Safety Rest Areas: Planning, Location, and Design

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The value of rest areas along Interstate highway routes is recognized by many people. Rest areas provide a safe place for motorists to pull off the highway. Rest and relaxation return a motorist to the highway a safer and better-informed driver. Although the Interstate system is approaching 100 percent completion, the rest-area program is only about 50 percent complete. The design of current rest areas often lacks consistency because a common body of knowledge about the state of the design art is not available. An effort was made to improve the procedures and features provided in Interstate rest areas by interviewing states with successful rest-area programs. This paper, which is a synopsis of a recently published manual, identifies rest-area development procedures in three steps: planning, location, and design. This paper is a state-of-the-art review of rest-area development.

The development of Interstate safety rest-area programs in various states is marked by many stages of completion. Recent surveys show that, although the Interstate highway program is approaching completion, rest-area programs are only about 50 percent complete. Some states have completed their programs, others are approaching completion, while some have hardly begun developing a rest-area system.

For states that have successful programs, public acceptance and response have been very favorable. They recognize the impact that good rest-area programs have on the image of their transportation agencies and states. Transportation agencies should favor programs that promote a positive public image. An example of a quality rest area is shown in Figure 1.

The Federal Highway Administration (FHWA) has recognized the importance of safety rest areas. Rest areas promote safer drivers by providing a place for rest and relaxation. They also are a valuable tool in promoting tourism. In order to identify this importance, the Minnesota Department of Transportation (MnDOT) was asked to prepare an up-to-date review of rest-area design principles and typical facilities. The manual that we prepared encourages a minimum level of rest-area design. This project was recently completed and a training course is currently offered to interested states. It is entitled Safety Rest Areas: Planning, Location, and Design (1).

This paper represents a synopsis of material from the manual. It points out the significant procedures required to develop a safety rest-area system and indicates special features normally provided in rest areas that contribute to their success. On Interstate routes, the system is not complete until a rest-area development program has been completed.

While preparing the manual, we interviewed designers in nine states, discussed their procedures, and visited representative rest areas. Their procedures were combined with specific experiences from MnDOT to form the basis for the manual.

The development of a safety rest-area system involves three main phases. Initially, the program must be planned and the general system framework stated in a printed document. Then, sites must be located along each route. Finally, each site must be designed to include a minimum level of services and features that should be considered in all rest areas.

PLANNING THE SAFETY REST-AREA SYSTEM

The process of planning a rest-area system along an Interstate highway should begin with a thorough development program. Seven major areas should be discussed, including scope, funding, budget, timetables, staffing, rest-area locations, and systems analysis. When a development program is prepared, administrators and others can clearly understand the ramifications that will result from developing a rest-area system. This is important, especially when administrators carefully analyze the necessity of each new program.

Program Scope

In order to efficiently plan a rest-area system, it is essential that everyone involved have a clear understanding of what services will be provided and how the system will operate. In order to identify the operation of a rest-area system, it is suggested that a series of operational guidelines be evaluated, including the following.

1. Traffic type--What type of traffic will each route handle and what will be the proportion of commercial, recreational, or through traffic? The facilities and services will vary depending on the type of traffic.
2. Spacing and volume--What rest-area spacing will be best to serve the traffic volume along each Interstate route? Spacing might vary from route to route in a state. Desirable spacing intervals are 80 km (50 miles) for average rest-area locations.
3. Tourism--Will tourism opportunities be an integral part of a rest-area system? If it is significant, buildings will require room for display space, and site development might require space for outside displays.
4. Quality of service--Each state must determine what services it will provide and what impression it wants its rest areas to make on travelers. This point is related to the attitude of the state toward tourism.
5. Maintenance--The operation and maintenance of a rest-area system must be considered as a rest-area program is developed. This is important when considering funding, since maintenance is an ongoing operation without federal funding sources.
6. Wastewater disposal--A decision on how extensive a wastewater-treatment system should be will affect all phases of planning. Some states select sites only if a certain kind of disposal system can be used.
7. Facility scheduling--The scope of a proposed rest-area program must include a general discussion about how rest areas will be built. Will they be constructed concurrently with other projects or combined with other state-operated facilities? If upgrading existing areas is required, how will that work be handled?

Analysis of these guidelines provides a sound basis for understanding the scope of the proposed rest-area program.

