Multiuse Corridor Master Planning: Integrating Infrastructure and Open Space Planning

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Key words
Corridor, green infrastructure, greenways, open space planning, utilities

Abstract

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Infrastructure and open space planning can be brought together to create a system of multiuse corridors that accommodate multiple types of infrastructure, recreation trails and open space, while protecting natural resources. Some of the potential benefits of this system is more efficient use of fewer utility easements, a more comprehensive open space system that can be paid for by utility users, and less environmental damage from utility placement. A multiuse corridor planning process is described that is meant to be used by a multiple disciplinary team to plan for infrastructure and open space in the context of town, city or region. This process inventories all human infrastructure such as roads, waterlines, and electric and natural infrastructure, such as streams, rivers, forests, wetlands, and geologic features. An assessment is made on what areas are most likely to need infrastructure in the future and a conceptual plan is put together to best serve those needs. A conceptual open space plan is created to serve the needs of future development areas. The infrastructure and the open space plans are woven together using routing guidelines and typical multiuse corridor sections to best design these multiuse corridors. This thesis brings together infrastructure and open space planning at the city and regional level.

Key words

Corridor, green infrastructure, greenways, open space planning, utilities

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1-Introduction

Infrastructure is part of every daily life. It is the roads that carry rush hour traffic, the rail commuters and freight trains, waterlines that bring drinking water, and waste water collection systems that transport liquid wastes. Cities across the United States are responsible for building and maintaining the infrastructure that enables them to function as places of concentrated human activity. Cities can plan infrastructure, together with open space, at the city and regional scale. Open space is parkland and undeveloped areas such as forests, rivers, and wetlands. The combining of infrastructure and open space can be accomplished by utilizing greenways as a form of open space that adapts to and incorporates the linear infrastructure corridors.

Greenways are linear strips of park or natural areas. When a city is planning its infrastructure, it can consider all potential utilities that may ultimately use that corridor, as well as its potential as a greenway. It is not enough to utilize single existing utility corridors as open space; cities must take it to the network level and begin planning to share these corridors before they exist. Some projects have utilized infrastructure as open space, but they did not factor open space into the planning phase of the project, and did not consider the entire infrastructure system in the possibility of providing open space. When infrastructure and open space planning efforts are combined, they better utilize a city's limited resources, reduce infrastructure impacts, and improve the quality of life of its citizens.

Infrastructure in the context of a city or urban area consists of the built systems that support human habitation and activity. Schulz defines infrastructure as "the physical facilities, which move people, goods, commodities, water, waste, energy and information. " (Schulz 2001) These include roadways, transportation, potable water, wastewater, stormwater, communications, and miscellaneous networks. Because these infrastructure systems tend to be linear, greenways would be a form of open space that would work well in utilizing the infrastructure corridors.

Greenways come in many different forms and can be defined several different ways. They are generally multi-functional. Charles Little, the author of "Greenways for America," gives this definition:

> **Greenway** 1. A linear open space established along either a natural corridor, such as a riverfront, stream valley, or ridgeline, or overland along a railroad right-of-way converted to recreational use, a canal, a scenic road, or other route. 2. Any natural or landscaped course for pedestrian or bicycle passage. 3. An open space connector linking parks, nature reserves, cultural features, or historic sites with each other and with populated areas. 4. Locally, certain strip or linear parks designated as a parkway or greenbelt. (Little 1990)

This definition allows for greenways to take many different forms; this is part of what makes greenways so popular as a way to provide open space. They adapt to linear recreation, such as jogging and bicycling, better than conventional parks, and connect many neighborhoods and destinations due to their form. They also adapt to linear elements in the landscape, like abandoned railroad beds, streams, and utility corridors, which makes them easier to implement than conventional parks in built up areas where large parcels are not available. A greenway does not have to allow for human access; ecological greenways serve primarily as habitat connectors, and do not replace conventional parks, but augment them, linking them into a wildlife habitat / open space network.

The combination of infrastructure and open space is not a new idea. The Back Bay Fens, part of Boston's Emerald Necklace designed in 1878 by Frederick Law Olmsted, is one of the earliest examples of a planned greenway. This project was unique for its day because it combined civil engineering and landscape architecture to create a multifunctional project. The Back Bay Fens project was built first out of ten proposed park projects, because it would alleviate problems of sewage buildup from two creeks and for flood control Open space was a secondary benefit of the project. Olmsted was able to accomplish the infrastructure goals, while providing a naturalistic greenway that became a vital link in Boston's first greenway network (Krieger 1999).

2-Literature Review

The literature reviewed comes from both the fields of greenway planning and public infrastructure. In addition to greenways, other projects are discussed because of their adaptation of infrastructure with other uses.

<u>Greenways</u>

The literature reviewed that pertains specifically to greenways can be divided up into several general categories. The categories would include general greenway information, applied material, and material on ecological greenways and green infrastructure. The first category gives a good background and understanding of greenways and examples of the different types of greenways. Little's book *Greenways for America* (1990) gives a very thorough understanding of greenways and their possibilities. . The second category, applied writings, deal with the entire process of greenway making from initial idea and organizing to operating and maintaining a greenway, however relatively little attention is given to the actual design and planning of the greenway. They can be thought of as more "how to" books that delve more into the community organizing, construction, and maintenance of greenways. Much of the material on greenways found in academic journals focuses on greenways and their ecological role. They subtract out for the most other functions of a greenway and assume a greenway or even greenway network could be designed in the vacuum of its ecological function.

An example of greenways in open space planning is Portland Oregon's Parks 2020 Plan (Portland Parks and Recreation 2001). It is a comprehensive open space plan for the city that establishes goals to provide better open space for its residents. The plan cites greenways and trails as ways to provide connections to existing parks and provide more recreational opportunities to walkers, joggers, hikers, and bicyclists. Portland's use of greenways to improve their open space system is part of a larger trend of cities using greenways to create open space systems out of their parks.

In much of the literature pertaining to greenways, typologies were utilized to organize the wide variety of greenways into several general types. The most common typology was to divide greenways into groups based on their function.

1. Urban riverside greenways usually created as part of (or instead of) a redevelopment program along neglected, often run-down city waterfronts.
2. Recreational greenways, featuring paths and trails of various kinds, often of relatively long distance, based on natural corridors as well as canals, abandoned rail beds, and other public rights-of way.
3. Ecologically significant natural corridors, usually along rivers and streams and (less often) ridgelines, to provide for wildlife migration and "species interchange," nature study, and hiking.
4. Scenic and historic routes, usually along a road or highway (or, less often a waterway), the most representative of them making an effort to provide pedestrian access along the route or at least places to alight from the car.
5. Comprehensive greenway systems or networks, usually based on natural landforms such as valleys and ridges but sometimes simply an opportunistic assemblage of greenways and open space of various kinds to create an alternative municipal green infrastructure
(Little, 1990, pgs 4-5).

This typology helps to organize and conceptualize greenways, however many times a greenway has several functions occurring simultaneously along its corridor. The fact that greenways cannot be put into just one type, points out that much of what makes greenways so useful is that they can accommodate these multiple functions simultaneously.

The second category of greenway literature is concerned with the implementation of greenways. Much of this information is geared towards Rails to Trails greenways. Theses are greenways that utilize abandoned railroad rights of way as the trail. The Rails to Trails movement is an example of greenways utilizing abandoned infrastructure, railroads, for their corridor. <u>Trails for the Twenty-first Century</u> serves as a practical guide for converting abandoned railroads into greenways (Flink 2001). Former railroad lines may or may not be located in the most desirable places for greenways and often do not connect with existing open space to help form a network. Rails to Trails greenways are rarely perceived or planned for at a network scale.

These abandoned railroad rights of way often contain underground or overhead utility lines and can be considered multifunctional corridors. The Washington and Old Dominion Trail in Northern Virginia was an abandoned railroad line that first became a power line easement, and then a paved trail, a sewer line, and fiber optic cables were added. Annual leasing fees from the utilities pay for the trail maintenance (Thompson 2000). This example demonstrates that it is possible for greenways to coexist with utilities and that there are also financial advantages.

Canals are another type of abandoned infrastructure that is adapted into greenways. The towpaths of the canal are usually adapted into trails that have a continuous connection to the water. The Delaware and Raritan Canal State Park in Central New Jersey is an example. The canal was abandoned as a transportation route, but continued to be used as a source for drinking water by communities along its route. It was later made into a state park. Today the canal is functioning as a greenway that provides for walking, biking, and canoeing as well as a drinking water.

The third category of greenway literature is Ecological greenways. These are greenways that focus on providing a habitat network for plants and animals. They connect patches of diverse and critical habitat together with as many links as possible. Ecological greenways create a habitat framework that helps plants and animals better survive in areas that are facing development pressure. They often utilize stream and river corridors and wooded steep slopes that tend not to get developed (Ahern 1991). Ecological greenways benefit plants in animals by consolidating habitat together and lessoning the fragmentation of habitat that limits animal migration and even isolates populations. Even though ecological greenway's primary focus is the protection and benefit of plants and animals, if conditions are appropriate, trails can be placed to allow for human access. This should be done with great care to minimize damage to the habitat that is the main reason for creating the greenway.

Green Infrastructure

The concept of green infrastructure is one way of looking at the combination of greenways and infrastructure. It is very similar to ecological greenways in that green infrastructure support and enhance habitat for plants and animals, but they also help support human habitation by absorbing and filtering the many of the by-products of its settlements. Green infrastructure is “an interconnected network of protected land and water that supports native species, maintains natural ecological processes, sustains air and water resources and contributes to the health and quality of life” (Greeninfrastructure.net 2001). Green infrastructure does not necessarily combine built infrastructure with natural systems, but recognizes that natural land in a connected system benefits the adjacent human population as well as the plant and animal populations. Natural areas can absorb and filter storm water runoff in place of expensive and destructive engineered solutions, while also providing open space.

Infrastructure

Much of the literature pertaining to infrastructure planning is concerned with financing the maintenance of existing lines and expansion of the network. These networks typically include wastewater or sanitary sewer, water treatment and distribution, stormwater management, road and sidewalk systems, gas lines, electric, and communication lines. One of the primary functions of local municipal government is to provide and maintain the public infrastructure. Vast amounts of money and large portions of budgets are dedicated to this end. Ideally the infrastructure is planned as a system or a series of overlayed, coordinated systems. Open space has historically often not been planned as a system and even more so not integrated in with the rest of a municipality’s infrastructure. This can be seen in many cities, where much of the park system was created from cast offs of other city infrastructure uses. When a certain piece of city property no longer had a use, such as a wastewater treatment plant or landfill, it was converted into parkland.

Melosi (2000), a professor of history at the University of Houston, looks at the history of civic infrastructure in the United States. The systems discussed in his book are water supply, sanitary sewer, and solid waste disposal. Infrastructure systems were designed to deal with epidemic diseases of the 19th Century and were not designed to deal with environmental issues of the 20th Century, such as non-point source pollution. When these infrastructure systems were started they were planned as best as possible, but they were making choices for future civic leaders would be difficult to change, because of the great cost invested in these systems. They inadvertently limited the choices available to current civic leaders in expanding or altering the system. Flexibility was not designed in. These systems also lacked modular flexibility or the ability to combine different systems such as sanitary and water supply systems. These infrastructure systems also greatly influence the growth of their urban areas. There is a call for integration of infrastructure systems because of their relationships with each other and possible improved efficiency, most notably water supply and sanitary sewer systems. The book does not address the potential for integrating open space (Melosi 2000).

Almost all cities and towns have some public water system. Water treatment and distribution networks often utilize water storage tanks located at strategic high points though out the service area to provide water pressure using gravity. The water distribution lines utilize a combination of street and overland easements. Larger public water systems also include reservoir watershed areas. There have been successes with integrating water supply lands and open space. San Francisco and other cities in the mid 19th-Century set aside land as protected watershed areas for its drinking water reservoirs (EDAW 1998). These areas are also used on a limited basis for recreation. Recreation was not originally envisioned as a use occurring in the watershed, but was later incorporated into the watersheds management plan due to public desire for recreation areas. This was done by carefully selecting suitable areas amidst a very sensitive landscape. These protected watershed areas can also serve as greenways where appropriate.

Sanitary sewer networks consist of collection lines that convey sewage from residences and business to the treatment plant. These smaller collection lines converge into larger trunk lines. These systems are usually planned to allow for the greatest portion of the network to flow to the treatment by the use of gravity. If this is not possible then the sewage is pumped using a force main that uses pressure to make the sewage flow up hill or lift station that collects the sewage by gravity at a low point and lifts it up to flow out to a gravity line at a higher elevation. Because these systems utilize gravity as much as possible and, because wastewater treatment plants need to be located by a water body for discharge purposes, these networks typically follow natural drainage patterns and watercourses where possible. The larger interceptor lines of wastewater collection systems typically follow creeks and streams and are within easements that would be able to accommodate other uses.

Stormwater management is another form of infrastructure common to most cities. It has many possibilities in accommodating other uses. An example of general planning principles shows what is considered in planning a watershed-wide stormwater management system. It does consider natural systems, which it is trying to mimic, but it does not typically include coordination with other infrastructure systems nor does it consider integration of an open space network. A watershed-wide stormwater management system would have the opportunity to utilize the idea of green infrastructure rather than removing a watershed's ability to process stormwater and allow it to function as open space.

An example of a citywide opportunity to integrate open space with stormwater infrastructure is Tucson, Arizona. Tucson suffered a serious of disastrous floods in the late 70s early 80s that pushed the city to change the drainage ways that ran through the city to reduce the threat to human life and damage caused by storm events. In some areas it was determined that it was cheaper for the city to purchase the land within these drainage ways and relocate the homes and other structures rather than build expensive engineered flood protection structures. What Tucson is developing is a better functioning drainage way system that doubles as a greenway network. Policy has been established to require developments to dedicate flood prone areas as open space. This is an example of using a stormwater management system as a greenway network. The main driving force is public safety, but the additional benefits are open space and habitat protection.

"Greenways, A Guide to Planning, Design and Development," (Flink 1993) lists different types of public utility easements and comments on whether each type lends itself to being used as a greenway. The larger trunk lines for different underground systems lend themselves better for greenway adaptation simply because of their larger easement width.

A gas pipeline that was routed through the Loantaka Brook Reservation in Morris County, New Jersey used special construction equipment that was able to replace slabs of soil, which made revegetation easier. A sewer line project in Loudon County Virginia that crossed Park Authority property used guidelines developed by landscape architects to design the alignment in a way that minimized environment damage and aesthetic impact. The guidelines included narrowing final easements to 35 feet, utility lines following topography, avoiding straight runs longer than 1,000 feet and minimizing openings to woodlands to 10 feet (Thompson 2000).

Schrijnen discusses the link between infrastructure network patterns and urban development patterns. Extending infrastructure facilitates the further growth of urban areas and the lack of infrastructure limits growth. The exclusion of infrastructure in natural areas that are sensitive to change helps to maintain these areas as natural.

