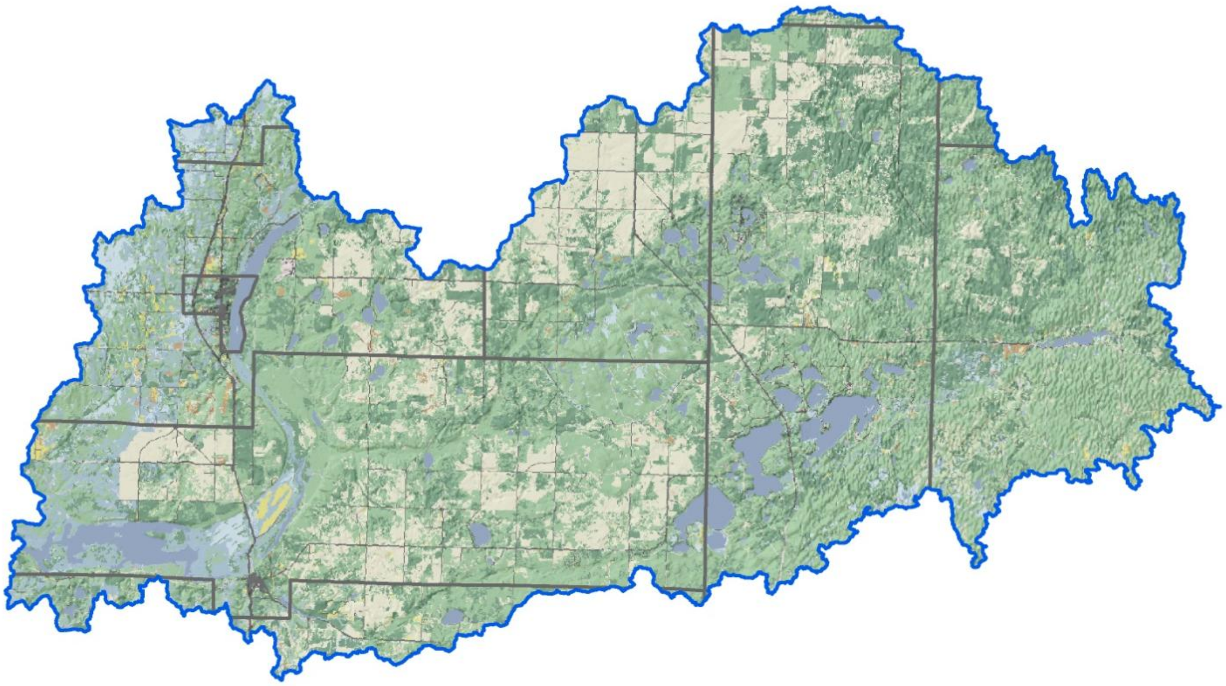
Residential Build-Out Assessment for the Upper St. Croix Watershed



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December 11, 2009

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Abstract

As part of the lake and watershed management planning process, Center for Land Use Education (CLUE) conducted a residential build-out analysis for the USCECRW to identify future residential development potential in accordance with current land regulations. The results are displayed in two ways: for the entire watershed and within direct drainage areas. We used Geographic Information Systems (GIS) software, land information, and Community Viz™ to identify and quantify development constraints (i.e., land-based features that restrict future development) and land yet available for future development. Current zoning regulations (mapped at the parcel level) were applied to the net developable land to produce maps and tables of build-out numbers in terms of the total and location of potential residential development. Finally, future land use maps were created to reflect the watershed as if it were completely built-out. The process produced theoretical growth scenarios for the watershed based on development constraints and the effect of specific zoning regulations. In total, three build-out scenarios were generated taking into account various wetland alternatives. We used a range of data sources to identify potential wetland areas as possible constraints to development in addition to other environmental and physical constraints. Results of the build-out scenarios were incorporated into a Soil Water & Assessment Tool (SWAT) to quantify the potential water quality impact of allowable development in the watershed (included earlier in this report). This analysis is functional for generalized land and watershed planning, and is not meant for site specific applications such as plotting a subdivision. Areas that would be developed to provide goods and services to a larger population are not considered in this build-out analysis.

