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HOW TO DO A TRANSIT STATION LAND USE IMPACT STUDY

by

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ABSTRACT

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Several improvements in the conceptual basis and methodology for land use impact studies have occurred over the past two decades, but the framework is still incomplete because it has not fully recognized the need to incorporate the policy context into the study design. A revised model for impact studies is proposed, and the approach illustrated by a case study of a planned rail rapid transit station. One of the major differences between the described and previous methods is the acknowledgement of several possible outcomes or impacts, as a function of alternative public policies in addition to the transit station itself. Five categories of impacts -- public facilities, environmental, market, neighborhood, and fiscal -- are evaluated.

INTRODUCTION

Both the theory and the methodology of land use impact studies have been improving gradually over the last decade or so, but the study designs have not yet adequately integrated the policy context with the research questions. The purpose in asking the question -- what are the land use impacts of a major transportation project? -- is to better evaluate the feasibility and desirability of such projects, and the answer to the question depends a great deal upon public policies other than the project itself. The theory and case study presented below are an attempt to construct a workable framework for executing land use impact studies of major transportation investment projects.

An Impact Model

Refinements in the "before/after" and the more recent "with/without" impact methodologies have advanced the state of the art (1,4), but the model, derived from experimental design in the physical and natural sciences, is still incomplete. Figure 1 portrays schematically an extension of the with/without model, in which the comparison is made between two sets of outcomes (options, because they are a consequence of conscious policy choices) resulting from the decision to build or not build the project. State-of-the-world assumptions are those things which are held constant for comparative purposes: regional population and employment growth, aggregate travel demand, the rest of the transportation system. Policy assumptions, in contrast, are specific to each option: for example, policy assumptions associated with intensive redevelopment are different from those associated with neighborhood preservation. The impact of the project is the difference between the options available without the project and the options available with the project.

Previous impact studies and the proposed model can be distinguished, in part, by the way the question is asked. In relation to the case study of the Vienna Metro transit station,

Old research question: What will happen if a transit station is placed at I-66 and Nutley Road?

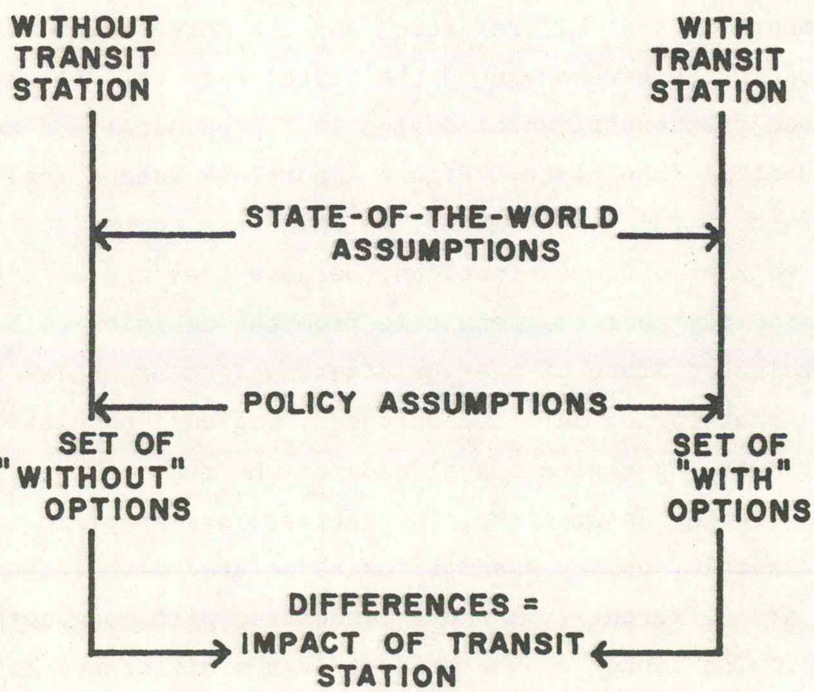

Figure 1. Proposed land use impact model.

Policy research question: What will be the differences between the choices available if a transit station is or is not placed at I-66 and Nutley Road?