> "Sustainable spatial patterns demand a planning approach that combines the planning of infrastructure and urban activities with the planning of their green counterpoint."

Hill (1972), Coordinator, Joint Use and Lines Relocation, Detroit Edison Company, spoke of his company's experience with the joint use of corridors and what their future might be. A feasibility study was performed to look at the issues of joint use of corridors.

The study looks at the subject from the utility company's point of view. It does suggest other uses such as passive recreation, bicycle trails and parking lots. Some of the issues raised by the report include.

Advantages

- Conservation of space
- Better public reaction
- Impact on the environment through concentration of aerial plants in limited areas
- Possible savings in right-of-way costs
- Avoid fragmentation of land

Disadvantages

- Necessity for close coordination in construction and maintenance
- Administration problems in ownership and operation
- Lack of coincidence in routing
- Mutual interference
- Heaviness of the equipment required to repair or install large diameter underground facilities, with the result that the equipment constitutes a hazard when used over, under, or near an adjacent facility.

Simonds (1978) proposes an idea he calls “joint use corridors” and briefly describes several strategies for planning them. A “joint use corridor” is a planned corridor that would allow for consolidating all present and future utilities. The corridors would be routed to be sympathetic to the terrain and designed in a way to also function as open space. The first step in planning a “joint use corridor” is to prepare maps showing all existing infrastructure for that particular city or region. This would allow these different systems to be viewed at once and relationships and problems could be detected (Simonds 1978).

Simonds thinking is important for two reasons. The first is that he is proposing to incorporate his “joint use corridor” ideas in the very beginning of the planning process rather than only considering retrofits to existing corridors. The second is that he is looking at infrastructure at the city and region scale where entire infrastructure systems can be considered rather than just considering limited stretches of infrastructure. The outline of planning strategies is vague, but could be used as a basis for a more detailed process of integrated infrastructure planning.

The City of Allen, Texas recently completed a consolidated Trail Plan. It is not a single purpose plan, but part of a Coordinated Transportation Plan, a Native Landscapes Preservation Plan, a Wildlife Corridor Plan, and a regional plan for cultural and recreational connections. The plan focuses on distinctive elements of the regional landscape. It uses the creek valleys as an organizing principle. The City ordinance reinforces the Trail Plan by requiring streets that front the open space to only allow lots on the side away from the creeks. This emphasizes the creeks and makes them the front yard of the community. The ordinance addresses the issue of the relationship between open space and neighborhoods. (Chusid 2002)

Significant elements of Trail Plan

- Addresses open space / neighborhood relationship
- Plan focuses on distinctive landscape elements
- Coordinated with other policy goals

The background information gives a general understanding of greenways and infrastructure. The information concerning multiuse was mostly about retrofits.

There are many examples of greenways being adapted to existing or abandoned infrastructure. There are examples of open space retrofitted into existing infrastructure at a limited scale and there are examples of greenways utilizing portions of existing utility corridors, but there is little information on examples of greenways being incorporated in the planning of utility lines or even more importantly being incorporated into the planning of infrastructure networks. This may be for many reasons, one of them possible being the limited scope of the infrastructure planning. The idea of “joint use corridors” is the next step in developing a city or region-wide attempt at planning for infrastructure, but there does not seem to be anything written that follows that idea. The next step would be to show how the planning process would work and how it would be implemented.

3-Design Position

The design position considers the conclusions from the literature and formulates a question. This question is developed into a claim that will be developed and tested by the design project in chapter five. Several problems have been identified from the literature review. Different infrastructure systems do not coordinate with each other and share easements as much as they could. Open space is often poorly planned, neglected and under funded in many areas of the country. Infrastructure corridors have many negative impacts on the landscape.

Claim

Infrastructure and open space networks can be planned together and integrated into multiuse corridors.

A process will be developed to guide a project to this end. It will consider the needs of both infrastructure and open space to produce a corridor master plan that accommodates those needs.

Goals

- Demonstrate that infrastructure and open space can be combined at the planning stage
- Develop a process for planning multiuse corridor networks
    - Comprehensive
    - Flexible
    - Simple
    - Existing infrastructure inventory and analysis process
- Develop strategies for accommodating multiple activities in the multiuse corridor
- Demonstrate integration of infrastructure with open space
- Protect natural resources and lessen the impact of conventional infrastructure

Greenways, like roads, are much more useful when they are part of a system that allows for many different routes to many different places.   Frederick Law Olmsted said, ”a connected system of parks and pathways is manifestly far more complete and useful than a series of isolated parks.”

Greenways are much more useful when they are accessible to many people at many different points. The most useful greenways are ones that form a network that has many access points close to where people live, allow for a number of uses, and can take users to where they want to go such as parks, schools, places of work, and shopping centers.

Infrastructure exists primarily as linear elements such as roads, pipelines in easements, and overhead power lines. Design strategies can be developed that better adapt these infrastructure systems to support the additional use of greenways. The planning of infrastructure should not only look at coordinating different systems, but also include open space planning mainly in the form of greenways.

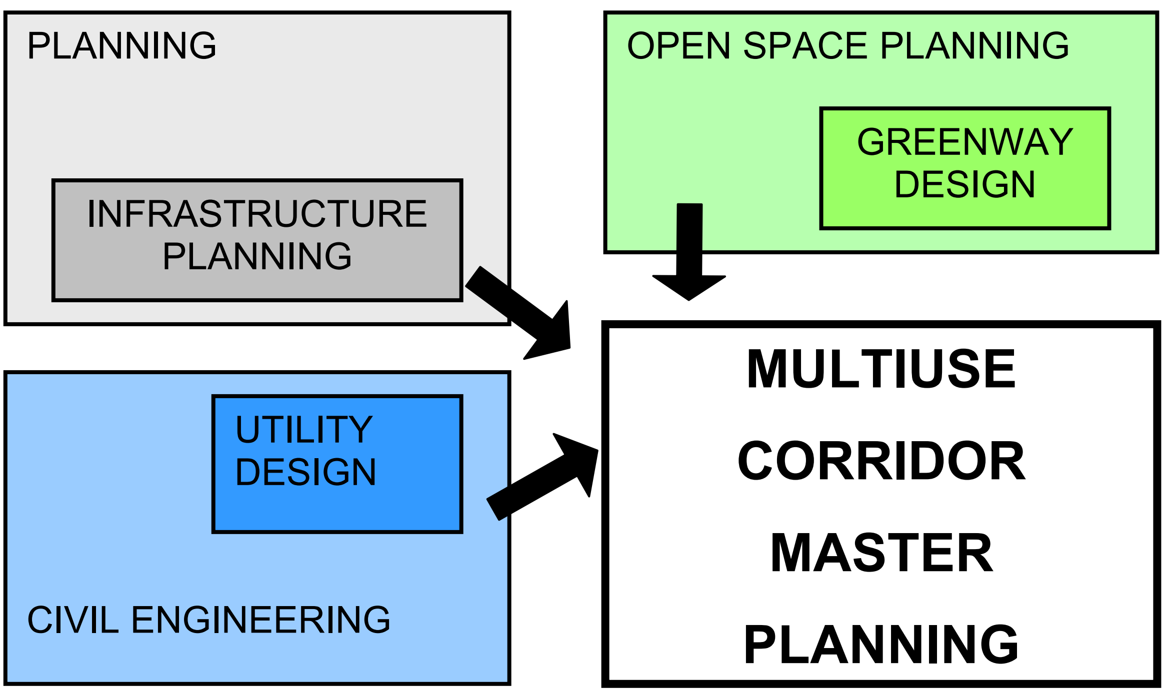


Fig. 1. Mind Map

Benefits

There would be several benefits in integrating greenways into infrastructure planning. If a greenway network could occupy land already earmarked for public infrastructure and get built along with the project the cost of the greenway could be substantially minimized. Integrating greenways with infrastructure helps address the problem of how open space is financed. Not only can land be utilized for multiple uses, but also one project can be used to pay for another. Infrastructure projects come with big price tags and open space can be also be provided in these projects with little overall additional cost if open space is included in the beginning of the planning process. The EPA estimated that between 1995 and 2015, $137 billion would be spent on sanitary sewer systems and up to $12 billion every year for drinking water systems, which it concluded, was inadequate (Melosi 2000). A more comprehensive open space network could be created.

Expensive and controversial infrastructure projects could be made more attractive by including greenways. Environmental impacts of infrastructure installation could be mitigated in the greenway construction. Integration of greenways could push for more integration of other infrastructure systems and more cooperation between utilities. There would be an opportunity to reveal and interpret infrastructure to the many residents of cities that are unaware of the vast systems of pipes and conduit underneath and give them a better appreciation of what goes into making an urban center function.

The benefits of cooperative planning are divided into those of infrastructure and those of open space. The list of benefits would vary from situation to situation, but many would improve aspects of the human and natural environment.

Infrastructure

- Nonstructural storm water management that is less expensive than conventional flood control
- Lower infrastructure capital and operational costs
- Fewer and less disruptive utility corridors
- Planned growth of utility systems
- Potential interpretation and education about utility systems

Open Space

- Recreation opportunities at lower costs
- Protected and linked habitat
- Protected drinking water supply
- Nonstructural storm water management that is less damaging to the environment

Issues

There are several reasons why open space has not been integrated into infrastructure planning. First, most infrastructure planning, especially in smaller cities, is done very piecemeal, and historically different infrastructure systems have been planned and developed independent of each other. Many cities and towns especially smaller ones do not have staff trained in open space planning and design. Also there is little information on integrating open space into infrastructure and almost no examples on how this might be done. The common way of open space planning is to try to accommodate it after the conventional infrastructure and development has been designed and built. This fact makes it difficult for the integration of greenways or linear open space. Open space is treated as pieces of green left over from the matrix of a city where nothing else would fit. It is not perceived as a citywide connected network. If open space could be perceived as an infrastructure system along with the other infrastructure systems, this would go a long way in planning for the better utilization of infrastructure corridors.

There are several issues that will need to be confronted in order for the idea of multiuse corridors to be a success. These will be addressed in the planning process in chapter four and in the design project in chapter five.

- Utility conflicts – Certain utilities for practical reasons may not be able to be located with other utilities.
- Habitat fragmentation – How is habitat fragmentation minimized or avoided by careful corridor route selection?
- Public safety – How are reasonable public safety standards maintained where public access is allowed near potentially dangerous utilities?
- Maintenance of utility lines – How is ease of maintenance accommodated for all utilities in corridor?
- Existing infrastructure constraints – How are existing infrastructure constraints minimized?

In conclusion there is an opportunity to further the sharing of corridors between infrastructure and open space in the scale of the city and region. The combined planning of infrastructure and open space will allow for the better use of limited resources, more extensive open space systems, and better-protected natural resources. This will be explored in the planning process that seeks to combine infrastructure planning and open space planning. The process will then be tested by applying it to a real site to produce a multiuse corridor master plan.

4-Multiuse Corridor Planning Process

The Multiuse Corridor Planning Process addresses how a Multiuse Corridor Master Plan is created. The design process described in this chapter is structured to allow for its application in a diverse range of circumstances. Different project applications, because of their goals and existing conditions areas are going to require the consideration of different information. This will also cause the design and success of multiuse corridors to vary from situation to situation.

The design process uses the product of three different sub processes to inform the design of the multiuse corridor master plan. The sub processes produce the Infrastructure Plan, the Open Space Plan and the Multiuse Corridor Template. The three groups of information are brought together and combined to produce the Multiuse Corridor Master Plan.

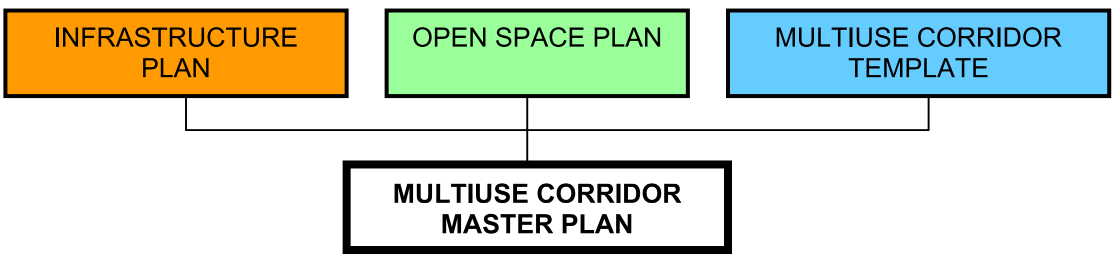


Fig. 2. MULTIUSE CORRIDOR MASTER PLAN

Process Outline

1. Infrastructure Plan
    a. Existing Composite Infrastructure Plan
    b. Development Suitability Plan
2. Open Space Plan
    a. Existing Open Space Plan
3. Multiuse Corridor Template
    a. Guidelines
    b. Cross-sections
4. Multiuse Corridor Master Plan

4a-Infrastructure Plan

The Infrastructure Plan is a conceptual plan meant to show simple connections between development and existing infrastructure as well as other needed new routes and extensions. Determining the infrastructure that is needed through the use of the Existing Composite Infrastructure Plan and the Development Suitability Plan produces the Infrastructure Plan. The comparison between the existing infrastructure and development areas will show where connections are needed.

Existing Composite Infrastructure Plan

The Existing Composite Infrastructure Plan is simply a plan showing all the infrastructure in the project area. It depicts the conventional or human infrastructure as prescribed by Simonds (1978) and goes a step further by including natural infrastructure such as hydrology, vegetated and natural areas. This recognizes that natural infrastructure can play a vital role in the functioning of a community. The infrastructure systems documented in this part of the process are the larger trunk lines that require easements. These larger lines are more likely to be able to accommodate multiuse.

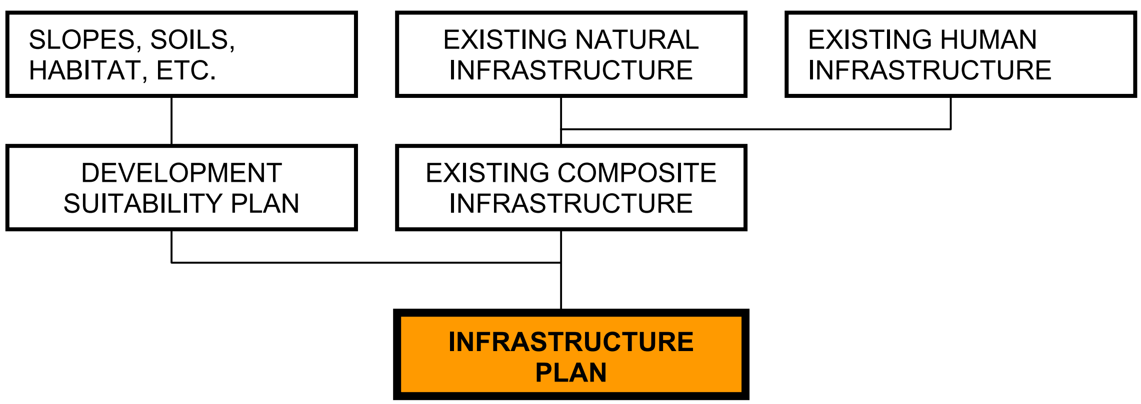


Fig. 3. INFRASTRUCTURE PLAN

The Existing Composite Infrastructure Plan is then analyzed system by system for its potential in supplying service, additional use of easement as well as for each system's limitations.