Introduction

As rural areas continue to outpace urban areas in terms of population growth, the demands on the attractive natural amenities (i.e., riparian areas) for development has been growing. Adding new homes to the landscape increases the amount of impervious surface in the form of rooftops, driveways, asphalt, and compacted earth, preventing the infiltration of water into the ground. As a result, stormwater runoff over the land surface greatly increases, even during small rainstorm events. This alteration of the water cycle can have significant impacts to waters and habitat of the USCECRW.

To cope with this demand and to better understand the development potential around some of the region's water bodies, the CLUE conducted a residential build-out analysis for the entire USCECRW. The USCECRW was determined to be about 215,537 acres or about 337 square miles in size. Over the years, parts of the watershed have experienced waves of growth and development. FIGURE 1 illustrates the results of more than 50 years of land division in the Town of Barnes in Bayfield County, with lots created at or near the minimum lot size. One can see that in 1954 the area was mostly undeveloped, with few landowners. Over the years, hundreds of small lots have been created, and although many remain undeveloped, the stage has been set for high residential density. Conducting a build-out analysis provides visual evidence of what certain land use regulations can potentially look like in terms of density and location. An understanding of the potential of future growth can have wide ranging effects on local government decisions. Policies from housing to economic development to transportation are all influenced by the quantity and quality of future growth, so the ability to "see into the future" can help local decision makers make more informed decisions.

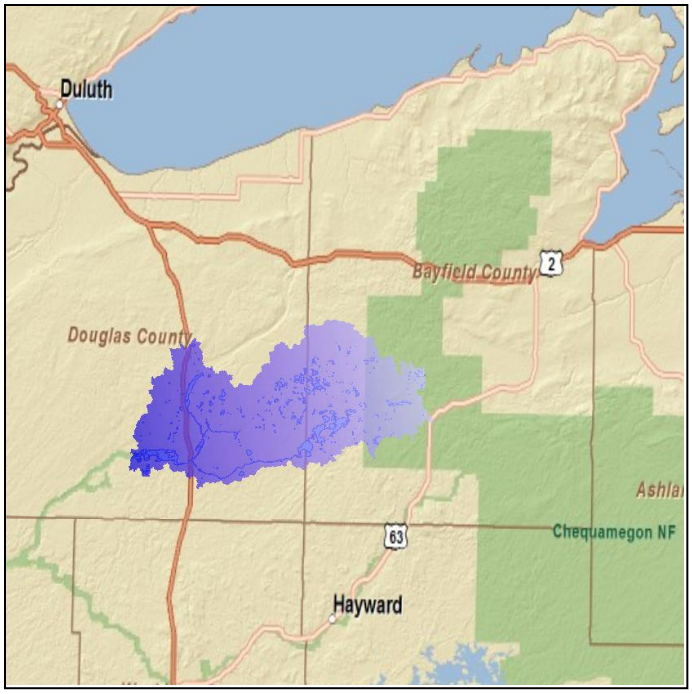
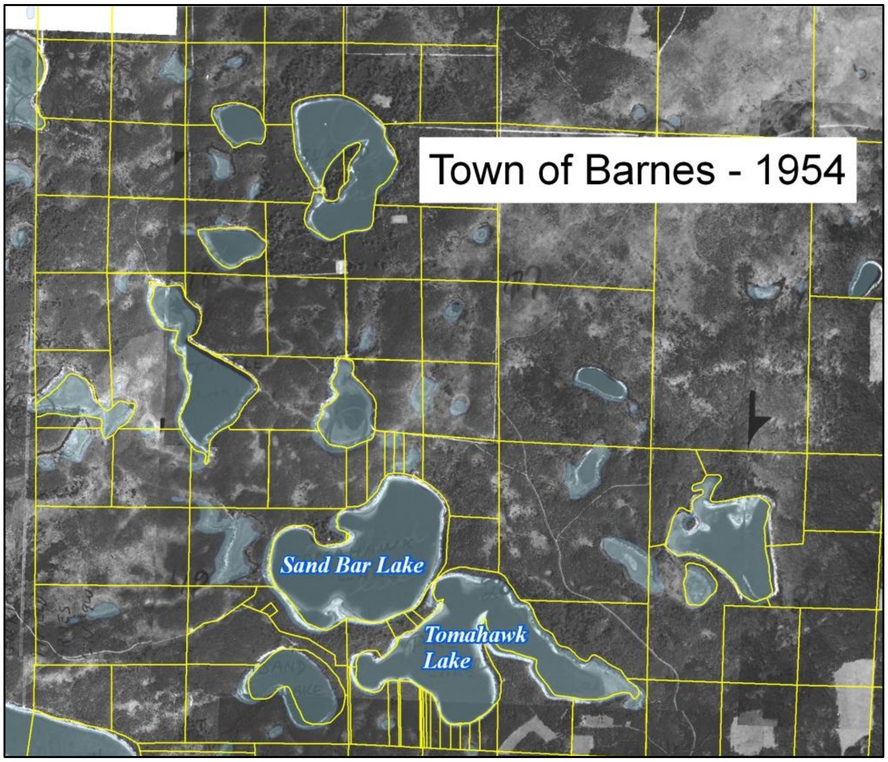


