Consideration of Environmental Factors in Transportation Systems Planning: the North Carolina Experience

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Incorporation of environmental factors and their consideration in transportation systems planning has become increasingly important in order to avoid conflicts and problems in future project development. Methods for incorporating environmental factors in thoroughfare planning studies in North Carolina are described and the most recent staff guidelines for incorporating these factors in studies are presented. Also discussed are the documentation of environmental inventories, the use of environmental data in development of the transportation plan, and the importance of system level environmental studies in right-of-way protection.

A goal at both the state and federal levels is to preserve and improve the natural and man-made environment. Improvements to the transportation system can help achieve this goal. Environmental factors have been a consideration in urban thoroughfare planning in North Carolina since its inception by the state in 1959. In the early years, however, environmental factors and considerations were not well documented and were somewhat different than environmental factors being considered today.

BACKGROUND

In the 1960s, major environmental factors considered in thoroughfare systems planning and in thoroughfare alignment decisions were neighborhoods, cemeteries, churches, historical areas, and parks. With enactment of the National Environmental Policy Act of 1969, the Clean Air Act of 1970, and other environmental laws and administrative orders, physical elements were introduced and consideration of environmental factors was formally incorporated into comprehensive thoroughfare planning studies. This was done even though federal regulations did not require an environmental impact statement (EIS) at the systems planning level.

The first thoroughfare planning study to document an environmental analysis of alternative plans was a study for Morehead City-Beaufort-Atlantic Beach, N.C. (*1*), which was completed in July 1971. The report's discussion of alternate thoroughfare plans relative to social, economic, and environmental effects included (1) a discussion of the physical characteristics of four alternative thoroughfare plans; (2) an evaluation of the social and economic effects of the alternative plans; (3) an evaluation of environmental effects; and (4) a discussion of the alternative plans relative to providing a feasible economic, safe, and efficient transportation system. The discussion of social and economic effects included effects on economy and employment; housing; parks, recreational facilities, and public utilities; public health and safety; and national defense. The number of homes and businesses damaged or taken by alternative plans were tabulated, but most of the evaluations were general in nature and not quantified. The discussion of environmental effects included air and noise pollution, aesthetics, conservation and water quality (including erosion, sedimentation, wildlife and general ecology of the area), and natural and historic landmarks. The majority of these evaluations was also general in nature.

The environmental analysis incorporated into thoroughfare planning studies at that time was careful to exclude terms such as "environmental impact" so as not to be confused with the EISs required for project studies. The highway engineer doing the thoroughfare planning study did not have access to environmental staff resources because of the environmental staff's heavy workload in project planning work. The thoroughfare planning staff used local staff resources, reference documents, and additional training to assist them in the environmental analysis work.

The identification of environmental factors, their application in thoroughfare planning, and their documentation in thoroughfare study reports has varied considerably since 1971. Some of the environmental factors tabulations included in a 1978 study report for New Bern (*2*) are shown in Tables 1 and 2 and are fairly typical of subsequent study reports. Identification and documentation has become more important as efforts to preserve and protect future rights-of-way well in advance of project planning and construction have become critical in order to reduce cost and disruption. The most recent staff guidelines for incorporating environmental considerations in thoroughfare planning were prepared in February 1989 (*3*). The following sections of this paper present the most recent guidelines used by North Carolina highway planning engineers in incorporating environmental considerations in transportation systems planning. Later sections discuss documentation of the environmental inventories, the use of environmental data in development of the transportation plan, and application of system level environmental studies in right-of-way protection.

It should be noted that, for the most part, the term "transportation systems planning" is synonymous with the term "thoroughfare planning" in North Carolina. Transit planning, other modes, and other transportation systems planning fac-

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TABLE 1 AIR QUALITY ANALYSIS FOR THE NEW BERN STUDY AREA (1978 NEW BERN STUDY)

Year	System	Estimated VMT/a	Emissions in Tons per year/b CO	HC	NOx
1975	Base Year	426,721	7610	1241	1004
1982	Plan A	522,453	3741	730	803
1985	Plan A	563,481	2865	529	675
2000	Plan A	768,623	2738	474	766
2000	Recommended Plan B	753,198	2710	438	766
2000	Plan C	761,549	2573	438	766
2000	Plan D	741,950	2500	438	766

a/Based on average weekday travel
b/Emissions estimates were obtained from nationwide factors

Plan A--Existing plus programmed improvements
Plan C--Includes US17 Bypass to east of Bridgeton crossing Neuse River south of New Bern and connecting to existing US70 Bypass
Plan D--Includes US17 Bypass north of New Bern in Glenburnie Road corridor