Inventory

<u>Human Infrastructure</u>	<u>Natural Infrastructure</u>
Highways, roads, railroads	Hydrology (water bodies)
Gas lines, power lines, communications	Floodplains, parks
Domestic water, waste water	Forested areas, sensitive habitat

Analysis

The analysis evaluates the existing systems specifically for further utilization and the potential liabilities they could be manifested if included in a multiuse corridor.

- What is that particular system composed of? I.e. pipeline, pump station, 20'-wide easement
- How much room in the easement is available for future use?
- What parts of the infrastructure system pose a risk to human health and safety?
- What natural resources or public amenities are adjacent to the easement?

20 year planning window

- What extensions to network are planned?
- What are the planning and design criteria for extensions?
- Are there any major repairs, replacements or upgrades planned?
- Are any parts of the network going to be abandoned?

Development Suitability Plan

The Development Suitability Plan uses an overlay analysis to determine the areas that are suitable for development. The type of development determines the kinds of information that is used in the overlay. Development is determined through the review of planning documents, such as comprehensive plans, zoning and future land use plans as well as other pertinent information. The type of development also determines the infrastructure that is needed to serve the development areas.

The Existing Composite Infrastructure Plan and the Development Suitability Plan are overlaid. The existing infrastructure is used as much as possible to serve the development areas. From that point it can be determined what new lines are going to be needed to fully serve these areas. New infrastructure is depicted conceptually as lines connecting points together, without considering limitations of the site. These lines represent the most efficient and ideal connections.

4b-Open Space Plan

The open space plan is meant to be a conceptual plan showing the basic outline of the open space network. This plan may already exist to some extent or it may have to be developed from the beginning. The open space plan will at least be an extension of an existing plan that takes into consideration the development suitability plan and the natural infrastructure. The type of development also determines the utilities that are needed to serve the development areas.

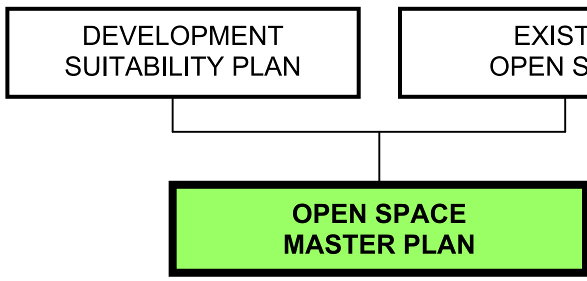


Fig. 4. OPEN SPACE MASTER PLAN

4c-Multiuse Corridor Template

The multiuse corridor template consists of guidelines and a series of typical cross-sections of different multiuse corridor scenarios. The guidelines and cross-sections are used with the Infrastructure Plan and the Open Space Plan to develop the Multiuse Corridor Master Plan. The multiuse corridor templates are used to bring together the infrastructure plan and the open space plan and weave them together.

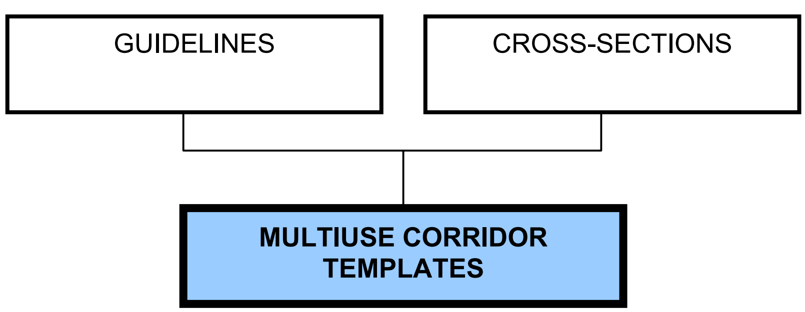


Fig. 5. MULTIUSE CORRIDOR TEMPLATES

Guidelines

The guidelines help place the entire multiuse corridor in the landscape, while the cross-sections define the arrangement of utilities in the corridor. The guidelines describe how the corridor relates to the landscape, how it should relate to slopes, streams, and vegetated areas, as well as built objects. These guidelines have been taken from different design recommendations relating to different types of greenway design, from general utility practices, and from specific innovative projects.

General

- Select most efficient routes and connections with existing infrastructure
- Use corridor as growth boundaries and buffers between development and natural areas
- Fit corridor to topography to minimize impact and allow for grade sensitive infrastructure

Environmental

- Link open space areas
- Minimize crossing of streams, wetlands and other sensitive habitat
- Maintain adequate buffer between the multiuse corridor and streams, wetlands and other sensitive habitat
    - Each situation should be evaluated to determine the proper buffer between the sensitive area and the potentially disturbing or harmful activities in the Multiuse Corridor.
- Portions of the corridor can widen to accommodate natural features
- Minimize fragmentation of habitat patches
    - Corridor should be routed to avoid fragmenting habitat
- Minimize construction easement through sensitive areas

Visual

- Minimize the view disruptions of overhead utilities from trails and adjacent properties
    - Underground placement would be used in most cases instead of overhead routings
- Avoid straight runs of 1,000 feet or greater to minimize visual impact
- Use existing linear elements in the landscape such as tree lines, roadways, and ridges

Cross-sections

Once the guidelines have been used to route the corridor, the cross-sections define how the uses are arranged within the corridor in the most efficient and beneficial layout. The cross-sections show how the different utilities can be laid in a corridor or run overhead and how open space usage or recreation can also occur in the corridor. They show in greater detail how the uses fit with the cross slopes, sensitive environment areas, and with adjacent uses.

The multiuse corridor cross-sections were developed by first reviewing the typical requirements of each utility. Then a further analysis looked at grouping certain utilities together and separating others for reasons of health and safety. The table organizes the information for each specific utility and this was used to develop each typical multiuse corridor template (Fig. 6.). The cross-sections follow some basic ideas on how to arrange uses in the most beneficial way.

- Cluster compatible utilities
- Place local service utilities to the outside of the corridor to minimize conflicts with new service connections and branch lines
- Configure access way to serve the maximum number of utilities in the corridor
    - In situations where the corridor is accommodating a trail it can be combined with utility maintenance access.
    - Factor in maintenance vehicle turn-around points (double as rest areas)
    - Build in excess capacity for future needs
    - Plan for future utility support structures and encourage structures to be multiuse where possible.

Fig. 6. Infrastructure Characteristics Table						
Infrastructure	**Jurisdiction**	**Type**	**Easement width (typ.)**	**Incompatible infrastructure**	**Opportunities**	**Constraints**
Gas Pipeline	National	Underground pipeline	50’	Electric transmission	Unobtrusive, Unbound by topography	Public safety
Domestic Water	Municipal	Underground pipeline	10’	Roadways	Visibility of water tanks	Water pressure, 10’ separation from waste water
Stormwater	Regional	Overland flow, pipes	Varies	Open space	Integration of natural areas and open space	Private property issues, public safety, grade sensitive
Waste water	Municipal	Underground pipeline	20’	Open space	Integration with open space	Gravity flow, pump stations, typically follows streams, 10’ separation from domestic water
Electric Transmission	Regional	Overhead & underground power lines 69 kv – 756 kv	100’-200’	Gas lines, fiber optics, open space	Unbound by topography	Visually obtrusive
Fiber Optics	Regional, National	Underground lines			Integration with other utilities	High repair costs
Roadway	Regional	Local roads	50’	Domestic water, electric	Basis of Multi-use corridor	Grade sensitive, noise
Highway	National	Limited access	150’		Basis of Multi-use corridor	Grade sensitive, noise, public safety
Railroad	Regional, National	At grade railroad	50’ - 150’	Fiber optics, electric transmission	Basis of Multi-use corridor	Grade sensitive, public safety
Solid Waste	Regional	Collection, processing and storage	N/A	N/A	Conversion to open space after closure	Troublesome site issues, ground water contamination
Open space	Municipal, regional	Parks, greenways and natural areas	N/A	Stormwater, waste water	Also serve as wildlife habitat	Public funding
Duct banks	Municipal, regional	Underground ducts	10’	Communications electric transmission	Unbound by topography	High initial cost

Duct banks are concrete encased plastic pipes grouped in underground ducts. They typically accommodate telephone, cable, fiber optic and electric lines. These lines are pulled through the ducts between manholes. Due to the nature of the lines contained in the duct banks they are not restricted by grade. Separate manholes must be provided for electric and communications lines due to code requirements. Manholes must also be placed every 200 feet, at junctions, and at bends in the line. The advantages of using duct banks are protection from weather and above ground activities, economy of trenching, minimizing future land disturbance, and the ease in maintaining and replacing lines. The disadvantages of duct banks are high initial costs, confined work areas and critical upfront planning.

Pipelines or other electric conductors near high-tension lines can result in AC interference. AC interference can make it dangerous for pipeline operations personnel as well as cause premature corrosion and breakdown of the pipe. It is possible to design mitigation systems to make the pipeline safe and increase its integrity.

4d-Multiuse Corridor Master Plan

The Multiuse Corridor Master Plan is the last stage of the design process. The Infrastructure Plan and the Open Space Plan are overlaid with project area base information such as topography and land cover. Then a Multiuse Corridor Template is applied to weave the two plans together.

The guidelines are first applied to determine the basic alignments of the corridors. This is a back and forth process of trying different groups of infrastructure with different alignments. Each of the guidelines is used to shape the alignment if applicable. This part of the process will also have to factor in information and make judgment calls about priorities, because many of the guidelines may conflict with each other. The goals for the specific project should be the basis for many of these decisions. For legitimate reasons there may be infrastructure that cannot be placed in a multiuse corridor and may have to be aligned by its self.

Once the basic corridor routes are determined, they are refined by applying the cross-sections. The cross-sections assist in determining the arrangement of the infrastructure in the corridor and whether that arrangement will work with the cross slopes and adjacent activities.

5-Design Project

The design project is a vehicle for testing the claims made in chapter three. It followed the design process outlined in chapter four and applies it to a real site. It is used to also refine some of the ideas stated earlier in the thesis, and is also evaluated in chapter six to determine its success.

Design Project Goals

The design project goals are derived from the position in chapter three and applicable goals of the Christiansburg Comprehensive Plan Update.

- Test Multiuse Corridor Planning Process
- Maximize the use of existing infrastructure
- Demonstrate that infrastructure and open space can be combined at the planning stage
- Develop a process for planning Multiuse corridor networks that is comprehensive, flexible, and simple.
- Develop strategies for accommodating multiple activities in Multiuse Corridor
- Protect natural resources and lessen the impact of conventional infrastructure

Study Area

The study area is located in Southwest Virginia, Montgomery County, directly west of Christiansburg. It is an area of approximately 2,600 acres or four square miles. The area is defined to the north by State Route 114, to the east by the western boundary of Christiansburg, to the south by US Route 11, and to the west by the drainage area for Christiansburg Waste Water Treatment Plant (C'brg WWTP). Ideally the design process would be applied to an entire urban area or region. However, that scope is not practical for a design project due to the volume of information required to inventory and analyze in a limited amount of time. The study area contains a wide variety of existing infrastructure and varied landscapes that are representative of the larger context of the Christiansburg.

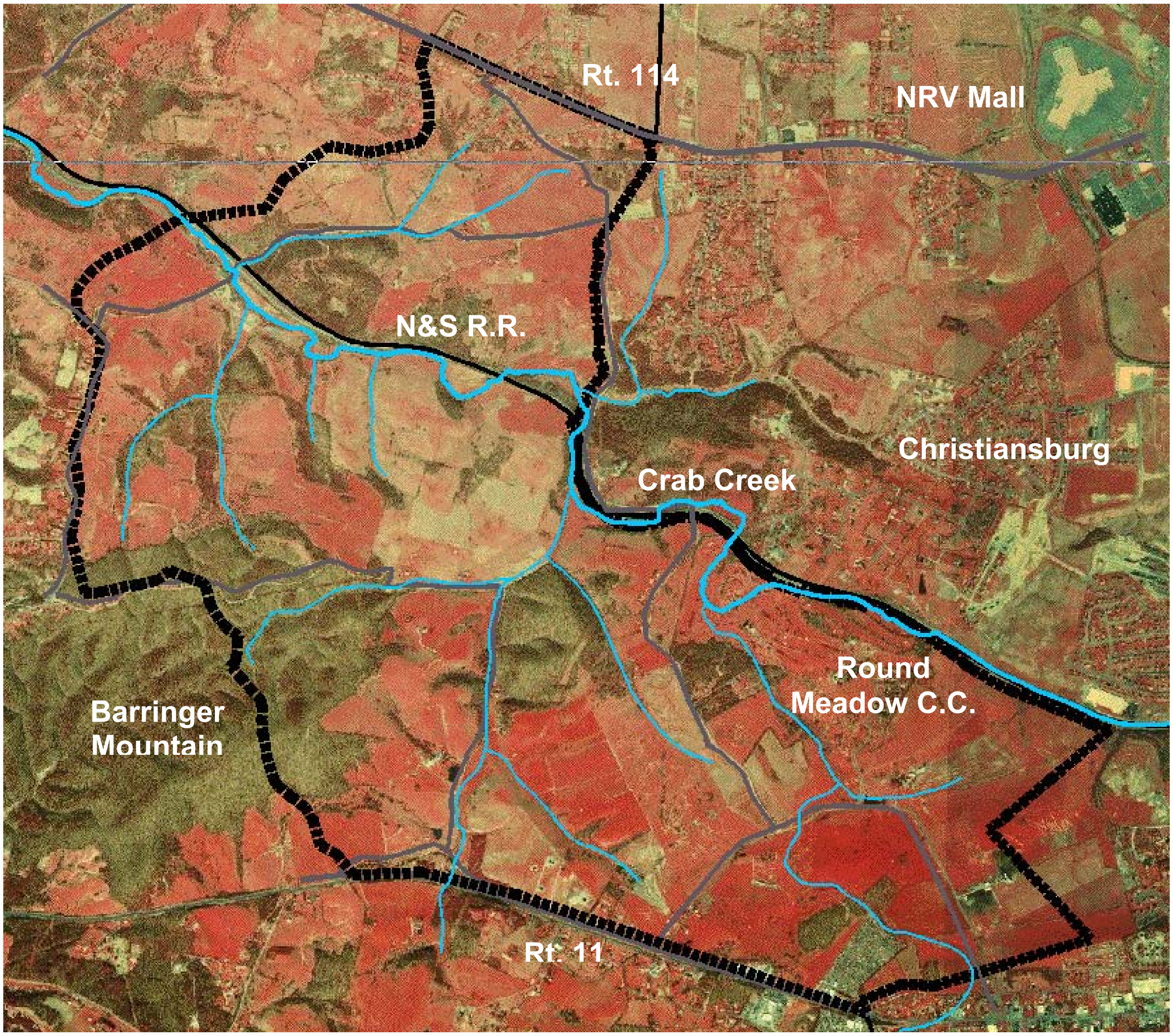


Fig. 7. Study Area Map

Panorama looking east

Typical local road (Barringer Mountain Road)

Railroad

The study area is currently experiencing some development in the form of single-family housing, but most land area is still in grazing or woodlands. The land is very rolling with some slopes exceeding 20 percent. The study area is bisected into north and south portions by a busy stretch of railroad that parallels Crab Creek. The Round Meadow Country Club is a golf course in the eastern portion of the study area. The entire study area is drained by Crab Creek.

