activities greatly influence water quality in this watershed. The most important parameters affecting water quality in the Swan Creek Watershed are nutrient enrichment, pesticide contamination, sedimentation and chemical contaminants such as organochlorine compounds, mercury and polychlorinated biphenyls (PCBs). Stormwater runoff contributes to elevated herbicide and nutrient concentrations (Reference 5.11-2). The potential water pollutant predicted during Fermi 3 construction is sediment or dust entering Lake Erie, the surrounding streams or groundwater.

A review of water quality data collected by the U.S. Geological Survey (USGS) and the MDNR from Lake Erie and the streams near the Fermi site demonstrates that impairments exist (described in

Subsection 2.3.3). The water quality data review (Subsection 2.3.3.1) identified turbidity, nutrients, persistent organics, metals, and oils as challenges to Lake Erie water quality. Fermi discharges are not a contributor to Lake Erie impairment, as noted in Section 5.2.

Fermi 2 water discharged to Lake Erie has not had a measurable water quality impact, based on the results of ongoing monitoring programs. The existing Fermi 2 wastewater discharge permit includes conditions intended by the MDEQ to be protective of Lake Erie water quality and the streams receiving stormwater. These conditions are based on an evaluation of facility operations, facility wastewater discharges, and state and federal regulations and guidance (Subsection 5.2.2). Fermi 3 operations will include similar impacts to those currently regulated and monitored for Fermi 2. Because of the volume of Lake Erie water, the assimilation ability of Lake Erie for discharge wastewater from Fermi 3 is expected to be scarcely affected by the addition of the new facility. The continuing limitations on the discharges from Fermi and other discharges to Lake Erie by NPDES discharge permits and continuing regulation of water quality criteria in Lake Erie by the MDEQ and EPA provide a regulatory system to manage impacts to water quality, reducing significant cumulative impacts to a negligible level.

Based on the above factors, the expected cumulative impacts of discharges to Lake Erie water quality from the continuing operation of Fermi 2 and the addition of Fermi 3 are expected to be SMALL.

5.11.3.3 **Groundwater Use**

The main water source used during Fermi 3 construction will be Lake Erie. There will be no major hydrologic alterations from construction activity. Except for dewatering during construction, no groundwater use will occur during Fermi 3 operation, so impacts to groundwater are limited to effluent discharges, which are regulated by the MDEQ.

5.11.3.4 **Groundwater Quality**

Existing operations of Fermi 2 have not resulted in significant, adverse impacts to groundwater quality. Groundwater sampling for a variety of physical and chemical parameters conducted in 2007 (summarized in Subsection 2.3.3.2) did not indicate apparent impacts from Fermi 2 operations.

Potential radioactivity release is monitored at Fermi 2 in compliance with the terms of the NRC license and NRC regulations and is reported annually to the NRC (10 CFR 20). This monitoring includes semiannual sampling of radioactivity in groundwater up-gradient and down-gradient from the Fermi site. Monitoring program results indicate the levels of radionuclides monitored continue to remain similar to results obtained in previous operational and pre-operational years.

The above information indicates that Fermi 2 has had no significant impact on groundwater quality. Similarly, impacts from Fermi 3 operations are expected to be negligible. The following demonstrate the minimal opportunities for impacts to occur:

- Storage and use of chemicals and other potential groundwater pollutants are very limited at Fermi.

- Process operations and materials storage are in sealed buildings with monitored containment and discharge points.
- Spills, leaks and releases of materials are prevented or managed by active programs at the site, such as the SWPPP, SPCC Plan, use of appropriate chemical storage systems, and inspection of material storage systems.
- Discharges from the site are controlled by the NPDES permit.
- Semi-annual groundwater monitoring for radioactivity will continue under terms of the existing Fermi 2 NRC license and an anticipated license for Fermi 3.
- There are no other significant sources of radionuclides (i.e., other nuclear facilities) in the area of consideration.

The cumulative impacts to groundwater from the operation of Fermi 2 and Fermi 3 are expected to be SMALL.