The Case Study

Vienna, the town after which the proposed station is named, lies just to the north of the station site, in the Virginia suburbs of Washington, D.C. The immediate station area, as shown in Figure 2, is largely vacant at present, and the station itself is located in the median of I-66 just west of Nutley Road. The Vienna station is the terminus of the Vienna line of Washington's Metro rail rapid transit system. Specifically, the question being asked in relation to this station is the following:

> Given that a transit station is located at I-66 and Nutley Road, what will its impact be? (the impact question)

Alternative questions not addressed include:

> Given the locations of all other transit stations and lines, what are the impacts of locating the Vienna station at I-66 and Nutley Road versus other possible locations? (the station location question)
>
> Given the general configurations of the line, what are the impacts of alternative numbers and locations of stations? (the route decision)
>
> Given the existence of a system, what are the impacts of alternative line locations and lengths of extensions? (the corridor decision)
>
> What are the impacts of a rail rapid transit system on the Washington, D.C. metropolitan area? (the build/no build decision)

Each of these is a separate question and must be addressed within a separate and suitable analytic framework. Most notably, it is not possible to add the pieces together to get the whole; the answer to the macro-question is not the summation of the answers to the microscopic questions.

Design and Selection of Options

It is important to emphasize that the options are discovered rather than invented, although a good deal of creativity is often required to ferret out the real options that exist. The process of discovering options

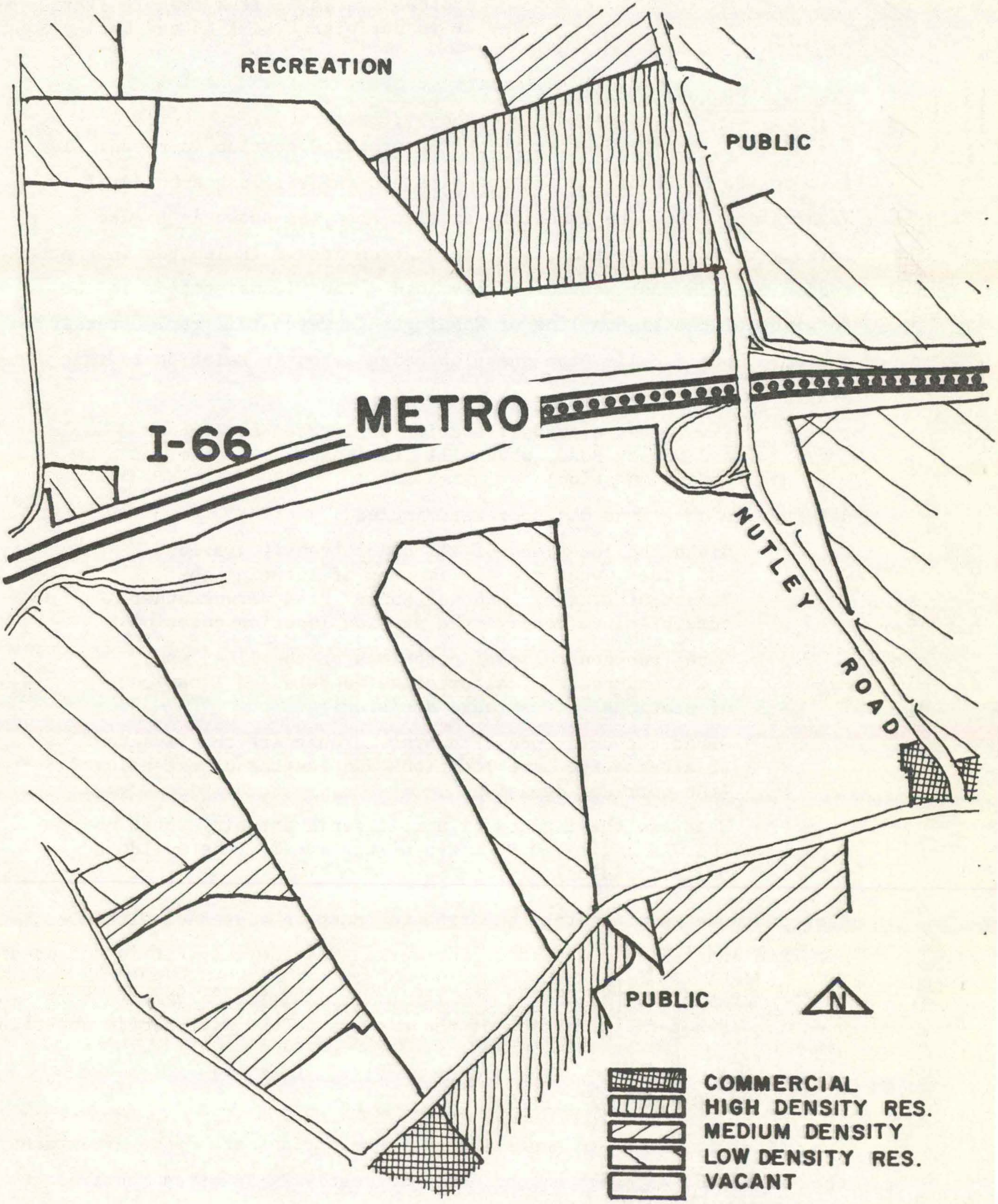

Figure 2. Existing land use and anticipated development.

