4.5 RADIATION EXPOSURE TO CONSTRUCTION WORKERS

This section discusses the exposure from the normal operation of Susquehanna Steam Electric Station (SSES) Units 1 and 2 to construction workers building the Bell Bend Nuclear Power Plant (BBNPP).

4.5.1 Site Layout

The physical location of BBNPP relative to the existing SSES Units 1 and 2 is presented in Figure 4.5-1. BBNPP will be located approximately 5000 ft (1524 m) west of SSES. BBNPP and SSES will have separate protected areas (See Section 3.1).

4.5.2 Radiation sources at BBNPP

During the construction of BBNPP, the construction workers will be exposed to radiation sources from the routine operation of SSES Units 1 and 2. Sources that have the potential to expose construction workers are listed in Table 4.5-1. They are characterized as to location, inventory, shielding, and typical local dose rates. They are also characterized in terms of potential to expose BBNPP construction workers. Only those with significant potential are analyzed in detail. Interior, shielded sources are not included. Figure 4.5-2 and Figure 4.5-3 show the locations of these sources.

These sources are discussed in the Offsite Dose Calculation Manual (ODCM) (PPL, 2006a), the annual Radiological Effluent Release Report (SSES, 2007), the Radiological Environmental Operating Report (PPL, 2006b), and the Final Safety Analysis Report (SSES, 2006a). The eight main sources of radiation to BBNPP construction workers are gaseous effluents, liquid effluents, the Independent Spent Fuel Storage Installation (ISFSI), the Condensate Storage Tanks (CSTs), the Low Level Radioactive Waste Handling Facility (LLRWHF), the SEALANDS, the Steam Dryer Storage Vault, and the Turbine Building. These are discussed below.

Airborne effluents are released via four rooftop vents: two on the reactor building and two on the turbine building. The releases are reported annually to the NRC. Doses to the general population are also reported annually.

Effluents from the liquid waste disposal system produce small amounts of radioactivity in the discharge to the Susquehanna River. All waterborne effluents are released in batch mode and are sampled and analyzed prior to release. Waterborne effluents from the site are released into the cooling tower blowdown line for dilution prior to release in the Susquehanna River (SSES, 2006a).

There are five sources of direct radiation that could contribute to construction workers dose: the Independent Spent Fuel Storage Installation (ISFSI), the Low Level Radioactive Waste Handling Facility (LLRWHF), SEALAND containers, the Steam Dryer Storage Vault, and the Turbine Building. There are three sources identified that are not significant contributors to construction worker dose. These are listed in Table 4.5-1 along with a brief discussion (SSES, 2006a).

There are five sources of skyshine radiation that could contribute to construction workers dose: the Condensate Storage Tanks (CSTs), the Low Level Radioactive Waste Handling Facility (LLRWHF), SEALAND containers, the Steam Dryer Storage Vault, and the Turbine Building. They are also listed in Table 4.5-1.

4.5.3 Historical Dose Rates

The historical annual dose rates reported to the NRC are summarized in Table 4.5-2.

4.5.4 Projected Dose Rates at BBNPP

Annual doses from all sources combined were calculated for each 99 ft (30 m) by 97 ft (30 m) foot square on the plant grid. For purposes of dose calculation, a 100% occupancy is assumed. (For purposes of collective dose calculations, the occupancy for construction workers is 2,200 hours per year.) The doses are the sum of the dose rates from the eight main sources; gaseous effluents, liquid effluents, the Independent Spent Fuel Storage Installation (ISFSI), the Condensate Storage Tanks (CSTs), the Low Level Radioactive Waste Handling Facility (LLRWHF), SEALAND containers, the Steam Dryer Storage Vault, and the Turbine Building. The annual doses are shown in Figure 4.5-4 for the year 2017, the last year of construction. It is this year that the dose rate will be greatest, primarily because the ISFSI will have the largest number of spent fuel storage casks.

The collective dose is the sum of all doses received by all workers. It is a measure of population risk. The number of workers (in terms of Full Time Equivalents) and their location by zone are given in Table 4.5-3. The zone locations are shown by squares in Figure 4.5-4. The details of the collective dose calculations are given in the following discussion. Dose rates from all sources combined were calculated for each square on the plant grid. The dose rates were the sum of the dose rate from the eight main sources and assume 100% occupancy.

The equation for dose rate during year t at location x,y on the plant grid is:

$$\dot{D}_{x,y} = \dot{D}_{gas} + \dot{D}_{liq} + \dot{D}_{ISFSI,t} + \dot{D}_{CST} + \dot{D}_{LLRWHF} + \dot{D}_{SEA} + \dot{D}_{SD} + \dot{D}_{TB}$$

where the terms are explained in the ER Sections.

The equation for the average dose rate in a zone is:

$$\overline{\dot{D}}_z = \frac{1}{N_z} \sum_{\text{(all x,y in z)}} \dot{D}_{x,y}$$

where N_z is the number of squares in the zone.

The equation for collective dose for the construction period is:

$$D = \frac{2200}{8760} \sum_t \sum_z \overline{\dot{D}}_z FTE_{z,t}$$

where $\frac{2200}{8760} = \text{fraction of work hours per year}$, $\overline{\dot{D}}_z$ is defined as above, and $FTE_{z,t}$ is the full time equivalent in zone z during year t, or

$FTE_{z,t} = P_Z C_t$

The probability of a worker in each zone, P_Z, reflects the average construction worker and is based on an approximation of how much time the average worker spends in each zone, as shown in Table 4.5-16. The spatial distribution of zones on the site is shown (red letters indicating a zone code in each square) in Figure 4.5-4. There are many locations where construction workers are not expected to perform work activities, so they are not marked in the figure. These squares that are marked are chosen because of planned activities at those locations.

4.5.4.1 Gaseous Dose Rates

The construction worker dose due to SSES gaseous effluents depends upon the airborne effluents release and the atmospheric transport to the worker. The releases, which flow out of the SSES Units 1 and 2 plant vents, are reported annually to the NRC. Doses to the general population are also reported annually. The releases are modeled as ground level releases, which is conservative as it does not take credit for the height of the releases. Although there are two reactor building and two turbine building vents, the Radioactive Effluent Release Reports (e.g., SSES, 2007) only give a total release. The releases were conservatively modeled assuming the vent closest to the workers.

The annual dose rate from gaseous effluents to construction workers on the BBNPP site is bounded by the following equation:

$$\dot{D}_{(j),\,gas} = c_{(j)}\, r^{b} \quad (\text{mrem/year})$$

where,

c(j) = dose type coefficient,

j = dose type (TEDE, total body, organ, or thyroid),

r = distance from the release point to the target in feet = $\sqrt{(N - N_s)^2 - (E - E_s)^2}$

N,E = location of receptor on plant grid in feet,

Ns,Es = location of source on plant grid in feet, and

b = fitting parameter for atmospheric dispersion model = -1.6925.

The c(j) are documented in Table 4.5-4. The equation is based on annual average, undecayed, undepleted ground level x/Qs without credit for building wake from Susquehanna Steam Electric Station site meteorology for the years 2001 to 2007 (see ER Table 2.7-158) which are modeled as

$$\frac{X}{Q}(r) = 38.603 r^{-1.6925}$$

where r is defined as above. The equation also assumes the most limiting gaseous effluent releases from the period 2001 to 2006. The model is based upon 100% occupancy.

The dose rates were calculated for an onsite location with a known x/Q for the years 2001 through 2006 according to the Regulatory Guide 1.109 (NRC, 1977) method with Total Effective Dose Equivalent (TEDE) calculations according to Federal Guidance Reports 11 (EPA, 1988) and 12 (EPA, 1993). The gaseous releases are shown in Table 4.5-5. The 2006 releases gave the highest dose rates.

4.5.4.2 Liquid Dose Rates

The projected dose at the shoreline to a construction worker with a 2,200 hours/year occupancy rate is 0.407 mrem/yr; for a person with a full-time occupancy (8,760 hr/yr) the dose rate is 1.62 mrem/yr. This is based on releases and dilutions in Table 4.5-6 and Table 4.5-7. Table 4.5-8 lists the dose contributions by year.

4.5.4.3 ISFSI Dose Rates

For the purposes of this calculation the ISFSI is broken into north and south pieces. The north piece is assumed filled in 2010. Loading of the south piece is assumed to begin in 2009. The dose rate from the ISFSI is:

$$D_{ISFSI,t} = k[f_N(t)\varpi_N e^{-\mu r_N} + f_s(t)\varpi_s e^{-\mu r_s}]$$

where, D = annual dose,

ϖ_I = the solid angle between the ISFSI and receptor in steradians = $\pi\left(1 - \frac{r_i}{\sqrt{R^2 + r_i^2}}\right)$

k = fitting parameter = 1500 mrem/sr,

$f_i(t)$ = function describing loading with time dependence = $a_i + b_i t$,

μ = effective removal coefficient in air in ft^{-1} = 0.002056 ft^{-1},

r_i = distance from ISFSI piece i to receptor in ft = $\sqrt{(N - N_i)^2 + (E - E_i)^2}$

t = time in years (i.e., 2007),

a_i = fitting parameter.

a_N = -233.88

a_S = -253.79

b_i = fitting parameter,

b_N = 0.177 yr^{-1}

b_S = 0.126 yr^{-1}

R = effective source radius = 116.52 ft, and

N_I, E_I = State plane coordinates of source and receptor

N_N = 341550 ft

N_S = 341450 ft

$E_N = E_s$ = 2,440,600 ft.

The equation is based upon TLD measurements in the vicinity of the ISFSI combined with historic loading data and a projected loading schedule. The incremental loading of the ISFSI is modeled as a linear function.

Figure 4.5-5 shows the effect of distance on dose and compares this to TLD measurements. Figure 4.5-6 shows a satellite image of the ISFSI, Figure 4.5-7 shows the locations of the TLDs. The effect of time on dose is shown in Figure 4.5-8. And the basic input data to the time equation (the load history and projections) are shown in Table 4.5-9.

4.5.4.4 Condensate Storage Tank Dose Rate

The Unit 1 Condensate Storage Tank (CST) is shielded on the west side by the Unit 1 Turbine Building, on the east by the Diesel Generator Building wall, on the north by the Refueling Water Storage Tank, and on the south by the Unit 1 Reactor Building (see Figure 4.5-2 and Figure 4.5-3). The Unit 2 CST is shielded on the west by the Unit 2 Turbine Building and on the north by the Unit 2 reactor Building. It is partially shielded on the east and south by an overflow berm which extends 10.5 ft (3.2 m) above grade, which means that 21.5 ft (6.6 m) is exposed above the berm height. When a line is projected from the top of the Unit 2 CST over the berm wall, it converges with grade 575 ft (175 m) from the CST, which means direct radiation is absorbed by the ground beyond that point. Since construction workers will spend the majority of their time on site west of SSES and the remaining time further than 575 ft (175 m) east or south of the CSTs, additional analysis for the direct dose from the CSTs is not required. The skyshine dose rate from the Condensate Storage Tank is represented by the equation

$$\dot{D}_{CST} = 2E\text{-}05e^{-0.0018r}$$

where $\dot{D}_{CST}$ is in mrem/yr (based on 8760 hr/yr occupancy) and r is in ft. This equation is based on the source terms listed in Table 4.5-10 (SSES, 2006a) and a source material of water with a density of 62 lb/ft^3 (1 g/cm^3). The effect of distance on dose is shown in Figure 4.5-9.

4.5.4.5 LLRWHF Dose Rate

The Low Level Radioactive Waste Handling Facility (LLRWHF) provides temporary storage for low level radioactive waste materials produced at SSES. It stores dry active waste, dewatered waste, and solidified waste. It is also used to temporarily store pieces of contaminated plant equipment and radioactive material. The LLRWHF source term, shown in Table 4.5-11, was conservatively developed based on 10,000 sq ft (283 m^2) of storage in containers with a maximum dose rate of 100 µGy/hr (10 mR/hr) at 6.56 ft (2 m), the maximum allowable per 49 CFR 173.411, (CFR, 2008). The storage containers are condensate demineralizer radwaste containers in linear storage modules. The facility has a 23 x 2 module orientation to the east

and a 7 x 2 module orientation to the south. The more conservative 23 x 2 was used in calculating the direct dose to construction workers.

The dose rate from the LLRWHF is

$$\dot{D}_{LLRWHF} = 15068653 r^{-2.3}$$

where $\dot{D}_{LLRWHF}$ is in mrem/yr (based on 8760 hr/yr occupancy) and r is in feet. The effect of distance on dose is shown in Figure 4.5-10.

4.5.4.6 Sealand Container Dose Rate

The area due west of the Unit 2 cooling tower was selected as an area to store actual or potentially contaminated material in containers such as SEALAND containers. The area is surrounded by dirt embankments to the west, north, and south. The Unit 2 cooling tower lies to the east. It is estimated that 80 SEALAND containers can be stored in the area. The dose rate from the SEALAND Containers is

$$\dot{D}_{SEA} = 5.7055 e^{-0.0006 r}$$

where $\dot{D}_{SEA}$ is in mrem/yr (based on 8760 hr/yr occupancy) and r is in feet. The source term used to develop the equation is given in Table 4.5-12. It is based on the restriction that the dose rate on the exterior of each SEALAND container shall not exceed 20 µGy/hr (2 mR/hr). The dirt embankment is assumed to provide 3 ft (0.91 m) of shielding with a density of that for dry packed earth (i.e., 93.6 lb/ft^3 (1.5 g/cm^3)). The effect of distance on dose is shown in Figure 4.5-11.

4.5.4.7 Steam Dryer Storage Vault Dose Rate

The original SSES Units 1 and 2 steam dryers, which have been replaced, are stored on site in a concrete storage facility located east of the LLRWHF. Prior to placement in storage, the steam dryers were cut into halves. Each half was placed inside its own steel box with one inch (2.54 cm) thick walls. The dose rate from the steam dryer storage vault is

$$\dot{D}_{SD} = 14.37 e^{-0.003 r}$$

where $\dot{D}_{SD}$ is in mrem/yr (based on 8760 hr/yr occupancy) and r is in ft. This is based on 708.3 Ci of Co-60 which is based on surveys performed by SSES. The effect of distance on dose is shown in Figure 4.5-13 .

4.5.4.8 Turbine Building Dose Rate

The N –16 present in the reactor steam in the primary steam lines, turbines, and moisture separators provides a dose contribution to locations outside the plant structure as a result of the high energy gamma rays which it emits as is decays. The following equipment components, located on or above the Turbine Building Operating Floor are considered in this analysis:

- High pressure turbine inlet piping
- High pressure turbines
- Moisture separators
- Low pressure turbines
- 42 inch cross-around piping from the moisture separators to the CIVs
- Combined intermediate valves and piping to low pressure turbines

Sources below the operating floor are not considered. Typically, these sources are pipes of smaller volume than the equipment above the Operating Floor, and hence, of smaller N –16 inventory. Their dose rate contributions are bounded by the equipment above the Operating Floor because the floor provides additional shielding to limit their contribution.

The dose rate from the turbine building is

$$\dot{D}_{TB} = 0.8744e^{-0.0009r}$$

where $\dot{D}_{TB}$ is in mrem/yr (based on 8760 hr/yr occupancy) and r is in ft. This was developed using source terms based upon component volume, the density of the source within the volume (i.e., water or steam), and the N –16 concentration listed in Table 12.2-11 of the Susquehanna Steam Electric Station Final Safety Analysis Report (SSES, 2006a). The effect of distance on dose for both direct and skyshine sources is shown in Table 4.5-14.

4.5.5 Compliance with Dose Rate Regulations

BBNPP construction workers are, for the purposes of radiation protection, members of the general public. This means that the dose rate limits are 100 mrem/year (1 mSv/yr). The construction workers (with the exception of certain specialty contractors loading fuel or using industrial radiation sources for radiography) do not deal with radiation sources.

There are three regulations that govern dose rates to members of the general public. Dose rate limits to the public are provided in 10 CFR 20.1301 (CFR, 2007a) and 10 CFR 20.1302 (CFR, 2007b) and 10 CFR 50, Appendix I (CFR, 2007c). Compliance with 10 CFR 20.1302 is discussed in Section 4.5.7. The design objectives of 10 CFR 50, Appendix I apply relative to maintaining dose as low as reasonably achievable (ALARA) for construction workers. Also, 40 CFR 190 (CFR, 2007d) applies because it is referred to in 10 CFR 20.1301. Note that 10 CFR 20.1001, 20.1201, 20.1203, 20.1204 and 20.1205 do not apply to the general public, but only to radiation workers. Thus, they will not be considered here.