5.11.4 **Ecology**

For this analysis, the geographic region encompassing past, present, and foreseeable future actions is the 7.5-mile diameter area immediately surrounding Fermi. After construction for Fermi 3 is complete, temporarily affected aquatic and terrestrial ecosystems are expected to return to predominantly pre-construction conditions. No other past, present, or future actions in Monroe County were identified that could affect wildlife and wildlife habitat in ways similar to Fermi 3 operation (e.g., cooling tower noise; adverse effects to agricultural crops, ornamental vegetation or native plants from cooling tower drift; or avian cooling tower collisions).

Cumulative impacts to terrestrial and aquatic ecosystems are discussed in more detail below.

5.11.4.1 **Terrestrial Ecology**

Construction and operation of Fermi 3 were evaluated to determine the relative contribution to regional impacts on terrestrial resources. Determinations for construction were discussed in Section 4.7. In this section, evaluations for operation of Fermi 3 are made concerning resource attributes normally affected by cooling tower operation, transmission line operation and right-of-way maintenance.

Impacts to terrestrial resources may include habitat alteration or conversion, adverse effects on crops or ornamental vegetation, impediment to wildlife movement through habitats (travel corridors), adverse effects to threatened or endangered species, changes in land use related to traffic, noise, dust or suspended particulate matter, and maintenance activities, both onsite and in offsite transmission corridors.

Habitat within the Fermi site is discussed with more detail in Subsection 2.4.1. The primary habitats present are forested areas, wetlands and agricultural fields, along with previously developed areas (e.g., Fermi 1 location) that will be re-developed for the Fermi 3 project. Forested and wetland habitats will be reduced in extent because of Fermi 3 construction (Subsection 4.7.1), but Fermi 3 operation would not extend the changes to areas unaffected by past activities, construction of Fermi

3 or operation of Fermi 2. Areas west and south of the Fermi site are zoned for agricultural and residential use and would be minimally affected by Fermi 3 operations. Fermi 3 would have no impact on area planning and zoning designations and will comply with local development plans, further limiting any impacts. While the acreage of some terrestrial habitats would be slightly reduced, extensive areas of similar habitat nearby would remain. County zoning prevents large-scale development from converting natural habitats to developed areas, as has been observed with Fermi 2 operations and a lack of related industrial or commercial development in the region. In the case of wetland habitats, mitigation would be undertaken to replace lost functions. Wetland mitigation requirements will be subject to Clean Water Act Section permits administered by the USACE and MDEQ after a Jurisdictional Determination is completed by USACE.

As described in Subsection 2.4.1.1.2, the Fermi 3 operation is not expected to block wildlife movement through existing travel corridors, because Fermi 3 is being developed close to the existing facility and existing transmission corridors are being used for linear facilities as much as possible. This limits the degree to which undeveloped habitats would be affected by any new construction or operations. Because wildlife have already adapted to the presence of Fermi 2 and the existing transmission corridor, the addition of Fermi 3 is not a substantial change resulting in destabilization of habitats.No designated critical habitat as defined by the USFWS is known to occur on the Fermi site or nearby. As described in Subsection 2.4.1.2.1, correspondence from USFWS did not report any federal protected plants or wildlife as occurring on or near the Fermi site. The MDNR indicated that two state-listed protected species, American Lotus and Bald Eagle, are present on or near the Fermi site. In April 2009, the Bald Eagle was delisted in Michigan, but it is still protected by two federal laws. Both species have been observed at the site. In addition, the Eastern Fox Snake, a state-listed threatened species, was observed at the site.

American Lotus would be affected by Fermi 3 construction, as discussed in Subsection 4.3.1.2.1. Construction-related impacts would be mitigated by transplantation or other mitigation measures. Operation of Fermi 3 is not expected to affect the onsite population of this species.

Bald Eagles nested onsite successfully in 2008 and 2009. No effects from Fermi 3 operation are expected, as the Bald Eagle has continued to use Lake Erie coastal environment during Fermi 2 operation. The most active nest location is less than 750 feet from the Fermi 2 natural draft cooling towers, demonstrating a tolerance of mechanical noise and human activity. Fermi 3 will be located inland of Fermi 2, further isolating it from the current Bald Eagle nest location.