Figure 1. Location of the Upper St. Croix watershed.

The USCECRW is located in both Bayfield and Douglas Counties, encompassing one incorporated village and nine unincorporated towns. The residents of the area have or are currently going through the comprehensive planning process which contains specific goals and objectives for a desired future landscape. The primary tools for achieving many of these goals are the county's zoning ordinances.

The build-out analysis is a tool used to project all possible future growth potential in a community given present environmental and physical constraints and current land use regulations using GIS. Build-out analysis can be used to visualize current land use in an area, such as a town or watershed, and to simulate where future development can occur under the current zoning. The analysis can reflect the density of development and the consequences of zoning ordinances (and alternative scenarios) and the effects of those changes on future resources, like water quality, infrastructure costs, and population, to name a few.

A build-out analysis can help residents understand what their municipality, or a section of it, will look like if built to the capacity allowed in current zoning and answers the question "how many buildings can be built in this area according to current land use regulations?" A build-out can also help identify changes needed in local master plans, zoning ordinances, and development regulations. While build-out studies are useful, they generally cannot predict when full development will occur. This depends on many pressures, such as the local or regional economy and other socioeconomic variables.



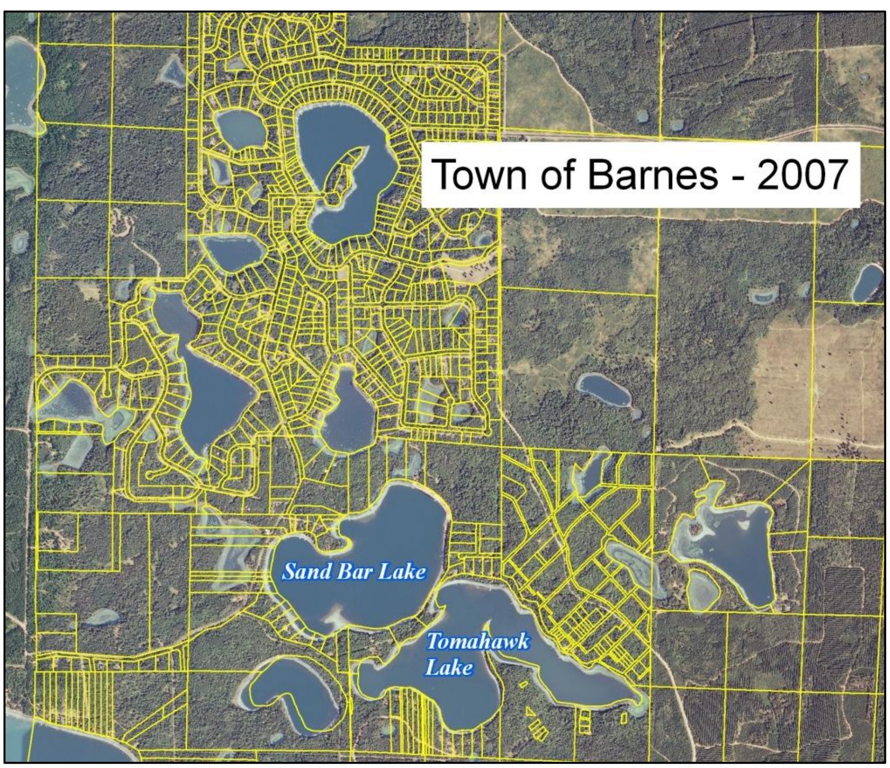


Figure 2. Early and current parcel patterns in the Town of Barnes in Bayfield County. Some areas have experienced complete build-out in terms of lot creation. This sets the stage for future development patterns and density.

Protecting our lakes and streams is vital for a number of uses, including fish and wildlife habitat, recreation, and drinking water. The goal of this Upper St. Croix watershed build-out study was to provide information to local decision-makers and to the Friends of the Upper St. Croix Headwaters (FROTSCH) group on the scope and magnitude of future development patterns based on current land regulations.