TABLE 2 SELECTED ENVIRONMENTAL EFFECTS OF ALTERNATE THOROUGHFARE PLANS (1978 NEW BERN STUDY)

	Plan A	Plan B	Plan C	Plan D
Total Miles of Street Construction:				
Widening	1.06	6.66	6.66	7.79
New location	6.11	23.52	18.39	16.38
Estimated Number of:				
Businesses displaced	0	5	4	4
Homes displaced	0	69/c	68/c	68/c
Schools affected	0	1	1	1
Recreational areas affected	0	2	2	2

c/Includes families being relocated as part of New Bern's urban re-development program

tors are often included in the thoroughfare systems planning for the larger urban areas in the state. Transportation systems planning also typically involves an evaluation of transportation system management (TSM) alternatives in both large and medium size areas above 10,000 population. However, for small communities under 10,000 population and counties, transportation systems planning consists almost exclusively of planning for the road and highway system ("thoroughfare planning").

NORTH CAROLINA GUIDELINES FOR INCORPORATING ENVIRONMENTAL CONSIDERATIONS IN SYSTEMS PLANNING

Environmental considerations in transportation systems planning include (1) identifying critical environmental factors that need to be considered in systems planning and subsequent project planning; (2) developing alternatives based on the environmental inventories and environmental preservation objectives; (3) evaluating alternatives relative to travel service and environmental factors; and (4) developing a recommended plan that best meets environmental, travel service, and other public goals.

The North Carolina guidelines provide that inventories should be made and evaluations conducted on a number of environmental factors. These can be separated into three broad categories: (1) physical environment, (2) social and/or cultural environment, and (3) economic environment.

Physical Environmental Factors

These include air quality, water resources, soils and geology, wildlife, and vegetation.

Air Quality

Existing air quality problems both areawide and site specific are to be identified to the extent possible in the data gathering phase so that they can be considered in plan development. In the evaluation of alternative plans, air pollutant emissions are computed for each significantly different alternative plan and the "do nothing" alternative.

Impacts include carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NOx).

Measures include tons or kilograms emitted per day, computed by a computer program that utilizes pollutant emission factors and tabulations of vehicle miles of travel (VMT) by average speed groups.

Mitigation measures considered in systems planning include: (1) vehicle emission controls, (2) reductions in VMT, (3) increasing average speeds, (4) eliminating congestion and delay, and (5) reducing fuel consumption. Comparison of pollutant emissions of alternate plans is one basis used for evaluation of alternatives.

Sources of information are air pollutant emission factors from MOBILE II computer program and VMT by speed increment group from alternative traffic assignments.

Water Resources

These are considered both (1) as they relate to the support of population, agriculture, and industrial consumption; and (2) for fish and wildlife uses. Water resources and wetlands are to be defined in environmental inventories for subsequent consideration in systems planning. Impacts of transportation on water resources need to be quantified in the evaluation phase.

Impacts include watersheds, wetlands, pollutants from vehicles (oils, particulates, etc.), and hazardous waste spills—area specific in each case.

Measures include acres impacted (map measurements) and exposure (VMT, truck routes, and truck movements).

Mitigation measures can include construction procedures, facility design, regulations, avoidance, and replacement.

Sources of information on water resources include aerial photography, topographic maps, soils maps, and flood hazard studies.

Soils and Geology

Consideration of soils and geology in systems planning is primarily concerned with identification in the environmental inventories of areas and sites that need to be considered in the planning phase. Effects may or may not need to be quantified in the evaluation and documentation.

Impacts include soil resources (farmland), mineral resources, construction (streets and other), hazardous waste disposal areas, and stability (earthquake risks, etc.).

Measures include acres and other quantities.

Mitigation measures include avoidance and construction procedures.

Sources of information include soil maps, geological survey maps, old land use maps, and aerial photography both old and new.

Wildlife and Vegetation

Considerations include identification of endangered species and habitats in the environmental inventories, consideration of these elements in development of alternatives, and quantifying any impacts in the evaluation of alternatives.

Impacts include habitats and endangered species.

Measures include acres (habitats).

Mitigation measures include avoidance and replacement.

Sources of information include soils reports, the North Carolina Natural Heritage Program, and local project planning reports.

Social and/or Cultural Environmental Factors

These elements include housing, neighborhoods, noise, educational facilities, churches, park and recreational facilities, public health, safety, national defense and emergency evacuation, and aesthetics.

Housing

Impacts of alternative plans on housing are quantified in the evaluation of alternatives. Considerations include housing stock, displacement, and minority groups. The evaluation is to include the number of displacements of minority group housing.

Impacts include displacement and disruption.