4.5.5.1 10 CFR 20.1301

The 10 CFR 20.1301 regulations limit annual doses from licensed operations to individual members of the public to 100 mrem (1 mSv) total effective dose equivalent (TEDE). In addition, the dose rate from external sources to unrestricted areas must be less than 2 mrem (20 µSv) in any one hour. This applies to the public both outside and within controlled areas. Given that the relevant sources are relatively constant in time, the hourly limit is met if the annual limit is met.

Dose rates in each 99 ft (30 m) by 97 ft (30 m) block of the plant grid are calculated and the array of dose rates searched for the maximum in the construction zones. The maximum dose rates by zone are given in Table 4.5-13. For an occupational year, i.e., 2200 hours on site, the maximum dose would be on Confers Lane west of SSES Unit 1 Cooling Tower where the dose is 16.2 mrem (162 µSv). This assumes the worker stood on Confers Lane for all working hours in one year. This is less than 100 mrem (1 mSv), thus, it meets the criterion and therefore construction workers can be considered to be members of the general public, for the purpose of radiation protection.

4.5.5.2 10 CFR 50, Appendix I

The 10 CFR 50, Appendix I criteria (CFR, 2007c) apply only to effluents. The purpose of the criteria are to assure adequate design of effluent controls (in this case at SSES Units 1 and 2). The annual limits for liquid effluents are 3 mrem (30 µSv) to the total body and 10 mrem (100 µSv) to any organ. Table 4.5-14 shows that these criteria are met for liquid effluents with regard to BBNPP construction workers.

For gaseous effluents, the pertinent limits are 10 mrad (100 µGy) to air gamma and 20 mrad (200 µGy) to air beta without credit for occupancy. If the air dose limits are not met then the limits become doses to real people (with occupancy credit allowed) of 5 mrem (50 µSv) to the total body and 15 mrem (150 µSv) to organs including skin.

Table 4.5-14 shows the TEDE dose limit for whole body assuming full-time occupancy. There is no dose rate to a construction worker that exceeds the limits. Therefore, the criteria have been met. Note that BBNPP occupational zones, during construction, are treated, for purposes of these criteria, as unrestricted areas.

4.5.5.3 40 CFR 190

The 40 CFR 190 (CFR, 2007d) criteria apply to annual doses, called dose rate here because the units are in mrem per year, received by members of the general public exposed to nuclear fuel cycle operations, i.e., nuclear power plants. Therefore, these regulations apply to BBNPP construction workers on the plant site just as they apply to members of the general public who live offsite. The most limiting part of the regulations states, "The annual dose equivalent (shall) not exceed 25 millirem (per year) to the whole body." In the case of SSES effluent releases, if this regulation is met for the whole body, then the thyroid and organ components will also be met.

Table 4.5-13 shows that the average dose rate in any of the construction zones is less than 25mrem/2,200 hours (250 µSv/2,200 hours). The units are expressed to be clear that an occupancy of 2,200 hours is assumed. The use of 2,200 hours assumes the worker works 40 hours per week for 50 weeks per year and works 10% overtime per year. Note, that this dose rate is for the maximum dose rate locations. The actual dose is expected to be considerably smaller. Therefore, the requirements of 40 CFR 190 will be met for all construction workers.

4.5.6 Collective Doses to BBNPP Workers

The collective dose is the sum of all doses received by all workers. It is a measure of population risk. The total worker collective dose for the combined years of construction is 6.18 person-rem (6.18E-02 person-Sieverts). This is a best estimate based upon the worker census and occupancy projections shown in Table 4.5-15 , and Table 4.5-16 . The breakdown of collective dose by construction year and occupancy zone is given in Table 4.5-17 . This assumes 2200 hours per year occupancy for each worker.

4.5.7 Radiation Protection and ALARA Program

Due to the exposure from SSES normal operations, there will be a radiation protection and ALARA program for BBNPP construction workers. This program will meet the guidance of Regulatory Guide 8.8 to maintain individual and collective radiation exposures ALARA. This program will also meet the requirements of 10 CFR 20.1302.

Since the construction workers are not radiation workers, but, for the purposes of radiation protection, are members of the general public, individual monitoring and training of construction workers on BBNPP is not required. Construction workers will be treated, for the purposes of radiation protection, as if they were members of the general public in unrestricted areas. However, they are exposed to effluent radioactivity and direct radiation sources from SSES Units 1 and 2. The most important reason for the ALARA program is that these source levels may vary over time from the projections made here. There may also be additional sources, unaccounted for by the above projections.

Some features of the BBNPP Construction ALARA Program will be:

- The BBNPP ALARA Committee will operate in parallel with the SSES Units 1 and 2 ALARA Committee. The Committee will meet quarterly, will review monitoring, and review worker does rate and dose projections. The Committee will be empowered to stop work if the "general public" status of any construction worker(s) is jeopardized. The Committee will publish a dose and dose rate report for construction workers.

- BBNPP radiation protection personnel will report to the Committee. The Radiation Protection Department will be in charge of radiation monitoring, worker census and source census. It will use this data to project worker doses and dose rates on a monthly basis into the next quarter and will report to the Committee.

- The SSES ODCM and other SSES processes such as the ISFSI projected loading process, will be updated to link dose-important SSES activities to the projected BBNPP construction worker ALARA dose.

- The Committee will periodically identify and direct construction management to control the occupancy of areas where dose rates can be high enough that workers might exceed 40 CFR 190 limitations.

- The Committee will establish a radiation monitoring program to assure 40 CFR 190 regulations are met for BBNPP construction workers. It is expected that monitoring will require either special instruments and/or measurements closer to sources and projected by calculation further out to where workers will be.

- The Committee will require, before any high dose rate evolutions, such as the transport of fuel to the ISFSI or transport of highly radioactive components, that the BBNPP ALARA evaluation be revised.

- Consumption of onsite agricultural products such as plants and fish will be prohibited.

- The program will survey the radiation levels in construction areas and will survey radioactive materials in effluents released to construction areas to demonstrate compliance with dose limits for BBNPP workers.

- The program will comply with the annual dose limit in 10 CFR 20.1301 by measurement or calculation to verify that the total effective dose equivalent to the

individual worker likely to receive the highest dose from any onsite operation does not exceed the annual dose limit.

4.5.8 References

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CFR, 2007b. Title 10, Code of Federal Regulations, Part 20.1302, Compliance with Dose Limits for Individual Members of the Public, 2007.

CFR, 2007c. Code of Federal Regulations, Title 10 CFR 50, Appendix I, Numerical Guides for Design Objectives and Limiting Condition for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light Water Cooled Nuclear Power Reactor Effluents, 2007.

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SSES, 2002. PPL Susquehanna, LLC, '"Susquehanna Steam Electric Station Annual Effluent & Waste Disposal Report for January - December 2001."

Table 4.5-1— Radiation Sources at SSES Units 1 and 2

(Page 1 of 2)

Source	Location on Plant Grid	Radioactive Inventory	Shielding	Dose Rate	Significance to BBNPP Workers
Unit 1 and Unit 2 Reactor Building Vents	N 341, 175 E 2, 442, 100	Gaseous effluents characterized in RETS	N/A (Airborne)	150 µSv/yr/unit (15 mrem/yr/unit)	The gaseous effluents from reactor building and turbine building vents are contributors to the dose to construction workers.
Unit 1 and Unit 2 Turbine Building Vents	N 341, 175 E 2,441,833	Gaseous effluents characterized in RETS	N/A (Airborne)	150 µSv/yr/unit (15 mrem/yr/unit)	
Liquid Waste Management System	N/A	Liquid Effluents characterized in RETS	N/A (waterborne)	<30 µSv/yr (3 mrem/yr/unit) total body <100 µSv/yr (10 mrem/yr) organ	Direct source
Refueling Water Storage Tank (RWST)	N341,424, E2,442,000.5	Liquid Waste	Shielded by neighboring buildings	<15 µSv/hr (1.5 mR/hr) contact	No impact because shielded by Turbine building
Condensate Storage Tanks (CSTs)	U1 N341,371, E2,442,007.5 U2 N340,979.0, E2,442,007.5	Liquid Waste	Shielded by neighboring buildings	Turbine Building shields direct dose to construction workers from the CSTs	Direct source
Low Level Radwaste Handling Facility	N341,400. E2,440,500	Temporary storage for low level radioactive waste and radioactive material	Concrete walls	<100 µSv/yr (10 mR/hr) at 6.6 ft (2 m)	Direct source.
Temporary Laundry Facility	Southwest of Unit 2 Turbine Building	Contaminated laundry	Shielded by neighboring buildings	<79.4 µSv/hr (7.94 mR/hr) at 1 ft (0.305 m) perimeter	No impact.
BB-10-0242 ISFSI	N341,500 E2,440,600	Spent fuel	Concrete walls	<700 µSv/hr (70 mrem/hr) on surface	Time dependent source.
BB-10-0242 Turbine shine due to N –16 in the reactor steam	N 341,175 E 2,441,833	N –16	Shielding around each turbine train and a roof slab over each moisture separator	<5 µSv/hr (0.5 mrem/hr)	Skyshine source.
BB-10-0242 SEALAND Containers	N340,750, E2,441,050	LSA boxes, barrels, shield blocks, turbine rotor stands, etc.	Shielded by dirt embankment	< 20 µSv/hr (2 mR/hr) at exterior surface	Direct and skyshine source.
Steam Dryers	N341,060.3, E 2,440,653.5	Original steam dryers	Concrete walls	< 5 µSv/yr (0.5 mrem/hr)	Direct and skyshine source.
Dry Active Waste Reduction System Facility	N341,700, E2,441,900	Equivalent of 30 mCi (1.11E+09 Bq)Co-60 max.	None	Negligible	No impact because of low activity.

Table 4.5-1— Radiation Sources at SSES Units 1 and 2
(Page 2 of 2)

Source	Location on Plant Grid	Radioactive Inventory	Shielding	Dose Rate	Significance to BBNPP Workers
For the purposes of this table and for the purpose of providing dual units, 1 mR/hr is assumed equal to 1 mrem/hr, i.e. 1 mR/hr = 10 µSv/hr.					

Table 4.5-2— Historical All-Source Compliance for Offsite General Public

Maximum Offsite Doses for 40CFR190 Compliance from Gas and Liquid Releases as Reported to the NRC in Annual REMP Reports						
	Dose in mrem/year (μSv/yr) from REMP Reports)			Dose as Percent of 40CFR190 Limit		
Year	Thyroid	WB	Limiting Organs	WB	Thyroid	Limiting Organs
2006	5.27E-01 (5.27E+00)	5.27E-01 (5.27E+00)	5.27E-01 (5.27E+00)	2.11E-02	7.03E-03	2.11E-02
2005	8.38E-01 (8.38E+00)	8.38E-01 (8.38E+00)	8.38E-01 (8.38E+00)	3.35E-02	1.12E-02	3.35E-02
2004	1.22E+00 (1.22E+01)	1.22E+00 (1.22E+01)	1.22E+00 (1.22E+01)	4.88E-02	1.63E-02	4.88E-02
2003	1.21E+00 (1.21E+01)	1.21E+00 (1.21E+01)	1.21E+00 (1.21E+01)	4.84E-02	1.61E-02	4.84E-02
2002	1.31E+00 (1.31E+01)	1.31E+00 (1.31E+01)	1.31E+00 (1.31E+01)	5.24E-02	1.75E-02	5.24E-02
2001	2.20E-01 (2.20E+00)	2.20E-01 (2.20E+00)	2.20E-01 (2.20E+00)	8.80E-03	2.93E-03	8.80E-03
2000	1.73E-01 (1.73E+00)	1.73E-01 (1.73E+00)	1.73E-01 (1.73E+00)	6.92E-03	2.31E-03	6.92E-03
1999	9.82E-02 (9.82E-01)	9.82E-02 (9.82E-01)	9.82E-02 (9.82E-01)	3.93E-03	1.31E-03	3.93E-03
1998	1.38E-01 (1.38E+00)	1.38E-01 (1.38E+00)	1.38E-01 (1.38E+00)	5.52E-03	1.84E-03	5.52E-03
1997	1.63E-01 (1.63E+00)	1.63-01 (1.63E+00)	1.63E-01 (1.63E+00)	6.52E-03	2.17E-03	6.52E-03
1996	5.64E-01 (5.64E+00	5.64E-01 (5.64E+00)	5.64E-01 (5.64E+00)	2.26E-02	7.52E-03	2.26E-02
1995	2.31E-01 (2.31E+00)	2.31E-01 (2.31E+00)	2.31E-01 (2.31E+00)	9.24E-03	3.08E-03	9.24E-03
1994	1.41E-01 (1.41E+00)	1.41E-01 (1.41E+00)	1.41E-01 (1.41E+00)	5.64E-03	1.88E-03	5.64E-03
Maximum	1.31+00 (1.31+01)	1.31E+00 (1.31E+01)	1.31E+00 (1.31E+01)	5.24E-02	1.75E-02	5.24E-02

Table 4.5-3— FTE for BBNPP Construction Workers

Zone	2012	2013	2014	2015	2016	2017
B	0.5	2.3	4.0	4.0	4.0	3.2
C	353.1	1516.9	2660.0	2660.0	2660.0	2138.0
L	10.6	45.6	80.0	80.0	80.0	64.3
O	85.0	365.0	640.0	640.0	640.0	514.4
P	10.6	45.6	80.0	80.0	80.0	64.3
R	10.6	45.6	80.0	80.0	80.0	64.3
S	35.0	150.5	264.0	264.0	264.0	212.2
T	35.0	150.5	264.0	264.0	264.0	212.2
W	1.6	6.8	12.0	12.0	12.0	9.6
By Year	542.2	2328.9	4084.0	4084.0	4084.0	3282.5

Table 4.5-4— Gaseous Dose Rate Type and Coefficients

Dose Type	Pathway	Methodology	c(j)
TEDE	All	ICRP26	1259244
Total Body	External	ICRP2	692594.5
Skin	External	ICRP2	845547.4
Organ I & P	I & P	ICRP2	721931
Total Body	All	ICRP2	813007.5
Thyroid	All	ICRP2	812811.5
Organ	All	ICRP2	826407

Table 4.5-5— Historic Gaseous Releases For 2001 Through 2006

Nuclide	2001 Ci (Bq)	2002 Ci (Bq)	2003 Ci (Bq)	2004 Ci (Bq)	2005 Ci (Bq)	2006 Ci (Bq)
H 3	1.29E+02 (4.77E+12)	1.37E+02 (5.07E+12)	1.56E+02 (5.77E+12)	1.60E+02 (5.92E+12)	8.61E+01 (3.19E+12)	5.87E+01 (2.17E+12)
Ar 41		9.68E+00 (3.58E+11)	3.37E-03 (1.25E+08)	8.07E+00 (2.99E+11)		
Cr 51	6.48E-03 (2.40E+08)	3.31E-03 (1.22E+08)	1.09E-03 (4.03E+07)	2.52E-04 (9.32E+06)	2.22E-04 (8.21E+06)	2.07E-04 (7.66E+06)
Mn 54	5.96E-04 (2.21E+07)	1.21E-03 (4.48E+07)	2.61E-04 (9.66E+06)	2.74E-04 (1.01E+07)	2.33E-04 (8.62E+06)	1.93E-04 (7.14E+06)
Co 57					3.11E-06 (1.15E+05)	
Co 58	4.43E-05 (1.64E+06)	5.62E-05 (2.08E+06)	9.42E-06 (3.49E+05)	9.93E-06 (3.67E+05)	2.43E-05 (8.99E+05)	1.09E-05 (4.03E+05)
Co 60	2.27E-04 (8.40E+06)	1.48E-03 (5.48E+07)	8.83E-05 (3.27E+06)	1.79E-04 (6.62E+06)	2.54E-04 (9.40E+06)	3.82E-04 (1.41E+07)
Fe 59	6.40E-05 (2.37E+06)	2.32E-04 (8.58E+06)			1.69E-05 (6.25E+05)	
Kr 85m			7.68E-04 (2.84E+07)	6.02E-01 (2.23E+10)		
Kr 87			5.44E-03 (2.01E+08)			
Kr 88			3.01E-01 (1.11E+08)	2.48E-01 (9.18E+09)		6.94E-01 (2.57E+10)
Kr 89			6.03E-02 (2.23E+09)			
Sr 90		2.95E-05 (1.09E+06)				
Nb 95	5.39E-06 (1.99E+05)			4.11E-06 (1.52E+05)	6.43E-06 (2.38E05)	
Ag 110m	1.18E-05 (4.37E+05)	2.32E-06 (8.58E+04)				
I 131					9.71E-06 (3.59E+05)	1.41E-05 (5.22E+05)
I 133					1.28E-05 (4.74E+05)	
Xe 133			2.36E+04 (8.73E+06)	6.04E-01 (2.23E+10)		
Xe 133m	1.27E-01 (4.70E+09)					
Xe 135	6.65E+00 (2.46E+11)		2.84E-03 (1.05E+08)			4.13E-02 (1.53E+09)
Xe 135m			1.52E-02 (5.62E+08)			
Xe 137			1.52E-01 (5.62E+09)			
Xe 138			6.73E-02 (2.49E+09)			
Cs 137		3.23E-06 (1.20E+05)				
Ce 141	1.76E-06 (6.51E+04)					
Ce 144	6.97E-06 (2.58E+05)				1.48E-05 (5.48E+05)	
Ba-La 140					8.73E-06 (3.23E+05)	
As 76	6.26E-03 (2.32E+08)	1.86E-03 (6.88E+07)				
Na 24	2.52E-04 (9.32E+06)	8.08E-05 (2.99E+06)				
Tc 99m	1.05E-03 (3.89E+07)	1.78E-04 (6.59E+06)				