In this study, we used the number, location, and disturbance area of potential dwelling units to quantify the amount of development and land use change possible at complete build-out. These are indicators of impervious surfaces for non-point source pollution. By understanding the potential changes of these indicators, decision-makers and citizens can better identify actions needed to protect the resources of the Upper St. Croix watershed.

It is important to note that this build-out analysis projects what could happen under the current regulatory framework. This analysis makes no prediction about when, or even whether, complete build-out will occur. The build-out assessment is only concerned with what the maximum permitted development is under a certain set of regulations.

Forecasting Future Development

We began the build-out analysis by collecting available land information layers, listed in Table 1, to prepare alternative build-out scenarios for the Upper St. Croix watershed. Available information on slopes, existing development, land use, wetlands, surface waters, roads, and public and industrial lands was combined in ArcGIS to create a comprehensive view of the watershed's environmental and physical resources.

Methods

Compile Data

A variety of materials and information was collected from different sources. The Bayfield and Douglas County Land Information Office was the repository for most of the GIS layers regarding zoning, parcels, roads, wetlands, and water bodies. Other GIS data, like land use, streams, and soils were obtained from the USGS and NRCS. Because the entire watershed spans across county boundaries, additional steps were needed to update and combine layers. Once collected, all the data layers were clipped to the Upper St. Croix watershed boundary and projected to the NAD 1983 Harn geographic coordinate system.

Data	Source	Formatting
Digital tax parcels	LIO	P, C, Q
Zoning districts	LIO	P, C, Q
Land Use	USGS	P, C
Wetlands	LIO, DNR, NRCS	P, C, Q
Slopes	LIO, USGS	P, C, SA
Building points	LIO	D
DNR land	DNR	P, C, Q
County forests	LIO, DNR	P, C, Q
Industrial forests	LIO	P, C, Q
Minor civil divisions	DNR	P, Q
Road centerlines	LIO	P, C, Q, SA
Floodplains	LIO	P, C
Hydric soils	NRCS	P, C, Q
DNR wetland points	DNR	D
Surface water	DNR	P, C

Sources Key		Formatting Key	
DNR	WI Department of Natural Resources	P	Project data to consistent coordinate system
LIO	County Land Information Office/Land Records Department	C	Clip data to geographic extent
USGS	United States Geological Survey	Q	Query data for specific attributes
NRCS	Natural Resources Conservation Service	D	Digitize images to create new data layers
		SA	Spatial Analysis

Table 1. Data collection and formatting requirements.