Measures include the number of units displaced by condition, minority households displaced, miles of street widening, and right-of-way cost.

Mitigation measures can include replacement, acquisition, and availability of replacement units.

Sources of information include housing condition survey maps, field inventories, and right-of-way cost estimates.

Neighborhoods

Neighborhoods are identified through an inventory and are considered in plan development and analysis of alternatives. Impacts of alternative plans on neighborhoods are usually subjective and can be both positive and negative.

Impacts include division, disruption of cohesion, degradation or improvement of access, and traffic impacts.

Measures include traffic (average daily traffic or VMT), subjective changes, and formation of lobbying groups.

Mitigation tools include redevelopment, landscaping and beautification, traffic control, and avoidance.

Sources of information include neighborhood and land use studies, field surveys, and local knowledgeable sources.

Noise

Detailed analysis of transportation noise impacts on abutting land uses is normally done in the project planning and design stages, when more information is available on the design and operation of the facility. However, noise problems may in some instances be identified, or voiced by the public, in the systems planning study and will need to be evaluated and addressed in the evaluation stage. In systems planning the evaluation will in most cases be subjective and based on "rule-of-thumb" methods. However, there are more sophisticated tools and reference texts available if needed.

Impacts are on humans (more sensitive receptors).

Measures are truck volumes (an indicator of problems) from field measurements.

Mitigation measures include elevation or depression of roadways, spatial separation, acoustical barriers, and building construction.

Sources of information include project planning reports and housing and urban development project studies.

Educational Facilities

These are usually considered of significant community value and are typically major traffic generators. Included are various facilities ranging from the local neighborhood school (if any still exist) to the major college or university. Usual social environmental concerns include access, parking, safety, proximity to play areas, school bus routing and accessibility, pedestrian movements, noise, and aesthetics. Systems planning considerations may include school attendance districts, functional obsolescence of school buildings, pedestrian and vehicular movements, and functions of the institution.

Impacts include access, traffic operations, safety, noise, effect on attendance areas, and effect on school bus routes.

Measures include trip attractions, access time, number of students, and traffic counts.

Mitigation measures include project planning and construction with consideration to pedestrian and vehicular movement and the functions of the institution.

Sources of information include the education system, trip generation manuals, and travel models.

Churches

These institutions are usually considered community value factors. Individual churches are usually important to a wide range of people and often may have large service areas. Functional obsolescence may need to be considered in the planning process.

Impacts include disruption, noise, parking, pedestrian access, and effect on service area.

Measures include right-of-way cost and size of congregation.

Mitigation measures include avoidance, replacement in kind, and design enhancements of the facility.

Sources of information are the employment survey and local church associations.

Park and Recreational Facilities

If a transportation improvement project encroaches on public land devoted to park or recreational purposes, a Section 4(f) statement is required verifying that there is no prudent or feasible alternative. These facilities need to be identified in the inventory phase and considered in the development of the plan and improvement recommendations. Transportation system impacts can be both positive and negative.

Impacts include encroachment, traffic, access, and aesthetics.

Measures are travel time (access).

Mitigation measures include avoidance, replacement in kind, and design.

Sources of information are land use maps and property maps.

Historic Sites and Landmarks

These are treated similarly to park and recreational facilities. Properties listed on the National Register can be determined fairly easily. Properties that "may qualify" for listing are usually more difficult to identify. Complete avoidance is usually the only alternative. Local historical societies and planning staffs are usually the best source of information.

Archaeological Sites

These sites have significance similar to park and recreational facilities and historic sites and landmarks. However, in many instances these sites can be excavated, evaluated, information and data extracted, and then used for transportation purposes. Finding a site of significance that could be affected by a proposed transportation facility can delay the project and increase project costs associated with archeological work at the site. Archaeological sites of significance may be difficult to identify during the systems planning process due to lack of information. Historical publications may sometimes provide information on sites to the systems planning engineer.

Public Health and Safety

This factor includes access to health care facilities, ambulatory services, fire and police protection, and garbage collection. Often this element is not seriously considered in either systems planning or project development planning. Major considerations are access to health care facilities and response time.

Impacts are primarily in terms of access.

Measures include travel time, level of service, and average speed.

Mitigation is not applicable.

Sources of information include the travel models, speed and delay studies, and the providers of the services.

National Defense and Emergency Evacuation

This is a social environmental factor concerned with the ability of the transportation system to serve transportation demands during periods of national or local emergency such as war and natural calamity. In North Carolina, for example, hurricane evacuation is a significant consideration for coastal areas. This environmental factor is considered during the plan development phase.

Impacts include troop and military equipment movements and population.