Table 4.5-6— Historical Liquid Releases for Input to LADTAPII

Isotope	2001 Ci (Bq)	2002 Ci (Bq)	2003 Ci (Bq)	2004 Ci (Bq)	2005 Ci (Bq)	2006 Ci (Bq)
Co-58	4.28E-04 (1.58E+07)	2.92E-04 (1.08E+07)	3.426E-04 (1.26E+07)	2.03E-04 (7.51E+06)	5.33E-05 (1.97E+06)	3.25E-05 (1.20E+06)
Co-60	3.90E-03 (1.44E+08)	3.27E-03 (1.21E+08)	5.14E-03 (1.90E+08)	1.32E-03 (4.88E+07)	9.01E-04 (3.33E+07)	2.67E-04 (9.89E+06)
Cr 51	1.25E-02 (4.61E+08)	1.15E-02 (4.27E+08)	8.16E-03 (3.02E+08)	2.67E-03 (9.86E+07)	8.43E-04 (3.12E+07)	7.08E-04 (2.62E+07)
Cs 137				6.57E-07 (2.43E+04)		4.45E-05 (1.64E+06)
F 18	1.82E-07 (6.72E+03)			1.96E-07 (7.25E+03)		
Fe 55	3.89E-03 (1.44E+08)	6.45E-03 (2.39E+08)	9.07E-03 (3.36E+08)	1.95E-02 (7.22E+08)		
Fe 59	3.03E-05 (1.12E+06)	6.12E-04 (2.26E+07)	1.29E-04 (4.77E+06)	4.90E-05 (1.81E+06)	4.63E-06 (1.71E+05)	1.24E-05 (4.58E+05)
H 3	2.44E+01 (9.04E+11)	6.61E+01 (2.45E+12	7.75E+01 (2.87E+12)	6.21E+01 (2.30E+12)	7.40E+01 (2.47E+12)	8.29E+01 (3.30E+12)
I 133					2.45E-07 (9.07E+03)	
Mn 54	3.44E-03 (1.27E+08)	7.68E-03 (2.84E+08)	5.34E-03 (1.98E+08)	1.29E-03 (4.77E+07)	2.95E-04 (1.09E+07)	1.40E-04 (5.17E+06)
Na 24	2.48E-06 (9.18E+04)					
Nb 95			6.81E-07 (2.52E+04)	2.66E-06 (9.84E+04)		
P 32	1.18E-05 (4.36E+05)	3.06E-05 (1.13E+06)				
Sb 124	9.07E-07 (3.36E+04)		2.96E-06 (1.10E+05)	9.12E-07 (3.37E+04)	3.32E-06 (1.23E+05)	1.22E-05 (4.51E+05)
Tc 99m						1.17E-06 (4.33E+04)
Zn 65	1.20E-04 (4.42E+06)	4.28E-06 (1.58E+05)	4.63E-05 (1.71E+05)	3.61E-06 (1.34E+05)	1.88E-04 (6.96E+06)	9.77E-05 (3.61E+06)
Xe 133m	1.27E-01 (4.70E+09)					
Xe 135	6.65E+00 (2.46E+11)		2.84E-03 (1.05E+08)			4.13E-02 (1.53E+09)

Table 4.5-7— Historical Dilutions for Input to LADTAPII

Year	1st Quarter L (ft^3)	2nd Quarter L (ft^3)	3rd Quarter L (ft^3)	4th Quarter L (ft^3)	Total L (ft^3)	Release Duration min	Flow Rate L/ min (ft^3/sec)
2001	6.84E+07 (2.42E+06)	6.39E+07 (2.26E+06)	3.36E+07 (1.19E+06)	2.20E+07 (7.77E+05)	1.88E+08 (6.64E+06)	6.28E+03	2.99E+04 (1.76E+01)
2002	7.70E+07 (2.72E+06)	2.07E+08 (7.31E+06)	1.58E+08 (5.58E+06)	1.33E+08 (4.70E+06)	5.75E+08 (2.03E+07)	1.90E+04	3.03E+04 (1.78E+01)
2003	9.05E+07 (3.20E+06)	6.54E+07 (2.31E+06)	2.13E+08 (7.52E+06)	1.38E+08 (4.87E+06)	5.07E+08 (1.76E+07	1.49E+04	3.40E+04 (2.00E+01)
2004	1.04E+08 (3.67E+06)	1.54E+08 (5.44E+06)	1.17E+08 (4.13E+06)	2.18E+07 (7.07E+05)	3.97E+08 (1.40E+07)	1.15E+04	3.45E+04 (2.03E+01)
2005	8.91E+07 (3.15E+06)	2.43E+08 (8.58E+06)	1.63E+08 (5.76E+06)	7.86E+07 (2.78E+06)	5.74E+08 (2.03E+07)	1.81E+04	3.17E+04 (1.87E+01)
2006	1.43E+08 (5.05E+06)	1.03E+08 (3.64E+06)	9.69E+07 (3.42E+06)	2.63E+08 (9.29E+06)	6.06E+08 (2.14E+07)	1.88E+04	3.22E+04 (1.90E+01)

Table 4.5-8— Historical Shoreline Dose

Year	LADTAPII mrem/yr (µSv/yr) with 12 hr/yr occupancy)	Worker mrem/yr (µSv/yr) with 2200 hr/yr occupancy)	Full mrem/yr (µSv/yr) with 8760 hr/yr occupancy)
2001	1.95E-03 (1.95E-02)	0.358 (3.58)	1.424 (14.24)
2002	1.71E-03 (1.71E-02)	0.314 (3.14)	1.248 (12.48)
2003	2.22E-03 (2.22E-02)	0.407 (4.07)	1.621 (16.21)
2004	5.61E-04 (5.61E-03)	0.103 (1.03)	0.410 (4.10)
2005	4.04E-04 (4.04E-03)	0.074 (0.74)	0.295 (2.95)
2006	1.31E-04 (1.31E-03)	0.024 (0.24)	0.096 (0.96)

Table 4.5-9— Historic and Projected Loading of SSES ISFSI

Year	Bundles Added	# of Bundles Total
1999	208	208
2000	208	416
2001	468	884
2002	416	1300
2003	0	1300
2004	409	1709
2005	244	1953
2006	305	2258
2007	305	2563
2008	427	2990
2009	366	3356
2010	732	4088
2012	0	4088
2012	488	4576
2013	488	5064
2014	0	5064
2015	488	5552
2016	488	6040
2017	122	6162

Table 4.5-10— Condensate Storage Tank Source Terms

(Page 1 of 2)

Isotope	Curies (Bq)
Br 83	2.75E-02 (1.02E+09)
Br 84	2.42E-02 (8.95E+08)
I 131	3.80E-02 (1.41E+09)
I 132	2.18E-01 (8.07E+09)
I 133	2.39E-01 (8.84E+09)
I 134	2.90E-01 (1.07E+10)
I 135	3.07E-01 (1.14E+10)
Cr 51	5.66E-05 (2.09E+06)
Mc 56	2.97E-03 (1.10E+08)
Co 58	5.67E-04 (2.10E+07)
CO 60	5.68E-05 (2.10E+07)
Sr 89	3.78E-04 (1.40E+07)
Sr 91	9.45E-03 (3.50E+08)
Sr 92	8.54E-03 (3.16E+08)
Mo 99	2.41E-03 (8.92E+07)
Tc 99m	2.35E-02 (8.70E+08)
Te 132	5.40E-03 (2.00E+08)
Cs 138	2.87E-02 (1.06E+09)
Ba 139	2.56E-02 (9.47E-08)
Ba 140	1.12E-03 (4.14E+07)
Ba 141	4.72E-03 (1.75E+08)
Ba 142	1.78E-03 (6.59E+07)
Np 239	2.62E-02 (9.69E+08)
Cs 140	9.75E-03 (3.61E+08)
Y 92	3.44E-03 (1.27E+08)
Cs 139	2.91E-02 (1.08E+09)
Sr 93	7.89E-04 (2.92E+07)
Y 93	1.71E-04 (6.33E+06)
La 141	1.89E-03 (6.99E+07)
Br 85	1.77E-03 (6.55E+07)
Tc 101	1.32E-03 (4.88E+07)
Cs 134	9.08E-05 (3.36E+06)
Cs 136	6.20E-05 (2.29E+06)
Cs 137	1.36E-04 (5.03E+06)
Na 24	1.97E-04 (7.29E+06)
Ni 65	1.77E-05 (6.55E+05)
W 187	3.11E-04 (1.15E+07)
Cs 141	4.44E-04 (1.64E+07)
Sr 94	1.09E-05 (4.03E+05)
Y 94	2.85E-05 (1.05E+06)
Y 95	1.06E-05 (3.92E+05)
Rb 91	1.05E-02 (3.89E+08)
Rb 90	2.03E-02 (7.51E+08)
Rb 89	1.42E-02 (5.25E+08)
Rb 88	2.13E-03 (7.88E+07)
La 142	1.23E-03 (4.55E+07)

Table 4.5-10— Condensate Storage Tank Source Terms

(Page 2 of 2)

Isotope	Curies (Bq)
Y 91m	5.11E-03 (1.89E+08)
Y 91	1.46E-05 (5.40E+05)
Sr 90	2.61E-05 (9.66E+05)
La 140	6.12E-05 (2.26E+06)

Table 4.5-11— LLRWHF Source Term

Isotope	Activity in Ci (Bq)
Ba 137m	2.59E-02 (9.58E+08)
Cr 51	3.17E-04 (1.17E+07)
Fe 59	9.49E-04 (3.51E+07)
Mn 54	1.66E-01 (6.14E+09)
Co 58	3.49E-03 (1.29E+08)
Cs 134	9.88E-03 (3.66E+08)
I 129	1.09E-03 (4.03E+07)
Sb 124	2.32E-05 (8.58E+05)
Co 60	1.12E+00 (4.14E+10)
Fe 55	1.40E+00 (5.18E+10
I 131	8.45E-06 (3.13E+05)
Zn 65	5.67E-02 (2.10E+09)

Table 4.5-12— SEALAND Container Source Term

Isotope	Activity in Ci (Bq)
Ba 137m	3.15E-04 (1.17E+07)
Co 58	2.95E-03 (1.09E+08)
Co 60	1.51E-01 (5.59E+09)
Cs137	3.33E-04 (1.23E+07)
Fe 55	4.00E+00 (1.48E+11)
Fe 59	5.35E-03 (1.98E+08)
I 129	1.30E-05 (4.81E+05)
Mn 54	2.26E-01 (8.36E+09)
Nb 95	3.10E-04 (1.15E+07)
Ni 59	2.21E-04 (8.18E+06)
Ni 63	1.33E-02 (4.92E+08)
Sb 125	5.62E-04 (2.08E+07)
Sr 89	4.74E-06 (1.75E+05)
Sr 90	2.42E-06 (8.95E+04)
Tc 99	7.07E-06 (2.62E+05)
Y 90	2.42E-06 (8.95E+04)

Table 4.5-13— Maximum Dose by Zone for 2200 Hours

Zone	Zone Description	Maximum Dose Rate µSv/ 2200 hours (mrem/2200 hours)
B	Batch Plant	15.8 (1.58)
C	Construction on main structures	3.7 (0.37)
L	Laydown	74.5 (7.45)
O	Office/Trailer	10.6 (1.06)
P	Parking	6.7 (0.67)
R	Roads	162.4 (16.24)
S	Shoreline, tunnel, barge, in/out flow	7.4 (0.74)
T	Tower/Basin	3.8 (0.38)
W	Warehouse/Shops	9.3 (0.93)

Table 4.5-14— Effluent Dose Rates by Zone

Maximum Dose Rate (mrem/year) Assuming Full Time Occupancy - Effluents Only				
Zone	**Zone Description**	**Gaseous Effluents µSv/hr (mrem/yr)**	**Gaseous Effluents Organ µSv/hr (mrem/yr)**	**Liquid Effluents TEDE µSv/hr (mrem/yr)**
B	Batch Plant	22.1 (2.21)	23.0 (2.30)	0.0 (0.00)
C	Construction on main structures	4.0 (0.40)	4.2 (0.42)	0.0 (0.00)
L	Laydown	13.8 (1.38)	14.4 (1.44)	0.0 (0.00)
O	Office/Trailer	14.3 (1.43)	14.9 (1.49)	0.0 (0.00)
P	Parking	6.7 (0.67)	7.0 (0.70)	0.0 (0.00)
R	Roads	25.0 (2.50)	26.1 (2.61)	0.0 (0.00)
S	Shoreline, tunnel, barge, in/out flow	5.4 (0.54)	5.7 (0.57)	16.2 (1.62)
T	Tower/Basin	4.1 (0.41)	4.3 (0.43)	0.0 (0.00)
W	Warehouse/Shops	9.6 (0.96)	10.0 (1.00)	0.0 (0.00)

Table 4.5-15— Projected Construction Worker Census 2012 to 2017

Year	Construction Workers On Site
2012	531
2013	2281
2014	4000
2015	4000
2016	4000
2017	3215

Table 4.5-16— Occupancy by Construction Zone

Zone Description	Zone Code	Conservative Occupancy Fractions Used in Calculation
Batch Plant	B	0.001
Construction on main structures	C	0.665
Laydown	L	0.020
Office/Trailer	O	0.160
Parking	P	0.020
Roads	R	0.020
Shoreline, tunnel, barge, in/out flow	S	0.066
Tower/Basin	T	0.066
Warehouse/Shops	W	0.003
	TOTAL	1.021

Table 4.5-17— Collective Dose to BBNPP Construction Workers

Zone	Collective Dose by Zone person-Sievert (person-rem)						Zone
	2012	2013	2014	2015	2016	2017	
B	1.00E-05 (1.00E-03)	3.00E-05 (3.00E-03)	5.00E-05 (5.00E-03)	5.00E-05 (5.00E-03)	5.00E-05 (5.00E-03)	4.00E-05 (4.00E-03)	2.20E-04 (2.20E-02)
C	1.00E-03 (1.00E-01)	4.30E-03 (4.30E-01)	7.55E-03 (7.55E-01)	7.55E-03 (7.55E-01)	7.55E-03 (7.55E-01)	6.07E-03 (6.07E-01)	3.40E-02 (3.40E+00)
L	7.00E-05 (7.00E-03)	2.90E-04 (2.90E-02)	5.20E-04 (5.20E-02)	5.30E-04 (5.30E-02)	5.40E-04 (5.40E-02)	4.50E-04 (4.50E-02)	2.39E-03 (2.39E-01)
O	2.50E-04 (2.50E-02)	1.06E-03 (1.06E-01)	1.86E-03 (1.86E-01)	1.86E-03 (1.86E-01)	1.86E-03 (1.86E-01)	1.50E-03 (1.50E-01)	8.39E-03 (8.39E-01)
P	4.00E-05 (4.00E-03)	1.60E-04 (1.60E-02)	2.80E-04 (2.80E-02)	2.80E-04 (2.80E-02)	2.80E-04 (2.80E-02)	2.20E-04 (2.20E-02)	1.25E-03 (1.25E-01)
R	8.00E-05 (8.00E-03)	3.50E-04 (3.50E-02)	6.30E-04 (6.30E-02)	6.50E-04 (6.50E-02)	6.70E-04 (6.70E-02)	5.50E-04 (5.50E-02)	2.91E-03 (2.91E-01)
S	2.50E-04 (2.50E-02)	1.08E-03 (1.08E-01)	1.89E-03 (1.89E-01)	1.89E-03 (1.89E-01)	1.89E-03 (1.89E-01)	1.52E-03 (1.52E-01)	8.53E-03 (8.53E-01)
T	1.10E-04 (1.10E-02)	4.60E-04 (4.60E-02)	8.10E-04 (8.10E-02)	8.10E-04 (8.10E-02)	8.10E-04 (8.10E-02)	6.50E-04 (6.50E-02)	3.67E-03 (3.67E-01)
W	1.00E-05 (1.00E-03)	5.00E-05 (5.00E-03)	8.00E-05 (8.00E-03)	8.00E-05 (8.00E-03)	8.00E-05 (8.00E-03)	6.00E-05 (6.00E-03)	3.60E-04 (3.60E-02)
By Year	1.81E-03 (1.81E-01)	7.78E-03 (7.78E-01)	1.37E-02 (1.37E+00)	1.37E-02 (1.37E+00)	1.37E-02 (1.37E+00)	1.11E-02 (1.11E+00)	6.18E-02 (6.18E+00)