Program Funding

As administrators review a proposed development program, a major concern will be funding sources for the system. Therefore, a successful rest-area development program must include a discussion of funding sources. For Interstate rest areas, funding will generally be 90 percent federal dollars matched

Figure 1. Vanderbilt rest area on Interstate 75 in Michigan.

by 10 percent from the state. This will be the case both for new construction and for upgrading of existing projects.

A good program will help administrators determine the acceptability of specific funding sources for a proposed system. In some cases, especially for travel information facilities, funds other than Highway Trust Fund monies might be provided by other state or local agencies.

Development Budget

A good rest-area program should include a complete description of the development budget. The budget figures should be based on averages either from past experience or construction costs from other states. Since a program will be developed over several years, budget figures should include an inflation factor.

Budget figures might also include maintenance costs for operation of the rest areas. Since these costs are the responsibility of state transportation agencies, they are especially important when considering a rest-area system.

Development Timetable

In order to be effective, the development program should include a definite timetable for system completion. The timetable should include all projects and indicate a steady progression toward program completion.

Development Staffing

Staffing requirements necessary to complete a rest-area system should be identified. Staff requirements will be useful to administrators as they consider the value of proceeding with rest-area system development, especially if new professional specialties are required.

General Location

Once the initial facets of the program have been discussed, maps for each Interstate route should be used to show the probable locations for rest-area sites. These locations should be based on traffic flows and the rest-area needs as indicated by a system analysis process, which is a process that involves eatablishing rest-area needs based on the percentage of highway traffic likely to stop at regularly spaced intervals along a route.

Systems Analysis Process

A system analysis process was developed to eliminate the hit-and-miss method of identifying rest-area needs and locations. Many times rest areas were located based on someone's judgment that traffic on the highway at a given point would require a rest area. A more specific rationale was often not available.

In addition to anticipating rest-area needs as expressed by the number of parking spaces provided, systems analysis calculations also can be used to determine other design factors. Site features such as tables, waste receptacles, water and wastewater system sizing, and number of restroom facilities can be quantified. Any site feature that can be related to traffic volume can be calculated by the systems analysis process.

Several parameters govern the development of systems analysis results: existing and projected traffic volumes, annual usage survey data, recommended spacing interval, thorough inventory of existing rest areas, and determination of the maximum number of parking spaces to be provided at any single rest-area location.

1. Traffic volumes. Existing and projected traffic volumes used in systems analysis calculations can be obtained from state traffic forecasting offices. These are average daily traffic (ADT) volumes commonly projected for all highway-related planning. The existing and projected traffic volumes provide the basis from which future rest-area needs and site facilities are calculated.

2. Annual Usage Surveys. Usage surveys taken annually at selected rest-area locations can provide current design data and information required in the detail design of future rest areas. Annual surveys identify the current percentage of vehicles stopping at rest areas, persons per vehicle, vehicle distribution, traffic classification, and other important information.

Some form of usage survey has been conducted in several of the states interviewed. When surveys are taken, it is valuable to have rest-area designers involved. This is an excellent way for them to see how rest areas function. The on-site experience permits them to remain current in their design thinking.

3. Recommended spacing interval. In analyzing an Interstate highway for safety rest-area needs and location requirements, an 80-km (50-mile) spacing interval is recommended. This interval is approximately one hour's travel time at the national speed limit of 88 km/h (55 miles/h).

Spacing between rest-area locations should be adjusted to allow for unusually high or low traffic volumes. Spacing should also be adjusted for sites with unique features or scenic quality that would make quality rest areas. As a rule, however, an 80-km spacing interval will most often result in parking needs and rest-area developments that are manageable and will not exceed the capacity of the available site. Most states interviewed have adopted such a spacing interval.

4. Existing rest-area inventory. If the highway route being studied has been partly developed or is being reevaluated for upgrading, a thorough inventory of existing rest areas and related facilities must be made based on existing rest-area facilities versus construction of new facilities.

5. Maximum parking spaces. The final parameter is determining the maximum number of parking spaces desired at any single rest-area location. A decision on maximum parking spaces will dictate the minimum-sized site that can be acquired to prevent overuse. Designers should avoid large shopping-center-style parking lots in rest areas, because they concentrate activity and they are visually disturbing. To minimize traveler and environmental impacts on sites, a parking-to-site-size ratio should be developed that limits the total number of parking

spaces for a certain size site.