Measures include travel time, level of service (capacity), and bridge weight limits.

Mitigation is not applicable.

Sources of information include the travel models, traffic capacity studies, bridge studies and inventories, and defense agencies.

Aesthetics

This is an important consideration in the plan development stage and is often involved in a number of other social environmental factors. Will the plan result in a future transportation system that will be pleasing to the public and contribute to an improved urban environment? Improving the aesthetics

of the urban environment through transportation improvements is a mitigation tool in dealing with environmental considerations in systems planning.

Economic Environmental Factors

Economic environmental factors include businesses, employment and income, economic development, public utilities, transportation costs, capital costs, and operation and maintenance costs.

Businesses

The implementation of a thoroughfare plan has both positive and negative effects on business within the area. As new thoroughfares are constructed, or old ones widened, the improved mobility tends to improve the overall business climate and proves more attractive to the establishment of new business interests. The construction of new facilities often opens up new land areas for business expansion. On the negative side is the potential disruption or removal of existing businesses as a result of thoroughfare construction.

Impacts include accessibility, parking availability, traffic operations, access control, and truck and service vehicle access.

Measures include level of service, truck VMT, number of businesses displaced, number of employees displaced, right-of-way costs, and parking lost.

Mitigation measures for adverse effects include acquisition, relocation, and provision of off-street parking.

Sources of information include the employment survey, right-of-way cost estimates, and system level of service measures.

Employment and Income

Improvement in the level of service provided by the transportation system will reduce transportation costs for industry, facilitate industrial employment expansion, and contribute to area income through additional business activity and reduced transportation cost for workers.

Impacts include accessibility, goods movements, and disruption of operations.

Measures include level of service, truck VMT, and employment.

Mitigation tools include acquisition, relocation, and access improvements.

Sources of information include travel models, employment survey, goods movement surveys, and local business organizations.

Economic Development

This factor is very similar to the employment and income factor. New thoroughfares that open new areas for development will most influence this factor. In general, new industry prefers good access to at least two transportation modes (i.e., rail and highway). Economic development would most often be considered in the transportation plan development stage, but may be identified as a high priority goal for the urban area in the early study stages.

Impacts include access to developable land, goods movement, and transportation costs.

Measures include acres of developable land served, miles of new thoroughfares, employment potential, and total VMT and truck VMT.

Mitigation is not applicable.

Sources of information include local business organizations, industrial development commissions, public utilities, and land development and land use plans.

Public Utilities

This factor is a consideration in the transportation plan development and evaluation stage. The transportation plan can impact utility service areas and existing utilities.

Impacts include relocation and disruption.

Measures are miles of street widening.

Mitigation is not applicable.

Sources of information include right-of-way cost estimates, utilities, and local officials.

Transportation Costs

This factor is applicable in the transportation plan evaluation stage and is used in the comparison of alternative system plans and projects.

Impacts include personal disposable income, business costs, and area economy.

Measures include VMT, vehicle hours of travel (VHT), level of service, vehicle operating costs, user time costs, and accident costs.

Mitigation is not applicable.

Sources of information include travel model data and local cost data, which can be used to develop these measures.

Capital Costs

This factor is applicable in the plan evaluation stage and is used for comparison of plans. Capital costs usually include construction costs and right-of-way costs as separate elements.

Operation and Maintenance Costs

These are usually considered in the evaluation of alternatives but could be identified as problems earlier in the planning process. Examples of this would be ferry operational costs, and high maintenance costs associated with obsolete bridges, traffic control devices and systems, and roadways.

ENVIRONMENTAL INVENTORY DOCUMENTATION

Environmental inventories need to be recorded and documented on planning base maps both for use in the systems

planning and for future reference. Environmental elements that are logical to record on maps include (1) watersheds, (2) wetlands, (3) prime farmland, (4) mineral resources deposits, (5) hazardous waste disposal sites, (6) wildlife habitats, (7) educational facilities and attendance areas, (8) churches, (9) public parks and recreational areas, (10) cemeteries, (11) historical sites and landmarks, (12) archaeological sites, (13) health care facilities, (14) ambulatory service facilities and service areas, (15) fire and police protection facilities and service areas, (16) national defense facilities, (17) industrial development sites, and (18) significant utilities. Some elements such as neighborhoods are not easy to delineate because of differing definitions.

It is also important that environmental factors be recorded in the study report, because it is the best long-term reference document. Recording information on maps to the extent possible is the best procedure. The old adage "a picture is worth a thousand words" is very applicable.