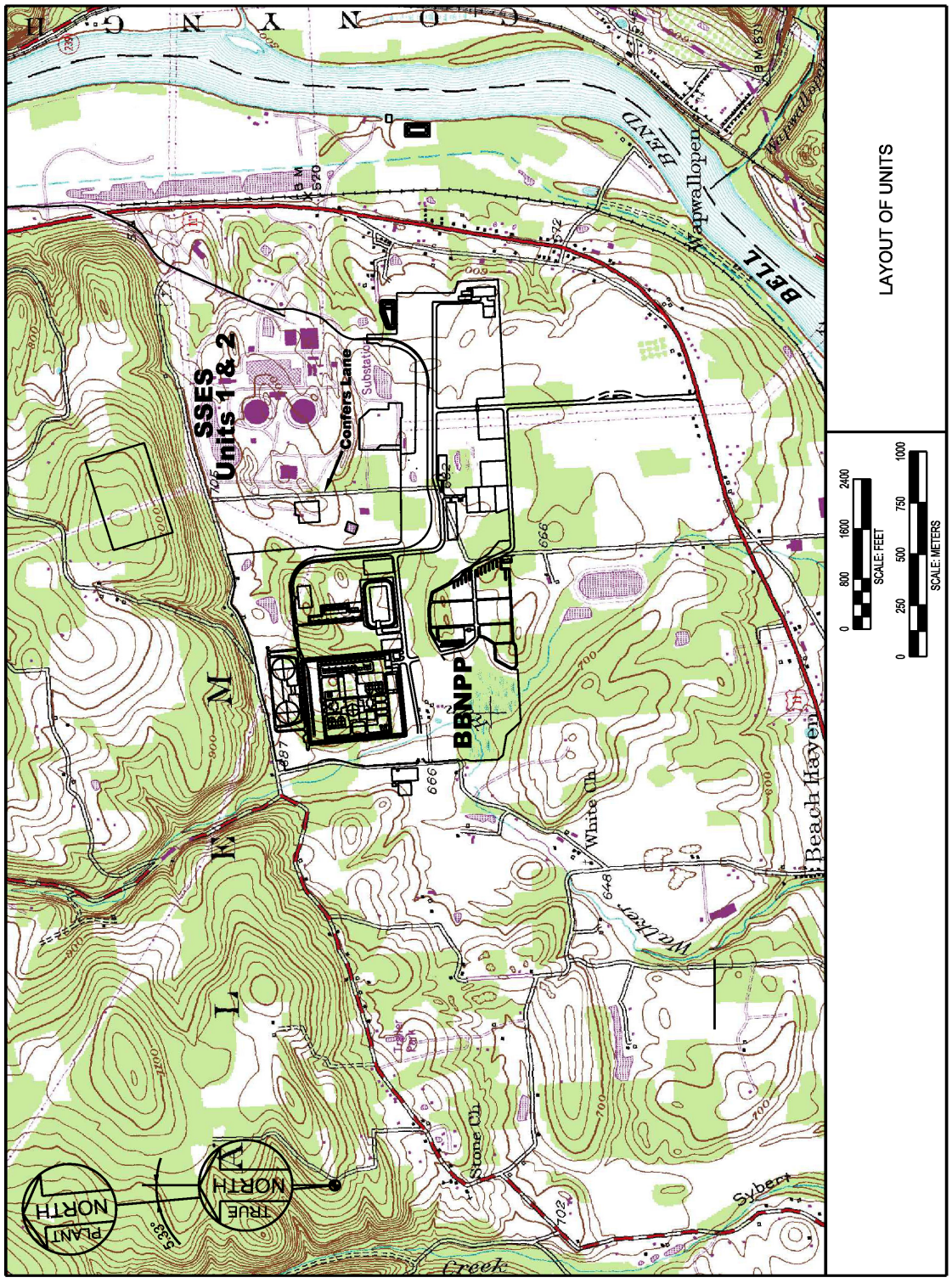


Figure 4.5-1— Site Layout

Figure 4.5-2— CST and RWST Locations on Plant Grid

(Background image for illustration purposes only. Pertinent information is labeled in red)

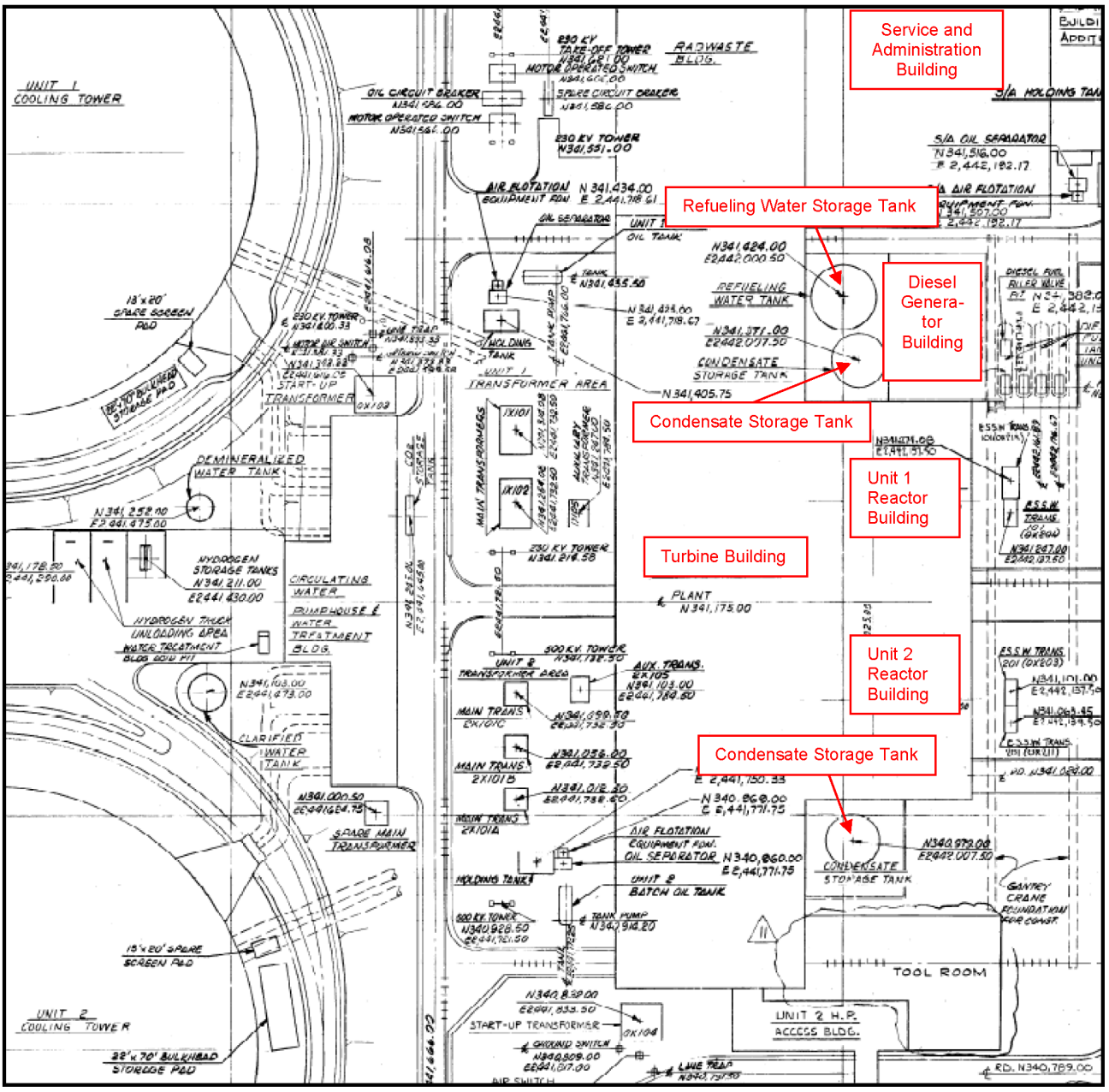
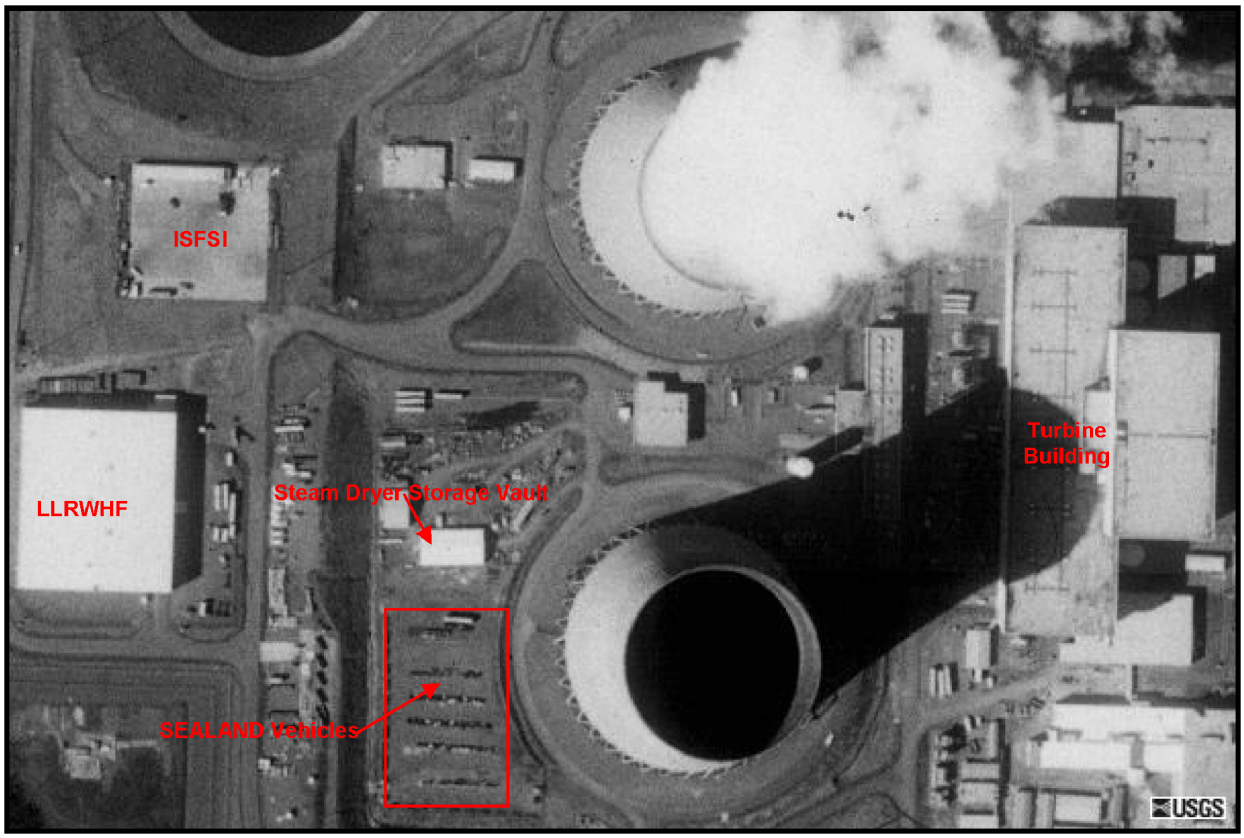


Figure 4.5-3— Source Locations



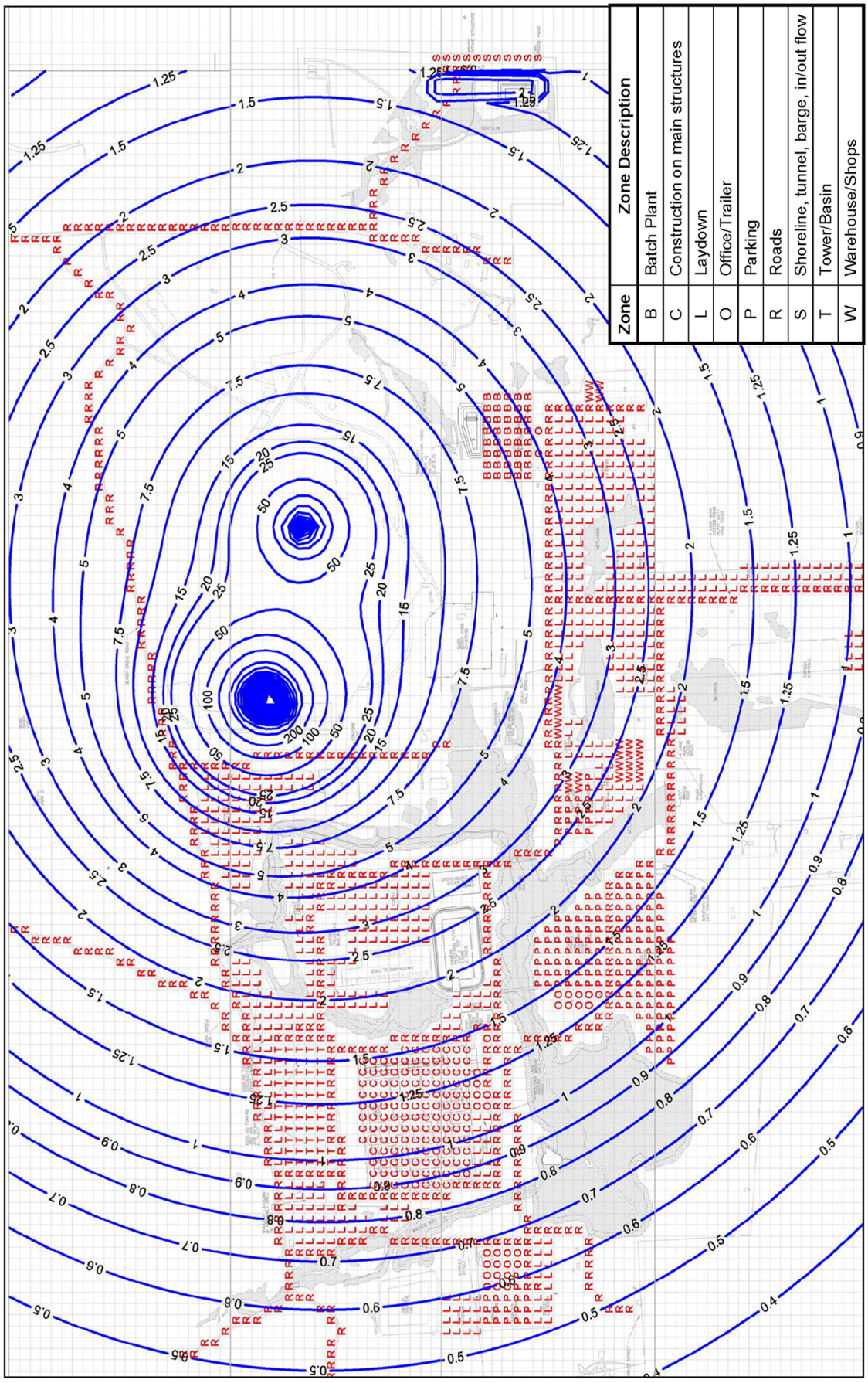


Figure 4.5-4— Annual Dose Rate in 2017 in Units of mrem 8760 hours
Background image for illustration purposes only. Illegible data is not pertinent.