is largely heuristic and judgmental; hence, it is misleading to break the process into separate steps, but a working approximation might include the following:

(1) List all possible alternatives for future development in the vicinity of the station. Clearly it is not possible to carry this out to the letter, but it is not necessary to list most of the implausible alternatives because they will be eliminated in the next step.

(2) Delete infeasible alternatives. Feasibility will be, of course, one of the judgmental determinations, but a key component will be market demand for various land uses at the particular site. Techniques for market studies are well known applications of macroeconomic concepts (3,5).

(3) Group options into categories. The categories used for the case study are based on levels of development or development intensity, and this might be a dimension suitable to many impact studies, although other dimensions can be used.

(4) Rank the options within the categories according to normative objectives. These objectives are specific to each of the five impact categories and are described below in the context of the land use impacts.

(5) Evaluate the preferred option(s) within each category. Impacts are estimated for each type and results tabulated as to costs, benefits, or residual impacts (those which are of interest but cannot be aggregated as either costs or benefits).

(6) Revise options and categories as appropriate. Steps 3 through 6 can then be repeated until a stable set of options is generated.

The desired result of the option design effort is a limited number of real choices that can be reviewed from both a technical and a political perspective. Thus the impact study is also, not surprisingly, a planning study, in that it provides information that will aid in resolving a problem of social choice. As represented in abstract form in Figure 3, the choice among options is an attempt to find a balance between social costs and social benefits. On the benefit side, demand is reflected in the prices of housing, personal services, retail goods, hotel rooms, etc.,

