A SunCam online continuing education course

A Guide to Environmental Impact Statements for Engineers

by

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Introduction:
This course presents an overview of Environmental Impact Statements (or EIS, for short). Writing a formal EIS is often beyond the expertise of an engineer and may require a team of professionals in various fields. However, on smaller sites and on less complicated projects, the design engineer may be required to provide at least an abbreviated EIS. In any case, knowing where to find the information that goes into the EIS and knowing how to read and interpret the data contained within an EIS is invaluable to the design engineer in many ways. This course attempts to provide this information.

When preparing an environmental impact statement for a land development project, the engineer should first determine the following:

1. Does the municipality, county, or other governmental agency having jurisdiction over the project require an EIS and, if so, have they published a checklist of what is required?
2. Is the project or the site complicated enough that one or more outside professionals need to be brought into the preparation of the EIS.
3. What on-site investigations need to be undertaken to prepare the EIS (or to prepare the project as a whole)? These can include topographic surveying, soil permeability testing, geotechnical borings, traffic counts, and a myriad of other investigations.
4. Where can the engineer go to obtain information required by the EIS?
5. What is the intended audience? Will it be read by the municipal planning board and engineer, the United States Environmental Protection Agency, stakeholders in the project, the general public, or some other audience?

The answers to these questions will, in large part, form the basis of the written environmental impact statement.

Description of the Project:
A description of the proposed development is a key element in any environmental impact statement. Some people reading the EIS may not be aware of what is being proposed so a succinct description of the project is an essential beginning to the document. In describing the project, the engineer should briefly state any unavoidable detrimental impacts. Typically, on a small scale land development projects these can include some or all of the following:

1. Tree clearing and a loss of green space.
2. An increase in traffic.

3. A short-term increase in the potential for soil erosion.
4. An increase in the rate and quantity of stormwater exiting the site. (This is generally the case if the amount of impervious surfaces on the property is being increased. Ordinarily, the engineer will have to design a stormwater management system to control this increase. The design and functioning of this system should be briefly described in the EIS).
5. Potential for short-term or long-term increase in ambient noise levels.

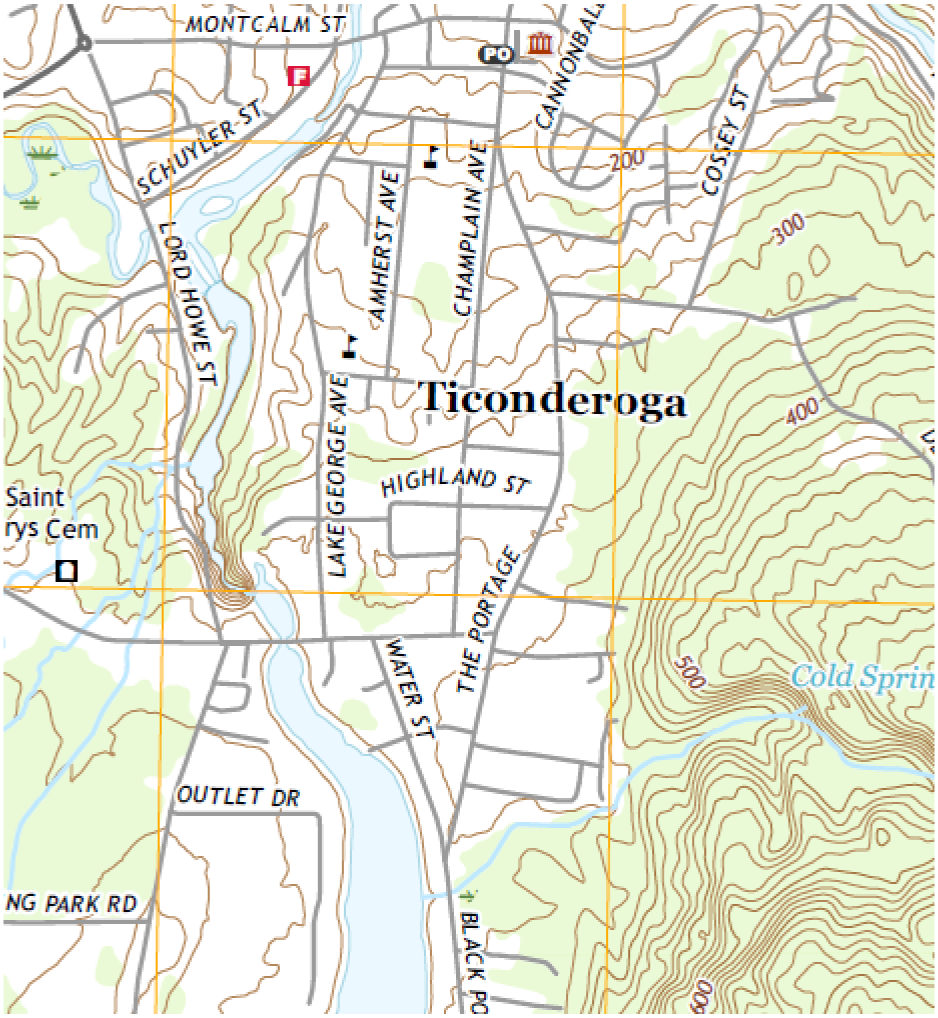
Of course, there are an unlimited number of project types that may require an EIS. The photograph below shows pumping equipment for a gas line project. This equipment is used to test the gas lines under high-pressure water. This kind of project should be described in detail in the environmental impact statement. (Note that the testing process, itself, is a complicated and dangerous procedure that requires significant experienced personnel. The EIS should briefly touch on this testing procedure.)

Alternatives to the Project:
Many jurisdictions require that alternatives to the proposed project be analyzed as part of the EIS. This is often a difficult task because n many cases there really is no viable, realistic alternative. The “no build” option is often not viable, for example. However, if there are not any realistic alternatives, the engineer can try to point to alternative features of the design that were considered. For instance, if a subdivision with a loop road is proposed other access means (a cul-de-sac arrangement, for one) can be discussed and the relative merits and/or problems can be mentioned.