The systems analysis process involves developing a series of factors and reducing those factors to a formula that provides the number of vehicle parking spaces for each rest area. Some factors are constants, which normally will not vary from state to state. Other factors must be derived based on traffic and user conditions in each state. The process should be systematically applied to all highway routes in a state.

Along a route to be analyzed, the first requirement is to identify study segments that correspond to logical breaks in the route. These segments are called design section lengths (DSLs). The DSL is divided into a series of base section lengths (BSLs). The BSL is the desirable spacing interval for rest areas (i.e., 80 km).

For each DSL, both current and projected ADT and design hourly volume (DHV) figures must be developed. Normally, the projected ADT and DHV will be for a 20-year design period. When a DSL has several ADT and DHV figures along the route, they should be averaged to arrive at a single representative figure.

A ratio is then established between ADT and DHV. The resultant figure is the design hour (DH) factor (i.e., DHV/ADT = DH). Minnesota's factor, based on its experience, is 0.15.

The percentage of traffic expected to stop at a proposed rest area must be developed for each DSL. This percentage will vary from state to state and can also vary along a route. It is best if each state conducts rest-area usage surveys to determine this percentage for their routes. Minnesota uses a 12 percent stopping figure on its rural Interstate routes except for information centers. Once the percentage is identified, it must be adjusted by the ratio of DSL to BSL. This adjusted vehicles stopping percentage (P) is derived by the calculation:

P = percentage of mainline stopping X (DSL/BSL).

The percentage of traffic using the rest area must be broken down by vehicle type. This vehicle distribution is spread between car parking (Dc), truck parking (Dt), and an optional category, recreational parking (Dr). Truck and recreational vehicles can also be combined in one parking lot. This distribution varies from state to state and should be substantiated by usage surveys. Minnesota uses a distribution of 0.75 for cars and 0.25 for trucks and recreational vehicles combined in one lot.

Usage surveys also provide information on the average length of stay by travelers. This factor should be developed on a per-hour basis. It is expressed as vehicles per hour per parking space (VHS). Minnesota experiences 3 VHS for an average vehicle stay of 20 min.

In Minnesota it has been noted that rest-area use is much higher in the summer months. August is the busiest month, with almost one-quarter of all rest-area use recorded in that month. To compensate for this variable, a peak factor (PF) should be developed. The PF is derived by developing a ratio between the average number of people per day for the five summer months when traffic increases (May through September in Minnesota) to the average daily use for the year [i.e., PF = average daily use (5 summer months)/average daily use for year]. This PF becomes a constant used in the systems analysis calculations. In Minnesota, the factor is 1.8. Other states may have different peak months or none at all. The final decision must be based on the traffic in each state.

Systems Analysis Calculations

The calculation for parking spaces required at a rest-area site applies the variables and constant factors discussed in the previous paragraphs. The formulas for car (Nc) and truck (Nt) parking spaces are as follows:

$$Nc = (ADT \times P \times DH \times Dc \times PF)/VHS \quad (1)$$

$$Nt = (ADT \times P \times DH \times Dt \times PF)/VHS \quad (2)$$

If independent parking space calculations are required for recreational vehicles (Nr) in the DSL, the following formula would apply:

$$Nr = (ADT \times P \times DH \times Dr \times PF)/VHS \quad (3)$$

By using the factors that apply to Minnesota's situation, the formulas can be reduced to the following equations that use the variables DH = 0.15, VHS = 3, Dc = 0.75, Dt = 0.25, and PF = 1.8:

$$Nc = [(ADT \times P \times 0.15 \times 0.75 \times 1.8)/3] = ADT \times P \times 0.067 \quad (4)$$

$$Nt = [(ADT \times P \times 0.15 \times 0.25 \times 1.8)/3] = ADT \times P \times 0.023 \quad (5)$$

The systems analysis process can be used to analyze a specific portion of a route or the entire length of a highway.

The systems analysis is the final ingredient in the rest-area planning process. It provides the justification for rest-area recommendations made in the development program.

SAFETY REST-AREA LOCATION

The discussion on the planning phase indicated that designer judgment was important in creating a successful safety rest-area program. The location phase requires these same judgments. There are no hard and fast rules that dictate how a designer locates rest-area sites.