Baseline Use

Current land use data was established from updating the USGS 2001 National Land Cover Dataset (NLDC) with current building locations. We digitized buildings using 2008 orhtophoto for the watershed portion of Douglas County (a building point shapefile was available for Bayfield County). Buildings were then buffered by 30 meters to create a developed and disturbance area for each structure. We then combined this layer with the 2001 NLDC to produce a current landcover/use dataset.

Parcels

The digital tax parcel layers, provided by each county's Land Information Office, were crucial to the build-out analysis. First, all parcels that were not within the watershed boundary were immediately removed. We then queried the parcel database to indentify and flag publicly owned lands and industrial forest parcels. We also excluded parcels that were no longer buildable by removing developed lots within platted subdivisions because it is unlikely that they will further split and develop. Finally, the two separate county parcel layers were combined into one using the Union tool. Figure 3 shows current building locations and the 2009 parcel pattern. We estimate there to be 3,817 buildings in the watershed (excluding secondary buildings).

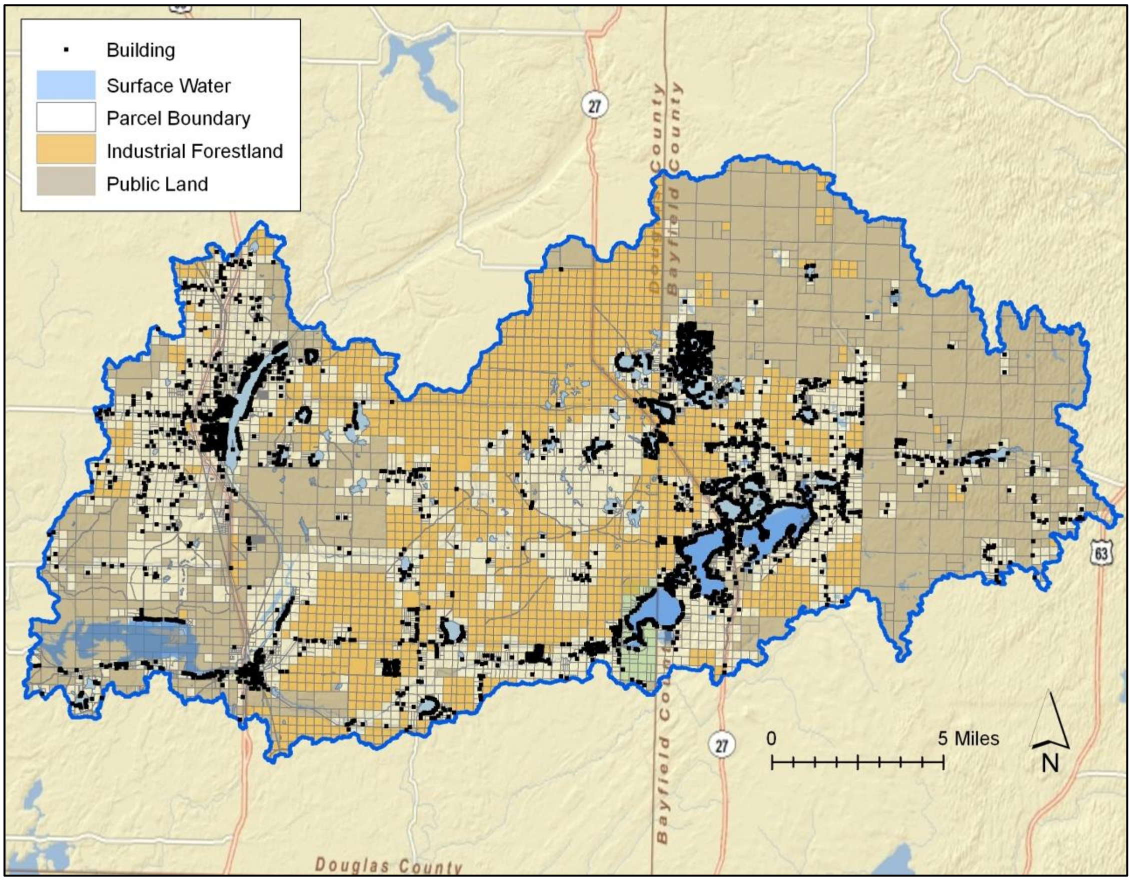


Figure 3. Current building locations and parcel pattern.