USING ENVIRONMENTAL FACTORS IN THE DEVELOPMENT OF THE TRANSPORTATION PLAN

Environmental factors identified and recorded in the inventories provide a data set for use in developing alternative plans along with many other data sets. Other environmental considerations that are directly related to the measures of the ability of the transportation system to provide a transportation service come into play when comparing alternative plans. Environmental factors and considerations may often be in conflict with each other and other transportation objectives. Different groups will place different weights on environmental factors based on their own priorities. Laws and regulations will place constraints on plan options and thoroughfare alignments. Urban area planning goals and objectives and community value factor studies can sometimes provide guidance on the weights that should be given to alternative environmental considerations.

A common problem that develops in the alternative plan development, plan evaluation, and plan adoption stages is that one environmental factor may become a focal point for a special interest group. Other equally important considerations may be pushed into the background. The transportation systems planner must be careful in these situations to use all available tools to ensure all important considerations are kept before the decision makers. Providing current maps and easily understood data tabulations on alternative plans, and responding quickly to requests for information and analysis, is the best method for ensuring adequate consideration of all important factors.

In the evaluation of alternative plans at the systems level, it is conceivable that the "best" systems plan from an environmental standpoint could have one key element which is "bad" from a project environmental impact standpoint. Good documentation of the environmental analysis at the systems level may be crucial to gaining approval for proceeding with the project when it reaches the EIS stage in project development.

APPLICATION OF SYSTEM LEVEL ENVIRONMENTAL STUDIES IN RIGHT-OF-WAY PROTECTION

One of the typical concerns in requiring reservation and/or dedication of rights-of-way for thoroughfares well in advance of programming and construction has been the concern with a potential conflict with the National Environmental Policy Act and other federal and state laws and regulations. This was one of the first issues addressed by a 1984 North Carolina Right-of-Way Task Force cosponsored by the North Carolina Division, Southern Section, Institute of Transportation Engineers, and the North Carolina Chapter of the American Planning Association.

Work on this issue was completed by the Task Force on February 11, 1986, through documentation of a set of questions and answers (*4*) that were cleared through the Federal Highway Administration's (FHWA's) state, regional, and Washington offices. One of the important findings that came from the question-and-answer approach was that an EIS need not be completed before right-of-way can be protected. However, it was noted by FHWA that a protected corridor may carry little weight in the selection of an alignment for federal funding once appropriate environmental studies were completed. If the protected corridor has serious environmental problems when compared to other alternatives, federal funds may not be available for construction in the protected corridor. It was recommended that a preliminary environmental screening be conducted prior to designation of an alignment for protection to minimize potential future problems. It was recommended by FHWA that the screening should consider the following factors:

- FHWA cannot approve a project which uses publicly owned parkland, historic properties, and certain other types of land (Section 4f land) unless it can be shown that there is no feasible and prudent alternative.
- Historic properties cannot be affected without first complying with the Advisory Council on Historic Preservation requirements.
- Wetlands cannot be taken unless there is no practicable alternative and the project includes all practicable measures to minimize harm to the wetland.
- The project cannot result in significant encroachments on floodplains unless there is no practicable alternative.
- Right-of-way actually acquired through donation or purchase must be acquired in accordance with Title VI of the Civil Rights Act of 1964.

In summary, if all "problem" land uses are avoided, there should be no problem with right-of-way protection through dedication, reservation, or advance acquisition prior to EIS studies.

The identification and documentation of environmental factors, using the environmental data in plan development, and documenting their consideration and effects on alternative plans in systems planning, should adequately meet the regulatory requirements and minimize the possibility that significant alignment changes will occur in project planning and implementation.

The current approach in North Carolina is to (1) identify and document the environmental factors affecting the thoroughfare system plan and thoroughfare alignments in the systems plan and report; (2) locate proposed thoroughfares as accurately as possible based on all available data and information; and (3) use all available planning tools such as the subdivision ordinance to protect the proposed thoroughfare alignments in anticipation that the thoroughfare improvement will be done as contemplated in the system plan. Adequate and thorough environmental studies done at the transportation systems planning stage minimize the possibility of problems at the project development stage.

It should be noted that it is always possible that some unanticipated problems or issues will occur that cause a change in alignment when a project reaches the construction stage. However, this will not happen often if a thorough job is done in the systems planning stage. Long-term protection of thoroughfare corridors is an absolute necessity. There is just no other feasible alternative.

SUMMARY

This paper has discussed the North Carolina approach and experience in incorporating environmental considerations into systems planning. Transportation systems planning should include inventories of environmental factors, consideration of these elements in plan development and evaluation, and documentation of their application. Documentation of inventories and their application is considered crucial to ensure that right-of-way protection actions are soundly based and no major pitfalls are encountered in subsequent project development.

REFERENCES

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