Summary of Christiansburg 1993 Comprehensive Plan Update

The Christiansburg 1993 Comprehensive Plan Update was reviewed for information concerning development trends, plans for future growth, and the goals that would be related to the design project. The review found that the town's rapid growth in recent years can be attributed to its location along Interstate 81, US Routes 11, and 460; proximity to the nearby communities of Blacksburg and Radford; and expansion of the two nearby universities, Virginia Tech and Radford. The town has grown to be a retail center in the New River Valley Region, and the Falling Branch area along Interstate 81 is experiencing industrial expansion. The slope analysis in the Christiansburg 1993 Comprehensive Plan Update showed that many areas surrounding the town were too steep for development and limited the town's options for growth. Slopes to the west of town are less severe and better allow for low intensity development. Slopes to the east of town are predominantly 16% and greater (Fig. 8.).

Fig. 8. Christiansburg's Slope Analysis

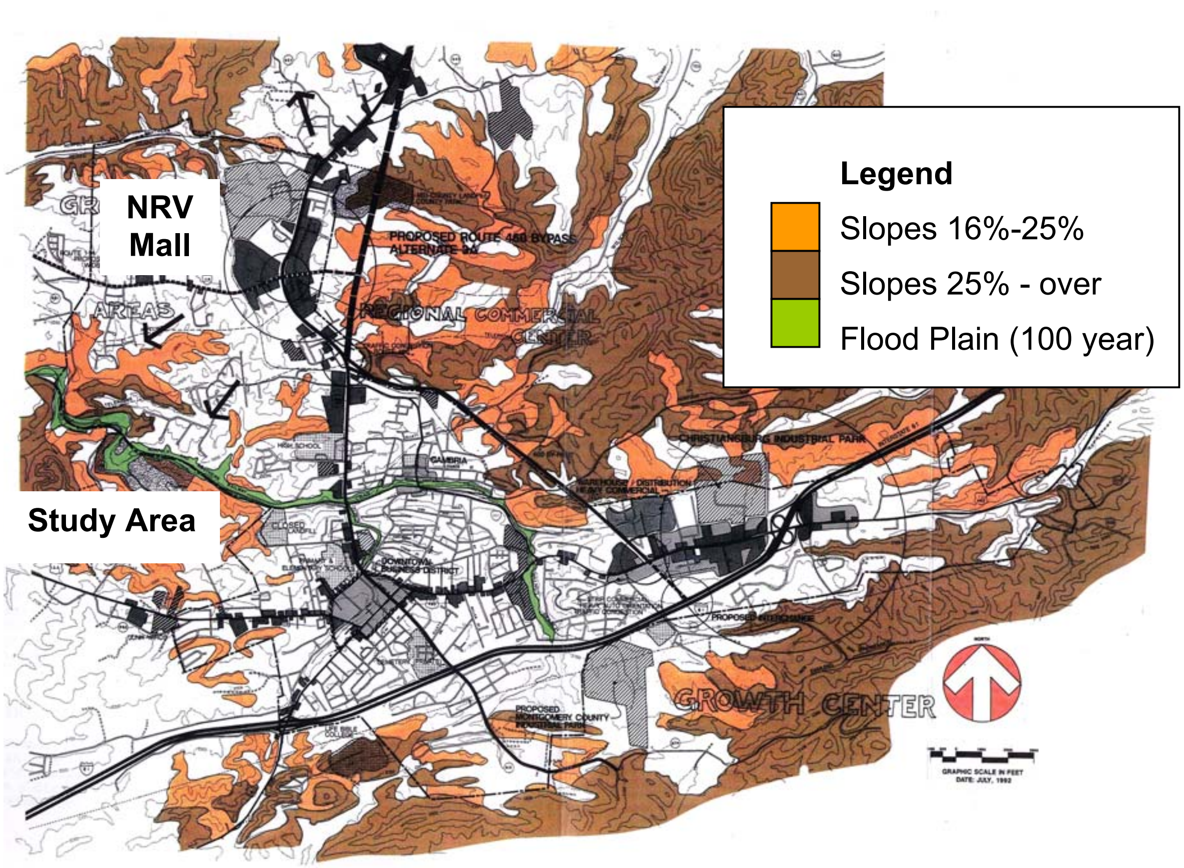


Fig. 8. Christiansburg's Slope Analysis

(Adapted from the Christiansburg 1993 Comprehensive Plan Update)

Goals & Objectives

The goals and objectives listed below were selected from the Comprehensive Plan due to their relevancy with the design project.

- Encourage development in areas where public utilities already exist.
- Require aesthetic improvements such as landscaping, attractive signage, buffers and underground utilities within subdivisions and new commercial developments.
- Expand public (municipal / county) ownership of open spaces and greenways within the Town. Protect the quality and reliability of the regional supply system.
- Eliminate private sewage facilities by extending sewage facilities to all customers within the Town limits.
- Encourage the County to limit development outside the Town limits to large lots unless the developer can connect to the municipal sewage system.
- Promote and encourage the use of the “Two Town Trolley” between Blacksburg and Christiansburg.
- Provide and maintain a safe, reliable water supply, treatment and distribution system for town residents.
- Protect by whatever means available the future use of the New River as a potential water supply source.

Stakeholders

The stakeholders for the design project include county residents, town residents, town officials and staff, developers, future residents, and private utility companies.

5a-Infrastructure Plan

The Existing Composite Infrastructure Plan illustrates a variety of infrastructure from municipal to private, local to national. It displays the entire infrastructure on one plan, so that any relationships between systems of infrastructure will be made obvious. This will help show opportunities and constraints of the existing infrastructure systems.

Roadways

The roadways in the study area range from US highway to one-lane dirt roads. They form the vehicular circulation system for the study area.

U.S. Route 11, Radford Street, Radford Road

- Paved 2-lanes with a center turn lane.

Primary State Route 114, (Peppers Ferry Road)

- Paved 2-lanes, planned widening to four lanes in the study area,
- Two 16-inch water supply mains, local power and communications lines

<u>Local roads</u>

Barringer Mountain Road, unpaved

Crisman Mill Road, paved and unpaved, portion to be paved

Crab Creek Road, unpaved, with a one-lane railroad underpass

Silver Lake Road, paved

Spaulding Road, paved and unpaved

Future paving and widening

Addition of local utilities, wastewater, domestic water, electric, communications

Multiuse trails

There is one underpass with the railroad and one at grade crossing. These will have to be upgraded or removed. This should be remedied in the first phases of development.

Railroad

Double track mainline, 24 trains per day, freight only, Abandoned and removed third track, Fiber optics lines, Maintenance roads, Historic structures

Passenger Rail proposal, Passenger rail or light rail, Rails with trails

Stormwater

Crab Creek drains the majority of Christiansburg as well as entire study area, few existing stormwater structures in study area

Increasing imperviousness of watershed will further degrade streams

Wastewater

Existing interceptor line along Crab Creek and tributaries, Christiansburg Waste Water Treatment Plant located on Crab Creek Road, plant can be expanded to double current capacity on site.

Interceptor maintenance roads that parallel Crab Creek can also serve as multiuse trails.

Domestic water

Mains on 114, Future branches for future growth can run off of 114 mains

Future water tower incorporated with multiuse tower

Gas line

Transcontinental gas line through study area, Route does not follow landform

Difficult for multiuse trail

Potential for easement to accommodate additional utilities

No local service

Electric

High voltage power lines, Route does not follow landform, no substation in study area

Possible substation to serve study area

Telephone

Regional underground telephone lines, Route does not follow landform

Difficult for multiuse trail, Potential to accommodate additional utilities

Parks and open space, Golf Course, to be purchased by Christiansburg

Future Wades Land Park and Diamond Hills Park adjacent to study area

Natural Infrastructure

Hydrology

Crab Creek and its tributaries, Existing wastewater interceptor and wastewater treatment plant along creek. Crab Creek is a perennial stream that drains a large portion of Christiansburg and flows into the New River. Smaller intermittent streams feed it. Many stretches along the streams are devoid of vegetation and grazing occurs along the stream banks. The streams are threatened by future development in the watershed that will alter the hydrologic regime and increase waterborne pollutants.

Ecological Greenway

Floodplain habitat and adjacent uplands

Linked habitat to New River

Future multiuse trail, Storm water management areas, Future wastewater routes

Soils, Soils are limited for single-family development by the presence of soils with moderate to severe limitations due to slope, shrink swell, and poor adaptability for onsite wastewater disposal systems

Topography, The study area has a change in elevation of approximately 650 feet. Extremes slopes approach 30 percent.

Vegetation

Vegetated patches include climax forest communities and old-field succession. These are found on the most severe slopes in the study area that are unsuitable for development of grazing. This is a favorable situation due to the high erosion potential on these steep slopes. The largest patch of forest in the study area is on Barringer Mountain, which extends out of the study area.

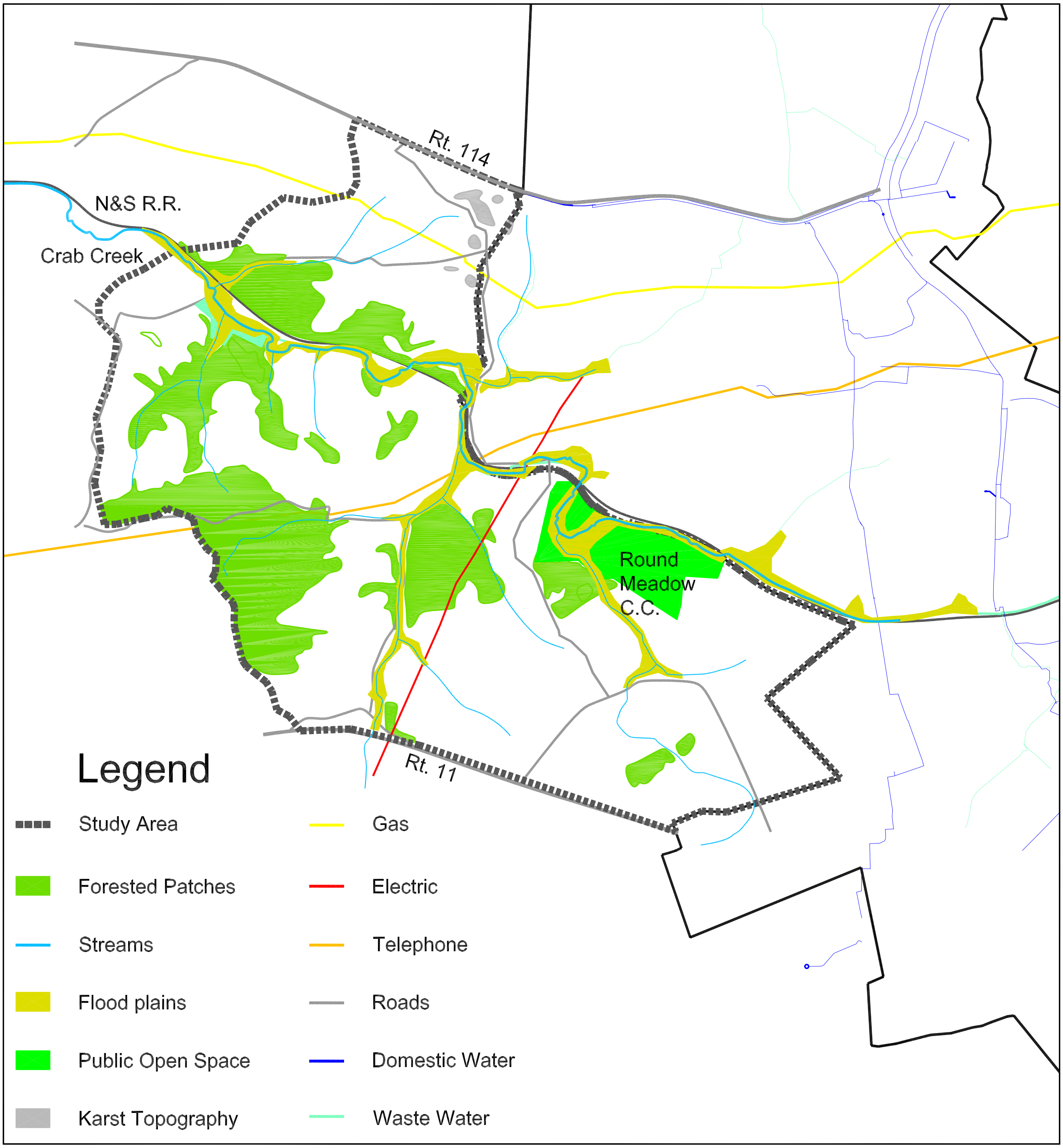


Fig. 9. Existing Composite Infrastructure Plan

Base information from USGS 7.5 minute Blacksburg South Quad Map revised 1988, Aerial map 1998 from Terra Server, Christiansburg Town Grid Maps Additional base information furnished from field visits performed Winter 2002

1" = 3,000'

3,000' 0' 3,000' 5,000'

Development Suitability Plan

The Development Suitability Plan is created by first performing a slope analysis of the study areas. Due to the rolling topography of the study area, slope is the essential layer of information in determining potential for development. Areas with a slope of 15 percent or less were determined to be developable for residential uses. These areas were further refined to exclude isolated areas smaller than 10 acres and areas adjacent to streams and other sensitive features. Some of the Development areas exist as single-family housing. These will remain in the development areas so as to be considered for proposed infrastructure service. The soils in the region are not conducive to on-site wastewater disposal; this forces most development to be on a municipal waste water system.

The Future Land Use Plan, the current zoning plan and the Comprehensive plan were examined to determine what type of development would occur in the study area. The most likely scenario would be single-family housing with some higher density housing. The Future Land Use Plan shows residential uses planned for the western portion of Christiansburg, adjacent to the study area. This would likely continue west into the study area (Fig. 10.).

