

# Environmental Impacts Of Substations



## Introduction

A substation is part of the electric grid and connects two or more transmission and/or distribution lines. Substations are designed to accomplish the following functions, although not all substations have all these functions:

- Change voltage from one level to another
- Regulate voltage to compensate for system voltage changes
- Switch transmission and distribution circuits into and out of the grid system
- Measure electric power qualities flowing in the circuits
- Connect communication signals to the circuits
- Eliminate lightning and other electrical surges from the system
- Connect electric generation plants to the system
- Make interconnections between the electric systems of more than one utility
- Change alternating current to direct current or direct current to alternating current
- Control reactive kilovolt-amperes supplied to and the flow of reactive kilovolt-amperes in the circuits

Substations can range from simple to complex. A small substation of about 500 square feet may contain little more than a transformer and associated switches. Other substations are very large and may be several acres in size with several transformers and dozens of switches. Substations are built in all types of locations, within agricultural fields, in undeveloped areas, in urban areas, or amidst residential developments (Figure 1). Regardless of their size, substations have several common features, including a gravel pad with concrete foundations that support the necessary electrical equipment, a tall chain link fence surrounding the equipment for safety purposes, and an access road from the nearest public road.

The general location of a substation is initially determined by transmission requirements and transmission line routing. The selection of a substation site involves the consideration of many

factors. Sufficient land area is required for installation of equipment with necessary clearances for electrical safety and for access to maintain large apparatus, such as transformers. The site should have room for expansion due to load growth or planned transmission additions. Potential environmental effects such as stormwater drainage, noise, and road traffic must also be considered.

**Figure 1 A Variety of Substations in Different Settings**



## **Types of Impacts Associated with Substations**

The impacts related to the construction and operation of a new electric substation will depend on its size as well as the topography, land cover, and existing land use of the selected site. Some impacts are temporary; however, most of the community and environmental impacts are permanent. The extensive land clearing and excavation activities required for the substation foundation creates permanent changes to the land cover of the site. In addition, a permanent access road is needed to allow for long-term monitoring and maintenance. Larger substations may require stormwater detention ponds, berms, additional transmission structures constructed outside of the fenced area, and other landscape alterations. These changes and other impacts related to the construction and operation of electric substations are described below, separated into temporary and permanent impacts.

## **Temporary Construction Impacts**

Prior to the construction of a substation, the entire area is cleared of vegetation and regraded. If nonsuitable soils are encountered, they are excavated and replaced.

Temporary impacts associated with the construction of a substation often include machinery noise, fugitive dust, and temporary disruptions in local electric-service. Substantial noise and airborne dust can be caused by the large equipment used to excavate the area of the substation pad and access road, concrete and gravel trucks that haul in materials for the foundation, and tractor trailers to bring in the electrical equipment. Short local electrical outages may be necessary to interconnect nearby transmission and/or distribution lines into the new substation.

Soil erosion and storm water runoff can also occur during construction when the existing vegetation is removed during foundation excavation, temporarily exposing bare ground. Installation of appropriate erosion control measures, such as silt fencing and straw logs should occur during construction and remain in place until the disturbed vegetation surrounding the fenced-in site has stabilized. The thick gravel pad that is laid down (within the fenced substation area) acts as an impermeable surface and increases runoff during rain events. Construction of permanent storm water ponds adjacent to the fenced area is a common practice, especially for larger substations, to mitigate the adverse effects of storm water runoff on water quality in nearby streams and wetlands.

## **Permanent Construction Impacts**

The permanent impacts related to construction and operation of a new substation (or expansion of an existing substation) may be substantial depending on the location of the new site and its proximity to residences. Among the more important and long-lasting impacts are land use changes and habitat loss, changes to local aesthetics and viewsheds, noise, and lighting. These potential impacts, as well as several others, are discussed below in alphabetical order.

### *Aesthetics*

The overall aesthetic impact of a new substation is highly dependent on the size and location of the facility. Smaller distribution substations can be camouflaged fairly easily with berms, fencing, or landscaping. Larger substations that interconnect transmission lines can appear quite industrial in nature. In rural settings, local property owners may not object to the facilities' strong visual impact. Within residential areas however, homeowners may find that the physical appearance of the transformers, switches and high fences of new substations detract from the character of the neighborhood. Because of the height of some substation equipment and the clearing necessary around the transmission facilities, it can be difficult to reduce the visual impact of transmission substations. Substation construction applications may include landscape plans and illustrations so that the public can understand how the new structures will look within the neighborhood when compared to adjacent land uses.

### *Cultural Resources*

Cultural resources include archeological sites, historic buildings, and sacred places. Potential impacts to cultural resources could occur in two ways: 1) ground disturbing activities could result in the loss of or damage to archeological artifacts or unmarked burial sites; or 2) the views and site lines to or from an important historical site could be adversely affected by the physical presence of a new substation. Both of these potential impacts must be considered when an applicant is selecting its final site alternatives.

A statewide database of known cultural resources must be consulted, and the direction of the Wisconsin Historical Society must be followed if it appears that cultural resources might be affected by a proposed construction project.

### *Electromagnetic Fields*

The electric and magnetic field (EMF) levels within the fenced area of a substation can be much higher than the surrounding area, especially at larger substations containing several transformers. However, these EMF levels decrease rapidly with distance from the transformers and other electrical equipment. Most of the time, EMF levels drop to the same as surrounding background levels at a distance of 100 to 200 feet from the fenced area.