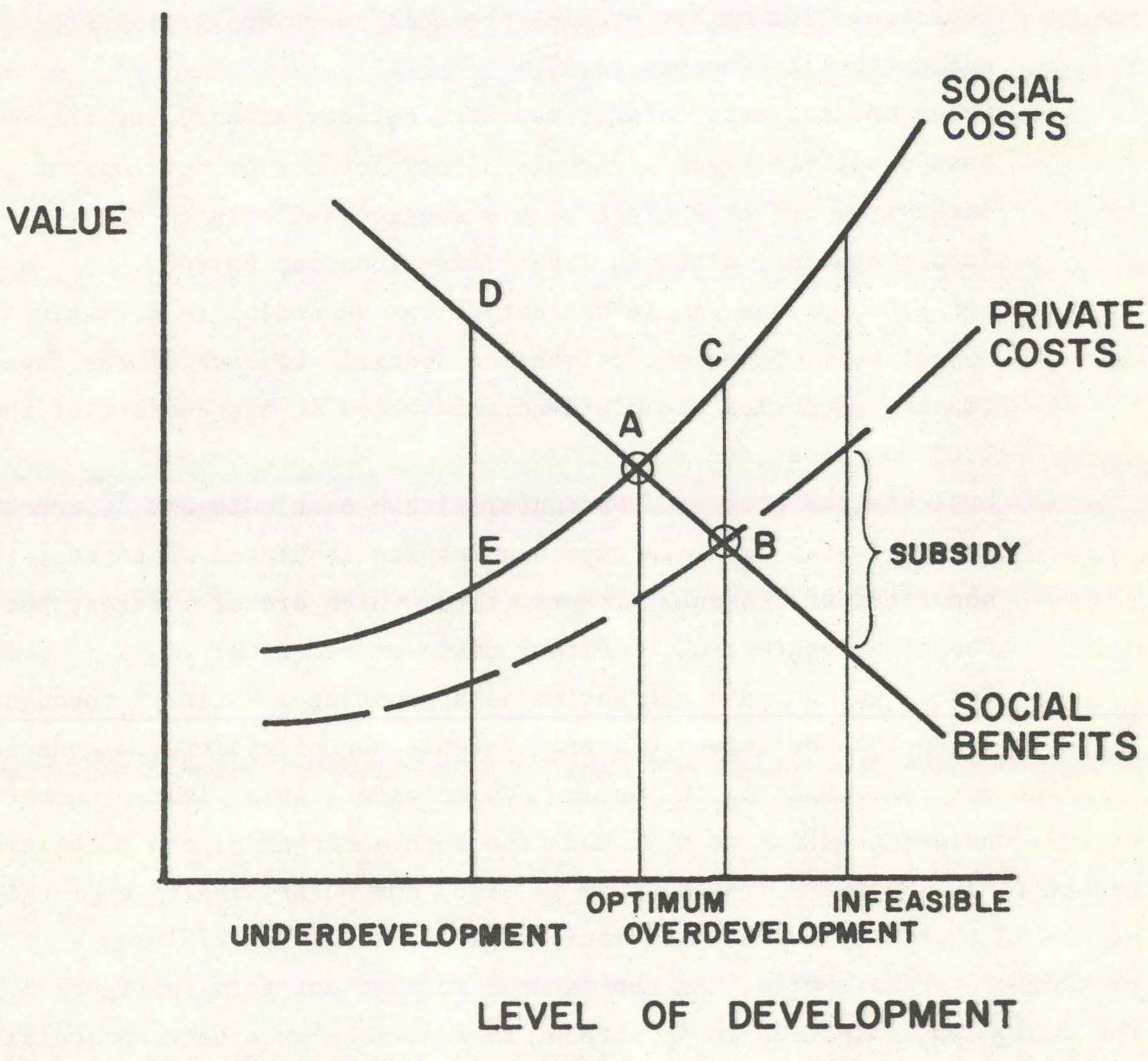

Figure 3. Social costs and benefits of development options.

that consumers are willing to pay; these benefits are transformed into demand for land development through the entrepreneurs and lenders who are able to perceive the demand and willing to invest in the development. On the cost side, the supply curve represents the opportunity costs of resources foregone by both the private and public sectors in order to achieve different levels of development. The optimum (A) is the point at which marginal social cost equals marginal social benefit.

In practice, there are a number of varieties of market failure that distort resource allocation from the optimum. Only one variety will concern us here: negative externalities, in the form of noise, dust, disruption, environmental degradation, etc., allow some of the social cost to be exported by the private market. Private sector decision makers consider only those costs represented by the dashed line in the diagram, and choose a level of development (B) that is higher than optimal; the area BAC represents the loss to society from this overdevelopment.

Normative targets are explicitly intended to place the full burden of costs upon those deriving the benefits, and constitute, for each option, a vertical movement from the private to the social cost curve. If costs are fully internalized, then a suboptimal level of development (D) results in a social opportunity loss equal to ADE, but this may be preferrable if the negative externalities cannot be controlled. A level of development higher than (B) would require a private market subsidy (even if external costs are ignored) and is, by our definition, infeasible. Two additional points should be made negative externalities: first, they may have the effect of reducing benefits if not controlled (a lower social benefit curve), which would further reduce the optimum level of development; and second, they amount to income transfers from those who suffer the externalities in favor of those who create them.

Only the end product is presented for the specific case of the Vienna station, so that the options "low", "medium", and "high" embody the best mix of development at each level, and negative externalities are assumed to be largely controlled as a result of specified public policies. Policy makers must then make their own assessments of whether the mixes are desirable and to what extent they are willing and able to impose regulations that will reduce the negative externalities. Specifications for the three options are shown in Table 1, and they can be generally described as follows:

Low: A mix of residential types and commercial would be included, but the largest single land use would be single family residential. This would have the effect of extending the existing neighborhood into the area around the station, thereby providing a transition and a buffer against the station and ancillary activities. Arrivals at the station would be predominantly by bus, kiss-and-ride, and park-and-ride.

Medium: Slightly more emphasis is placed on commercial and considerably more on multifamily residential units. Some clustering of structures could be accomplished, and most of the land not covered would be in public common areas, as around garden apartments.

High: More emphasis on commercial and multi-story apartments, with lower land coverage and more clustering, would characterize this option. Pedestrians would form a relatively high proportion of the trips to and from the station.