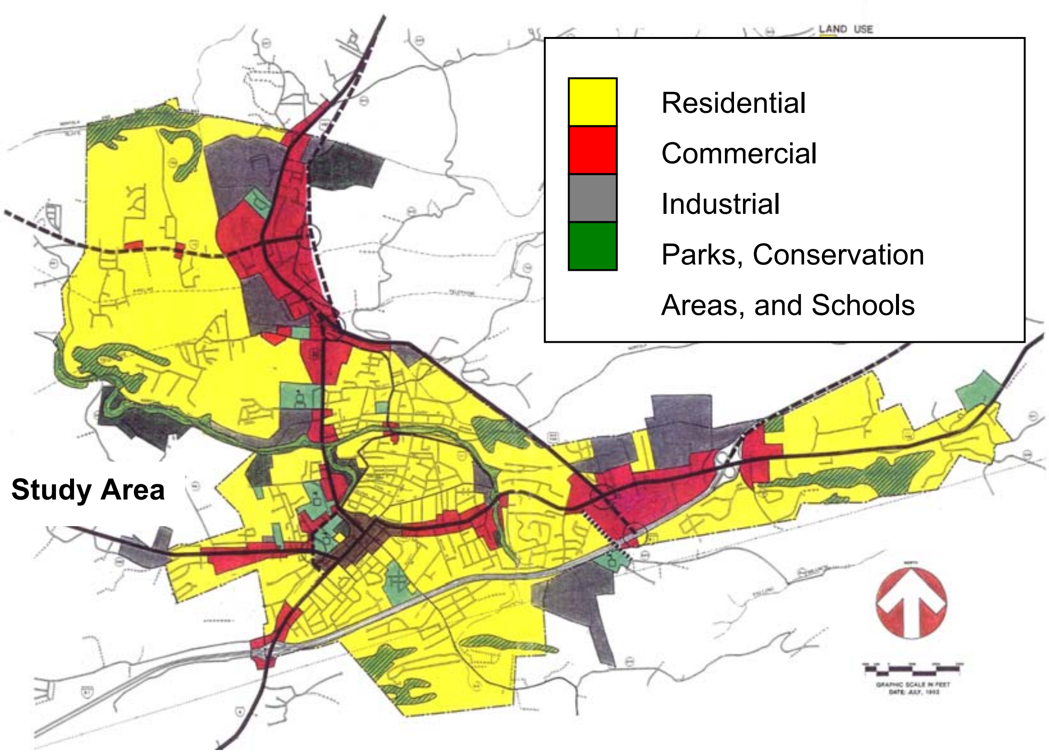


Fig. 10. Christiansburg's Future Land Use Plan
(Adapted from the Christiansburg 1993 Comprehensive Plan Update)

The area determined to be suitable for development is 802 acres, or 1.25 square miles. This would be approximately 30% of the study area. A mix of single family and townhouses would be likely using the precedent of recent development in the western portion of Christiansburg. The land area is divided up for 90% single-family housing and 10% townhouses.

Single Family Housing

1/2Acre lots with 25% in roads yields 270 units

Town Houses

10 units per acre with 25% in roads and parking yield 600 units

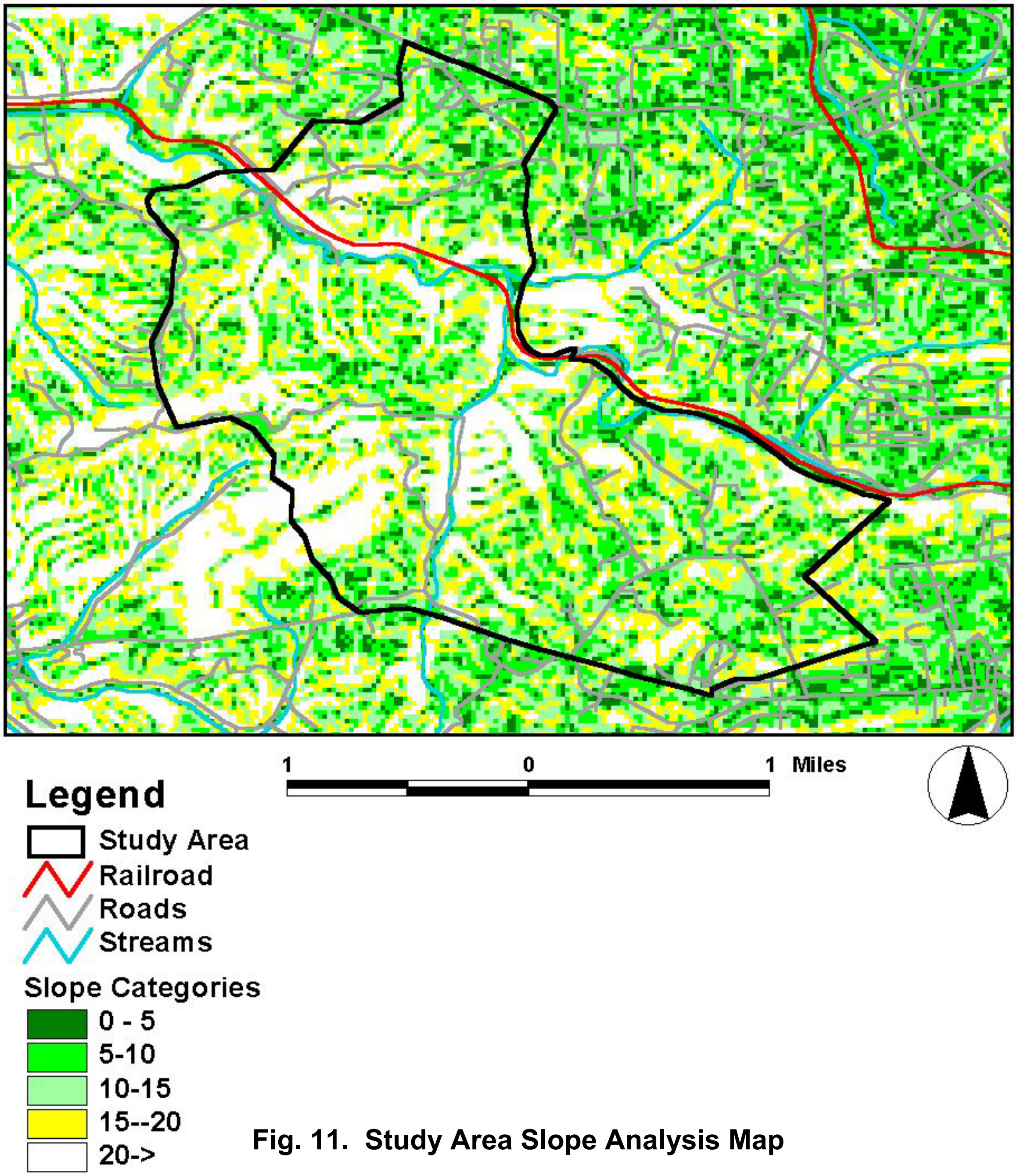


Fig. 11. Study Area Slope Analysis Map

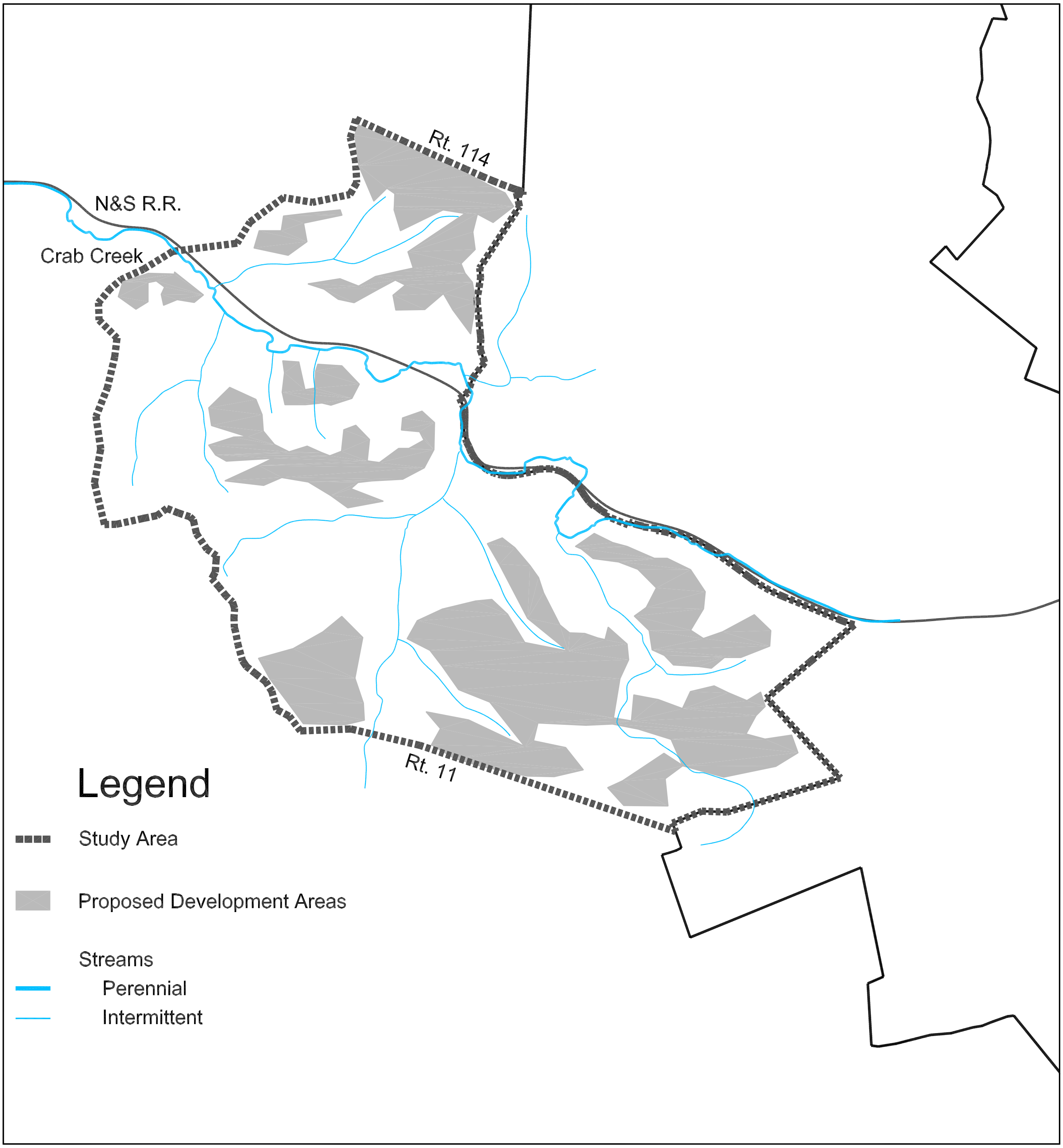
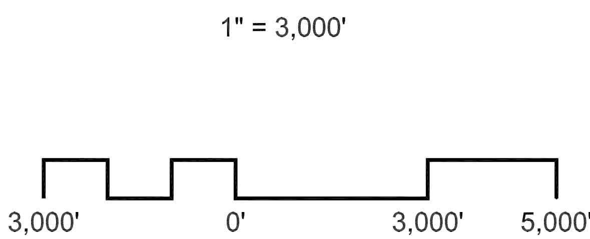
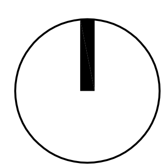


Fig. 12. Development Suitability Plan

Base information from USGS 7.5 minute Blacksburg South Quad Map revised 1988, Aerial map 1998 from Terra Server, Christiansburg Town Grid Maps Additional base information furnished from field visits performed Winter 2002





Infrastructure Plan

The Infrastructure Plan is a schematic plan depicting proposed infrastructure and its relationship with the development areas and existing infrastructure. It shows what kinds of infrastructure would be needed in the study area. The Development Suitability Plan was overlaid onto the Existing Composite Infrastructure Plan to create the Infrastructure Plan. The inventory and analysis of the existing infrastructure was used to determine what needs of the development could be met through existing infrastructure. A hypothetical program element was added in the form of a parkway to add a regional element that is not necessarily driven by development in the study area.

The goals of the infrastructure plan are to serve the residential areas with water, wastewater, electricity, and communications, to accommodate any proposed regional lines that are planned to run through the area, and to consider vehicular circulation. These are to be accomplished by utilizing the existing infrastructure as much as possible for local residential service, and by utilizing existing easements for other uses.

List of Proposed Infrastructure

Roads

Parkway, 4-lane roadway with median
Bridge over existing railroad
Criteria, link 114&11 and connections to development areas, resolve railroad conflicts, utilize existing roadways where possible
Domestic water
Connections to 114 water mains, water tower sited in study area, service development areas, connect to existing water mains along route 11 and provide connections to future water service south of route 11.
Waste Water
Connections to interceptor along Crab Creek, service development areas, connections to future waste water service south of route 11.
Duct Utilities (electric, telephone cable and other communications)
Provide service to development areas and connections to future service, connection to regional telephone line, and high voltage line within study area.