Figure 4.5-5— ISFSI Distance Equation

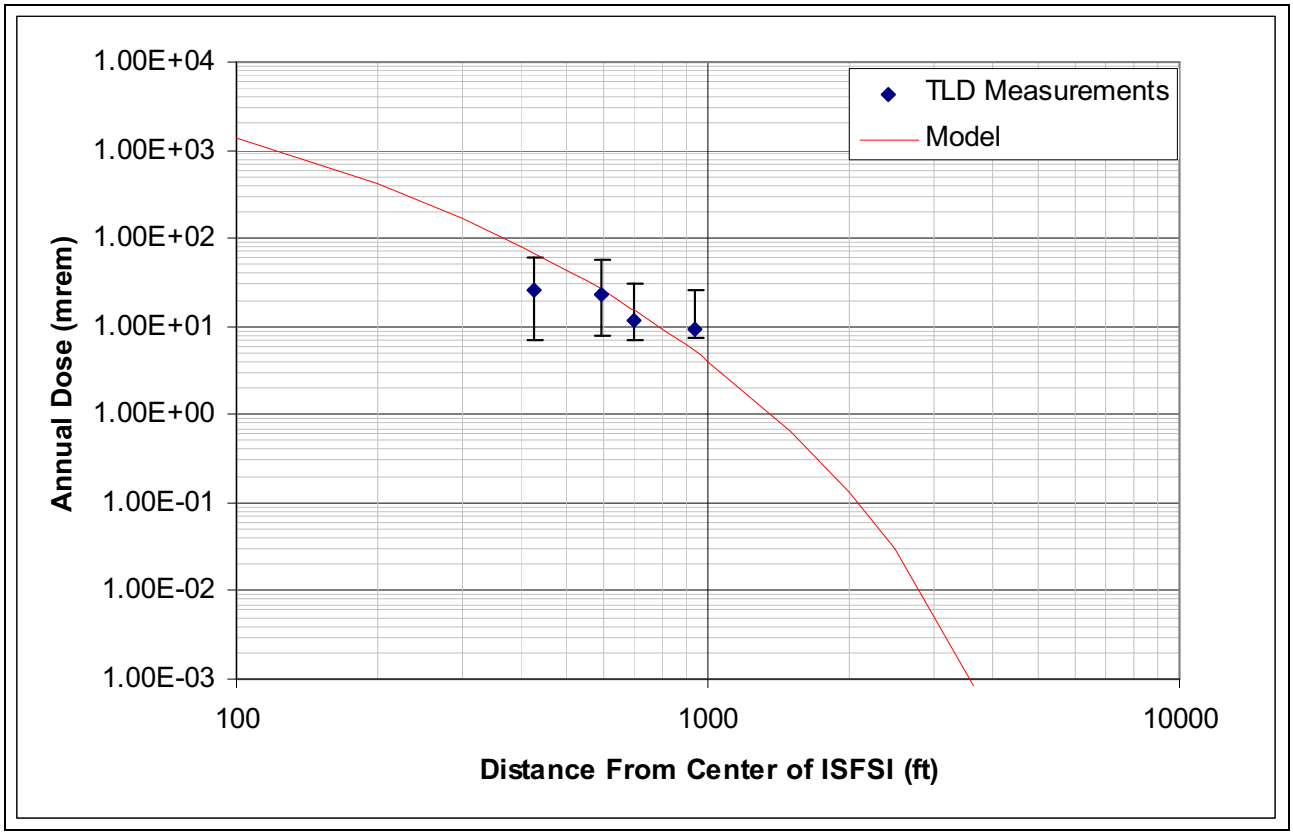


Figure 4.5-6— ISFSI Satellite Image

Figure 4.5-7— SSES ISFSI (blue border) with TLDs and Grid

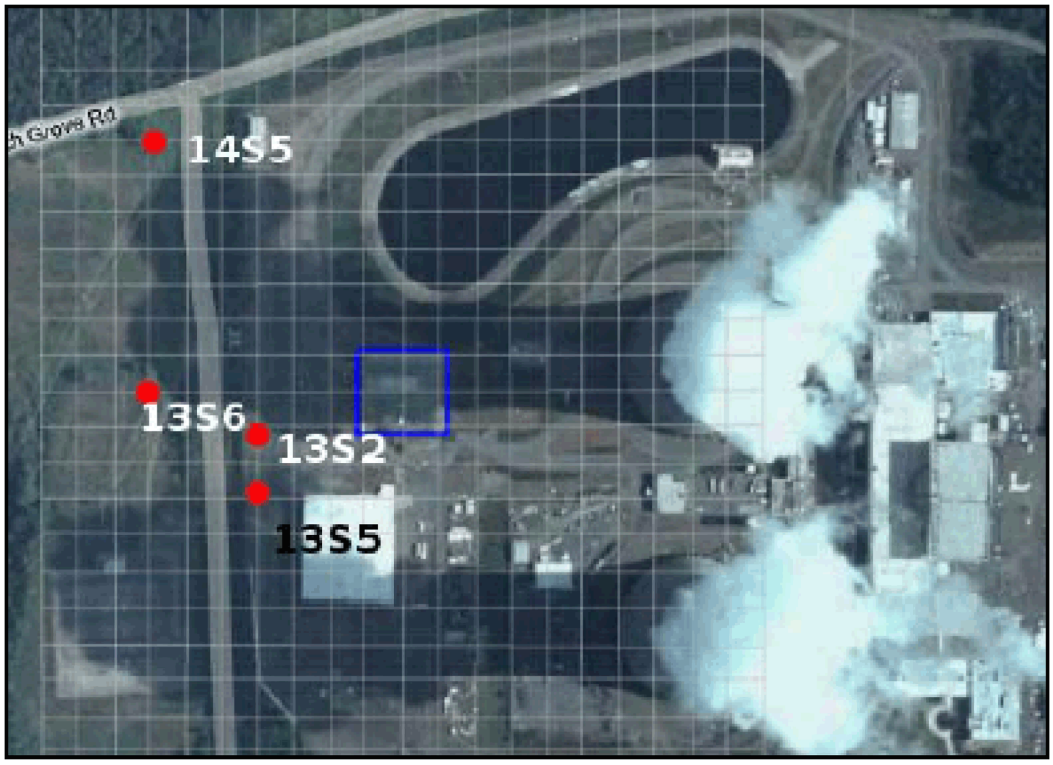


Figure 4.5-8— TLD (ID 13S2) Data Verifying Time Correlation Function

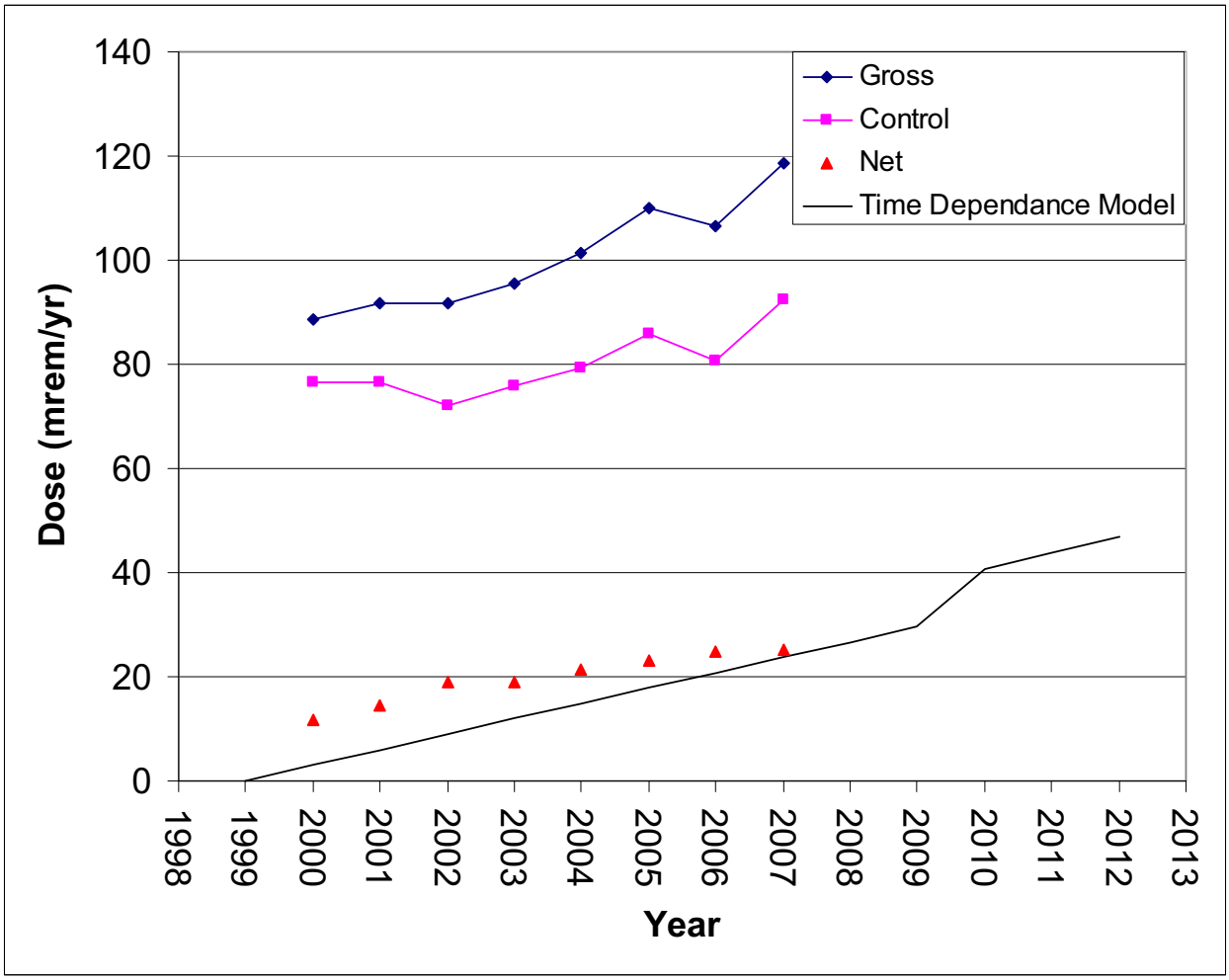


Figure 4.5-9— Dose vs Distance for CSTs

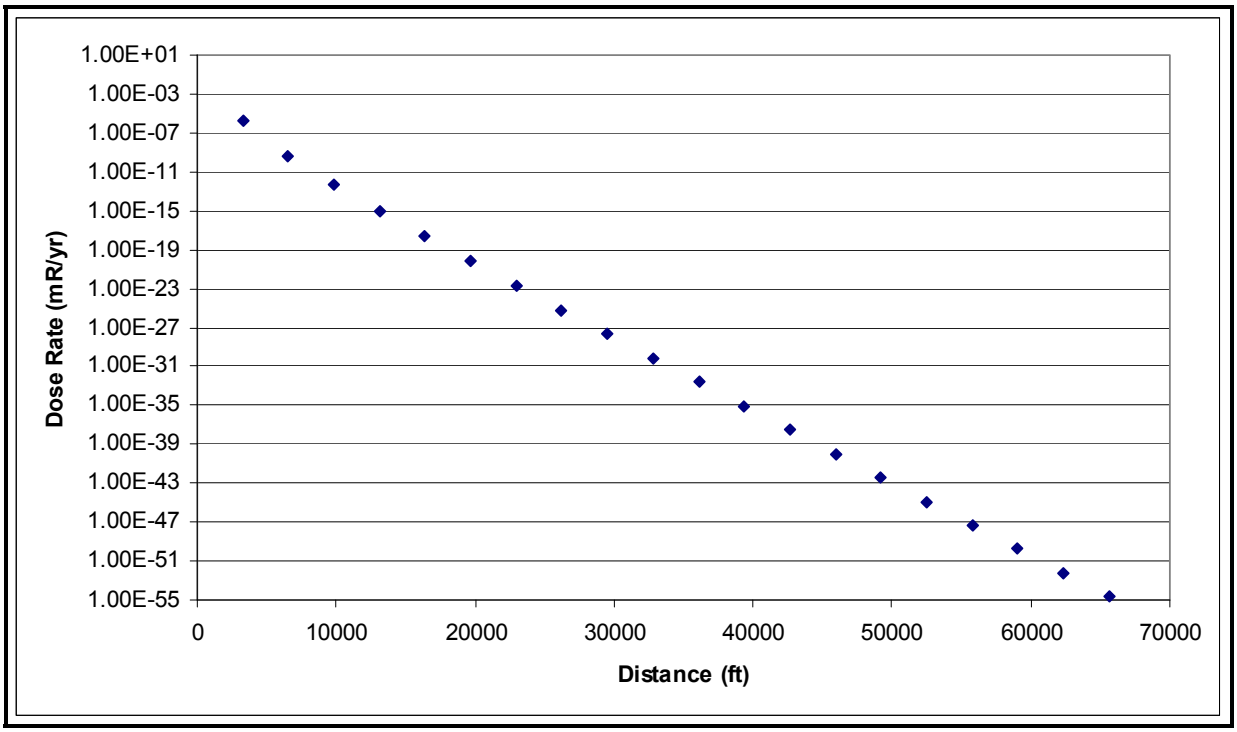


Figure 4.5-10— Dose vs Distance for LLRWHF

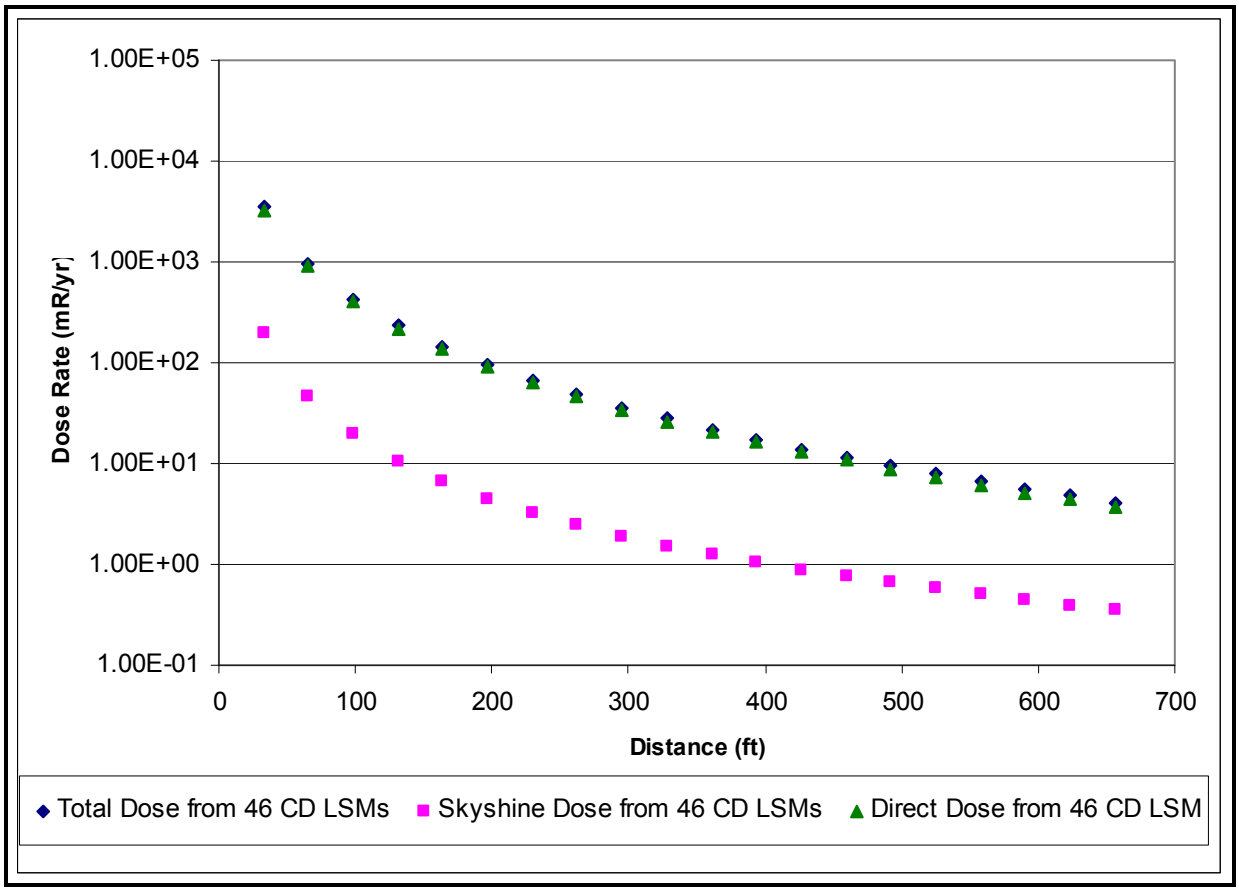


Figure 4.5-11— Dose vs Distance for SEALAND Containers

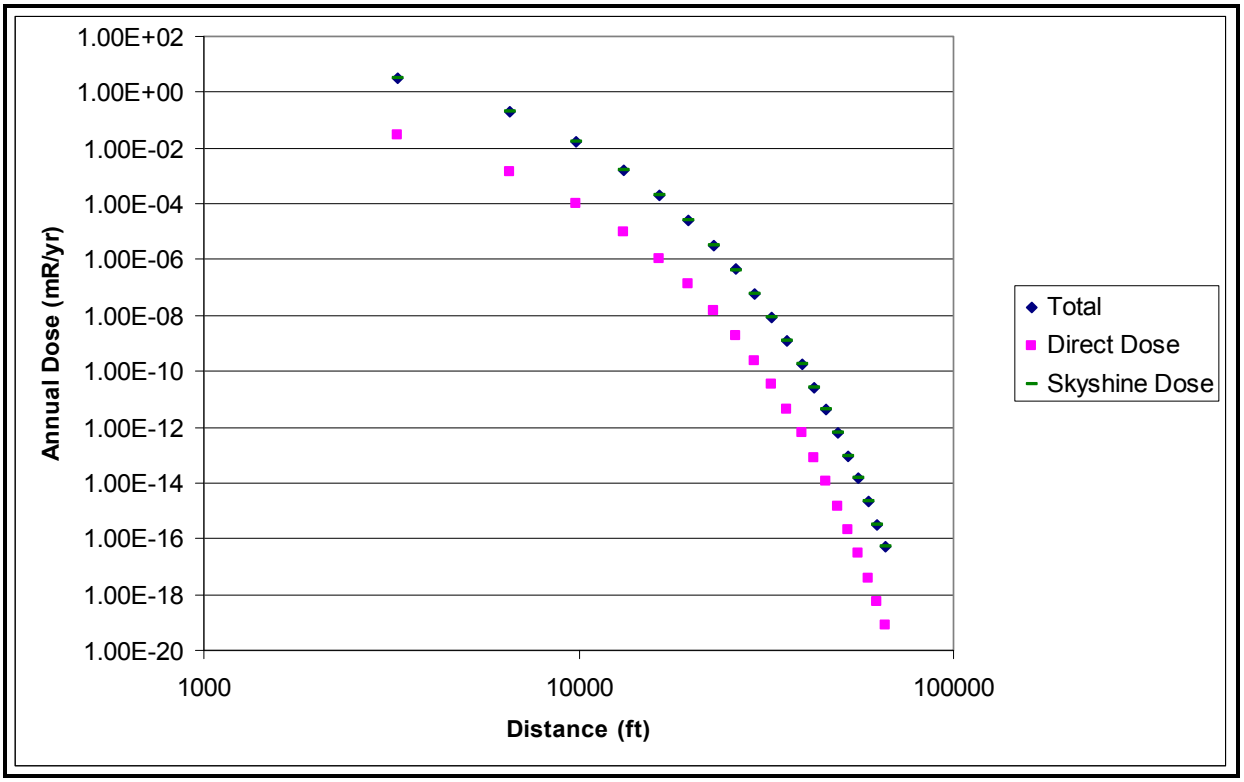


Figure 4.5-12— Dose vs Distance for Steam Dryer Storage Vault

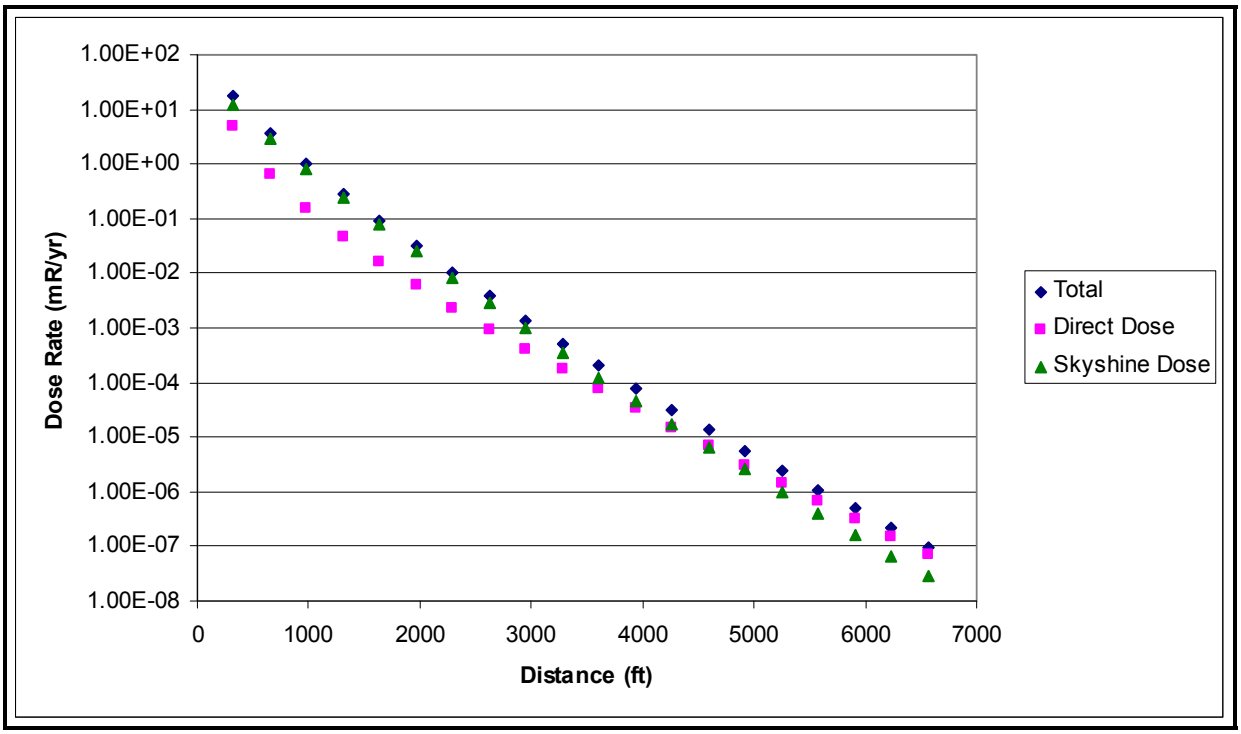
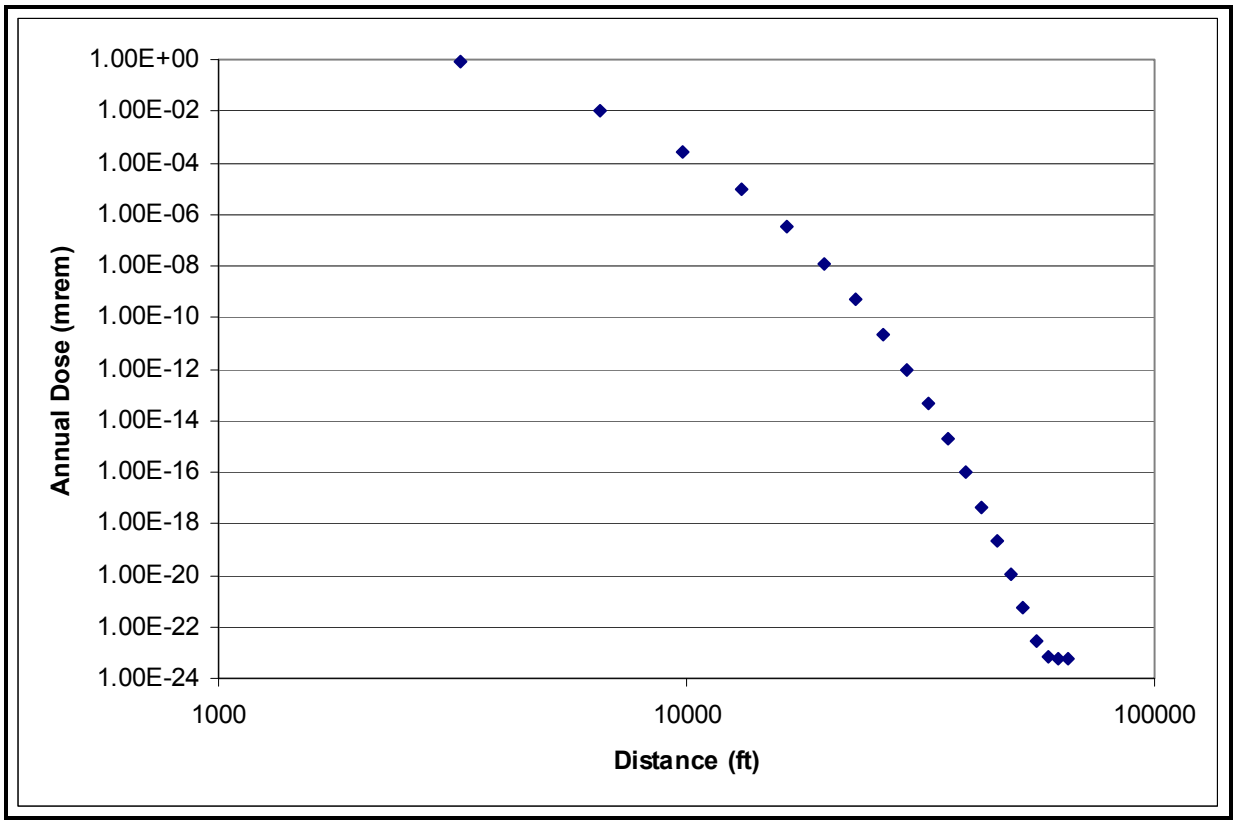


Figure 4.5-13— Dose vs Distance for Turbine Building



4.6 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING CONSTRUCTION

In general, potential impacts will be mitigated through compliance with applicable federal, Pennsylvania, and local laws and regulations enacted to prevent or minimize adverse environmental impacts that may be encountered such as air emissions, noise, storm water pollutants, and spills. Principal among these will be the National Pollutant Discharge Elimination System (NPDES) Individual Permit for Discharge of Stormwater Associated with Construction Activities and the Corps of Engineers 404 Permit to minimize sediment erosion and protect water quality. The Site Resource Management Plan will address affected site lands and waters. Also included will be required plans such as a Storm Water Pollution Prevention Plan (SWPPP) and associated Best Management Practices (BMPs) as well as administrative actions such as a Traffic Management Plan.

Table 4.6-1 lists the potential impacts associated with the construction activities described in Section 4.1 through Section 4.5 and Section 4.7. The table identifies, from the categories listed below, which adverse impact may occur as a result of construction activities and its relative significance rating (i.e., [S]mall, [M]oderate, or [L]arge) following implementation of associated measures and controls. Table 4.6-1 also includes a brief description, by ER Section, of each potential impact and the measures and controls to mitigate the impact, if needed.

- Erosion and Sedimentation
- Air Quality (dust, air pollutants)
- Wastes (effluents, spills, material handling)
- Surface Water
- Groundwater
- Land Use
- Water Use and Quality
- Terrestrial Ecosystems
- Aquatic Ecosystems
- Socioeconomic
- Aesthetics
- Noise
- Traffic
- Radiation Exposure
- Other (site specific (i.e., non-radiological health impacts))

Based on existing site conditions, Susquehanna Steam Electric Station programs and procedures, as well as the measures and controls proposed, the potential adverse impacts identified from the construction of BBNPP are anticipated to be SMALL, if any, for all categories

evaluated except noise, wetlands, and socioeconomics, which are expected to be MODERATE, but manageable with mitigation.

Table 4.6-2 provides estimates of the percentage of impacts attributable to "construction" and to "preconstruction," as well as a summary of the basis for the estimates. The estimated construction related impacts presented in the table were based primarily on two factors, namely the area associated with the construction of SSCs and the labor hours associated with the construction of SSCs. Information related to these two factors is provided as follows:

- Construction Area - During construction, land disturbance will be contained within a Limit of Disturbance (LOD) of approximately 687 ac (278 ha). Of these developed areas, approximately 69 ac (28 ha) will be occupied by SSCs, 11.0 ac (4.5 ha) for the ESWEMS Retention Pond and Pump House, 5.2 ac (2.1 ha) for the 500 kV BBNPP Switchyard, and 52.6 ac (21.3 ha) for the Power Block. It is assumed that preconstruction activities of clearing/grubbing/site preparation will impact land area to be occupied by both SSCs and non SSC structures/activities; therefore, this results in an allocation of a 95% (659 ac) land area impact due to preconstruction and a 5% (35 ac) land area impact during construction.

- Labor Hours - Based on construction estimates for all phases of development of the BBNPP, the estimated labor hours associated with the construction of SSCs is approximately 50% of the total labor hours associated with the development of the entire BBNPP plant site.

Other factors that were considered where applicable include the following:

- Construction Duration - Estimates of impacts generally associated with construction activities were estimated to be related to construction of SSEs 50% of the time and to preconstruction activities 50% of the time.

- Water Usage - The quantity of water to be used for preconstruction is estimated to be 45% of the total water requirements in Table 4.2-1. Preconstruction activities were assumed to begin at the start of Year 1 and extend ten months into Year 3 to align with the assumption that preconstruction activities comprise 50% of time of construction. The water usage predicted for the first 34 months of the 68 month BBNPP construction period is allocated to preconstruction activities. That usage totals 45% of the total volume in Table 4.2-1.

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction

(Page 1 of 12)

ER Reference Section	Potential Impact Category and Description															Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Groundwater(GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	
4.1 Land Use Impacts						S										
4.1.1 The Site and Vicinity	Clearing, grading, excavation, and re-contouring. (ES) (AQ) (L) (A)															Comply with Individual NPDES Permit for Discharge of Stormwater Associated with Construction Activities, including U.S. Environmental Protection Agency (USEPA) effluent limitations.
																Obtain and comply with required agency programs listed in Table 1.3-1.
	Disturbance (temporary and permanent) of wetlands and surface water systems in vicinity. (ES) (SW) (W) (AE)															Use site Resource Management Plan and Best Management Practices (BMPs - silt fences, vegetative stabilization, infiltration beds, and other controls) to protect and mitigate resources such as wetlands and surface water systems in vicinity.
																Obtain Chapter 105 Water Obstruction and Encroachment permits; comply with BMP requirements.
																Obtain individual Corps of Engineers 404 Permit.
	Soil stockpiling and disturbance to natural drainage channels. (ES) (SW) (L) (AE)															Implement Post Construction Stormwater Management (PCSM) Plan including erosion and sediment control plan, as part of the Individual NPDES Permit for Discharge of Stormwater Associated with Construction Activities requirements.
	Removal of existing trees and vegetation. (L) (TE) (A)															Use site Resource Management Plan and comply with BMP requirements.
																Chip unmerchantable trees and spread as wood chips, and/or disposed of at an offsite landfill.

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
		Restore acreage following construction to the maximum extent possible.
	Construction of temporary and permanent structures. (L) (TE) (A)	Place construction footprint wholly within a dedicated nuclear power plant site.
	Release of fuel, oils, or other chemicals. (SW) (GW) (W) (TE) (AE)	Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan.
	Heavy equipment transported to the site. (A) (N) (T)	Construct new site access, perimeter roads, and a rail spur.
4.1.2 Transmission Corridors and Offsite Areas	-The existing transmission lines have sufficient capacity to carry the total output of the existing Susquehanna Steam Electric Station, as well as BBNPP; as a result, there will be no new offsite transmission lines or rights-of-way disturbance. (L)	Continue existing transmission corridor maintenance policies and practices to protect terrestrial and aquatic ecosystems.
4.1.3 Historic Properties (and Cultural Resources)	Disturbance of potentially eligible archaeological resources. (L)	Consult with State Historic Preservation office (SHPO) on results of the Third Supplemental Phase I study, Site 36LU301 Phase II study, and additional cultural resources investigations in order to identify measures to avoid, minimize, or mitigate any adverse effects.
4.2 Water-Related Impacts	Erosion/Sediment (ES): S Air Quality (AQ): Wastes (WS): Surface Water (SW): S Groundwater(GW): S Land Use (L): Water Use & Quality (W): S Terrestrial Ecosystems (TE): Aquatic Ecosystems (AE): Socioeconomic (S): Aesthetics (A): S Noise (N): Traffic (T): Radiation Exposure (R): Other (site specific) (O):	
4.2.1 Hydrologic Alterations	Erosion, sediment, and storm water runoff (from onsite building, utilities, and road construction activities). (ES) (SW) (W) (AE)	Implement PCSM plan, including erosion and sediment control plan, as part of the Individual NPDES Permit for Discharge of Stormwater Associated with Construction Activitiess requirements.
		Monitor construction effluents and storm water runoff.