Topographic Information:
Topographic information is obviously an important part of any land development project. As a general rule, the engineering plans will be based on an on-site field topographic survey performed by a licensed land surveyor. However, lacking this information, the engineer can refer to the USGS quad sheets which are available at the following website:
https://www.usgs.gov/core-science-systems/ngp/tnm-delivery/topographic-maps
These maps are published at a scale at a scale of 1”=2000’ and ordinarily show contours at 20 foot vertical intervals. Therefore, they are generally not suitable for site design. However, they are very usable to obtain the overall slope of a neighborhood or region and they are invaluable for determining the limit of the drainage area to a stream or other watercourse.
A copy of a portion of a USGSD quad sheet is shown below. This shows the area around Ticonderoga, New York, not far from historic Fort Ticonderoga on Lake George. The following features in the photo should be noted:

1. The topographic contour lines are shown in brown at 20 foot vertical intervals. (The 300, 400, and 500 foot lines are labeled).
2. Roadways are shown in gray. Note that not all roads are named on the map.
3. Waterways are shown in blue.

This level of detail is typical of USGS quad sheets.



Of course, an on-site topographic map will be much more precise and more accurate than anything that could be shown on the USGS mapping. A portion of a typical topographic survey prepared by a land surveyor is shown below. Note that the level of detail is much, much greater than the map shown above. In particular, the following features are shown which could never be presented on a USGS topo quad sheet:

1. The contours are shown at a vertical interval of 1 foot.
2. Details of the building including first floor elevation (FF), basemen floor elevation (BF) and roof peak elevation are shown.
3. Existing trees are shown along with the diameter of the trees.
4. Existing spot elevations are shown.
5. A significant number of other topographic features includes, porches, walls, the macadam driveway, slate walkways, inlets, etc. are shown.

Note that often an assumed datum (rather than using sea level datum) is used for topographic mapping. This is the case in the topographic survey shown above. A datum of 100 was assumed at a point in the road in front of this dwelling. (This can be seen in the label "PK Nail Benchmark" in the screen shot above).

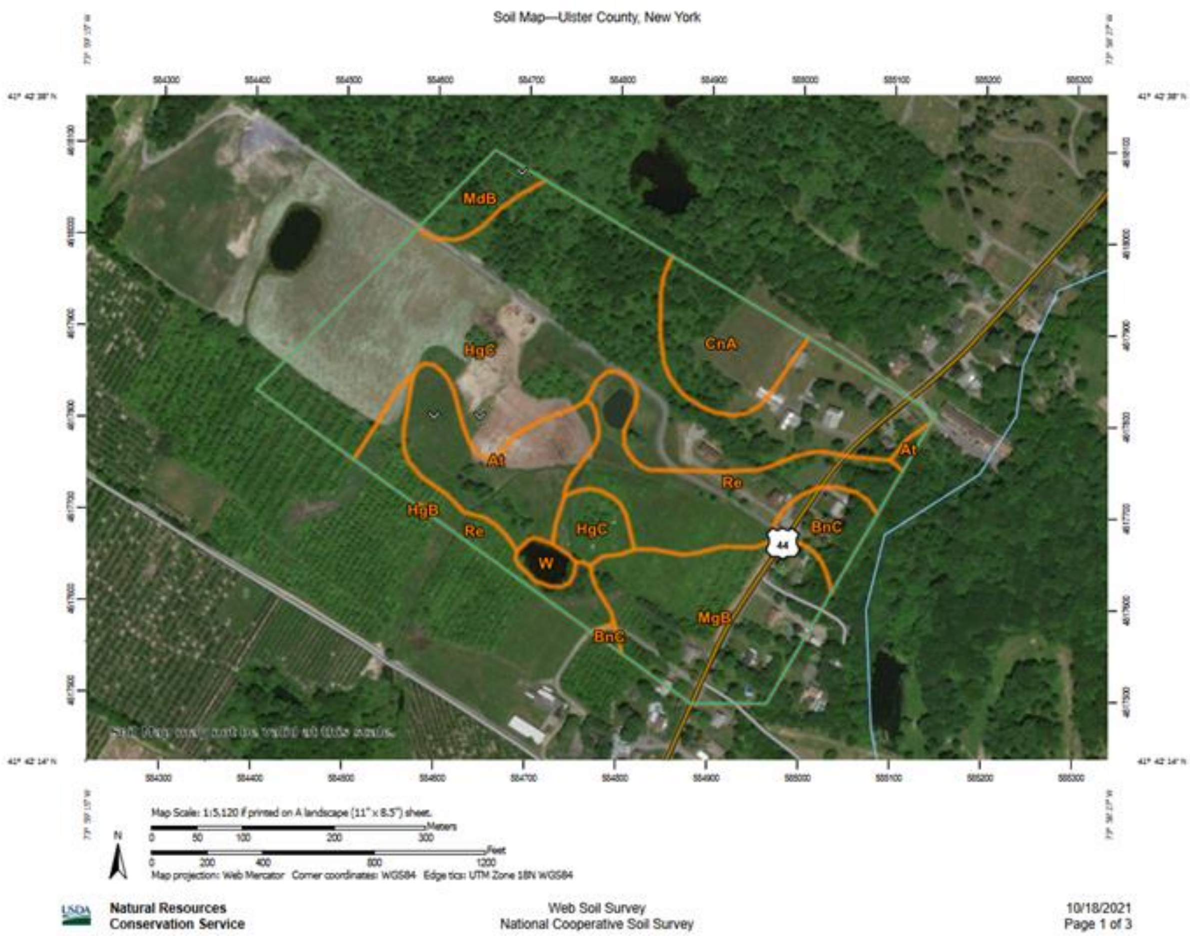
Whether the engineer has an on-site topographic survey to use or is relying on the USGS mapping, the Environmental impact statement should include a general description of land slope, runoff patterns, and similar data. The level of detail that the EIS should cover regarding topographic data will naturally depend on what is being proposed. If an at-grade structure is proposed then, obviously, less topographic discussion will be required than if there is a massive amount of earthwork proposed including large retaining walls, etc. If soil needs to be brought onto the site or removed from the site, the Environmental Impact Statement may also need to briefly address the source (or final destination) of the material.