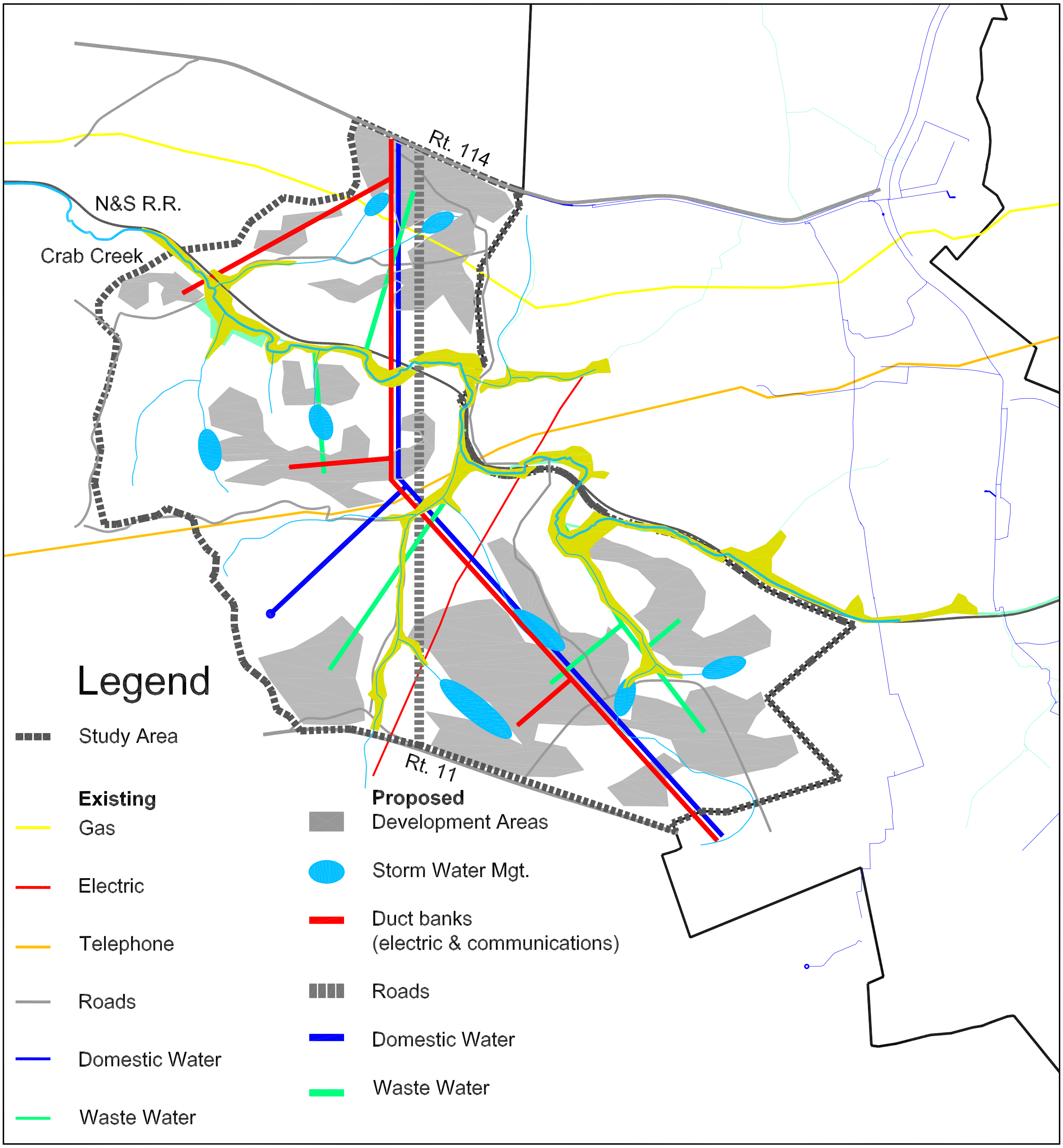
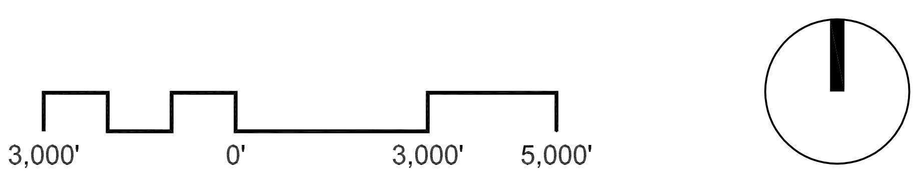


Fig. 13. Infrastructure Plan

Base information from USGS 7.5 minute Blacksburg South Quad Map revised 1988, Aerial map 1998 from Terra Server, Christiansburg Town Grid Maps Additional base information furnished from field visits performed Winter 2002

1" = 3,000'



5b-Open Space Plan

The Open Space Plan is a conceptual plan depicting a network of parks and greenways linking development areas with natural areas, and connections in Christiansburg with regional greenways. The goals of the open space plan are to provide recreation opportunities to the new residents, connect to Christiansburg's existing and planned open space network, connect to existing community nodes such as schools and churches, protect and interpret culturally and historically significant features, protect natural features and environmentally sensitive areas, and protect and enhance wildlife areas and migration corridors.

Existing information is first overlaid to inform the design, this information includes: streams, floodplain, vegetation, karst topography. The stream network and the 100-year flood plain serve as a logical framework for an open space network. Crab Creek serves as the spine of this network that connects into downtown Christiansburg and connects to the New River and other areas of future development. Other pieces are added to this framework; forested areas, steep slopes and neighborhood parks.

Neighborhood parks are planned to serve as the central open space of one or more of the development areas and as a primary connection with the open space system. They should be planned to provide three to five acres minimum for every one thousand residents of the development area (Calthorpe 1993). These parks serve as a gateway between the development areas and the multiuse corridor. The parks should be one to four acres in size, and include areas with minimal slope to accommodate active recreation. The higher density townhouses, community buildings, and small-scale commercial activity would be sited around the neighborhood parks to define them and allow them to serve as the nuclei of each development area.

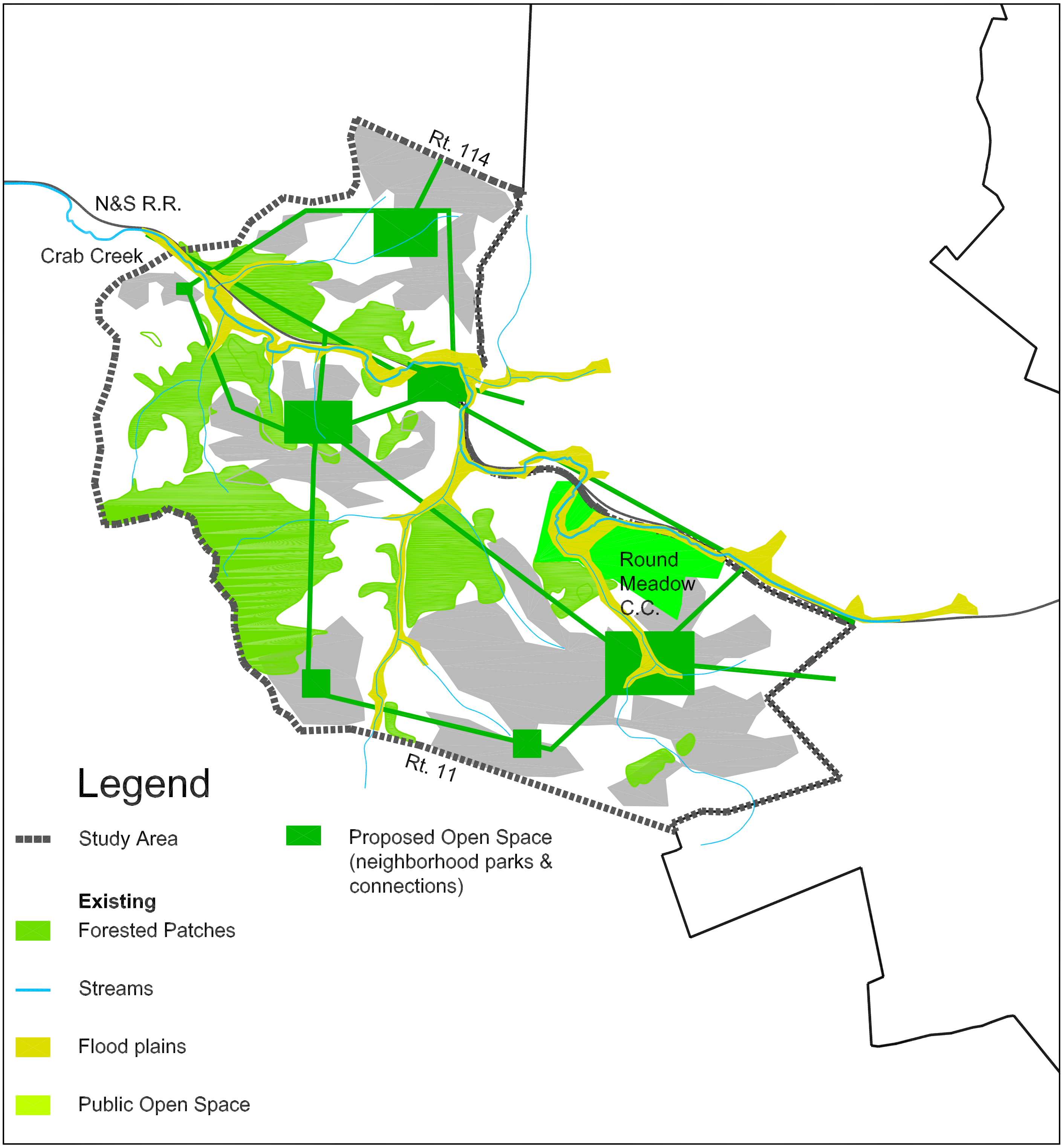


Fig. 14. Open Space Plan

1" = 3,000'

Base information from USGS 7.5 minute
Blacksburg South Quad Map revised 1988,
Aerial map 1998 from Terra Server,
Christiansburg Town Grid Maps
Additional base information furnished from
field visits performed Winter 2002

5c-Multiuse Corridor Templates

The Multiuse Corridor Templates are adapted to conditions and characteristics of the study area. The guidelines in section 4c are adapted to the landscape characteristics of the study area. They address the rolling topography and steep slopes present in the study area. The cross-sections are adapted to the specific utilities that are present in the study area and the particular requirements that each utility may have.

Guidelines

- Corridors sited along stream valleys should stay to the side that minimizes severing of the stream riparian corridor with uplands habitat.
- Disruptive and damaging activities occurring in the Multiuse Corridor should, where practical, be placed furthest from sensitive habitat, and out of the 100-year flood plain.
- In situations where the corridor crosses sensitive habitat eco duct principles should be used to minimize impacts of the crossing.
- Corridor can be widened to accommodate natural features within the corridor i.e. rock outcroppings or vegetation.

5d-Multiuse Corridor Master Plan

The Multiuse Corridor Master Plan consists of seven interconnected corridors that provide service to the development area, routes to regional infrastructure and infrastructure connections to adjacent areas. The corridors are also the framework of an open space system that provides for the recreational needs of the study area future residents, preserves natural areas, environmentally sensitive areas, and culturally significant features.

List of Multiuse Corridors (Fig. 15, 16.)

1. Crab Creek Road
   - Upgrade of unpaved roadway
   - Restoration of stream
   - Installation of domestic water line, waste water line, duct bank, recreation trail

2. Parkway Section 1
   - Build 2-lanes of 4-lane roadway
   - Install domestic water main, duct bank

3. Barringer Mountain
   - Install Domestic water main, Multiuse tower, recreation trail

4. Barringer Road
   - Abandon road to through traffic
   - Install domestic water main, duct bank, waste water main
   - Restore stream, install recreation trail along abandoned roadway

5. Parkway Section 2
   - Build 2-lanes of 4-lane roadway
   - Install domestic water main, duct bank
   - Install recreation trail along roadway

6. Round Meadow
   - Install waste water main
   - Restore stream and install recreation trail

7. Railroad Corridor
   - Restore stream and install recreation trail

The relationship and interface between the multiuse corridor and the development area should receive special attention. There are opportunities to set off the corridor to become the central open space of the development areas rather a division. Housing should front the corridors where appropriate to emphasize the corridor as more of a front yard to maximize public access of its recreational amenities and favorable vistas.

Access points should be carefully selected to allow for safe, convenient access to the recreation trails (fig. 21).

The master plan calls for the revegetation of stream corridors to filter runoff, provide wildlife habitat, and reduce erosion. Many of the streams are devoid of vegetation; suffer from excessive erosion, and pollution from animal waste runoff. The revegetation should be seen as a restoration rather than an alteration as it will help to alleviate some of the environmental problems mentioned. The revegetation process will be implemented along with the multiuse corridors and will take some time to fully mature. This will gradually alter the existing views, but will help screen views of new development.

The parkway would ultimately take the form of a four land divided roadway with a vegetated median. Each two lanes would have their own alignment that would allow the road to fit better with the topography and minimize its visual impact (fig. 21.). The median could vary in width in order preserve features in the right of way. Minimal travel way widths would be used to help control the maximum speed of 35 miles per hour. In residential areas parallel parking would be placed along the residential side of the roadway to serve as a buffer and help calm traffic. Traffic circles would be used at intersections with streets, and pedestrian crossing would be striped and signalized. Sidewalks and trails would parallel the roadway where appropriate and street trees would be planted. Transit stops would be located at strategic points along the parkway to allow for future bus service (fig. 18.).

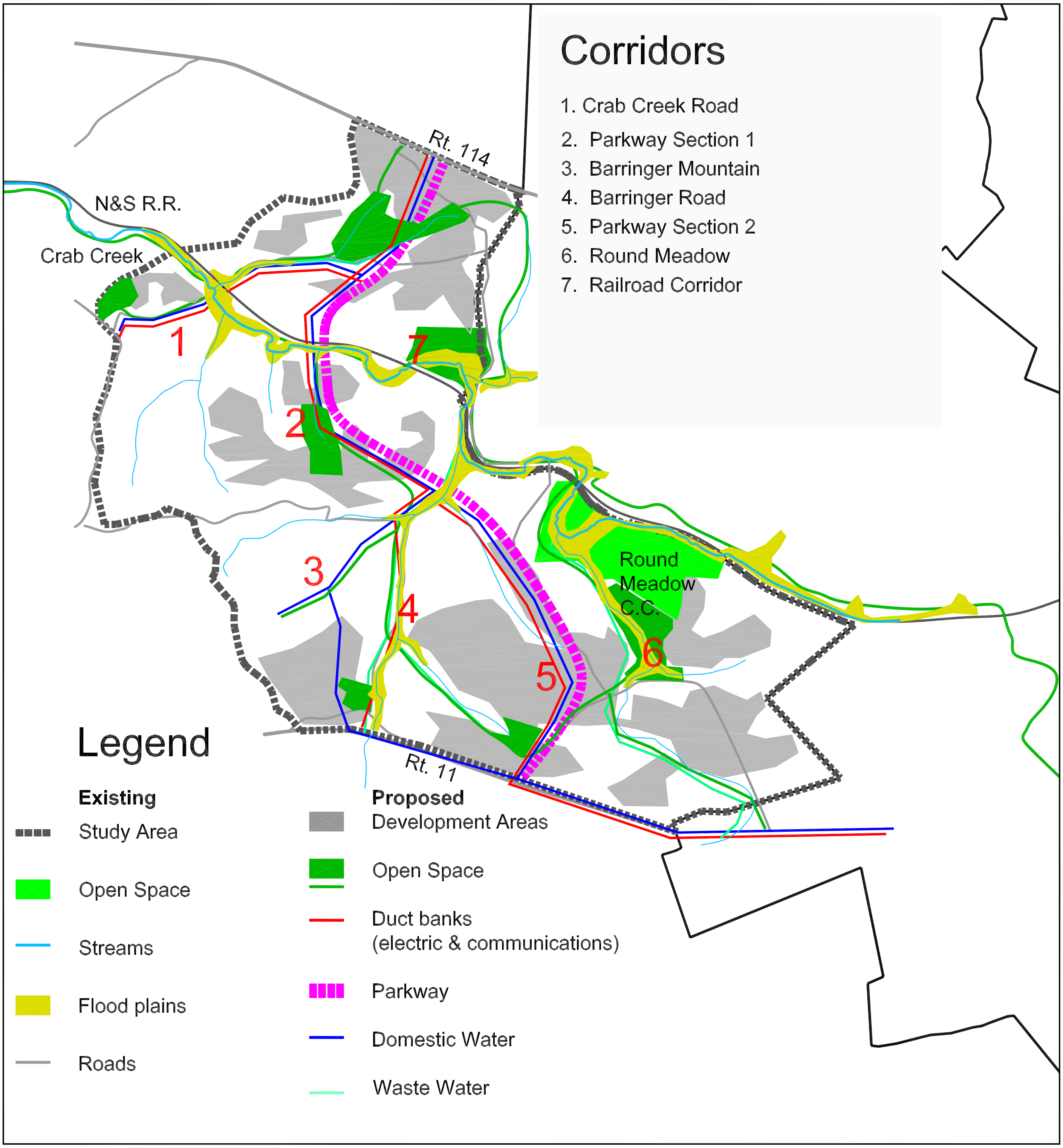


Fig. 15. (Draft) Multiuse Corridor Master Plan

Base information from USGS 7.5 minute Blacksburg South Quad Map revised 1988, Aerial map 1998 from Terra Server, Christiansburg Town Grid Maps Additional base information furnished from field visits performed Winter 2002