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction

(Page 3 of 12)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
	Susquehanna River turbidity/sediment effects (from dredging and installation of the Intake and Discharge Structures). (ES) (SW) (W) (AE)	Comply with Corps of Engineers 404 Permit requirements.
	Temporary use of groundwater. (GW)	Use offsite water supply, as needed.
	Temporary dewatering activities. (W) (AE)	Comply with 25 PA Code, Chapter 102 for dewatering activities.
		Obtain individual Corps of Engineers 404 Permit; comply with BMP requirements.
		Use groundwater flow barriers.
		Monitor perched water and groundwater levels.
	Disturbance (temporary and permanent) of wetlands and surface water systems in vicinity. (ES) (SW) (AE)	Use site Resource Management Plan and BMPs to protect resources such as wetlands and surface water systems in vicinity.
		Obtain Chapter 105 Water Obstruction and Encroachment permits; comply with BMP requirements.
		Obtain individual Corps of Engineers 404 Permit; comply with BMP requirements.
	Shift of the glacial outwash aquifer recharge area(s). (ES) (SW) (GW) (W)	Install infiltration beds.
	Release of fuel, oils, or other chemicals. (SW) (GW) (W) (TE) (AE)	Implement SPCC Plan.
4.2.2 Water Use Impacts	Erosion, sediment, and storm water runoff (from onsite building, utilities, and road construction activities). (ES) (SW) (W) (AE)	Implement PCSM plan, including erosion and sediment control plan, as part of the Individual NPDES Permit for Discharge of Stormwater Associated with Construction Activities requirements.
		Monitor construction effluents and storm water runoff.
	Temporary use of groundwater. (GW)	Use offsite water supply, as needed.

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction

(Page 4 of 12)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
	Reduction and/or increase in available pervious (infiltration) areas. (ES) (SW) (L)	Use site Resource Management Plan and BMPs to protect resources such as wetlands and surface water systems in vicinity.
		Direct runoff into infiltration beds.
		Use offsite water supply, as needed.
	Temporary dewatering activities. (W) (AE)	Comply with 25 PA Code, Chapter 102 for dewatering activities.
		Obtain individual Corps of Engineers 404 Permit; comply with BMP requirements.
		Use groundwater flow barriers.
		Monitor perched water and groundwater levels.
	Disturbance (temporary and permanent) of wetlands and surface water systems in vicinity. (ES) (SW) (AE)	Use site Resource Management Plan and BMPs to protect resources such as wetlands and surface water systems in vicinity.
		Obtain Chapter 105 Water Obstruction and Encroachment permits; comply with BMP requirements.
		Obtain individual Corps of Engineers 404 Permit; comply with BMP requirements.
	Increasing sediment loads into Walker Run. (ES) (SW) (W) (AE)	Implement PCSM, including erosion and sediment control plan, as part of the Individual NPDES Permit for Discharge of Stormwater Associated with Construction Activities requirements.
	Shift of the glacial outwash recharge area(s). (ES) (SW) (GW) (W)	Install infiltration beds.
	Creating a local and temporary glacial outwash aquifer depression. (L) (TE) (A)	Complete construction, after which the glacial outwash aquifer water level is expected to recover.
		Use groundwater flow barriers.
		Install infiltration beds.
	Release of fuel, oils, or other chemicals. (SW) (GW) (W) (TE) (AE)	Implement SPCC Plan.

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction

(Page 5 of 12)

ER Reference Section	Potential Impact Category and Description															Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Groundwater(GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	
4.3 **Ecological Impacts**				S		S		S	M		S	S				
4.3.1 Terrestrial Ecosystems	Loss of vegetation (i.e., red maple, river birch, black cherry, spice bush, skunk cabbage and Canada goldenrod) and some of the existing habitat for important fauna (i.e., Indiana bat, eastern small-footed myotis, northern myotis, Allegheny woodrat, bald eagle, peregrine falcon, osprey, redbelly turtle, timber rattlesnake, eastern hognose snake, eastern spadefoot, northern cricket frog, long dash, mulberry wing, Baltimore checkerspot, white-tailed deer, black bear, wild turkey, etc.), as well as forest cover. (ES) (L) (TE) (A)															Implement PCSM plan, including erosion and sediment plan (silt fences, vegetative stabilization, infiltration beds, and other controls) as part of the Individual NPDES Permit for Discharge of Stormwater Associated with Construction Activities requirements.
																Review BBNPP historic survey database to identify important terrestrial species; conduct new surveys, as needed.
																Use site Resource Management Plan and BMPs (may include restoration), to protect resources.
																Design construction footprint to account for important habitat.
																Minimize lighting, as practicable and allowed by regulation.
																Limit tree cutting activities, if needed, to times and sizes that will not affect fauna habitat.
																Restore acreage or mitigate, where needed, following construction to the extent practicable.
	Disturbance (temporary and permanent) of trees. (L) (TE) (A)															Preserve aesthetically outstanding tree clusters, as practical; harvest merchantable timber; use or recycle other woody material, as appropriate; and develop reforestation plan.

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction

(Page 6 of 12)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
	Disturbance (temporary and permanent) of wetlands and surface water systems in vicinity. (ES) (SW) (AE)	Install infiltration beds, a temporary sedimentation pond, and use site Resource Management Plan and BMPs to protect resources such as wetlands and surface water systems in vicinity.
		Conduct wetland mitigation, and enhancement where needed, per State and Federal permits.
		Propose program to remove invasive species, replace native tree/shrub species, and install stabilization measures, including in-stream habitat enhancements, at waterways within project boundary.
		Obtain Chapter 105 Water Obstruction and Encroachment permits; comply with BMP requirements.
		Obtain individual Corps of Engineers 404 Permit; comply with BMP requirements.
		Implement monitoring and corrective action plan following construction of wetland mitigation features per regulatory agency direction.
	Disturbance (temporary and permanent) of the Susquehanna Riverlands Environmental Preserve in vicinity. (ES) (SW) (AE)	Use site Resource Management Plan and BMPs to protect resources such as wetlands and surface water systems in vicinity.
		Conduct wetland mitigation, and enhancement, where needed, per State and Federal permits.
	Limited mortality of wildlife (e.g., avian collisions with man-made structures). (TE)	Use site Resource Management Plan and BMPs to protect resources.
		Monitor and maintain records of environmental data, as needed, per 10 CFR 50.36b
		Reduce cooling tower lighting, as practicable, and use flashing lights instead of flood lights.
	Temporary displacement of mobile wildlife (TE).	Minimize noise as practicable, especially noises that are loud, sudden, and unpredictable.
	Release of fuels, oils, or other chemicals. (SW) (GW) (W) (TE) (AE)	Implement SPCC Plan.

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction

(Page 7 of 12)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.3.2 Aquatic Ecosystems	Disturbance (temporary and permanent) of wetlands and surface water (dewatering Canal, Susquehanna River bank and bottom substrate, etc.) in vicinity; however, onsite wetlands are not substantively distinguishable from other wetlands in the site vicinity and streams within the construction zone contain no rare or unique aquatic species, with the exception of two species of mussel classified as rare that are found in the Susquehanna River. (ES) (SW) (L) (W) (AE) (A)	Review BBNPP historic survey database to identify important aquatic species; conduct new surveys, as needed.
		Implement SPCC Plan.
		Use site Resource Management Plan and BMPs to protect resources.
		Consult with PA Fish and Boat Commission regarding construction footprint impact to mussel species of special concern.
		Obtain Chapter 105 Water Obstruction and Encroachment permits; comply with BMP requirements.
		Obtain individual Corps of Engineers 404 Permit; comply with BMP requirements.
	Temporary sediment and silt increases in surface water systems. (ES) (SW) (W)	Implement PCSM plan, including erosion and sediment control plan (silt fences, vegetative stabilization, dust suppression, the construction of new impoundments, and other controls), as part of the Individual NPDES Permit for Discharge of Stormwater Associated with Construction Activities requirements.
		Install infiltration beds and s temporary sedimentation pond.
	Temporary turbidity increase. (SW) (W)	Comply with Corps of Engineers 404 Permit requirements.
		Construct cofferdams around work areas where appropriate.
	Release of fuel, oils, or other chemicals. (SW) (GW) (W) (TE) (AE)	Implement SPCC Plan.

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction

(Page 8 of 12)

<table>
<tr><th>ER Reference Section</th><th colspan="15">Potential Impact Category and Description</th><th>Proposed Measures and Controls or Mitigating Circumstances</th></tr>
<tr><td rowspan="2"></td><td colspan="15" rowspan="2">Limited mortality of fish and insects (i.e., resulting from sedimentation and surface water modifications).
(AE)</td><td>Implement PCSM, including erosion and sediment plan (silt fences, vegetative stabilization, dust suppression, the construction of new impoundments, and other controls), as part of the Individual NPDES Permit for Discharge of Stormwater Associated with Construction Activities requirements; comply with BMP requirements.</td></tr>
<tr><td>Install infiltration beds and a temporary sedimentation pond.</td></tr>
<tr><td rowspan="2">4.4 Socioeconomic Impacts</td><td>Erosion/Sediment (ES)</td><td>Air Quality (AQ)</td><td>Wastes (WS)</td><td>Surface Water (SW)</td><td>Groundwater(GW)</td><td>Land Use (L)</td><td>Water Use & Quality (W)</td><td>Terrestrial Ecosystems (TE)</td><td>Aquatic Ecosystems (AE)</td><td>Socioeconomic (S)</td><td>Aesthetics (A)</td><td>Noise (N)</td><td>Traffic (T)</td><td>Radiation Exposure (R)</td><td>Other (site specific) (O)</td><td rowspan="2"></td></tr>
<tr><td></td><td>S</td><td>S</td><td></td><td></td><td>S</td><td></td><td></td><td></td><td>M</td><td>S</td><td>M</td><td>S</td><td></td><td></td></tr>
<tr><td rowspan="6">4.4.1 Physical Impacts</td><td colspan="15" rowspan="4">Equipment and non-routine noise.
(N)</td><td>Comply with applicable PA Department of Environmental Protection (DEP) and Salem Township noise restrictions.</td></tr>
<tr><td>Comply with applicable Occupational Safety and Health Administration (OSHA) noise-exposure limits.</td></tr>
<tr><td>Implement appropriate training, personal protective equipment, health and safety monitoring and other good industry noise control practices.</td></tr>
<tr><td>Maintain noise limiting devices on vehicles and equipment and shield high noise sources near their origin; conduct non-routine activities such as blasting during weekday business hours.</td></tr>
<tr><td colspan="15" rowspan="2">Air emissions (dust and volatiles) increase.
(AQ)</td><td>Comply with applicable USEPA and PA DEP air quality regulations.</td></tr>
<tr><td>Implement routine vehicle/equipment inspection and maintenance program.</td></tr>
</table>

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction

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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
		Implement measures to comply with Ambient Air Quality Standards (NAAQS) and National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulatory limits.
		Obtain required permits and/or operating certificates.
	Local and regional temporary traffic increase. (AQ) (T)	Heavy plant equipment will be brought to the site on rail when possible.
		Install new site perimeter and access road.
		Provide traffic mitigation measures, where needed, such as installing signals at the BBNPP entrance access road, realigning lanes on U.S. 11, adding new entrance and exit lanes on the access road at the intersection of U.S. 11, retiming signals, restriping, and adding thru lanes, temporary traffic signals, parking restrictions, and/or other measures at intersections affected by construction traffic.
	Site aesthetically altered due to plant construction; construction activities visible, but temporary. (L) (A)	Use low points in topography to create lowest visual profile practicable and place new structures on the river shoreline near existing structures.
		Minimize tree and vegetation removal and, where feasible, use native trees and vegetation during post-construction restoration.
		Add a new access road.
		Cover exteriors of structures, where practicable, with a compatible color of the surrounding area.
4.4.2 Social and Economic Impacts	Influx of large construction work force. (W) (S) (T)	Small aggregate socioeconomic impacts anticipated; mitigation not required.
	Public services need (employment, housing, emergency services, schools, land use) increase. (S) (T)	Small to moderate aggregate socioeconomic impacts anticipated; mitigation not required, with the possible exception of schools. Additional local tax revenue would be generated from BBNPP to offset impacts to schools.

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction

(Page 10 of 12)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
	Traffic volume increase. (T)	Small traffic impact due to mitigation measures, such as installing signals at the BBNPP entrance access road, realigning lanes on U.S. Highway 11, adding new entrance and exit lanes on the access road at the intersection of U.S. Highway 11, retiming signals, restriping, and adding thru lanes, temporary traffic signals, parking restrictions, and/or other measures at intersections affected by construction traffic.
	Spending and tax revenue increase. (S)	Large beneficial impact to property tax revenues; small beneficial impact for other types of tax revenues. No mitigating measures or controls required.
4.4.3 Environmental Justice Impacts	No disproportionate adverse impacts to minority or low-income populations. (S)	None necessary.
4.5 Radiation Exposure to Construction Workers	Erosion/Sediment (ES) | Air Quality (AQ) | Wastes (WS) | Surface Water (SW) | Groundwater(GW) | Land Use (L) | Water Use & Quality (W) | Terrestrial Ecosystems (TE) | Aquatic Ecosystems (AE) | Socioeconomic (S) | Aesthetics (A) | Noise (N) | Traffic (T) | Radiation Exposure (R) | Other (site specific) (O) S	
	SSES Units 1 and 2 gaseous effluents exposure. (AQ) (SW) (TE) (AE) (R)	Implement a radiation protection and/or monitoring program and/or as low as is reasonably achievable (ALARA) practices at construction site per 10 CFR 20.1301.
		Prohibit consumption of onsite agricultural products.
	Independent Spent Fuel Storage Installation (ISFSI) direct radiation exposure. (TE) (R)	Implement a radiation protection and/or monitoring program and/or as low as is reasonably achievable (ALARA) practices at construction site per 10 CFR 20.1301.
		Prohibit consumption of onsite agricultural products.

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Page 11 of 12)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
	Low Level Radioactive Waste Handling Facility (LLRWHF) direct radiation exposure. (TE) (R)	Implement a radiation protection and/or monitoring program and/or as low as is reasonably achievable (ALARA) practices at construction site per 10 CFR 20.1301.
		Prohibit consumption of onsite agricultural products.
	SEALAND containers direct radiation exposure. (TE) (R)	Implement a radiation protection and/or monitoring program and/or as low as is reasonably achievable (ALARA) practices at construction site per 10 CFR 20.1301.
		Prohibit consumption of onsite agricultural products.
	Steam dryer storage vault direct radiation exposure. (TE) (R)	Implement a radiation protection and/or monitoring program and/or as low as is reasonably achievable (ALARA) practices at construction site per 10 CFR 20.1301.
		Prohibit consumption of onsite agricultural products.
	Turbine building direct radiation exposure. (TE) (R)	Implement a radiation protection and/or monitoring program and/or as low as is reasonably achievable (ALARA) practices at construction site per 10 CFR 20.1301.
		Prohibit consumption of onsite agricultural products.

ER Reference Section	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Groundwater(GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	Proposed Measures and Controls or Mitigating Circumstances
4.7 Non-Radiological Health Impacts															S	

Table 4.6-1— A Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Page 12 of 12)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
	Risk to workers from accidents and occupational illnesses. (O)	Implement site-wide Safety and Medical Program, including safety policies, safe work practices, as well as general and topic-specific training.

Table 4.6-2— Summary of Construction and Preconstruction Related Impacts

(Page 1 of 8)

Section Reference	Potential Impacts and Significance[a]	Estimated Impacts (%)		Basis of Estimate
		Construction[b]	Preconstruction	
Section 4.1 Land Use Impacts				
Section 4.1.1 The Site and Vicinity				
Section 4.1.1.1 The Site	S - Land Use	5	95	The percentage of the Construction Area impacted during Pre-construction is estimated to be 95% as described previously..
Section 4.1.1.2 The Vicinity	S - Land Use	95	5	Estimates are based on the activities for the construction of BBNPP and supporting facilities that will take place above the tree line and will thus be visible from nearby roadways.
Section 4.1.2 Transmission Corridors and Offsite Areas	S - Land Use	0	100	Transmission corridors are not included in the definition of construction of SSC's. There are no offsite areas associated with the project that are included in the definition of construction of SSC's.
Section 4.1.3 Historic Properties	S - Land Use	5	95	The impact of historic properties will apply primarily to preconstruction activities since they will be identified and mitigation plans established prior to land clearing, grading, installation of drainage, erosion and other environmental mitigation measures, construction of temporary roads and laydown areas, etc. There is some small potential for discovery of historic properties during the construction-related excavations.
Section 4.2 WaterRelated Impacts				
Section 4.2.1 Hydrologic Alterations				
Section 4.2.1.1 Description of Surface Water Bodies and Groundwater Aquifers				N/A
Section 4.2.1.2 Construction Activities	S - Erosion and Sediment S - Surface Water S - Groundwater	5	95	The percentage of the Construction Area impacted during Pre-construction is estimated to be 95% as described previously.
Section 4.2.1.3 Water Sources and Amounts Needed for Construction	S - Surface Water	55	45	Estimates are based on a planned 68 months of construction, of which 50% is preconstruction. Estimates are based on the quantity of water to be used during the initial 50% time (assumed for preconstruction) and the remaining years for construction as shown in Table 4.2-1.