Soils Information:

Depending on the type of project, it may be necessary to obtain on-site soils information. This is especially true if an on-site septic system or recharge basin is to be employed. In cases where on-site soils investigations are not warranted (or to obtain preliminary soils information) the engineer can refer to the USDA Natural Resources Conservation Service Web Soil Survey which can be accessed at https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Although this website covers the entire country, the soils data is remarkably accurate.

The map below is taken from the NRCS web soil survey and shows the soil types of a property outside Poughkeepsie, in Ulster County, New York.



In the screen shot above, the soil types (outlined in orange) are transposed on top of an aerial photograph of the site. Each of the soils designations is described in a legend that is available on the website. For instance, the soil designated as CnA stands for "Chenango gravelly loam, 0-3% slopes". For this particular soil type the website indicates the following data:
Depth to restrictive layer: >80 inches.
Depth to water table: >80 inches.
Hydrologic Soil Group (For use with the SCS Method of calculating runoff): A
Typical landform: Valley trains and terraces.
The information above is just a very small sampling of the data provided by the NRCS web soil survey for literally thousands of mapped soil types across the nation. It includes information pertaining to climate, farming, suitability of the soils for construction of houses and roadways, chemical composition, and a host of other parameters.
In addition, the soil survey provides a typical profile for each soil. The typical profile listed for the CnA soil is as follows:
Depth 0-9": Gravelly silt loam.
Depth 9-35" Gravelly silt loam.
Depth 35-80" extremely gravelly sand.

All of this information is important for the design of a project and it should be summarized and provided within the environmental impact statement.
As stated above, however, it is often imperative to obtain on-site soils data, which is obviously much more detailed and accurate than the soil survey can possibly be. This is especially true when an on-site septic system is to be utilized. In that case, the engineer will need to obtain the services of a backhoe and do exploratory digging to determine the suitability of the site for such a system. A detailed description of soil permeability testing is beyond the scope of this course (although it is covered in the author's SunCam course #223 "Soil Permeability Testing"). However, a brief overview of these tests is as follows:

1. Percolation tests: This is an on-site test in which a small hole is dug within the larger soil excavation. This small hole is filled to a specified depth and the time for the water to drain out is recorded.
2. Soil class ratings analysis (SCRA): In this case one or more soil samples are tested in a laboratory to determine the percentages of sand, silt, and clay in the material. A resulting permeability is determined based on existing soils charts.
3. Pit-bail test: This test can be used when there is groundwater encountered in the soil log. The water is bailed or pumped out and the time it takes for the water to reenter the hole to a specified depth is used to calculate the permeability.

4. Basin flood test: This is generally used when fractured rock is encountered in the soil log. The hole is filled with 12" of water and the time it takes to drain is used to calculate the permeability.
5. Tube-permeameter test: This test combines some of the aspects of the above tests but is generally more labor intensive than any of the others.

Each one of the tests described above should be done in conjunction with a soil boring log which can describe the different layers (or horizons) of the material. The horizons are usually described in terms of texture (e.g. sandy clay or silt), firmness, moisture and color.

In addition, the soil bearing capacity is often a parameter that has to be determined, especially if the project will include particularly heavy loads or multistory buildings. A table of some presumed bearing capacities (taken from the Uniform Building Code) is provided below:

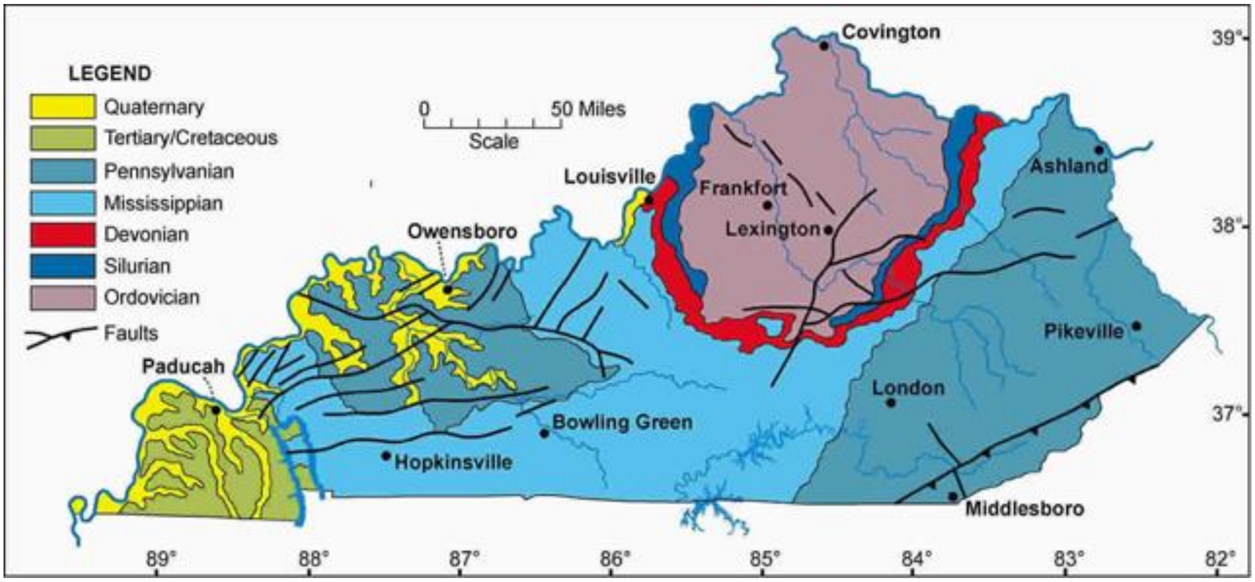
Class of Material	**Vertical Foundation Bearing Pressure (psf)**	**Lateral Bearing Pressure (psf)**
Crystalline bedrock	12,000	1200
Sedimentary & foliated rock	4000	400
Sandy gravel & gravel (soils classified as GW and GP)	3000	200
Sand, silty sand, clayey sand, silty gravel, & sandy silt (soils classified as SW, SP, SM, SC, GM, & GC)	2000	150
Clay, sandy clay, silty clay, clayey silt, silt, and sandy silt (soils classified as CL, ML, MH, and CH)	1500	100

Of course, the table above is only a guide and on-site geotechnical testing often must be done to determine the actual bearing capacities of the soil.