Zoning

Also critical to a build-out analysis is the feasibility of modeling zoning requirements. The analysis is actually a matter of dividing land areas, while not determining the real site design potential of a subdividable lot. Using overlay techniques, we assigned zoning districts to each lot in the parcel layer. Parcels were split where they overlapped multiple zoning districts. Figure 4 illustrates the 2009 zoning status for the Upper St. Croix Headwaters and shows that a large portion of residentially zoned land in the watershed is near surface water features. Oftentimes minimum lot sizes are reduced for parcels serviced by public sewer and water. Because GIS data on public services was not available, we used the municipal boundary Solon Springs as the extent of these services. We manually mapped zoning districts in Solon Springs based on a zoning map provided by the village.

This analysis made use of the following assumptions in determination of the final build-out scenarios.

- Future dwelling units will be built on the smallest sized lot allowable for the zoning district, taking into account the minimum lot size and minimum buildable area.
- There will be one dwelling unit per new lot.
- Potential unit types are not specified; they can be of any permitted use of the zoning district.
- Rezones and variances were not modeled. (Conditional use permits were modeled for the F-1 district in Douglas County)
- Cluster subdivisions and multi-family developments are not modeled in this study.
- The size of each buildable parcel was reduced by a factor that accounts for land dedicated for roads and open space requirements (this typical ranged from 0% for larger minimum lot sizes to 20% for smaller minimum lot sizes).
- Only residential development was modeled in this analysis
- Existing dwelling units were subtracted from the total allowable development for each parcel.