Much of the substantive information presented below in the case study comes from a study of three stations on the Vienna line (2) and their market forecasts project an adequate demand for any of the three options. It is the conclusion of the present study that the "high" option comes the closest to constituting the optimum (A) in Figure 3, but this result depends upon the many policy and other assumptions listed below and no implication is intended that high levels of development are suitable for transit stations in general. The Vienna station was selected, in part, because it is illustrative of situations in which a range of options is available and hence the impact of the station is not uniquely predetermined.

LAND USE IMPACT EVALUATION

Impacts are grouped into five categories -- public facilties, environmental, market, neighborhood, and fiscal impacts -- on the basis of policy

TABLE 1
DEVELOPMENT OPTIONS FOR THE
VIENNA STATION

Residential			
Single Family	364(91)	0	0
Townhouse	600(60)		
Garden Apartment	825(55)	1,620(108)	1,830(122)
Elevator Apartment	1,250(45)	1,850(60)	3,250(95)
Total Residential (In Dwelling Units)	3,039	4,300	5,420
Office (Square Feet)	240,000	360,000	700,000
Retail (Square Feet)	50,000	150,000	250,000
Hotel (Rooms)	100	200	300

100 - Number of Units

(10) - Acreage Required

Source: (2)

treatment and underlying assumptions. Three aspects of each category will be addressed: normative (ideal policy) objectives, the nature and measurement of impacts, and evaluation of impacts. Evaluation concerns the extent to which the impacts can be entered and aggregated in a cost-benefit framework, as well as the extent to which the assignment of values is inherently political. Impacts for each option will be summarized, evaluated, and compared with the options available without the station.

1. <u>Public Facilities Impacts</u>

Normative Objectives:	The costs of all facilities and services which create benefits that occur directly to the user should be paid for with suitable user charges; capacity of public facilities should be adequate to provide for expected demand.
Impacts:	Measure (a) the drawdown in capacity of existing facilities resulting from each option, and (b) the extent to which demand has been anticipated and capacity programmed to meet the demand.
Evaluation:	The only circumstances under which value can be attached to the consumption of capacity is when the demand created by the land use development could not reasonably be foreseen and constraints (e.g., long lead time, bonding limits) exist on providing the adequate capacity; this condition is, by definition, temporary.

Services provided by public facilities can be roughly separated into two components: one which creates direct benefits (e.g., travel, water, waste disposal) to the consumer, and one which creates general benefits, (e.g., government, primary education) to the community as a whole. For the former, costs should be paid either through direct user charges (parking fees, hookup charges) or through development charges (fees or in-kind contributions from developers). Facilities which create general benefits can be financed from general revenues (property, sales, and income taxes). If these policies are adhered to, then the infrastructure required by development is paid for by those benefiting, and general facilities are supported by the community in proportion to ability to pay. Facilities required to support development at the transit station are listed below:

1. Road Improvements. Nutley Road should be widened from 2 to 6 lanes, and a handful of similar improvements undertaken, in order to increase the capacity of vehicle access to the station. All three options require these road expenditures.

2. Metro Station. The design of the road and parking area immediately adjacent to the station needs to be redesigned in order to better facilitate pedestrian arrivals; this is especially needed to support the high development option. The present design requires pedestrians to cross a large parking area in order to reach the station.

3. Public Amenities. Pedestrian walkways throughout the station area, public squares and furniture, landscaping, shelters, etc., should be constructed at the expense of developers; more amenities can be obtained under the high development option due to higher use intensity and economies from clustering structures.

4. Other Public Facilities. Capital facilities as needed to support each development option should be provided, financed in accordance with the guidelines above. More recreation and open space acreage is needed for the high option than the low, for example, and should be provided by developers.

2. Environmental Impacts

Normative Objective:	Environmental resources should be protected by suitable constraints on development.
Impacts:	Measure the residual changes in environmental characteristics.
Evaluation:	Values to be placed on net changes in environmental variables can only be assessed through the political process, since normal market mechanisms undervalue most environmental resources.

Clearly, some changes in the natural environment will occur if any development at all takes place, with minor reductions in environmental quality (controlled as described below) perhaps offset by absence of reduction elsewhere. The first component of the problem is to determine which changes are acceptable, which changes are acceptable if minimized, and which are unacceptable. The second component is the design of standards or other methods to achieve only acceptable changes.

1. Stream Valleys. Several notable stream valleys traverse the site, and these are generally wooded. No development should be permitted in any 100-year floodplains, or within 100 feet of a stream bed.

2. Wildlife Habitats. Portions of the stream valleys have been identified by Fairfax County as wildlife habitats, and these should be protected with a minimum of 250' of natural buffer on either side of the stream.