Geologic Information:

In most cases for small projects, only the most basic geologic information is required. However, for projects with heavy loads or with potential unsuitable subgrades extensive geologic investigations may be required. The results of these investigations will be used to determine whether standard footings, spread footings, piles, or other solutions will be required. All of this data should find its way into the EIS.

For general geologic information the engineer can refer to a map such as the one shown below, which is taken from the Kentucky Geologic Survey:



Obviously a map like the one pictured above can only show the underlying geology in the broadest terms. In this case, the map is color-coded to show the ages or geologic epochs of the different regions. A very brief description of these is included in the table below:

Geologic Classification	**Approximate Age (million years before present or myp)**	**Brief Description**
Quarternary	Within the last 1.8 million years	Unconsolidated sediments: till, gravel, sand, silt, clay, & organic deposits.
Tertiary/Cretaceous	145 to 66 mya	Igneous rocks; granite, gabbro, schist, etc. Continental origin.
Pennsylvanian	302 to 318 myp	Sedimentary rocks; shale, sandstone, siltstone, conglomerate, with some coal and limestone. Continental and marine origin.
Mississippian	322 to 359 myp	Sedimentary rocks; sandstone, shale, siltstone, conglomerate, and minor limestone. Marine to marginal marine origin.
Devonian	359 to 407 myp	Sedimentary rocks; shale, limestone, siltstone, and dolomite. Marine and eolian origin.
Silurian	416 to 435 myp	Sedimentary rocks; dolomite, gypsum, salt, and shale. Marine origin.
Ordovician	446 to 460 myp	Sedimentary rocks; limestone and shale.

Other state and regional maps supply more data. The Georgia Environmental Protection Division, for instance, provides a map that divides the state into numerous geologic divisions and subdivisions based on the age and composition of geologic deposits and the Montana Geologic Map (Provided by the Montana Bureau of Mines and Geology), shown below shows additional information such as shear zones and suture zones.

Geologic Map of Montana Booklet

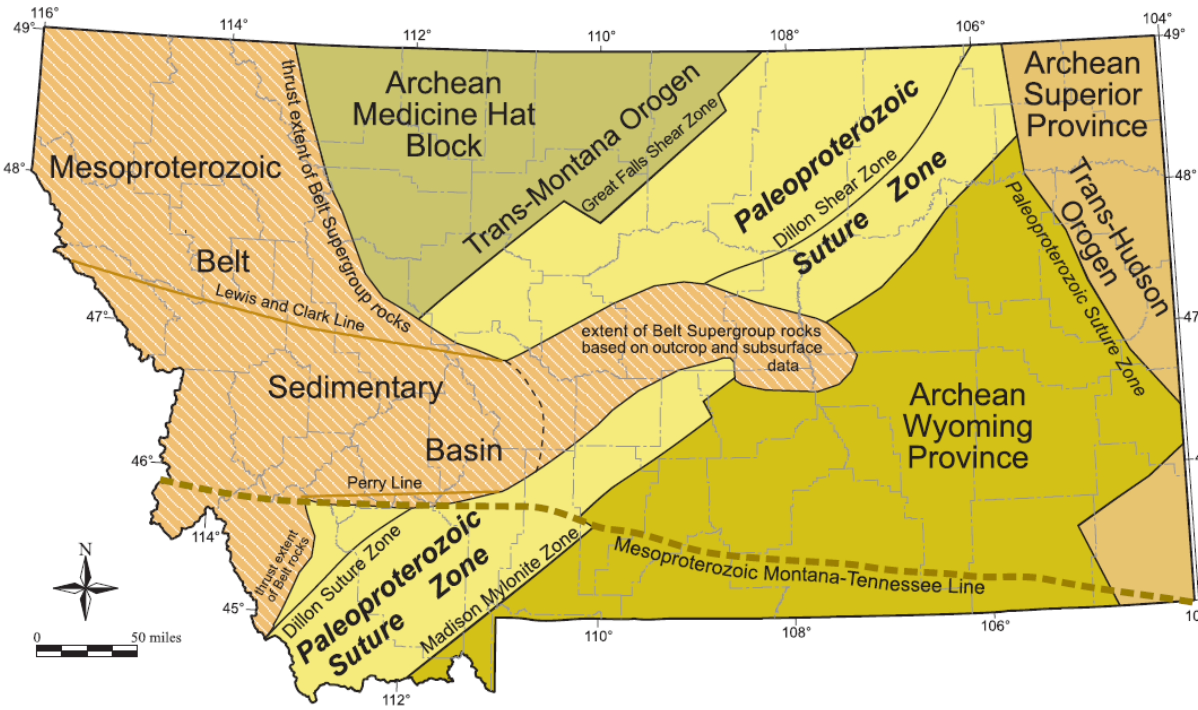


Figure 3. Precambrian provinces. Modified and compiled from Lisenbee and DeWitt (1993), Nelson (1993), Sears (2006), and Sims and others (2004).

However, as stated above, all of these references are only to be used as guides. Whenever detailed geologic information is required it must be based on on-site investigations.

On-site geologic investigations may be required for any number of reasons. If limestone sinks are a possibility or karst topography is expected than a qualified geotechnical engineer should be brought into the project in its early planning phases to avoid unpleasant surprises later on. Of course, a brief description of any on-site geological investigations should be included in the EIS.

Water Quality Information:

This can be a very broad topic and can include a very wide range of sub-topics including some or all of the following:

- Surface water quality.
- Ground water quality.
- Potable water quality.
- A discussion of existing or potential sources of water pollution.

As with virtually all aspects of an environmental impact statement, the level of detail in these discussions will depend on the nature of the project being proposed and the nature of the existing site conditions. For instance, a proposed large residential subdivision that will depend on individual wells for water will naturally require a determination of the quality (and available quantity) of groundwater. On the other hand, a proposed shopping center that is to be constructed over an existing woodland that drains to a trout stream will require a discussion of the existing surface water quality and how the stream water quality will be protected during and after construction.