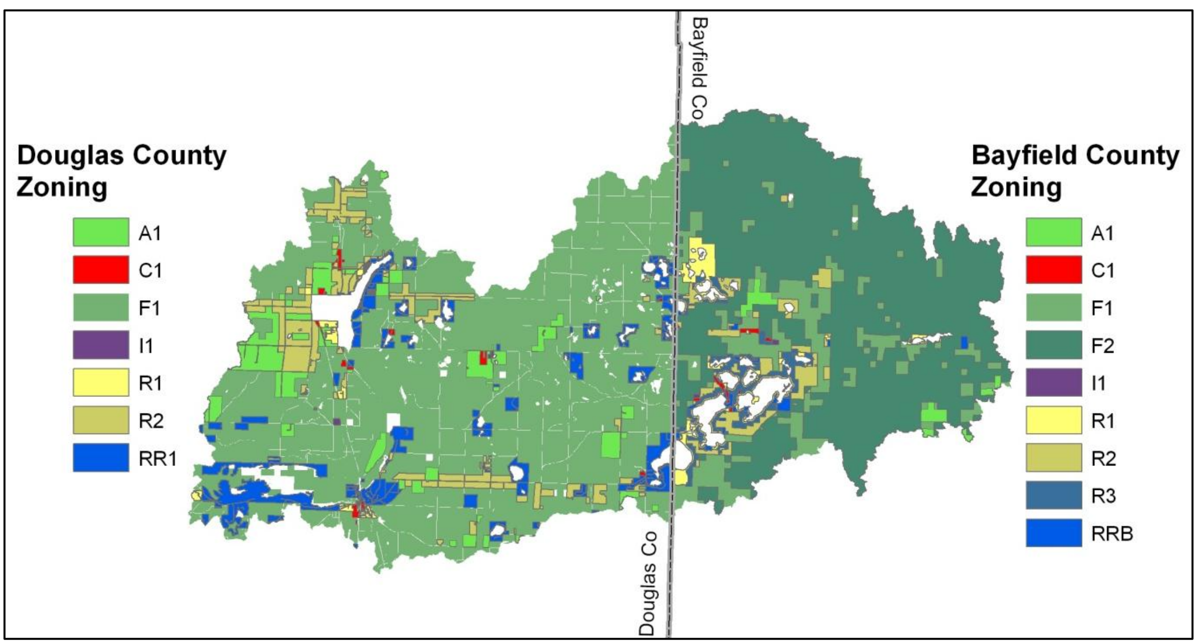


Figure 4. Bayfield and Douglas County zoning configuration.

Dimensional requirements, such as, setbacks, minimum lot sizes, and separation distances were obtained from each county's zoning ordinance and entered into an Excel spreadsheet. During the build-out process, buildings are modeled as point locations, with building size included in the minimum allowable distance between buildings. Each building was assumed to be 60 feet wide on all sides. Thus, for modeling purposes, the potential buildings are round with a radius of 30 feet. The additional distance between buildings was given as the average of the front, side and rear setbacks (Table 2).

Zone	**R1**	**R2**	**R3**	**RRB**	**A1**	**F1**	**F2**
Minimum Lot Size	30,000 sqft	4.5 acres	2 acres	30,000 sqft	4.5 acres	4.5 acres	35 acres
Front Setback	30	50	30	30	50	50	50
Side Setback	10	75	20	10	75	75	75
Rear Setback	10	75	20	10	75	75	75
Building Radius	30	30	30	30	30	30	30
Building Separation	86	135	94	86	135	135	135

A)

Zone	**R1**	**R2**	**RR1**	**A1**	**F1**	**SS-R1**	**SS-R2**
Minimum Lot Size	20,000 sqft	5 acres	5 acres	5 acres	10 acres	.20 acres	.20 acres
Front Setback	30	50	30	50	30	6	6
Side Setback	10	20	10	20	10	6	6
Rear Setback	40	50	40	50	40	50	50
Building Radius	30	30	30	30	30	30	30
Building Separation	113	140	113	133	113	101	101

B)

Table 2. Zoning dimensional requirements for A) Bayfield County and B) Douglas County, excluding shoreland overlay standards.

Shoreland Zoning Overlay

The shoreland zoning district, as modeled in this analysis, comprises all lands within 1,000 feet of navigable lakes and within 300 feet from navigable stream. The shoreland overlay district was created by buffering navigable waters by either 1,000 or 300 feet in unincorporated areas. The new polygon layer was then used to assign shoreland zoning attributes to the parcel layer. Dimensional requirements for each zoning district within the shoreland overlay zone can be found in the zoning ordinance text available on each county's website. The dimensional requirements, such as lot size and setbacks, are based on a lake classification system and are too detailed to describe in this document. Potential residential development was restricted to specific lot sizes and frontage lengths within the required setbacks from the ordinary highwater mark, generally between 75 and 125 feet, depending on the lake class. We used the DNR hydro layer as the basis for determining the ordinary highwater mark to buffer from.

Road Setbacks

Each county's zoning ordinance provided road centerline setback distances based on a road classification (Table 3). Residential development within these distances is prohibited. Class A roads include state and numbered highways, Class B roads comprise all county roads, and Class C roads are all town roads. We buffered the street centerline layers based on the road classification attribute by the distances in Table 3. The resulting road setback polygon layer was then used as a constraint to development during the build-out process.

	Class A	Class B	Class C
Bayfield	110	75	63
Douglas	130	75	63

Table 3. Road setback distances in feet.

Community Viz Build-Out Wizard

Next, we used the Community Viz™ Build-Out Wizard, an ArcGIS extension, to generate future development scenarios of the entire watershed. The Build-Out Wizard includes tools for performing a spatial analysis in which it attempts to place as many buildings within the buildable parts of each parcel. The buildable sections are the areas that are outside the development constraint layers. The buildings are also placed at user specified minimum separation distances. The parcel based zoning layer was added as the input data to the wizard (Figure 5). Environmental and physical constraints layers were added to the build-out wizard as areas off limits to development.