The Eastern Fox Snake may be temporarily displaced during Fermi 2 construction. However, Fermi 3 operation is not expected to affect populations of these species on the site based on measures taken to reduce impacts during construction.

No additional roads would be needed to accommodate transportation needs for Fermi 3 during operation. The existing roadway infrastructure near the Fermi site has managed a fluctuating work force during construction and operation at Fermi 2, including outages and refueling. Adding a slightly smaller work force dedicated to Fermi 3 operation will likely result in minor increases in traffic on existing public roads, mainly Dixie Highway, to and from the Fermi site during normal commuting hours. However, by the time Fermi 3 operations begin in 2020, various planned road improvement projects for local roads in the Fermi vicinity will have been completed, alleviating possible congestion. Occasional deliveries via the Canadian National spur to the Fermi site would continue during Fermi 3 operation, as it has during Fermi 2 operation.

Unpaved roads at Fermi may release minor quantities of dust when driven under dry conditions, especially if they are subjected to increased traffic by heavy vehicles. During operation, impacts associated with dust will be confined to the Fermi site because of gravel surfacing on most roads and nominal use of the roads (mostly single vehicles spaced apart in time). Measures such as spraying the roads with water or adding more gravel to road surfaces may be used to reduce fugitive dust emissions when traffic use is increased.

Noise during normal Fermi 3 operation is expected to be similar to, or slightly greater than, ambient noise during Fermi 2 operation (Table 5.8-1). Operational noise levels for Fermi 2 have not affected land use in the plant area and it is reasonable to believe that Fermi 3 noise impacts during operation will not represent an exponential increase leading to land use changes in the region.

The transmission corridors between the Fermi site and the existing Milan Substation would be upgraded along the existing 29.4-mile long route within a presumed 300-foot wide transmission ROW. Forested, agricultural and wetland or open water areas are the most significant habitats represented in the corridors. Affected Federal and State agencies were contacted or consulted by way of publicly available information regarding potential impacts to the terrestrial ecosystem resulting from the construction for Fermi 3. It is expected that consultation of appropriate agencies will be conducted by ITC*Transmission* before the transmission upgrade is started. No impacts to Federal of State-threatened or endangered species or critical habitats are expected because these are not present in the existing transmission corridors.

In addition, no past, present, or future actions in the region were identified that could affect wildlife or wildlife habitat in ways similar to those associated with the transmission line operation and right-of-way maintenance (birds colliding with transmission lines; electrocution of raptors or other large birds; flora and fauna affected by electromagnetic fields; and flora, fauna, floodplains or wetlands affected by right-of-way maintenance). During construction, it is anticipated that impacts to wetlands will be avoided to the maximum extent possible (e.g., matting used for traversing wetlands, avoid pole placement in wetlands, etc.). Consequently, cumulative impacts on wildlife and wildlife habitat in the region are expected to be negligible due to the operation and maintenance of the transmission line ROW.

Operational impacts to terrestrial resources would be minimal because zoning, various permit conditions and other regulatory requirements control land use to limit environmental impacts to minimal levels. The operation of Fermi 3 or the offsite transmission corridor is not expected to have a substantial effect on any current or planned land uses; therefore, its overall cumulative impact on terrestrial ecological resources is expected to be SMALL.

5.11.4.2 **Aquatic Ecology**

Construction and operation of Fermi 3 were evaluated to determine the relative contribution to regional impacts on terrestrial resources. Determinations for Fermi 3 construction are discussed separately in Section 4.7. Determinations for operation of Fermi 3 were made for those resource attributes normally affected by cooling tower operation, transmission line operation and right-of-way maintenance. This includes an evaluation of the potential effects from water intake, consumption and discharge.

For this analysis, the geographic region encompassing past, present, and foreseeable future actions is the area immediately surrounding the Fermi site, including adjoining sections of Lake Erie, the area surrounding Fermi 2 and offsite transmission line rights-of-way. Aquatic ecology reviews reflect cumulative impacts of current activities and past actions along Lake Erie near the Fermi site, and impacts from the planned Fermi 3 operation.