3. Storm Water Runoff. Because of the high clay content of the soil and the sudden hard rains which are common, water quantity must be explicitly controlled. Natural vegetation should be retained as much as possible, especially on slopes, and retention facilities required for all development such that the natural drainage capacity will not be overloaded.

4. Soil Stability. Slippage-prone soils should be identified, by the developer, and measures taken to ensure stability or avoid the problem.

5. Open Space. The county has delineated Environmental Quality Corridors, which are designed to create a network of open space and also protect stream valleys and other environmental resources. A portion of the site is included in this network.

For most environmental attributes, degradation can be kept to tolerable levels with appropriate policies and attendant costs, without detracting from development potential. Because the high density option emphasizes clustering of structures and lower coverage, many of the environmental resources (open space, stream valleys, water quality, water quantity) are actually more easily protected under high development than otherwise.

3. Market Impacts

Normative Objectives: Resources exchanged (labor, materials) in private markets related to station development are properly valued in those markets, i.e., there are no significant externalities, inefficiencies, or market imperfections.

Impacts: Estimate changes in market activities (employment, housing mix, land use), including those indirectly related to the existence of the transit station.

Evaluation: No costs or benefits can be attached to market impacts except in cases where (a) there is specific evidence of significant market failure (public sector imposition of (D) in Figure 3 is a form of market failure), or (b) there are expressed community goals that pertain to certain market impacts.

For the most part, market impacts are simply spatially or intersectorally redistributive, i.e., the activities (employment, housing) would have occurred somewhere, perhaps in a different form; the difference may be of interest, but it is seldom a matter of "new" jobs or net increases in land value. Changes which occur as a result of properly functioning markets can be legitimately diverted only by "buying out" responsible property rights, e.g., through acquisition of land for parks instead of development.

1. Land Use. Private market land use changes resulting from the presence of the Vienna station could range from minor to major, depending upon public policies. If low intensity development was the option followed, land use changes would largely be limited to those involving vehicular access to the station. High intensity development, however, would result in substantial land use changes. Hence, market impacts of the station depend heavily on development policies, not solely on the presence or absence of the station.

2. Housing Types. Which development option was chosen would have only a small effect on the number of housing units constructed in the region, but location of the units within the corridor and perhaps within the region would be altered. The high level of development would shift the mix of structure types away from single family units toward townhouses and apartments, and would allow for more moderate and low-income (with suitable policies) units to be constructed.

3. Commercial. More specialized commercial activities would also be likely under the high development option, in comparison to the highway and shopping center commercial that would take place under the low and medium density options.