1" = 3,000'

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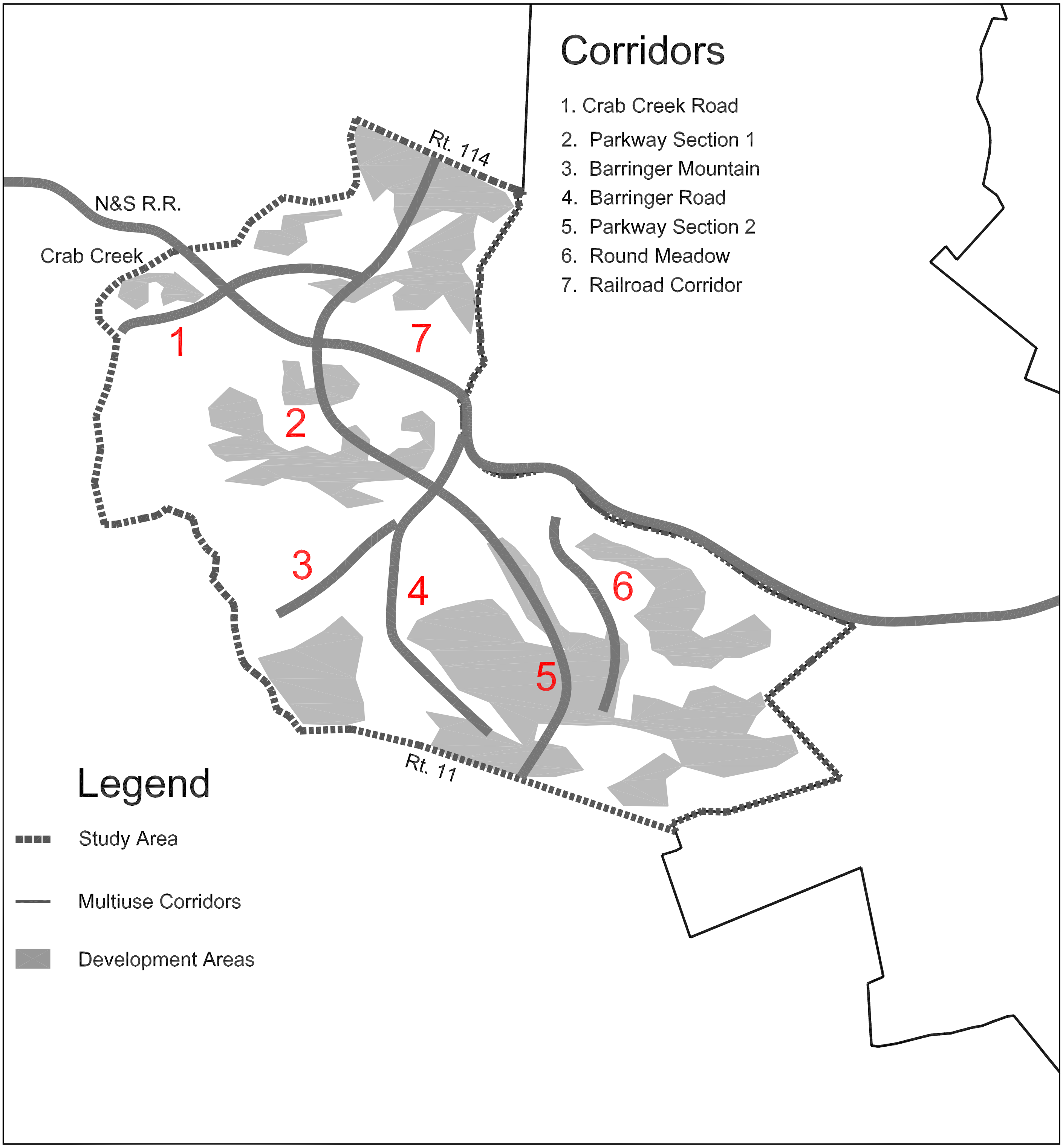

Fig. 16. Multiuse Corridor Master Plan

Base information from USGS 7.5 minute Blacksburg South Quad Map revised 1988, Aerial map 1998 from Terra Server, Christiansburg Town Grid Maps Additional base information furnished from field visits performed Winter 2002

1" = 3,000'

3,000' 0' 3,000' 5,000'