The construction of Fermi 2 in the 1980s did not cause substantial changes in Lake Erie fish species composition near the Fermi site. Fish communities identified in both historic and recent surveys have similar species composition, suggesting the fish community of Lake Erie near the Fermi site is relatively stable (Subsection 2.4.2.2.2.1). Similarly, populations of aquatic macroinvertebrates have been relatively consistent, with one notable exception. Higher densities of mayfly nymphs indicate better water quality. Mayfly densities dropped in the 1970s, but have increased because of the implementation of various water quality improvements, such as stormwater runoff controls. Concentrations of mayflies near the Fermi site tend to be higher than in locations distant from the site (Reference 5.11-1), an indication that water quality near the Fermi site has not been adversely affected by Fermi 2 construction and operation. Given the regulatory controls associated with Fermi's NPDES permits, comparable results are expected for Fermi 3.

Potential cumulative impacts related to impingement and entrainment of aquatic organisms were evaluated, based in part on experience with Fermi 2 operations. Operation of the combined Fermi facility intake structure will lead to future impingement and entrainment of aquatic organisms, although Fermi 2 experience demonstrates that this is generally lower than other power stations along the western shore of Lake Erie (Subsection 5.3.1.2.3.2). Future actions are those related to operation of the proposed facility through a complete license term. Intake screens would be sized so the average intake through the screen would have a flow velocity of less than or equal to 0.5 fps, the recommended flow rate to reduce fish entrainment. Based on these design plans and experience with Fermi 2 operation, impingement and entrainment during operation of the proposed Fermi 3 facility would be minimal.

Impacts from cooling tower operations are from visible plumes and drift composed of solids concentrated from evaporated water. Biocides are used to inhibit thermophilic organisms and drift eliminators are used to reduce the volume of drift. Because of these measures, it is anticipated that impacts from the Fermi 3 cooling tower will be SMALL, just as they are for Fermi 2. An additive effect from operation of both Fermi units would still be SMALL and the cumulative effect is not considered significant.

Operation of the proposed intake structure is not expected to affect species of special interest, or Federal or State-listed threatened and endangered species because none are reported in prior studies, including Fermi 2 operation (Subsection 2.4.2.2.2.1). As noted in Subsection 2.4.2.2.2, lake sturgeon could potentially inhabit Lake Erie waters near the Fermi site. Lake Sturgeon have been found in the Detroit River, 10 miles north of the Fermi site. Because conditions favorable to this species are not present in Lake Erie near the Fermi site, operations at the Fermi site should not affect this species and neither juveniles nor adults have been present in previous studies related to Fermi 2.

Potential cumulative impacts related to water discharge are primarily related to the temperature difference and the effect on biota inhabiting the discharge area. The geographical area over which the cumulative effects were considered for past, present, and future actions is all surface waters within the Fermi site, which is principally the Lake Erie shoreline and nearshore waters. Since beginning Fermi 2 operation, heated effluent has been discharged into the Lake Erie nearshore environment. The plume size from the combined Fermi 2 and 3 discharge would be insignificant relative to the volume of Lake Erie. The Fermi 3 discharge pipe would be buried in the Lake Erie bank southeast of the site and the average flow rate would be low, approximately 8.5 fps (Subsection 3.4.2.2). Some minimal warming of water near the Fermi discharge pipe is likely, but this will quickly dissipate in the larger body of water. Operation of Fermi 2 has produced no discernible changes in Lake Erie, and similar results are likely with Fermi 3 discharges, because both units will be subject to NPDES permit conditions.

Operation of the proposed discharge structure is not expected to affect species of special interest or Federal or State-listed threatened and endangered species because none have been located in prior studies. The water volume, water temperature and chemical composition are regulated by the MDEQ through the NPDES permit program. MDEQ regulates point sources discharging pollutants to ensure the protection and propagation of aquatic organisms. Under regulations, the MDEQ is required to take into consideration the cumulative impacts of multiple discharges to the same body of water. Therefore, discharges from Fermi and other area facilities are included in the review and development of permit requirements (including measures to minimize any cumulative effects) for a new Fermi 3 and for subsequent renewals of permits for combined Fermi 2 and 3 operations. Although the addition of Fermi 3 will essentially result in a doubling of the Fermi discharge to Lake Erie, no adverse effects are anticipated, as discussed above.