In interviewing states for the training manual, we found that each one developed a location procedure that fit its system. The degree of refinement in the procedure was partly dependent on the amount of public involvement required to locate sites. The location process offers the state a good opportunity to develop a positive public response toward its transportation agency. However, we did find certain procedures that were commonly used and are recommended for states that are starting a rest-area system. This common location procedure begins with development of site-selection criteria. These criteria must be developed to fit each state's operation and development requirements.

Site-Selection Criteria

Site-selection criteria cover six major areas. The first and most important criterion should be an emphasis on selecting the best-quality site available. Quality sites provide the designer with a clear advantage when developing a rest area, especially if budgets are limited.

The definition of a quality site varies around the country. It might be wooded or have rolling topography or even have a water feature or interesting view. Some sites might include historical or cultural features. For some states, a quality site might be a clearing in a dense mass of trees. In any case, by selecting the best available site, a better quality rest area will result because the qualities of the site will enhance all parts of the design.

The second criterion, emphasized by many states, is the importance of having certain utilities available. The ability to obtain potable water and dispose of wastewater will determine if a rest area can be developed at a site. In sparsely settled states, the availability of electricity and phone service is also a factor.

The third criterion, spacing between potential rest-area sites, is also important. The systems analysis process used a BSL of 80 km (50 miles). However, in reality, spacings of 56 km (35 miles) to 96 km (65 miles) can be used in order to take advantage of all available sites. Consideration of a range of spacing distances should be exercised in conjunction with selecting the highest-quality site available. Since the best sites are never evenly spaced, the designer must exercise judgment so that the advantages of sites are compared against potential problems with spacing that is not 80 km.

A fourth criterion emphasizes that the designer should identify all significant rest-area sites for study, regardless of potential geometric design problems. Often a potential site will be rejected very early in the process because a conventional geometric alignment solution will not fit the site. However, because geometric alignments that involve sharper curves or more complex traffic movement can be applied so that special sites can be used (such as the rest area shown in Figure 2), these sites should continue to be analyzed until all alternatives have been exhausted. A potential site must also be compatible with the adjacent highway alignment. Such factors as sight distance, horizontal and vertical curves, and distances between interchange and rest-area ramps must be considered. The rest-area alignment must relate smoothly to the mainline geometrics to avoid dangerous vehicle transitions.

The impact of rest-area development on the natural surroundings of a potential site must also be carefully considered. Identifying an acceptable impact is the fifth selection criterion. The designer must anticipate the effect of construction on each potential site and determine if it is manageable of if adverse environmental impacts can be mitigated during construction.

The final selection criterion suggests that states consider the availability of land-locked or vacant parcels of right-of-way when locating potential sites. Normally this type of parcel is easier to acquire. In some states, however, rest areas cannot be acquired through eminent domain proceedings, so sites must be purchased from willing landowners. The positive public reaction that can develop when dealing with landowners willing to sell property should not be overlooked.

Figure 2. Unusual geometric solution for Funks Grove rest area on Interstate 55 in Illinois.

These criteria serve only as a catalyst in selecting rest-area sites. The process should also include locating and using the best possible base maps available. Topographic maps or high resolution aerial photographs should be used to study the highway routes along which rest areas are to be located.

All potential rest-area sites should be plotted on the base mapping prior to making field reviews. It is essential that the designer visit each site to evaluate its potential, preferably several times. In order to establish consistency, a site-reconnaisance form should be used to reduce the potential sites to those selected for development. This process involves many compromises and trade-offs, especially when many sites are available. Eventually, final sites are selected when the designer identifies one determinant that takes precedence in the evaluation process.

Preliminary Design Process

Once sites are selected, the manual suggests that these selections be substantiated by a preliminary design process. This process involves a series of studies that result in a design concept in the form of a concept plan for each site that fits that site and is geometrically workable.

Environmental documentation required for rest-area construction will vary significantly from state to state. A well-rendered concept plan is the best means available of conveying the design development to the public, both at meetings and in environmental impact statements and project design reports. The four steps in the preliminary design process are briefly noted here.

Site Analysis

The site analysis is a graphic evaluation of the site's "feel" and its potential for development. Site features that should be incorporated as part of the rest area or that affect the design are identified. Drainage patterns, slopes, vegetation cover, views, and scenic qualities should be graphically identified on the drawing.