Fig. 17. Proposed Crab Creek Park

Plan

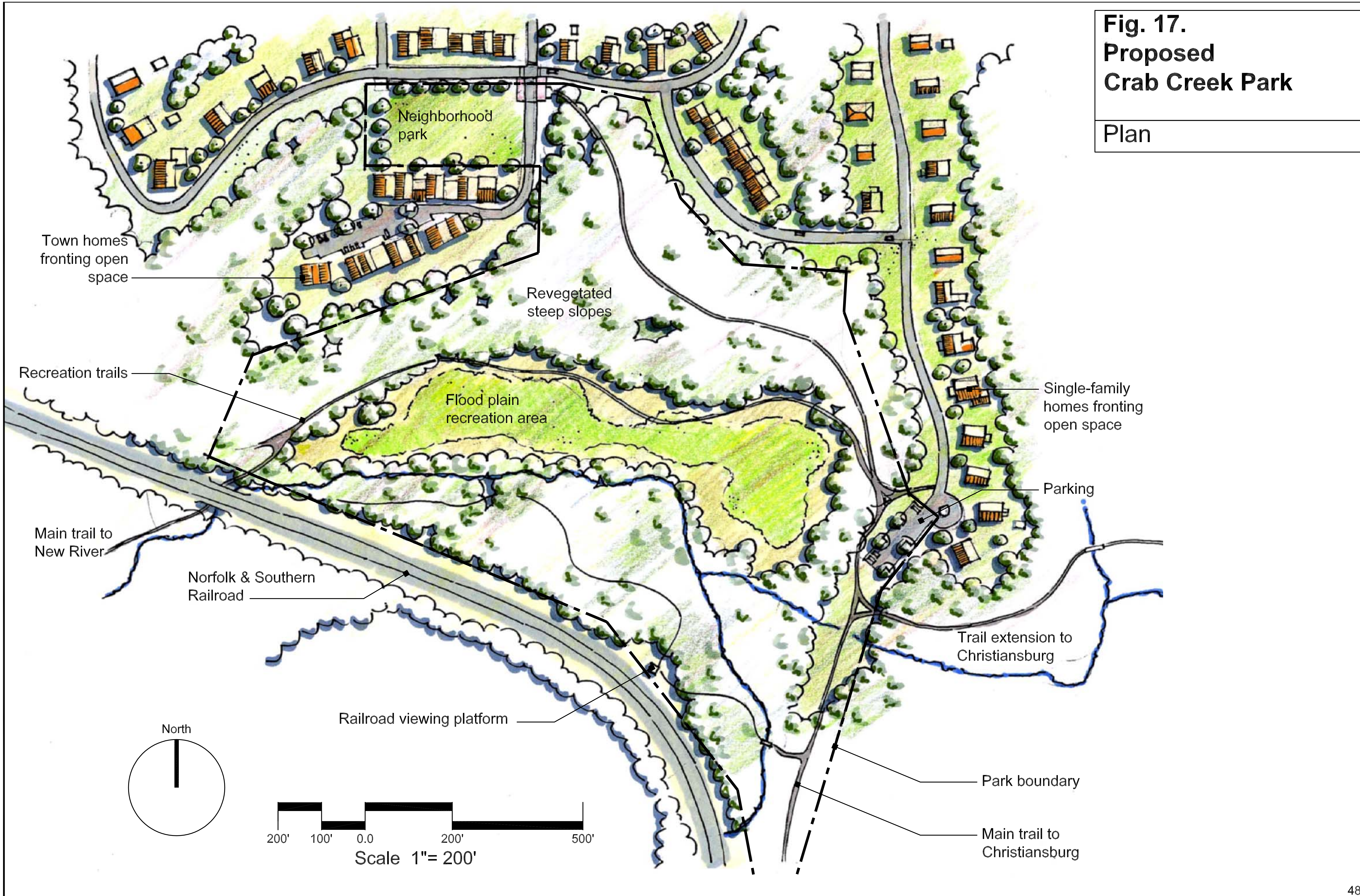

Fig. 18.
Parkway Corridor

Typical Plan Enlargement

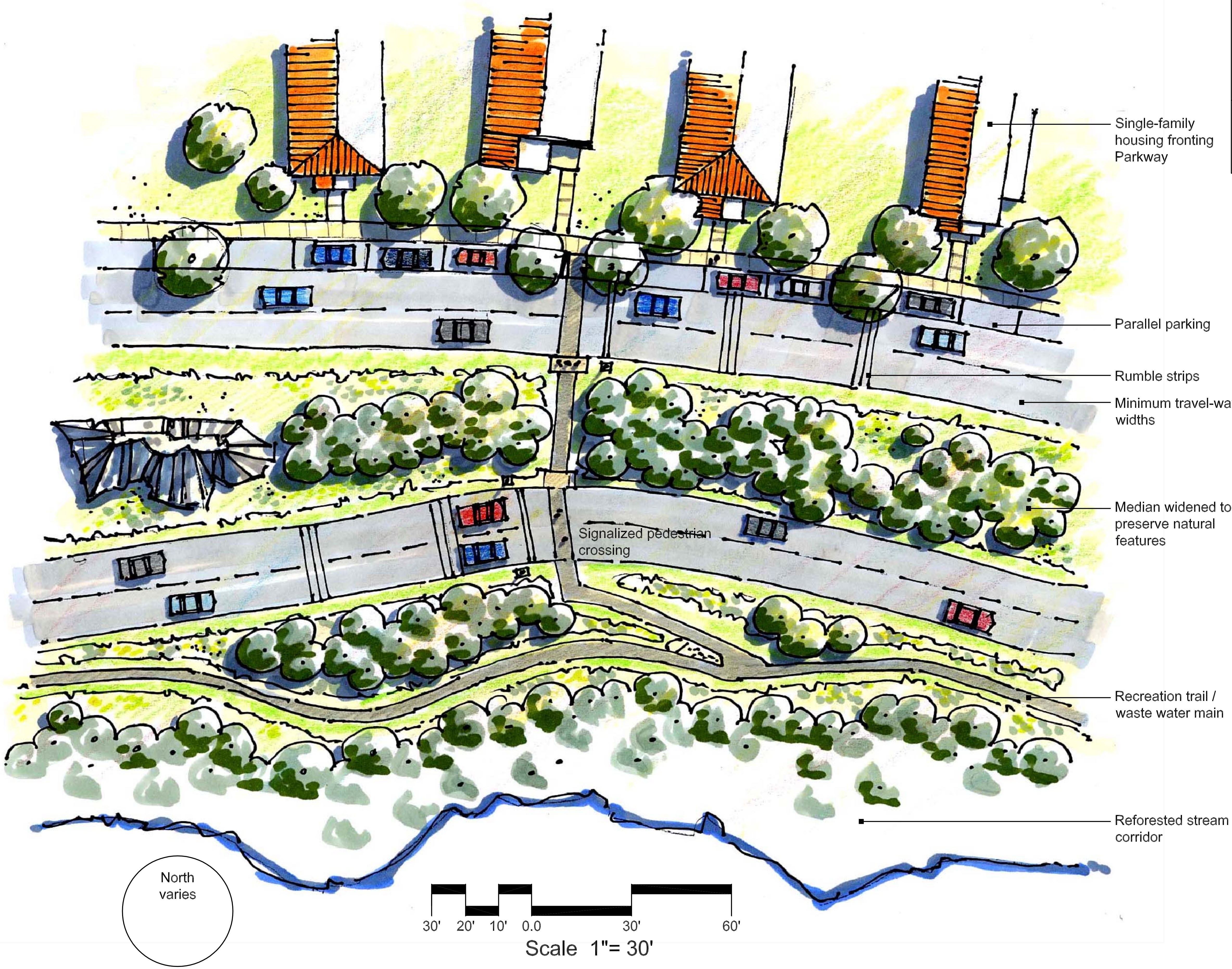

Fig. 19. Relationship to Development Section

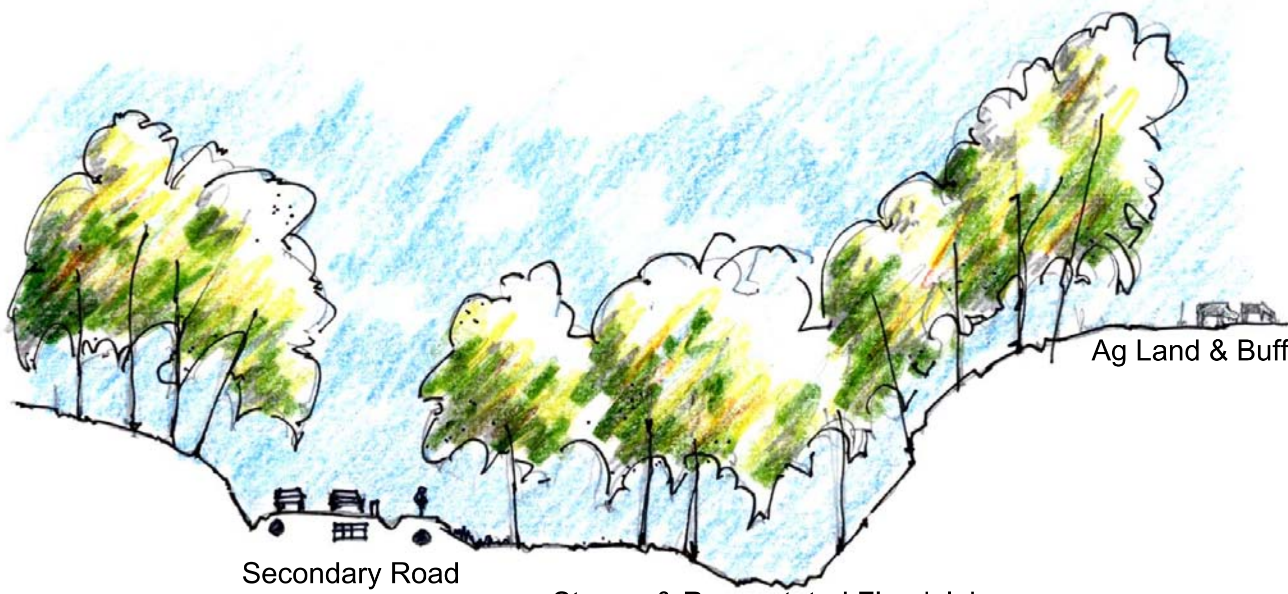

Fig. 20. Crab Creek Road Section

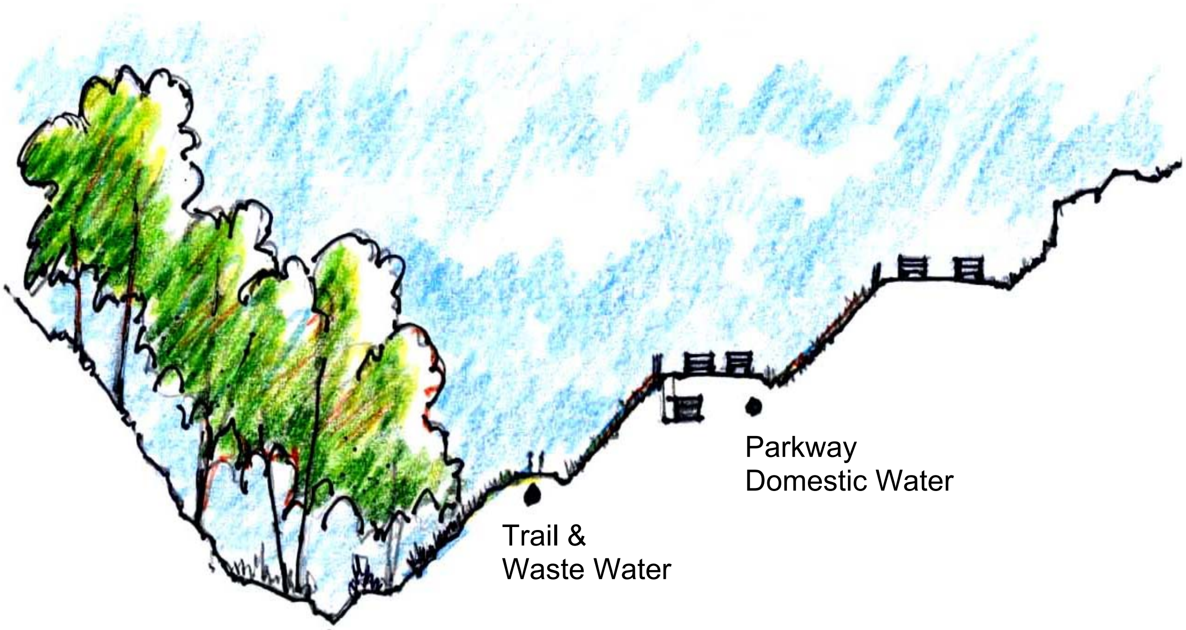

Fig. 21. Parkway Section

Fig. 22. Railroad Corridor Section

Fig. 23. Barringer Mountain Multiuse Tower Perspective
Water Storage, communications, and public observation Platform

5e-Implementation

The Multiuse Corridor Master Plan is meant to guide infrastructure and open space construction for the next 10 to 20 years. Three questions are raised in the implementation stage; what gets built when, who does it, and who pays for it. The implementation section only begins to delve into these complicated issues and is not meant to provide definitive answers.

Phasing

The phasing plan address the question of what gets built when. It would show the stages of implementation of the Multiuse Corridor Master Plan. This would have to consider the economic and political realities of the Christiansburg and Montgomery County. The services for each development area would have to be put in as that area was built. The parkway could be built as a 2-lane road with the second 2-lanes built at a later date. The other utilities and open space would be, most likely, built with the first phase of road construction. The greenways and parks would be installed along with other parts of the corridor, but should be in place before build out of that specific development area occurs.

Administration

Due to the variety of groups involved in the multiuse corridors, a county group should be charged with administering the Multiuse Corridor Master Plan. This could be given to an existing department such as planning. However, that department should be budgeted additional resources in order to be able to handle the additional workload. Because many of the utilities serving the study area will be Christiansburg's, those departments should be reorganized to allow for the coordination of all the planning for each separate utility. A senior town staff person should be responsible for heading this effort and be given the authority and resources to involve all the town's affected departments. The Town Comprehensive Plan should include in its goals, the coordination of infrastructure and open space planning.

The Multiuse Corridor Master Plan will have to be coordinated and integrated into other planning activities. These would include the Christiansburg Comprehensive Plan, the Montgomery County Comprehensive Plan, and the VDOT 6 year plan.

Financing

It is common practice to require the developers to pay for the public infrastructure of their project and then turn it over to the municipality for operation. This practice could also be applied to the multiuse corridors that serve the development areas. The private utilities that use the multiuse corridor would also help pay for the overall corridor costs. T21 money would also be available for the trail planning and building portions of the corridors. Several funding sources would be available for constructions because of the multiple uses occurring. These sources would share the costs of easements, land acquisition, restoration of streams, constructions of trails and planting of vegetative buffers. The human infrastructure would essentially pay for natural infrastructure and open space.

6-Conclusions

The conclusions are derived from evaluating the process described in chapter four and its application in chapter five. The process was refined while applying it to the design project. It would be probable the process could be further refined by further applications.

6A-Evaluation of Design Project

The evaluation of the Design Project is based on the goals outlined in chapter 3.

Goals

- Demonstrate that infrastructure and open space can be combined at the planning stage
- Develop a process for planning Multiuse corridor networks
  - Comprehensive
  - Flexible
  - Simple
  - Existing infrastructure inventory and analysis process
- Develop strategies for accommodating multiple activities in Multiuse Corridor
- Demonstrate integration of infrastructure with open space
- Protect natural resources and lessen the impact of conventional infrastructure

The design project was able to coordinate existing infrastructure, development and proposed infrastructure. The Open Space design utilized the Christiansburg's open space plan to create an open space/parks network that served as an extension of Christiansburg's parks. This would provide a system that would grow with the town rather than being retrofitted after development has occurred. The proposed parkway fitted well with development and other infrastructure to create a multiuse corridor that complemented the landscape and became a linking, rather than a dividing element. The stream corridors worked well as a framework for the open space plan network and as multiuse corridors. Several of the multiuse corridors are along streams and include stream restoration in their list of proposed improvements. This creates habitat in currently denuded stream corridors, provides some type of buffer from the impacts of storm water runoff and adjacent uses, and helps lower stream water temperatures. The streams would have incompatible uses removed from their corridor and allow then to better function as ecological greenways. The proposed stormwater management network places basins adjacent to the development areas, as close to the source of runoff as possible. In several instances, the basins are included in the open space network. The Multiuse Corridor Master Plan did consider and incorporate, where possible, new uses and infrastructure into the existing infrastructure easements.

The design project could not take advantage of utilities like gas and telephone lines due to their alignments disregard for topography. This makes them unusable for gravity utility systems like wastewater and are unattractive as recreational trail routes. The railroad is very active and it is difficult to coordinate or share its space with other uses.

6b-Evaluation of Multiuse Corridor Planning Process

The Design Process is the part of this thesis that can be applied to a variety of situations. It has potential benefit beyond the design project. The strengths of the design process come mainly from the multifaceted approach to problem. The process was applied with little modification to fit the design project. The most valuable aspect of the design project is determining where growth should occur and developing an efficient infrastructure system to support and encourage growth in those areas. This is different from the normal way infrastructure is implemented in that the process is a planned comprehensive effort than a piecemeal haphazard effort. Open space planners can use the existing infrastructure plan portion of the design process to find routes available for greenways that otherwise would not be considered.

The process inventories existing infrastructure and determines its additional uses in relation to the multiuse corridor concept. Existing infrastructure is a problem in that it is in place and often times is not in the right place or configuration for potential multiuse. This might make the design process less successful in established regions with highly developed infrastructure. Some of the ideas may work better on a larger scale than the design project or in a higher growth area. These ideas may also be more applicable in lesser-developed parts of the world where infrastructure is not in place.

A problem with the clustering of utilities occurs when there is an outage there is the potential of having more than just the one utility out of service. This could cause massive disruptions to the population centers that these utilities serve. The intersection of multiuse corridors that contain critical utilities would also present a target to terrorism. There could however be steps taken to minimize these vulnerabilities.

There is an opportunity to put open space in locations where it will maximize the benefit for residents and create strong links between the open space and residential areas. Achieving the benefits of this plan will take some time and may only be fully realized in the build out of the study area. It is likely that the initial capital investment will be greater than if each use worked on its own. The potential benefits of the multiuse corridors could be used in the negotiations of easements between municipalities, landowners and utility companies.

The process described in chapter four can be used by a design team as a guide through the infrastructure and open space planning process, but it is the responsibility of the team to determine the parts of the process that are applicable, and the parts that are missing. Certain projects may require more information to produce a Development Suitability Plan or an open space plan may already exist for an area. The process can also be adapted as a way of developing an open space plan.

The design process is lengthy and requires the time consuming inventory and analysis of existing infrastructure. It requires inter- disciplinary and inter-organizational cooperation. It attempts to utilize easements that private companies retain complete control. Existing easements may only allow underground use of the easement and does not allow for recreational uses. There is a problem with different scales of infrastructure and how they relate to each other, which may not be entirely solved in developing cross-sections. A large national network would be hard pressed to coordinate with every municipality's infrastructure plan that was along its route.
There is the cost of not planning for an open space system and trying to retrofit one after the community is in place. The open space system that results will never function as well as one that was planned from the onset and it will probably cost more in the end.

6c-Implication to Professionals

The multiuse corridor planning process described moves away from the practice of planning a single system of infrastructure by a single discipline. It is meant to be a collaborative effort between many different professions. The process brings in professionals that are not typically involved with infrastructure planning as well as open space planning. This would allow infrastructure to be integrated into more phases of design and be manipulated to accommodate multiple goals. The design team should include a more diverse membership such as architects, engineers, planners, landscape architects, ecologists, natural resource experts, and others. It would behoove other design professionals to understand the basic design criteria and limitations of infrastructure planning and design and insist on contributing to that effort. This interdisciplinary effort may spillover into other aspects of design such as downtown revitalization and subdivision design. This may make the instance of a single profession designing a less likely scenario.

There are many opportunities in the multiuse corridor planning process for landscape architects to be key members of an interdisciplinary design team. There is a wide range of information that needs to be brought together and analyzed. The larger context of the project area needs to be understood. Design decisions need to be made that will affect the natural and human environments. There would many situations that a landscape architect would be the best professional to lead a design team.

6d-Further Research

In the course of this project and its evaluation, there are questions raised that go beyond the scope of the project. These questions may have potential for further research that could build on this thesis and create a larger, more useful body of work. Many of these questions are beyond the realm of landscape architecture and arise from the subject of implementing the ideas proposed in this thesis. Implementation barriers may include legal, economic, and logistical problems.

Research could be done to work directly with representatives of specific utilities to develop innovative ways of integrating their systems with other forms of infrastructure and open space. How much coordination exists between utility companies and other groups involved with infrastructure?

Construction techniques could be developed that would reduce construction easement widths, land disturbance, and separation from other utilities. Investigate current efforts to integrate infrastructure.

The investigation of the utility design requirements did not probe the reasons for certain required easement widths and other standard design practices. Further investigation into the reasons would be essential to attempts in reducing dimensional requirements for each utility. This would allow for accommodating more uses in a narrower multiuse corridor. One such way of reducing individual utility requirements is the use of new construction techniques. Research could be done on construction techniques that are entirely new or existing techniques that could be applied to this type of construction.

An expanded test of the multiuse corridor planning and design process could develop variations on the design process that could be applied more successfully to different parts of the country. This would create regional design processes that focus on addressing and incorporating the characteristics of that region.

7-References

Books and Articles

Ahern, J., 1991. Planning for an extensive Open Space System: Linking Landscape and Function. 21: 131-145

Ahern, J., 1995. Greenways as a Planning Strategy, Landscape and Urban Planning. 33: 131-155

Calthorpe, Peter, 1993. The Next American Metropolis Ecology, Community, and the American Dream, Princton Architectural Press

Chusid, Jeffrey M., The Subtle Side of Texas, Landscape Architecture Magazine, May 2002, p 50-56

Flink, Charles A. and Robert M. Searns. Greenways, A Guide to Planning, Design and Development. Washington D. C. Island Press, The Conservation Fund, 1993.

Flink, Charles A. et al. Trails for the Twenty-first Century, second edition. Rails to Trails Conservancy. Island Press. 2001

Hill, James C. Utility Corridor Concepts, Conference on Engineering Utility Tunnels in Urban Areas Proceedings, American Public Works Association, 1972

Kark, Warren R.. Planning of the Urban Infrastructure. University Printing Services, Virginia Tech. 2001

Krieger, Alex. David Cobb. Mapping Boston. MIT Press. 1999. p 212

Little, Charles E. Greenways for America. Baltimore: The Johns Hopkins University Press, 1990.

Lynch, Kevin, Gary Hack, Site Planning 3rd Edition, MIT Press, 1984

Mac Donald, Stuart H., Greenways: Preserving our Urban Environment

Melosi, Matin V., The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present, The Johns Hopkins University Press, 2000.

National Association of Home Builders, Land Development, 1987

Portland Parks and Recreation, Parks 2020 Vision, 2001

Ryan, Robert L., Mark Linhult, Knitting New England Together, Landscape Architecture Magazine, February 2000, 50-55

Rockwood, P., Landscape Design, Integrated open space Planning, March 1990, 28-29

Schrijnen, Pieter M., 2000. Infrastructure networks and red-green patterns in city regions, Landscape and Urban Planning. 48: 191-204

Schulz, David F. What is Infrastructure?. 11/18/2001, http:/iti.acns.nwu.edu/def_infr.html

Simonds, J.O., Earthscape, A Manual of Environmental Planning and Design, Van Nostrand Reinhold, 1978. p 170-173

Thompson, J.W., Kim Sorvig, Sustainable Landscape Construction, Island Press, 2000.

Turner, T., 1995. Greenways, blueways, skyways and other ways to a better London, Landscape and Urban Planning. 33: 269-282

Alameda Watershed Management Plan. San Francisco Public Utilities Commision. EDAW. 1998.

Viles, R.L., D.J. Rosier., 2001, How to use roads in the creation of greenways: case studies in three New Zealand landscapes, Landscape and Urban Planning. 55: 15-27

Maps

Town of Christiansburg, Virginia, 1993 Comprehensive Plan Update, Town Planning Commission assisted by: K. W. Poore & Associated, INC., December 21, 1993

Christiansburg Zoning Map, 2002

USGS downloaded JPEG file of Christiansburg area dated 1988, Terra Server, February 2002

Aerial map of Christiansburg area dated 1998, Terra Server, February 2002

Montgomery County, Comprehensive Plan, GIS date set

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