In summary, the contribution of Fermi 3 operation to cumulative impacts on aquatic resources would be SMALL, and further mitigation is not warranted.

5.11.4.3 **Socioeconomic, Historical and Cultural Resources**

The socioeconomic impacts of power plant operation are mainly a function of workforce size, wages and worker commutes relative to available facilities and services. For example, if a larger proportion of workers have to commute between a distant home and the plant, negative impacts from traffic could increase locally, unless adequate traffic management and travel services are available. Reasonable assumptions appropriate for evaluating the socioeconomic impacts on the region were made to evaluate potential impacts; these are further described in Section 5.8. The geographical area of the cumulative analysis varies with the type of impacts considered, and may depend on specific boundaries, such as tax jurisdictions, or may be distance-related, as for environmental justice. For evaluation of cumulative effects from a socioeconomic perspective, Monroe County may have the highest concentration of adverse socioeconomic impacts because of a history of slow rural growth. The Fermi project could adversely affect normal growth by encouraging rapid urbanization or industrial development.

During operation of Fermi 3, the project will generate considerable direct and indirect socioeconomic benefits (e.g., stabilized housing market, worker wages and increased tax and user fee revenues) while maintaining consistency with the county development plan. Expansion and development did not occur after Fermi 2 went into operation, and a similar result is expected for Fermi 3. Substantial positive benefits from Fermi 3 operation would accrue in Monroe County, including low income and minority areas, while having a SMALL impact on area culture and human health. The potential for negative impacts, such as increased traffic congestion, will be addressed through traffic flow management and other measures as discussed in Section 5.10.

The potential for negative impacts arising from the demand for local facilities and services will be controlled through: (1) appropriate operating practices at the site (security, fire, safety measures), (2) county or local zoning ordinances, (3) or are not a concern due to sufficient excess capacity (e.g., schools and water supply). Approaches to alleviate a current shortage of worker/starter housing in Monroe County are being studied, but housing to accommodate operating staff is available. Increased traffic because of worker commutes or supply shipments and waste disposal is the only identified concern potentially having an impact larger than SMALL, which will be studied further in cooperation with the MDOT and the county before construction is begun. It is anticipated that with appropriate control measures and traffic design near the plant, any potential negative impacts can be reduced to insignificance. Therefore, socioeconomic impacts are considered SMALL, and further mitigation is not warranted.

Regarding historical properties and cultural resources, the operation of Fermi 3 is not expected to add any cumulative impacts beyond those impacts to the APE, as identified in Subsection 5.1.3. Detroit Edison will implement procedures to ensure that known or newly discovered historical and cultural sites would not be affected during onsite activities that involve land disturbances. These procedures will be developed in consultation with the State Historic Preservation Office (SHPO) and will only be implanted following SHPO validation. Operation and maintenance of the existing Fermi 2 and Fermi 3 would not alter land uses outside the bounds of the current Fermi property. Impacts to historic above-ground resources within a 10-mile radius of the Fermi 3 project are considered SMALL, and further mitigation is not warranted.

5.11.5 **Environmental Justice**

In accordance with Executive Order 12898, "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations." Environmental justice impacts result when adverse human health or environmental impacts fall disproportionately on low-income and minority populations.

The geographic focus for environmental justice contains those areas impacted by operation and maintenance of the Fermi 3 facility, including those locations outside the legal boundaries directly affected by plant operations and maintenance. The only known or likely future action is the construction and operation of Fermi 3 and continuing operation of Fermi 2. Based on an absence of low income or minority neighborhoods, it is reasonable to conclude that conditions required for environmental justice impacts to occur are absent in the Fermi project area. Specifically, adverse cultural, economic, or health impacts in the form of slightly increased traffic are anticipated to be minimal, and concentrations of low income or minority populations are not close to the Fermi site or disproportionately affected by Fermi operations. The potential for negative impacts will be controlled through appropriate construction and safety practices, traffic flow management and other measures as discussed in Section 5.10. Therefore, the cumulative impacts on environmental justice would be SMALL.