Relationship Diagram

The relationship diagram builds on the information identified in the site analysis. It represents the functional relations of design components that make up a rest area, shown in diagrammatic form. These components include

1. Parking lots for cars, trucks, and recreational vehicles;
2. Buildings, including restroom buildings, picnic shelters, and maintenance-related structures such as storage or wastewater treatment buildings;
3. A major use area, including most picnic tables and shelters, childrens' play area, and walkways; and
4. Secondary use areas that extend some distance from parking lots and often include special points of interest such as overlooks, interpretive areas, and other features.

Alignment Study

Once the functional relations have been resolved to

Figure 3. Two common rest area relationship diagrams.

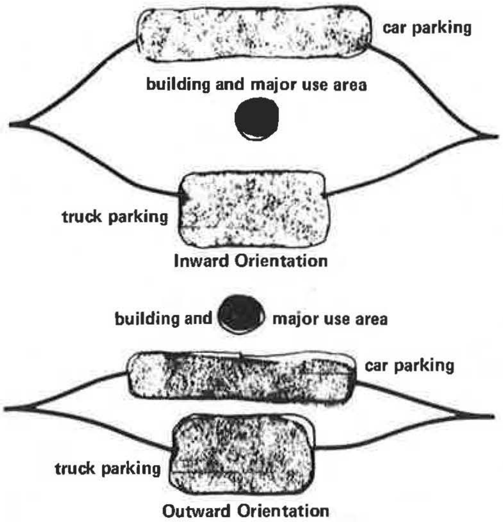

Figure 4. Goose Creek rest area on Interstate 35 in Minnesota.

the satisfaction of the designer, a workable geometric alignment must be developed. Accurate horizontal and vertical alignments, based on earlier quick studies, should be prepared. Figure 3 shows the relationship diagrams of two of the most common geometric designs for rest areas.

By using the inward-oriented plan, the building and major use areas are located among the car, truck, and recreational vehicle parking lots. This concept permits easy access to all features within the major use areas from the parking lots. For this plan to be effective, the area within the parking lots must be large enough to avoid concentrated activity that destroys grass and vegetation and leads to overuse of the site. Overuse results in long-term maintenance problems.

By using the outward-oriented plan, the building and major use areas are located beyond the parking lots that are adjacent to one another. This plan avoids concentrated activity and permits larger, more unrestricted use areas. The design permits development flexibility and is particularly suited to sites with variable topography.

Design Concept Plan

A graphic representation of the rest-area design (the design concept plan) should be prepared to show the workability of the concept. This plan, drawn to scale, shows the actual locations for proposed facilities and identifies the specific features that should be provided at the rest area. The concept plan should be used as the basic tool to explain the purpose for and the effect of the rest area on its surroundings.

SAFETY REST-AREA DESIGN

The design development of rest areas involves many different steps. Each state visited had different steps for assembling construction plan packages and constructing rest areas. The manual thoroughly identifies detail design procedures that should be used by states that develop rest-area systems.

The major emphasis in this section is that good design procedures must take advantage of the features on the site. The ability of the designer to resolve many design questions and blend diverse site elements together will determine how well a rest area serves the traveling public. The designer should be permitted to carefully consider all appropriate detail design elements for a site and should have considerable latitude in construction techniques, materials, and budgets.

States with successful programs allow the rest-area designer to participate in all phases of rest-area development, from site selection to construction advice. Active participation leads to better understanding of rest-area operations, which leads to better design solutions.

Designers have a difficult time remaining familiar with new rest-area service facilities being provided around the country. A goal for the design chapter was to provide a review of current rest-area facility state of the art. Necessary facilities that should be provided in Interstate rest areas are discussed. Examples from several states illustrate these facilities.

Rest areas must provide a complete range of facilities to operate successfully. Careful design placement of these facilities, incorporating them into a quality site, is the major thrust of a successful program.

The first important rest-area design step should be to preserve or enhance what is already there. The final roadway alignment should approach the building location in a way that will clearly show the organization of the area and create a positive visual impression. The grading of the entire site should further enhance those views and build on the existing topography. Large cuts and fills, severe slopes, and other intrusions should be avoided. Drainage in parking areas and around buildings should be controlled by curbs and drainage structures. This design approach avoids carving up sites with drainage channels that destroy natural topography and restrict pedestrian movements. All detail design efforts should be geared to improve the appearance and function of the rest area and blend it into the existing site.