### *Land Use and Habitat Loss*

New substations located within residential neighborhoods or subdivisions may be perceived as an industrial land use, inconsistent with the aesthetics of the community. They have the potential to affect the character and desirability of the residential area unless adequately landscaped or designed to be less obtrusive. Some examples of substation landscaping or design include surrounding the substation with tree-covered berms, attractive wood fencing, or the use of low-profile facility designs.

Locating a substation in a rural area that is primarily agricultural could result in the loss of productive farmland. Utilities may purchase more land than is needed for the substation footprint. In these situations, once the substation and required infrastructures, like storm water ponds or access roads are constructed, the surrounding acreage is usually leased to a farm operator and returned to agricultural use.

New substation sites within existing wooded areas will result in the loss of trees and woodland habitat for birds and other wildlife. Substations constructed in grasslands may impact high quality bird habitat. Depending on the size and purpose of the substation, the area affected could vary from less than one acre to up to 10 acres.

### *Noise and Lighting*

The noise produced by an operating substation can be quite loud to adjacent property owners. A constant humming or buzzing noise may be audible several hundred feet from the substation fence. The sound may be especially noticeable during nighttime hours when ambient noise levels are lower. A barrier of mature trees or tall soil berms between the substation and nearby residences can be helpful in partially reducing noise impacts.

Light pollution may present a nuisance in residential areas or diminish enjoyment of the night time sky in rural areas. Substations may have lights that operate all night long to discourage vandalism and unauthorized individuals. Newer downward-focused security lighting can help to avoid or reduce light pollution.

#### *Public Safety*

The installation of equipment within substations must meet the requirements of the Wisconsin Electrical Code. There are also strict safety requirements for personnel assigned to work in substations. To maintain safe conditions for the general public, all substations are fenced and have gates that must be locked at all times. Appropriate signage must also be posted that shows the owner of the substation, the hazardous nature of the substation, and contact information.

#### *Threatened, Endangered, or Rare Species*

Construction and operation of a substation could have direct impacts on rare species or their habitat if the substation is sited in an area with high-quality habitat suitable for protected species. Applicants are required to consult with the Wisconsin Department of Natural Resources (WDNR) to determine if protected species or high-quality habitat are present on the site. In some cases, field surveys may be necessary. When these resources might be present, the utility is required to avoid or reduce possible impacts. Methods to avoid or minimize impacts may include choosing an alternative site, scheduling construction so as to avoid active breeding seasons, or other methods. An “incidental take” permit may be needed.

As described above in the land use discussion, substation construction can also result in the direct loss of grassland or woodland habitat for other non-listed birds, mammals, reptiles and other wildlife.

#### *Vegetation Management*

Buried beneath the gravel in a substation yard is a grid of wires that functions as the grounding for the high voltage equipment. In order to ensure safety for utility employees and the public, it is important to prevent this ground grid from being compromised by vegetation growth. For this reason substation yards are regularly maintained by using a variety of herbicides.

#### *Wetlands/Waterways*

Because of the need for a stable, level ground surface, new substations are rarely constructed within wetlands. If no other suitable alternatives are available, the environmental permitting requirements for siting a substation in a wetland include minimizing the amount of fill placed in a wetland and the impact on wetlands/waterways adjacent to the construction site. They might also include creating, restoring, or preserving additional wetland acreage on other sites. If wetlands or waterways are present near an upland substation site, it is likely that construction of a storm water pond to retain runoff from the substation site would be required.

## **The Role of the Public Service Commission**

The Public Service Commission of Wisconsin (PSCW) regulates Wisconsin's utilities. A three-member board (the Commission) is appointed by the governor to make decisions for the agency based on analyses and information gathered by a technical staff with a wide range of expertise.

The PSCW staff analyzes a substation application to determine the degree of need for the project, its potential social and natural resource impacts, and the accuracy of the applicant's cost estimates. The applications detail the location of the sites and the types of construction or modifications to existing substations being proposed. They typically contain a variety of diagrams showing the location and arrangement of the principal substation components including lines, switches, circuit breakers, and transformers. The size and complexity of the proposed project determines whether and what type of review process is conducted by the PSCW.

Because of the high cost of electrical equipment placed in substations, the Commission is required to review the applications for the construction of most substations, including distribution substations built by local electric service providers (Wis. Admin. Code § PSC 112.05(3)). Most proposed substation construction requires a Certificate of Authority (CA) from the Commission. A substation application that is proposed as part of a larger construction project such as a high-voltage transmission line or generation facility will require either a CA or a Certificate of Public Convenience and Necessity (CPCN) from the Commission, depending on the total size of the proposed project. A public hearing is not usually required for applications requiring a CA, but may be requested by interested parties or members of the public. CPCN project applications always require a public hearing in the project area.

The Commission is responsible for making the final decisions about the proposed substation construction. The Commission decides whether the substation will be built, where it will be located, and under what conditions. If there is a hearing, the Commission reviews all hearing testimony from PSCW staff, the applicant, WDNR staff (if permits are required), full parties, organizations, and members of the public. The three Commissioners meet regularly in open meetings to decide cases before them. The public can observe any open meeting. At these open meetings, the Commission approves, denies, or modifies the proposed project. The Commission has the authority to order environmental protections or mitigation measures as a condition of construction.



The Public Service Commission of Wisconsin is an independent state agency that oversees more than 1,100 Wisconsin public utilities that provide natural gas, electricity, heat, steam, water and telecommunication services.



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