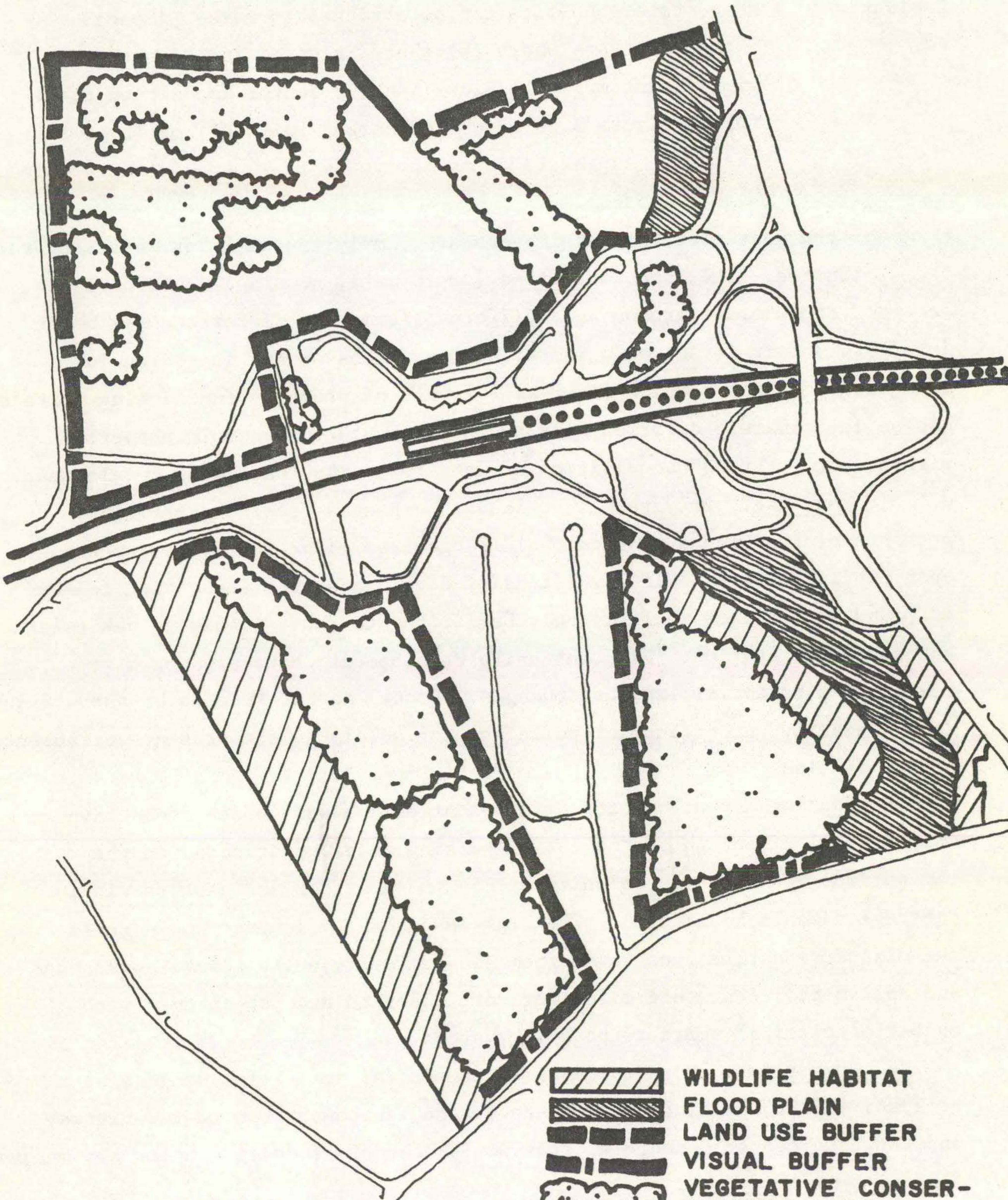

Figure 4. Environmental and development constraints.

4. Neighborhood Impacts

Normative Objectives: Existing and constructed neighborhood resources should be protected by suitable constraints on development, or compensation paid to affected parties.

Impacts: Measure residual changes in neighborhood characteristics.

Evaluation: Inadequately compensated changes to existing neighborhoods should be considered as costs; other changes are a matter of individual taste and perhaps political choice.

Neighborhood quality is dependent upon many factors, but a major group--and the group that land use controls attempt to ameliorate--are those negative externalities created by land use interactions that can broadly be referred to as nuisances. Protecting neighborhood resources means preventing the negative impacts of new development on existing neighborhoods, as well as ensuring compatibility within new development.

1. Noise. The neighborhood surrounding the station area is generally low density residential, so noise levels should be compatible: moderately low during the day and quiet at night. Potential sources of noise are traffic (especially trucks and motorcycles), truck loading and unloading, garbage containers, power equipment, stereos, parties, discotheques, etc. The source of most objectionable noise in the station area is motor vehicles, and the most efficient protection is design standards for buffering development from trafficways.

2. Visual Intrusion. High intensity uses are visually incompatible with low density neighborhoods, but the impacts can be almost fully eliminated with three measures: (a) place the largest structures closest to the station and reduce intensity of use outward, down to garden apartments and townhouses; (b) use vegetative buffers between different intensities that are incompatible; and (c) impose a height restruction of 40 feet above highest local grade (taller buildings would be permitted on lower grades) to ensure that structures blend in rather than sticking up. Because of the existing vegetation and the topography of the site, both of the last two measures would be very effective in this instance. Figure 4 shows the combined results of environmental constraints and buffering requirements on site planning.

3. Population Mix. Low density development will maintain the age, family structure, and income mix that already exist in the area, while the high development option would allow for some elderly, singles, young couples, and moderate income households to also join the community.

4. Other Impacts. Dust, fumes, loss of architectural or historic sites, vibration, flooding, etc., can also reduce neighborhood quality; under the stated policy conditions, problems with these impacts are not expected. With suitable access control, construction impacts should be minimal on the largely vacant site.