5.11.6 **Non-Radiological Health**

This public health analysis includes onsite workers within the Fermi grounds. Non-radiological health impacts may include solid wastes generated by facility construction or operation and exposure to thermophilic organisms from cooling tower drift. Non-radiological health impacts as discussed here do not include air quality and water quality impacts.

Non-radioactive solid wastes will be managed in licensed facilities using safety procedures to minimize worker exposure, wherever appropriate. The waste volume will be minimized through waste minimization programs; therefore, cumulative impacts of waste disposal, including any health impacts from this waste, are expected to be SMALL.

The cumulative health impacts of operation of the existing Fermi 2 and proposed Fermi 3 on the ambient temperature of Lake Erie with regard to potential formation of thermophilic microorganisms were evaluated in Subsection 5.3.4.1. The evaluation showed that the addition of Fermi 3, which would use cooling tower as the cooling source, would not be a significant impact because the discharge would be into a large lake. Fermi 2 currently uses biocides to reduce hazards from microbiological organisms in the cooling tower, and Detroit Edison has committed to employ appropriate industrial hygiene practices to protect the occupational workers from the effect of thermophilic microorganisms in the cooling tower for Fermi 3. The health risk to workers is expected to be dominated by occupational injuries at rates below the average U.S. industrial rates. Health impacts on the public and workers from noise and dust emissions were also evaluated and found to be SMALL. The cumulative impacts on non-radiological health would be SMALL, and additional mitigation is not warranted.

5.11.7 **Radiological Impacts of Normal Operation**

Detroit Edison has conducted a radiological environmental monitoring program around the Fermi site since 1978 to the present (see also Section 6.2). The radiological environmental monitoring program measures radiation and radioactive materials from all sources, including Fermi. The NRC and MDEQ regulate any reasonably foreseeable future actions that could contribute to the cumulative radiological impact.

This impact analysis includes the Fermi site during the operational service life of Fermi 2 and 3. The geographical area within 50 miles of the Fermi site was evaluated in accordance with NRC guidelines. The Fermi property is the only noteworthy radioactivity source in the immediate project area to which workers or the public could be potentially exposed.

The radiological exposure limits and standards for public protection and for occupational exposures were developed assuming long-term exposures; therefore, the standards intrinsically incorporate cumulative impacts. The public and occupational doses predicted from the operation of Fermi 3 would be well below regulatory limits and standards (Section 5.4). Specifically, the site boundary dose to a maximally exposed individual from Fermi 2 and 3 combined would be well within the regulatory standard at 40 CFR 190.

The volumes of low-level and high-level radioactive wastes (i.e., spent fuel) will be reduced through waste minimization programs. High-level wastes currently are stored onsite, while low-level wastes are removed to an offsite licensed disposal facility. Low-level wastes may continue to be shipped to a disposal facility; however, both low and high level wastes may be stored onsite at Fermi for various periods until a national repository is available. Sufficient storage space is available for both Fermi reactors, but the time to reach available storage capacity may be reduced. However, decommissioning of Fermi 2 during the service life of Fermi 3 would alleviate this problem. Storing additional waste from Fermi 3 would not significantly increase radiological impacts because standard safety and storage procedures would prevent problems from occurring. Based on the existing Fermi 2 safety record, similar results are anticipated for Fermi 3. Cumulative impacts from waste disposal are expected to be SMALL, and further mitigation is not warranted.

5.11.8 **Uranium Fuel Cycle and Fuel Transportation**

Operation of the proposed Fermi 3 would mean added fuel to supply both units at the Fermi site. Impacts related to reactor fuel production are uranium ore mining, milling of the ore, conversion of uranium oxide to uranium hexafluoride, uranium hexafluoride enrichment, fuel fabrication (uranium hexafluoride converted into uranium oxide fuel pellets), and eventual disposal of spent fuel in an approved long-term storage facility, such as Yucca Mountain. Because a permanent long-term storage facility is not available yet, spent fuel will be stored onsite in the existing storage facility as discussed above in Subsection 5.11.7.