Rest-area buildings should be designed to be compatible with other features of the site design and should be properly sized to meet traffic needs (see Figure 4). Rest areas are playing an increasingly significant role in tourism. There should be provision for tourism-related displays in the building and around the site. The building design and choice of materials should include materials that are durable and easily maintained so that they present a positive image to travelers and reflect concern against vandalism. The building and materials selection should be compatible with natural site features and should include energy-conserving design features, such as earth sheltering or solar systems. They must also meet federal accessibility requirements for the handicapped.

Where appropriate, the building and site should be enhanced with special design features. These might include wood decks, terraces, and historical and geologic displays. Special features add interest and can serve as an extension of the building. Overlooks or interpretive areas take advantage of natural features of a site and can enhance the tourism potential of the area.

Site furniture is an important design element in rest areas. Picnic tables should be durable, comfortable, and well designed. Benches and waste receptacles should be attractively designed yet function efficiently. For example, barrels are not appropriate as waste receptacles because they are unsightly and function poorly. Benches that are built into other elements such as retaining walls or decks are encouraged. Drinking fountains and aesthetically pleasing information signs should also be provided. Wood signs with messages regarding use of the site are a good signing system.

Childrens' play areas that incorporate a simple play structure with a sand cushion beneath it are an important safety feature in a rest area. Walkways that encourage travelers to explore a site and stay away from their cars several moments longer will result in more-rested travelers. It is important that both adults and children be relaxed and refreshed before returning to the highway. States with these types of facilities report nothing but positive comments from travelers when rest-area usage surveys are taken.

Lighting plans should be carefully designed to provide varying illumination levels. Entry ramps and parking lots should have higher poles to broadly light these areas for safety. Areas along the entry walks and car parking lots can have lower mounting heights to provide a feeling of security. There should be enough light in the rest area so that it looks open and safe. Designers should select light poles and luminaires from one manufacturer for visual continuity. Careful selection of materials, furniture, and site elements enhances the architectural quality and consistency of the rest-area design.

Where tourist-related displays are developed, they should be integrated into the rest-area design. If covered displays are developed, materials and roof design should match those of other structures. These displays should be located so they fit the flow of pedestrians within the site.

FHWA has recognized the significant effect that properly designed wastewater disposal and water supply systems have on safety rest area success. These topics were of such importance to the development of rest-area programs that separate training manuals were prepared for each one [e.g., Wastewater Treatment Systems for Safety Rest Areas (2) and Manual for Safety Rest Area Water Supply Systems (3)].

The design process should also include preparation of site management plans that identify how the rest area should be managed once it opens. This attention to rest-area management and operation keeps the designer in touch with the rest-area system. Management tasks include building management, mowing and turf management, irrigation, fertilization, and vegetation maintenance. These plans should be formulated for a one-to-five-year period. They serve as the designer's final link between the initial concepts that motivated the original design and the operation and management of the rest area.

The overriding focus of the training manual and course we prepared is that rest areas are an essential part of the highway system. They promote safe travel and can be used to enhance state tourism programs. In order to be effective, safety rest areas must be designed with care and sensitivity to many factors. Quality rest-area sites and careful, thorough design procedures will result in successful safety rest-area systems that meet the needs of the traveling public.

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The rest-area design staffs of nine states were interviewed for information on development and design of their rest-area systems. This information was very valuable in preparing the manual. The states interviewed included Virginia, North Carolina, Texas, Illinois, Nebraska, California, Arizona, Washington, and Michigan. Much of the material in the manual was developed through the experiences of MnDOT since 1967. MnDOT procedures were found to parallel the procedures of other states with successful programs.

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On-Site Land Treatment Systems for Freeway Rest Areas

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This study evaluates the effectiveness of existing on-site sewage treatment systems used at freeway rest areas in Michigan. It also evaluates the effectiveness of land-treatment systems designed to polish and dispose of the partially treated effluents from septic tanks and lagoons. The selection of the proper system or combination of systems to match the physical constraints of a particular site can ensure quality effluents and dispose of them so that they will not harm the environment. Tile drain field, seepage pits, seepage beds, sand filters, overland flow evapotranspiration systems, and a modified barriered landscape water renovation system were studied. The parameters measured included total coliforms, fecal coliforms, total streptococci, fecal streptococci, biological oxygen demand, total organic carbon, total phosphorus, inorganic phosphate phosphorus, total Kjeldahl nitrogen, ammonium nitrogen, nitrite nitrogen, nitrate nitrogen, and suspended solids.