The question arises: where can the engineer find information pertaining to water quality? One source of groundwater data is available from The United States Geologic Survey (USGS) at the following website: https://www.usgs.gov/special-topics/water-science-school/science/groundwater-quality

Conversely, general information regarding surface water quality data can be found at the USEPA website: https://www.epa.gov/waterdata/water-quality-data

Of course, both of these websites can only supply general water quality information. In order to obtain specific on-site data, the engineer must collaborate with a qualified environmental consultant to do appropriate testing.

Stormwater quality control measures should also be discussed in detail in the EIS. A photograph of a stormwater quality control structure (the StormScape inlet system designed by Hydro International) is shown below. This is one of a number of cutting-edge stormwater quality control structures that are being developed to prevent source pollution and to keep pollutants from migrating downstream. This particular device contains a sandy media that filters out pollutants and provides a suitable growing substrate for the tree shown in the photograph. There are a wide variety of these manufactured treatments units available, which are manufactured by a number of companies.

Information Regarding Utilities:
The statement should include some description of utilities (if applicable). This can range from a brief summary mentioning that a small proposed residential building will be serviced by public sewer and water to a much more detailed analysis describing water demand, etc. The availability and adequacy of existing utilities should be noted.

Information Regarding Endangered Species:
Before proceeding too far with a land development project, an evaluation should be made as to whether there are threatened and/or endangered species on the site and, if so, how they will be impacted by the project. Often this can only be determined by a qualified biologist. However, the engineer can make some preliminary explorations in this area. One good starting point is the United States Fish & Wildlife (USFW) website, which can be accessed at https://ecos.fws.gov/ipac/

Some states have their own websites, which provide additional information. In New Jersey, for instance, the engineer can contact the NJ Natural Heritage Program (administered by the New Jersey Department of Environmental Protection Division of Parks and Forestry) to obtain a list of these species on or in the immediate vicinity of the site.
Whatever the results of these investigations are, they should be summarized in the EIS.

Historical, Archaeological, & Cultural Information:
In many cases, there are features on a site that are of significant historical, archaeological, and cultural significance. Obviously, there is an almost limitless variety to these features. Many municipalities have historic overlay zones which encompass properties of at least local historic interest. Other sites have historic interest on a regional, national, or global scale.
The Ford Mansion (pictured below), in Morristown New Jersey, was used as a headquarters by George Washington during the winter of 1777 – 1778 and is of national importance.

The brownstown building pictured below, constructed in 1825, is located in Passaic County, New Jersey. Obviously, this building is of much more local interest. However, there was enough support for the restoration of this dwelling that it was preserved while all of the buildings around it were razed for a downtown urban revitalization project. Properties like this should always be described in some detail in the Environmental Impact Statement.

Archaeological and cultural features are ordinarily, but not always, of historic interest as well. Sometimes a local restaurant, school building, shop, etc. can become a local cultural icon. When these buildings are removed in the name of "progress" it can be painful for the neighborhood and the local community. If these features are present and will be affected by the project, the EIS should make at least some mention of them.

As one of very many examples of this nature, the Edison-Eastlake Housing Project in Phoenix, Arizona has recently come under criticism for damage to ancient native American gravesites. Extensive archaeological excavations are currently taking place at the site to determine the extent of the cemetery and to try to mitigate further damage. A picture of the excavations is shown below. Obviously, archaeological findings like this should feature prominently in the environmental impact statement (as well as in the overall planning and design of a development site).

The actual reporting of the cultural or archaeological site depend on many factors, including the governmental agency having jurisdiction over the project. In Washington State, for example, the assessment should follow the guide entitled "Washington State Standards for Cultural Resources Reporting". To show some of the variety of cultural sites that can be found just in this one state the following list is extracted from the guide:

Type of Site	**Description**
Pre-contact* camp	A short-term occupation site
Pre-contact village	Larger sites or clusters of dwellings
Pre-contact rock shelter	Shallow overhang showing at least temporary human habitation
Pre-contact pictograph	Pre contact paintings
Historic pictograph	Historic era graffiti and/or paintings
Historic homestead	Collection of features (house, barn, shed, etc.) which may or may not be intact.
Historic irrigation	Canals and constructed waterways that are greater than 50 years old and intact.
Historic bridges	Structural ruins (pilings, abutments, footings, etc.) if greater than 50 years old.
Submerged shipwreck	Must be greater than 50 years old
Historic townsite	Site of former town with no extant buildings.
Historic water structures	Wharves, pilings, piers, etc.
Historic public works	Water systems, sewer systems, water tanks, power transmission features, etc.

*Pre-contact refers to sites that were occupied prior to contact with people of European descent.

Even this partial list shows the great variety of cultural and archaeological features that can be encountered. Obviously, the presence of some of these features (e.g. pre-contact village) can have a profound effect on a potential land use project, while some others (e.g. historic public works) can probably be addressed without significantly impacting a project.
All of these factors should find themselves in the environmental impact statement.

The identifying sign for the Shawnee-Minisink Archaeological Site, located in Pennsylvania, is shown below. The presence of these types of sites are of interest and need to be described, or at least mentioned.

Sometimes a part of a feature is left many decades after its useful life is over. The water wheel pictured below (located in Hunterdon County, New Jersey) is all that is left of a 19th century mill. These types of anomalies can sometimes be worked into the overall project. If so, they can add a whimsical, aesthetic benefit.

Aesthetics:

This is one of the more subjective subjects that is covered in an EIS. What is aesthetically pleasing to one person may not be to another. "Beauty is in the eye of the beholder". Because of this, aesthetics will not be covered in any detail in this course. However, the engineer should point to any obvious aesthetic features including, but not limited to, the following:

1. Any unique architectural features.
2. Any landscaping features that will enhance the look of the project.
3. Views of mountains, coastlines, or other notable features.
4. Unsightly, run-down buildings, or unkempt landscaped areas that will be removed or renovated by the project.