Table S-3 (10 CFR 51.51) provides the environmental impacts from uranium fuel cycle operations for a model 1000-MW(e) light-water reactor operating at 80 percent capacity with a 12-month fuel loading cycle and an average fuel burnup of 33,000 MWd/MTU. Per 10 CFR 51.51(a), the NRC typically considers the impacts in Table S-3 to be acceptable for the 1000-MW(e) reference reactor. As discussed in Subsection 5.7.1.9, the environmental impact of fuel-cycle activities for Fermi 3 is within the limits of Table S–3.

Fuel cycle impacts would occur not only at the Fermi site, but also would be scattered to other locations in the United States or in other nations if uranium fuel were foreign-purchased. However, advances in reactor technology since Table S-3 development have had the effect of reducing environmental impacts of the operating reference reactor. For example, a number of fuel management improvements were adopted by nuclear power plants that achieve higher performance and reduce fuel and enrichment requirements, thereby reducing the amount of fuel required to produce the same power output. The cumulative fuel cycle impacts of operating Fermi 3 are expected to be SMALL, and further mitigation is not warranted.

The addition of the proposed Fermi 3 may result in additional shipments of un-irradiated fuel to the site and additional shipments of low-level spent fuel or waste from the site. High level wastes will continue to be stored onsite. Cumulative impacts related to fuel transportation would be approximately twice that of the existing operating plant because of the increased amount of fuel needed for both units.

Because of conclusions drawn from environmental impact reviews, measures to minimize occupational and population exposure from radiological waste have been widely implemented by the nuclear industry. These measures include operational restrictions on transport vehicles, ambient radiation monitoring, special packaging requirements, NRC licensing standards, changes in waste form to minimize the release of radioactivity during transit and training of emergency personnel to respond to mishaps. Environmental impacts from transportation of unirradiated fuel, spent fuel and waste were derived by the NRC from an analysis of un-irradiated fuel shipments.

The public radiation exposure and other potential transportation impacts resulting from radioactive waste transport are addressed generically in Table S-4. These practices result in safe and acceptable impacts to the environment or to exposed workers, onlookers, or the public during transport. Potential health effects are small; even if these impacts were increased by a factor of two (as they might be with the addition of Fermi 3 in this case), the impacts would remain small. Thus, cumulative impacts of transportation relative to operating both Fermi 2 and Fermi 3 units would be SMALL.

5.11.9 **Conclusion**

The impacts from Fermi 3 operation will not be cumulatively significant relative to impacts of the operation of Fermi 2. There are no other existing or planned projects of a similar scale to Fermi 3 in the vicinity resulting in increased negative cumulative impacts to the identified resource areas.

The potential adverse short-term and long-term impacts from the operation of Fermi 3 were identified and actions to mitigate those impacts were proposed. Activities to be undertaken during operation of Fermi 3 are consistent with those currently in place for Fermi 2. Except for the construction footprint, available land use and terrestrial resources will remain largely unaffected. Construction activities are considered temporary and actions to mitigate any impacts are proposed to hasten a return to pre-construction conditions.

Fermi 3 operations require the use of certain natural resources, including water withdrawal from Lake Erie for cooling. Fermi 3 operations will result in the release of process gaseous, liquid and solid wastes, all in conformance with applicable local, State and Federal permit requirements and standards. Because these criteria were developed to restrict environmental effects, it is anticipated that permit compliance will result in minimal impacts.

In evaluating potential cumulative impacts resulting from operation of a new nuclear unit at Fermi for the duration of the proposed action (approximately 40 years of operation), the evaluation took into account the potential impacts from factors known or likely to affect the environment. This included considering conditions at the site and surrounding vicinity from past, present, and future human activities and their effects on the human environment.

For each impact concern, the potential cumulative impacts resulting from operation with planned mitigation are generally SMALL, and further mitigation is not warranted.

5.11.10 References

5.11-1 Latimore, J.A., “Report on Stony Creek Watershed Sampling,” Huron River Watershed Council, July 29, 2004.

5.11-2 Myers, D.N., M.A. Thomas, J.W. Frey, S.J. Rheaume, and D.T. Button, “Water Quality in the Lake Erie-Lake Saint Clair Drainages Michigan, Ohio, Indiana, New York, and Pennsylvania, 1996–98,” U.S. Geological Survey, Circular 1203, 2000.