Table 4.6-2— Summary of Construction and Preconstruction Related Impacts

(Page 2 of 8)

Section Reference	Potential Impacts and Significance[a]	Estimated Impacts (%)		Basis of Estimate
		Construction[b]	Preconstruction	
Section 4.2.1.4 Surface Water Bodies Receiving Construction Effluents that Could Affect Water Quality	S - Erosion and Sediment S - Surface Water	55	45	Estimates are based on a planned 68 months of construction, of which 50% is preconstruction. Estimates are based on the quantity of water to be used during the initial 50% time (assumed for preconstruction) and the remaining years for construction as shown in table Table 4.2-1.
Section 4.2.1.5 Construction Impacts	S - Erosion and Sediment S - Surface Water S - Groundwater	55	45	These estimates are based on the land area that will be impacted by the construction of BBNPP and related facilities and on water usage over the time period of construction. A significant contributor to construction impacts will be de-watering of the deep excavations, with water routed in accordance with a required NPDES permit.
Section 4.2.1.6 Identification of Surface Water and Groundwater Users				N/A
Section 4.2.1.7 Proposed Practices to Limit or Minimize Hydrologic Alterations				N/A
Section 4.2.1.8 Compliance with Applicable Hydrological Standards and Regulations				N/A
Section 4.2.1.9 Best Management Practices				N/A
Section 4.2.2 Water Use Impacts				
Section 4.2.2.1 Description of the Site and Vicinity Water Bodies				N/A
Section 4.2.2.2 Hydrologic Alterations and Related Construction Activities	S - Erosion and Sediment S - Surface Water S - Groundwater	50	50	These estimates are based on the land area that will be impacted by the construction of BBNPP and related facilities and on water usage over the time period of construction. A significant contributor to construction impacts will be de-watering of the deep excavations, with water routed in accordance with a required NPDES permit.

Table 4.6-2— Summary of Construction and Preconstruction Related Impacts

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Section Reference	Potential Impacts and Significance[a]	Estimated Impacts (%)		Basis of Estimate
		Construction[b]	Preconstruction	
Section 4.2.2.3 Physical Effects of Hydrologic Alterations	S - Erosion and Sediment S - Surface Water S - Groundwater	50	50	These estimates are based on the land area that will be impacted by the construction of BBNPP and related facilities and on water usage over the time period of construction. A significant contributor to construction impacts will be de-watering of the deep excavations, with water routed in accordance with a required NPDES permit.
Section 4.2.2.4 Water Quantities Available to Other Users	S - Surface Water S - Water Use S - Groundwater	55	45	Estimates are based on a planned 68 months of construction, of which 50% is preconstruction. Estimates are based on the quantity of water to be used during the initial 50% time (assumed for preconstruction) and the remaining years for construction as shown in Table 4.2-1.
Section 4.2.2.5 Water Bodies Receiving Construction Effluents	S - Surface water S - Groundwater	55	45	Estimates are based on a planned 68 months of construction, of which 50% is preconstruction. Estimates are based on the quantity of water to be used during the initial 50% time (assumed for preconstruction) and the remaining years for construction as shown in Table 4.2-1.
Section 4.2.2.6 Baseline Water Quality Data				N/A
Section 4.2.2.7 Potential Changes to Surface Water and Groundwater Quality	S - Surface water S - Groundwater	55	45	These estimates are based on the water usage over the time period of construction. The assumption is made that the disturbed land will be stabilized so as to prevent erosion and that potential changes to water quality will be associated with water usage and consequent runoff potential during active preconstruction and construction. A significant contributor to construction impacts will be de-watering of the deep excavations, with water routed in accordance with a required NPDES permit.
Section 4.2.2.8 Surface Water and Groundwater Users				N/A
Section 4.2.2.9 Predicted Impacts on Water Users	S - Water Use S - Surface water S - Groundwater	55	45	Estimates are based on a planned 68 months of construction, of which 50% is preconstruction. Estimates are based on the quantity of water to be used during the initial 50% time (assumed for preconstruction) and the remaining years for construction as shown in Table 4.2-1.

Table 4.6-2— Summary of Construction and Preconstruction Related Impacts

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Section Reference	Potential Impacts and Significance[a]	Estimated Impacts (%)		Basis of Estimate
		Construction[b]	Preconstruction	
Section 4.2.2.10 Measures to Control Construction Related Impacts	S - Erosion and Sediment S - Surface water S - Water Use S - Groundwater	5	95	The percentage of the Construction Area impacted during Pre-construction is estimated to be 95% as described previously.
Section 4.2.2.11 Consultation with federal, state, and local environmental organizations				N/A
Section 4.2.2.12 Compliance with Water Quality and Water Use Standards and Regulations				N/A
Section 4.2.2.13 Water Quality Requirements for Aquatic Ecosystems and Domestic Users				N/A
Section 4.3 Ecological Impact				
Section 4.3.1 Terrestrial Ecosystems				
Section 4.3.1.1 Vegetation	S - Terrestrial Ecosystems	5	95	The percentage of the Construction Area impacted during Pre-construction is estimated to be 95% as described previously.
Section 4.3.1.2 Fauna	S - Terrestrial Ecosystems	5	95	The percentage of the Construction Area impacted during Pre-construction is estimated to be 95% as described previously.
Section 4.3.1.3 Wetlands	M - Aquatic Ecosystem	55	45	Estimates are based on a planned 68 months of construction, of which 50% is preconstruction and the quantity of water to be used during the initial 50% time (assumed for preconstruction) and the remaining years for construction as shown in Table 4.2-1. Direct physical disturbances to wetlands will occur primarily during preconstruction; however, wetlands will experience water quality and hydrologic impacts throughout construction.
Section 4.3.1.4 Other Projects Within the Area with Potential Impacts				N/A
Section 4.3.1.5 Consultation				N/A
Section 4.3.1.6 Mitigation Measures				N/A
Section 4.3.2 Aquatic Ecosystems				

Table 4.6-2— Summary of Construction and Preconstruction Related Impacts

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Section Reference	Potential Impacts and Significance[a]	Estimated Impacts (%)		Basis of Estimate
		Construction[b]	Preconstruction	
Section 4.3.2.1 Impacts to Impoundments and Streams	S - Surface Water S - Aquatic Ecosystem	50	50	These estimated are based on the land area that will be impacted by the construction of BBNPP and related facilities and on water usage over the time period of construction. A significant contributor to construction impacts will be de-watering of the deep excavations, with water routed in accordance with a required NPDES permit.
Section 4.3.2.2 Impacts to Surface Water Bodies	S - Aquatic Ecosystem	50	50	These estimates are based on the land area that will be impacted by the construction of BBNPP and related facilities and on water usage over the time period of construction. A significant contributor to construction impacts will be de-watering of the deep excavations, with water routed in accordance with a required NPDES permit. The majority of these construction impacts are temporary. No important fish species or unique habitats are present in the river and thus none will be affected by the construction of BBNPP.
Section 4.3.2.3 Impacts on the Transmission Corridor and Offsite Areas	S - Aquatic Ecosystem	0	100	Transmission corridors are not included in the definition of construction of SSC's. There are no offsite areas associated with the project that are included in the definition of construction of SSC's
Section 4.3.2.4 Summary				N/A
Section 4.4 Socioeconomic Impacts				
Section 4.4.1 Physical Impacts				
Section 4.4.1.1 The Public and Workers				N/A
Section 4.4.1.2 Noise	M - Noise	50	50	Estimates are based on a planned 68 months of construction, of which 50% is preconstruction.
Section 4.4.1.3 Dust and Other Air Emissions	S - Air Quality	50	50	Estimates are based on a planned 68 months of construction, of which 50% is preconstruction.
Section 4.4.1.4 Buildings	S - Other (Site Specific)	50	50	Estimates are based on a planned 68 months of construction, of which 50% is preconstruction.
Section 4.4.1.5 Transportation Routes	S - Transportation and roads	50	50	Estimates are based on a planned 68 months of construction, of which 50% is preconstruction.

Table 4.6-2— Summary of Construction and Preconstruction Related Impacts

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Section Reference	Potential Impacts and Significance[a]	Estimated Impacts (%)		Basis of Estimate
		Construction[b]	Preconstruction	
Section 4.4.1.6 Aesthetics	S - Other (Site Specific)	95	5	Estimates are based on the visual aesthetic impact from construction of the BBNPP. The reactor building, turbine hall, and two natural draft cooling towers are expected to affect the aesthetics around the site. However, effects will be limited due to the topography that includes forests and rolling terrain. Additionally, mitigation measures will be implemented.
Section 4.4.2 Social and Economic Impacts				
Section 4.4.2.1 Study Methods				N/A
Section 4.4.2.2 Construction Labor Force Needs, Composition and Estimates				N/A
Section 4.4.2.3 Demography				N/A
Section 4.4.2.4 Housing	S - Socioeconomic	50	50	Estimates are based on the workforce estimated to be necessary for each phase of construction as shown in Table 4.4-3. Estimates are based on a planned 68 months of construction, of which 50% is preconstruction.
Section 4.4.2.5 Employment and Income	S - Socioeconomic	50	50	Estimates are based on the workforce estimated to be necessary for each phase of construction as shown in Table 4.4-3. Estimates are based on a planned 68 months of construction, of which 50% is preconstruction.
Section 4.4.2.6 Tax Revenue Generation	L - Socioeconomic	50	50	Estimates are based on the workforce estimated to be necessary for each phase of construction as shown in Table 4.4-3.
Section 4.4.2.7 Land Values	S - Socioeconomic	100	0	Estimates are based on the presumption that preconstruction activities have no impact on land values; only permanent structures as will be developed during construction may be perceived to impact land values.

Table 4.6-2— Summary of Construction and Preconstruction Related Impacts

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Section Reference	Potential Impacts and Significance[a]	Estimated Impacts (%)		Basis of Estimate
		Construction[b]	Preconstruction	
Section 4.4.2.8 Public Services	S-M -Socioeconomic	50	50	Public services availability is based on the ability of the emergency services to respond simultaneously to an emergency as well as offsite evacuation. For the educational system, estimates are based on the workforce estimated to be necessary for each phase of construction. Estimates are based on the workforce estimated to be necessary for each phase of construction as shown in Table 4.4-3.
Section 4.4.2.9 Public Facilities	S-M - Socioeconomic	50	50	Estimates are based on the workforce estimated to be necessary for each phase of construction as shown in Table 4.4-3.
Section 4.4.3 Environmental Justice Impacts				
Section 4.4.3.1 Minority and Low Income Populations and Activities	S - Socioeconomic	50	50	Estimates are based on the workforce estimated to be necessary for each phase of construction as shown in Table 4.4-3. Estimates are based on a planned 68 months of construction, of which 50% is preconstruction.
Section 4.4.3.2 Subsistence Activities	S - Socioeconomic	5	95	The percentage of the Construction Area impacted during Pre-construction is estimated to be 95% as described previously.
Section 4.5 Radiation Exposure to Construction Workers				
Section 4.5.1 Site Layout				N/A
Section 4.5.2 Radiation Sources at BBNPP	S - Rad Exp to Constr Wkrs	50	50	Estimates are based on the workforce estimated to be necessary for each phase of construction as shown in Table 4.4-3. Estimates are based on a planned 68 months of construction, of which 50% is preconstruction.
Section 4.5.3 Historical Dose Rates				N/A
Section 4.5.4 Projected Dose Rates at BBNPP				N/A
Section 4.5.5 Compliance with Dose Rate Regulations				N/A
Section 4.5.6 Collective Doses to BBNPP Workers	S - Effluent and Wastes S - Rad Exp to Constr Wkrs	50	50	Estimates are based on the workforce estimated to be necessary for each phase of construction as shown in Table 4.4-3. Estimates are based on a planned 68 months of construction, of which 50% is preconstruction.

Table 4.6-2— Summary of Construction and Preconstruction Related Impacts

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Section Reference	Potential Impacts and Significance[a]	Estimated Impacts (%)		Basis of Estimate
		Construction[b]	Preconstruction	
Section 4.5.7 Radiation Protection and ALARA Program				N/A

Notes:
a) The qualitative significance levels of (S)MALL, (M)ODERATE, or (L)ARGE have been assigned based on deployment and effective implementation of mitigation measures and controls required by local, state and federal regulations.
b) "Construction," as defined in 10 CFR 50.2 "Definitions" refers to the construction of "safety-related structures, systems, or components (SSCs) of a facility"

4.7 NONRADIOLOGICAL HEALTH IMPACTS

4.7.1 Public Health

Members of the public can potentially be put at risk by construction of a new power generation unit. Nonradiological air emissions and dust can migrate offsite through the atmosphere to nearby residences or businesses. BBNPP non-radiological air emmissions will meet required PaDEP air permit limits. Noise can also propagate offsite. The increase in traffic from commuting construction workers and deliveries can result in additional air emissions and traffic accidents. Section 4.4.1, "Physical Impacts, addresses these potential impacts to the public from construction activities.

4.7.2 Occupational Health

Construction of a new power generation unit and associated transmission lines would involve risk to workers from accidents or occupational illnesses. These risks could result from construction accidents (e.g., falls and burns), exposure to toxic or oxygen-replacing gases, and other causes.

During construction of BBNPP, PPL Bell Bend, LLC will provide a safety and medical program with associated personnel to promote safe work practices and respond to occupational injuries and illnesses. The safety and medical program will utilize an industrial safety manual providing a set of work practices with the objective of preventing accidents due to unsafe conditions and unsafe acts. These safe work practices address hearing protection, confined space entry, personal protective equipment, respiratory protection, heat stress, electrical safety, excavation and trenching, scaffolds and ladders, fall protection, chemical handling, storage, and use, and other industrial hazards. The safety and medical program provides for employee training on safety procedures. Site safety and medical personnel are provided to handle construction accidents and occupational illnesses.

Contractors, including construction contractors, will be required to review all safety policies/ safe work practices applicable to their work with site personnel. The contractors will be required to comply with site safety, fire, radiation, security polices, procedures, safe work practices, and federal and state regulations.

The Bureau of Labor Statistics maintains records of a statistic known as total recordable cases (TRC), which are a measure of annual work-related injuries or illnesses that include death, days away from work, restricted work activity, medical treatment beyond first aid, and other criteria. The 2006 nationwide TRC rate published by the Bureau of Labor Statistics for utility system construction is 5.4 per 100 workers (BLS, 2008a). A similar statistic for the Commonwealth of Pennsylvania is 4.1 per 100 workers (PLDI, 2007). PPL Bell Bend, LLC has calculated the TRC incidence for the proposed construction site.

The number of injuries or illnesses that might occur during construction of BBNPP can be calculated as the product of the incidence rate and the number of full time workers divided by 100. The calcuated annual average numbers of injuries and illnesses that could be expected each year of construction, using both the nationwide and Pennsylvania TRC values, are as follows:

	TRC Incidence Based on US Rate	TRC Incidence Based on PA Rate
Average Annual	162	124

The Bureau of Labor Statistics published 2006 statistics for fatal occupational injuries (BLS, 2008b) and average employment (BLS, 2008a) that were used to calculate the nationwide

annual rate of fatal occupational injuries for utility system construction. Using monthly construction employment predictions and the calculated rate 0.025%, it is estimated that 5 construction deaths could occur over the pre-construction and construction period of 68 months. PPL Bell Bend, LLC will require all construction contractors and subcontractors working at the construction site to comply with all safety procedures in order to prevent and/or minimize the number of deaths, injuries, and illness during the construction of BBNPP. Even with effective safety procedures, construction work carries the risk or injury, illness, and death. However, it is not expected that the construction of a new nuclear power generation facility will result in more construction deaths than other similarly sized non-nuclear heavy construction projects.

4.7.3 References

BLS, 2008a. Table 1, Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2006, Bureau of Labor Statistics, Website: http://www.bls.gov/iif/oshwc/osh/os/ostb1765.pdf, Date accessed: March 25, 2008.

BLS, 2008b. Table A-1, Fatal occupational injuries and even or exposure, All United States, 2006, Bureau of Labor Statistics, Website: http://www.bls.gov/iif/oshwc/cfoi/cftb0216.pdf, Date accessed: March 25, 2008.

PDLI, 2007. 2006 Pennsylvania Worker's Compensation and Workplace Safety Annual Report, Website: http://www.dli.state.pa.us/landi/lib/landi/bwc/publications/2006_annual_report.pdf, Date accessed: March 25, 2008.