Of course, there are some projects (e.g. a proposed warehouse in a large industrial complex bordering a major highway) that have few, if any aesthetically pleasing features.

Traffic:
An analysis of the traffic generated by a project can be an important part of an EIS. On many projects, traffic and parking together make up one of the largest and most controversial subjects of the development. There are several components which may be applicable to a project including the following:

1. The traffic generated by the project.
2. The parking required by the project.
3. The on-site and off-site parking provided or available.
4. The proximity of the project to mass transportation.
5. Any roadway improvements proposed.

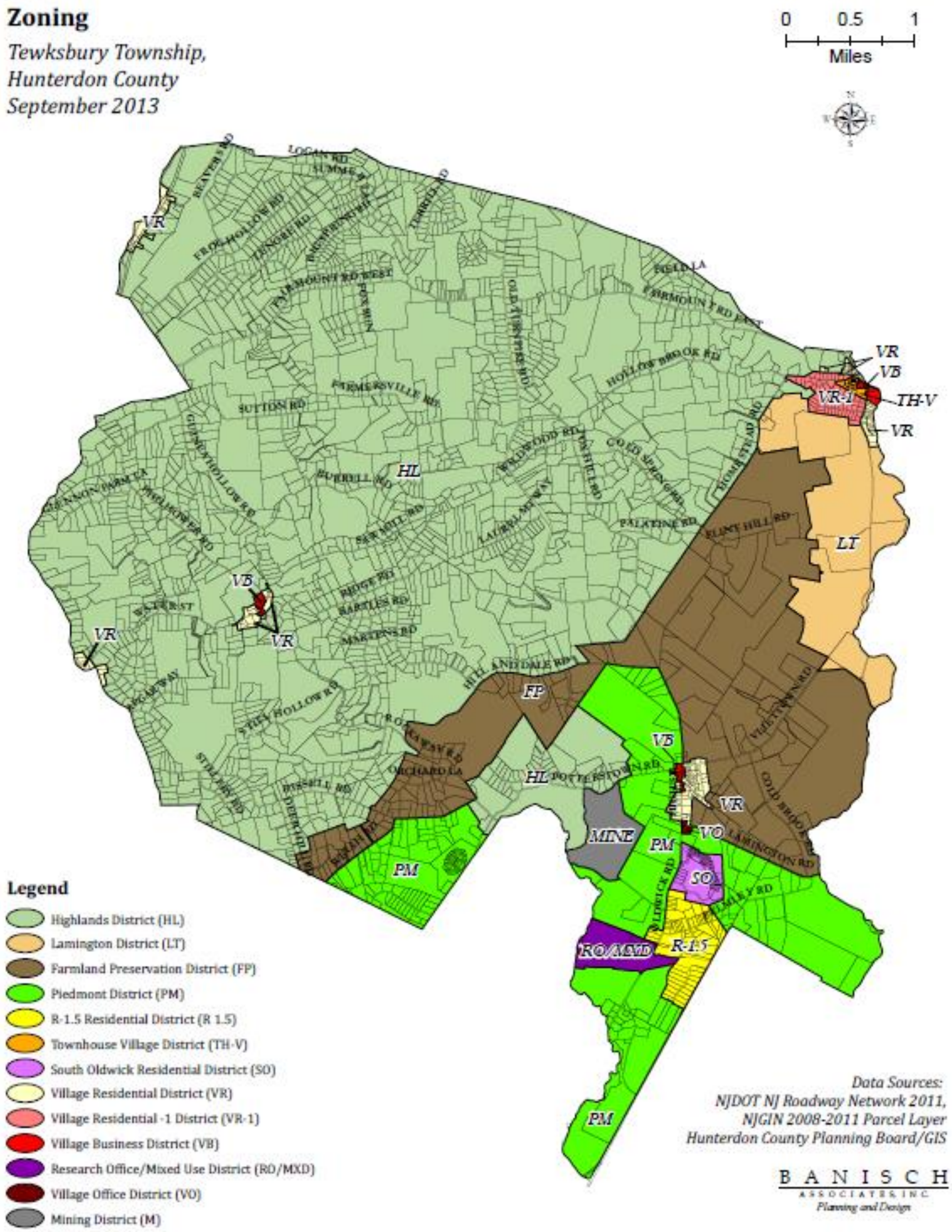
On major projects it is often necessary to engage a traffic engineer to provide a detailed analysis of the level of service of the access roads, existing traffic patterns and volumes, and expected impacts of the development. These may be based on actual traffic counts, on calculations derived from the Institute of Transportation Engineers (ITE) publications, or a combination of these. Whatever, the findings are, they can be summarized in the EIS.

Overall Land Use & Zoning:
The zoning of a particular tract obviously one of the first parameters that needs to be checked when determining the suitability of a site of for a particular development. Many municipalities have codified their zoning ordinances and they can be found at the following website: https://www.generalcode.com/library/

A copy of a zoning map (this one from Tewksbury Township in Hunterdon County, New Jersey) is shown below. This map is color-coded with the various zones. The engineer can check the map to determine what zone a particular property is located in and then check the website above to determine the actual zoning requirements. These generally include:

- Minimum lot area.
- Minimum lot width (or, possibly minimum frontage).
- Minimum front, side, and rear setbacks.
- Maximum building height.
- Maximum impervious coverage.

Several zoning jurisdictions have unusual provisions such as the amount of rear yard covered by impervious surfaces or the minimum setback from a retaining wall to a property line. If these materially affect the design, they should be noted in the Environmental Impact Statement. The EIS should make note of any deviations from these standards and include a brief justification for them.