5. Fiscal Impacts

Normative Objectives:	(Same as for public facilities).
Impacts:	Estimate changes in annual revenues and expenditures for affected municipal budgets.
Evaluation:	(a) Changes in general revenue patterns should be noted and corrective measures taken if problems appear; (b) underpayments by users and direct beneficiaries of facilities should be regarded as costs of development, to be minimized as much as possible.

Cost revenue calculations typically reflect little more than the number of school children that will be brought in by new development. Preferrably, direct-benefit government functions (utilities and the like) should be balanced separately, with user fees distinct from general revenues. Road users fail to pay property taxes on the right-of-way, sales tax on gasoline (they pay an excise tax), as well as a share of construction, maintenance, and administrative costs; hence, any increase in highway capacity implies an increased and countinuing transfer from general tax-payers to highway users. Unfortunately, this inefficiency cannot be corrected at the local level, although the costs of some kinds of facilities can be levied on developers on the assumption that the costs will be passed on to those creating the need for the facilities. Several fiscal viewpoints are needed, including those of the county, the Town of Vienna, Metro, and the highway department.

IMPACTS SUMMARY

The impacts resulting from the presence of the Vienna Metro station depend to a large extent upon public policies affecting the amount of development which takes place in the immediate vicinity, and the regulatory constraints placed on that development. Comparisons can be made between the three development options via a cost-benefit framework and by means of a tabulation of residual impacts.

Costs and Benefits

Given the assumptions set forth, there should be no uncompensated costs of high level development versus low. One possible exception would be traffic: to the extent that the high option generated more total trips than it substituted walking for auto, there would be some negative neighborhood effects; one estimate is that there will be 1400 additional vehicles in the peak hour (2). With this caveat, the benefits of high level development over low or medium (area ADE in Figure 3) are listed below:

1. Desirability of integrated mixed land uses, housing types and price ranges, population ages and incomes, and commercial enterprises, as reflected by what consumers would be willing to pay in the market.

2. Additional public facilities and amenities that can be provided (this is instead of savings in the cost of public facilities due to clustering, or higher profits to private entrepreneurs).

3. Improved utilization of the rail transit system (if other facilities would be needed for highway travel while there is excess capacity on Metro, the benefit is the savings in the cost of new facilities).

4. Greater retention of existing vegetation, and protection of environmental resources.

Because the low development option is similar to what will occur without the station, the costs and benefits of the transit station under high development (relative to no station) are similar to the comparison between options. The major differences are in the road improvements and traffic impacts, since these will occur under any development option.

Residual Impacts

For the Vienna site, the location of a transit station offers opportunities for development that would not be available without the station but will not necessarily occur with the station. In fact, rather stringent policy assumptions (the normative objectives) are required in order to realize the full potential of the opportunities; if these assumptions are generally not followed in implementation, the resulting impacts would be different from those stated. Assuming that the high development level and constraints are effectuated, the remaining impacts would be limited to the following:

1. Impacts listed above as benefits.

2. A change in the character of the neighborhood from one which is suburban to one which is low density residential but having a small semi-urban neighborhood core.

3. Impacts of increased traffic volumes in the neighborhood, to the extent that these are not buffered (primarily in comparison to no station at all).

4. Some reduction in open space and vegetation (relative to no development), although an increase in public open space.

5. Somewhat higher ambient noise, particulate, and air pollution levels in the immediate environs, although less in the aggregate.

6. Increases in land value in the area immediately adjacent to station, but dampened increases because of the requirements for public anemities, facilities, and environmental controls.

Finally, while there has been little mention of citizen participation in the decision process, the structure of the impact analysis and evaluation is designed to be able to maintain (even depend upon) a continuous dialogue between the technical and political sides of the process. Various groups (neighbors, developers, investors, residents, taxpayers, modal lobbies) have both positive and negative considerations at stake in the outcome, and they should be encouraged to participate actively in resolving the many choices to be made. The impact evaluation framework provides them with a solid yet flexible basis for debate.

Conclusion

An extension of the with/without impact methodology framework has been proposed and demonstrated, in conjunction with a case study of rail rapid transit station. The primary intent was to incorporate the policy context as a part of the impact study, and the result was to generate a range of possible outcomes (rather than a single impact) -- each outcome being associated with a matched set of policy conditions. The impact of the station is then the difference between the options available with the station and those available without the station. Although the extended impact framework is still incomplete, it is offered as a step toward improved evaluation of major transit or transportation projects through the analysis of land use impacts.

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