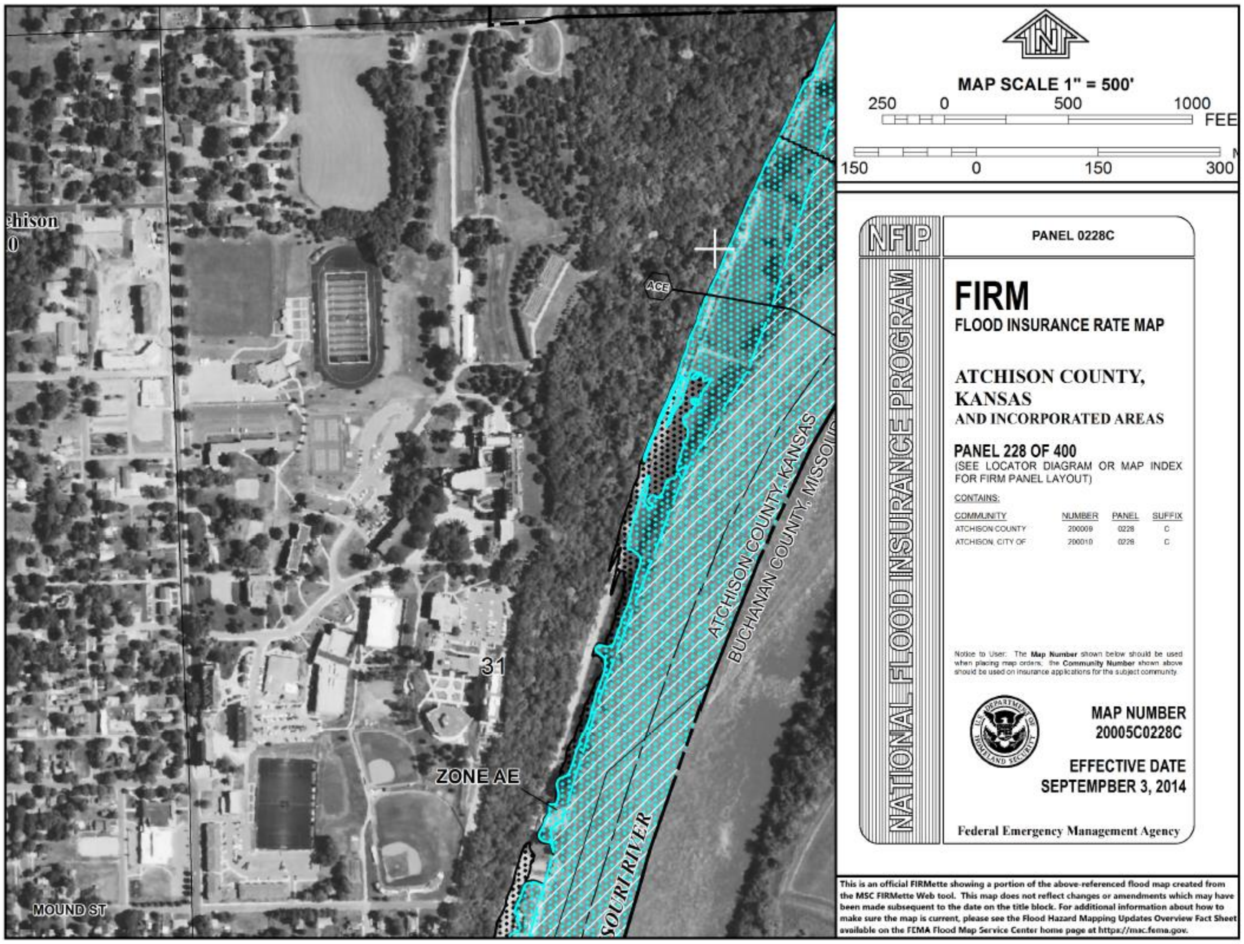


If the municipality in question is not included on the website shown above, using the municipality's own website will generally yield the zoning ordinance. For a few municipalities, the engineer may have to resort to the old-fashioned way of obtaining information and call the municipal zoning department.

Wetlands:
The US Army Corps of Engineers regulates development within wetlands and associated transition areas (although in many states the Corps of Engineers has delegated the actual review to a state agency). Wetlands can obviously have a dramatic impact on a land development project. The delineation of wetlands on a site is beyond what an engineer can reasonably be expected to know so the engineer should work in tandem with a qualified wetlands expert. The findings should be incorporated into the environmental impact statement. Of course, wetlands can have associated transition areas which are also regulated areas. Depending on the jurisdiction and the characteristics of the wetland, this transition area can range from zero to 150 feet (or even more).

Floodplains:
In many areas, the first thing to check on a land development project is to determine if the property is subject to flooding. In order to determine if a parcel is located within a flood zone, the engineer should consult the Federal Emergency Management Agency (FEMA) Flood Map Service Center at the following website:
https://msc.fema.gov/portal/advanceSearch
This website allows the user to input the municipality in question and then lists the flood products that are available. (The engineer should be careful to consult both the "Effective Products" and the "Preliminary Products" to ensure that the latest data is used). There is also a section labelled "Historic Products" but this is obviously only of interest to see what was formerly considered to be within the flood zone.

The flood map shown below was generated by the FEMA website and shows the area around Benedictine College in Atchison, Kansas. The blue hatched area to the right of the map shows the 100 year floodplain of the Missouri River which, in this area, is confined to a relatively narrow belt adjacent to the channel (at least on the Kansas side of the river).



Streams, like the one pictured below, and other environmentally sensitive areas should always be highlighted in the EIS. As with wetlands, streams can have associated riparian zones, which may be outside the floodplain, but can still be regulated.

Demographics:

On some projects a discussion of demographics is especially important. This is generally the case on large residential projects where the following parameters should be considered:

1. The expected increase in population (for housing projects).
2. The amount of school-aged children that will live in the development.
3. The potential effect of the project on police, fire, and other emergency services.
4. Any provision made for handicapped, elderly, or disabled people that will live in the development.
5. Any provisions made to provide walkways from the development to downtown areas or to mass transit stations.
6. The potential for newly-created jobs developed by the project. Note that in large scale projects or projects that are constructed in phases over a number of years there can be an increase in both short-term and long-term employment opportunities.

Contaminated Soils:
According to the Soil Science Society of America, by definition, "any substance in the soil exceeds naturally-occurring levels and poses a human health risk is a soil contaminant. Obviously, the list of potential soil contaminants is so broad that it can include almost an unlimited variety of substances. If soil contamination is suspected, once again a qualified environmental consultant needs to be retained, and the findings can be summarized in the Environmental Impact Statement.

Contaminated Sites:
Obviously contaminated sites present a special challenge. There are several different types of contaminated properties. Some of these are described below:

- Brownfield Sites: The EPA defines a brownfield site as "A property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contamination."
- A Superfund site is a contaminated property that can be cleaned up by the EPA under the authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). This act was established by congress in response to toxic waste dumps such as Love Canal in Niagara Falls, New York and the Valley of the Drums near Louisville, Kentucky. An EPA photograph of this area (showing a small portion of the thousands of drums filled with heavy metals, polychlorinated biphenyls, and other contaminants).

The federal government has a list of superfund sites which can accessed at the following website:
https://www.epa.gov/superfund/search-superfund-sites-where-you-live
This website also gives information on the current status of these sites and any cleanup work that has been done or is in process.
Many other sites can have some contamination. Orchards, for instance, often have elevated levels of arsenic due to years or decades or fertilizer use. Other sites from farms, to junkyard, to factories should be checked for contamination. While this work is ordinarily not under the engineer's purview he or she should be aware of the possibility of contamination and what steps might have to be taken to deal with it.

Phase I & Phase II Environmental Assessments:
These assessments are prepared by an environmental company and are beyond the scope of ordinary engineering knowledge. A Phase I Environmental assessment basically consists of a thorough review of available documentation of the use of the site. This will check for records relating to underground storage tanks, historic property use, and similar data. Of course, if it was found that the property once housed a paint factory or chemical plant, then there is an obvious

need to do actual on-site exploration and testing. However, even seemingly benign land uses can have detrimental effects on the environment (such as orchards, as mentioned previously). Once again, this is definitely an area where the engineer must engage the services of a qualified environmental expert.

Phase II assessments (as the name implies) are quite simply the follow-up to Phase I assessments. After determining what might be expected on the site (based on a Phase I analysis) additional on-site investigations are performed. These can take a wide variety of forms including visual inspection, ground-penetrating radar, excavations, or many others depending on the nature of the potential contaminants that might be expected on a property.

Seismic Information:

In much of the United States geologic conditions do not warrant seismic investigations. However, there are certainly locations (i.e. much of California) that are prone to earthquakes. The American Geosciences Institute has an interactive map of California earthquake hazard zones which can be accessed at the following website:
https://www.americangeosciences.org/critical-issues/maps/interactive-map-california-earthquake-hazard-zones

This map is searchable by address and maps the following three main hard zones:

1. Fault zones. (This term can have several different meanings and is often used to depict a zone of crushed rock along a single fault.
2. Landslide zones which depict areas with higher probabilities of landsliding.
3. Liquefaction zones. (In liquefaction zones, saturated sand and silt take on the characteristics of a liquid during intense shaking).

As with many other factors that are discussed in this course, seismic investigations are generally beyond the scope of ordinary engineering and a qualified geologist must be brought onto the project to determine the risk for earthquake-related damage.

Soil Erosion & Sedimentation:

All states have their own regulations regarding soil erosion control. In New York, for example, the Department of Environmental Conservation regulates soil erosion & sediment control issues through a series of standards and specifications known as the Blue Book. Whatever the jurisdiction, the EIS should briefly discuss any measures taken to control soil erosion. These generally include some or all of the following:

- A comprehensive sequence of construction that is meant to ensure that the land disturbance takes place in an orderly, expeditious manner.
- Sediment barriers including silt fence, staked haybales, or other similar products.
- Inlet filter barriers.

- Details of dewatering operations.
- Temporary & permanent seeding specifications and mulching specifications (including specifications for mulch anchoring).
- A stabilized construction entrance (or entrances) and stabilized staging areas.
- Provisions for tree protection.
- Details regarding the stockpiling of topsoil or excess subsoil during construction.
- Specifications for the remediation of soils compacted during construction (to ensure a proper medium for establishing new lawn or landscaped areas).

The photograph below shows a pond in the process of being refurbished. Note the silt fence that is placed to prevent mud from travelling downstream.

Conclusion of the Environmental Impact Statement:

Obviously, at the end of the statement some conclusion or conclusion should be stated. Rather than making self-serving statements such as ‘no detrimental impact is anticipated” these conclusions should honestly address any beneficial and detrimental results that are expected. In a well-designed project, the environmental benefits should outweigh the detriments (or, at the very least, detrimental effects should be mitigated to the maximum extent possible). However, it is obvious that some projects will irreversibly change a site and not necessary for the better from an environmental point of view. Therefore, the conclusions should state what damage (if any) cannot be avoided while, at the same time, expressing all of the benefits of the proposed project. The photograph below shows an attractive woodland trail. Obviously, a project which will convert this land to a parking lot or a strip mall will have a significant detrimental environmental and aesthetic effect. This should not be sugar-coated in the EIS but should be explained in a straight-forward manner. Possible mitigation measures, including an enhanced landscaping plan or setting aside another area as a permanent conservation easement, should also be described.

Statement of Qualifications:
In order to give credence to the opinions expressed in the environmental impact statement there should be a brief statement of the qualifications of the writer or writers of the report. As has been said many times throughout this course, in many cases the EIS will be a collaborative effort so all of the contributing authors should be mentioned in this section. In addition, any relevant bibliography should be cited.

Final Thoughts:
The topics discussed in this course are only a few of the very many and varied environmental impacts that may need to be discussed in an environmental impact statement. Obviously, some projects (underwater dredging, off-shore oil drilling (like the rig shown in the photograph below), strip mining, and many others) will have impacts that have not been addressed in this course. For this reason, as has been pointed our repeatedly throughout this course, the engineer must be willing to ask for input from other professionals knowledgeable in the specific fields under discussion.

The environmental impact statement should present a finding of the actual, expected results of a particular project. Of course, unseen situations can arise during and after construction that will not have been addressed by the EIS. However, by relying on experience and by leaning on other consultants where needed, the engineer should be able to contribute to a comprehensive environmental impact statement that can be understood by the target audience.