The wizard was used to create three scenarios (Table 4) of future development at complete build-out in the watershed based on alternative wetland layers. The DNR wetland points are potential wetlands under five acres in size. They were collected as a point layer from the DNR's Surface Water Data Viewer and buffered to create polygons of 2.5 acres to represent their approximate size and location.

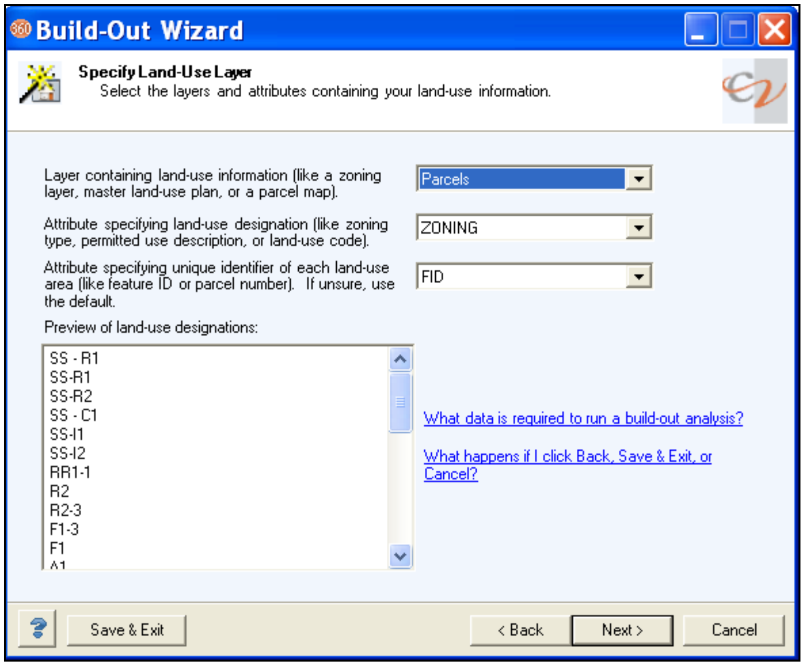


Figure 5. Build-Out Wizard.

Scenario	Description
1	Wisconsin Wetland Inventory (WWI) used as the only wetland constraint.
2	WWI and NRCS hydric/partially hydric soils as wetland constraints.
3	WWI, NRCS hydric/partially hydric soils, and DNR wetland points as wetland constraints.

Table 4. Build-out scenario descriptions

Estimating Impervious Surfaces

The amount of impervious surface associated with different development patterns was estimated from locally derived impervious surface coefficients. An impervious surface layer containing roads, driveways, structures, and yards of Douglas County was collected from UW-Superior (original data was developed by Community GIS). The impervious surfaces were combined with the digital parcel layer to calculate an average percent imperviousness for different residential lot sizes. Ten-acre residential parcels had an average of 3.4 percent impervious surfaces; 5-acre lots had an impervious coefficient of 5.6 percent; one-acre lots had a coefficient of 9.6 percent; and 30,000 square foot lots had an impervious surface of 12.8 percent. We applied the impervious surface coefficients to each build-out scenario to calculate the approximate amount of impervious surface per new residential building. The buffered building points represent roughly the amount of area that would be converted to residential development. Finally, we combined the build-out results to the current land use coverage to calculate potential change for the entire watershed and within direct drainage areas.

Results

Under the watershed's current zoning density, the model projects a theoretical maximum of 11,660 buildings, including 7,843 new buildings and the 3,817 existing buildings. The distribution of these new units is indicated in Figures 6. Each red dot represents a potential new residential development that could be built. One can see that much of the watershed is not developable because of the abundance of both public lands and industrial forests. However, a significant amount of development exists throughout the watershed, especially along roads and in close proximity to riparian areas (Figure 7).

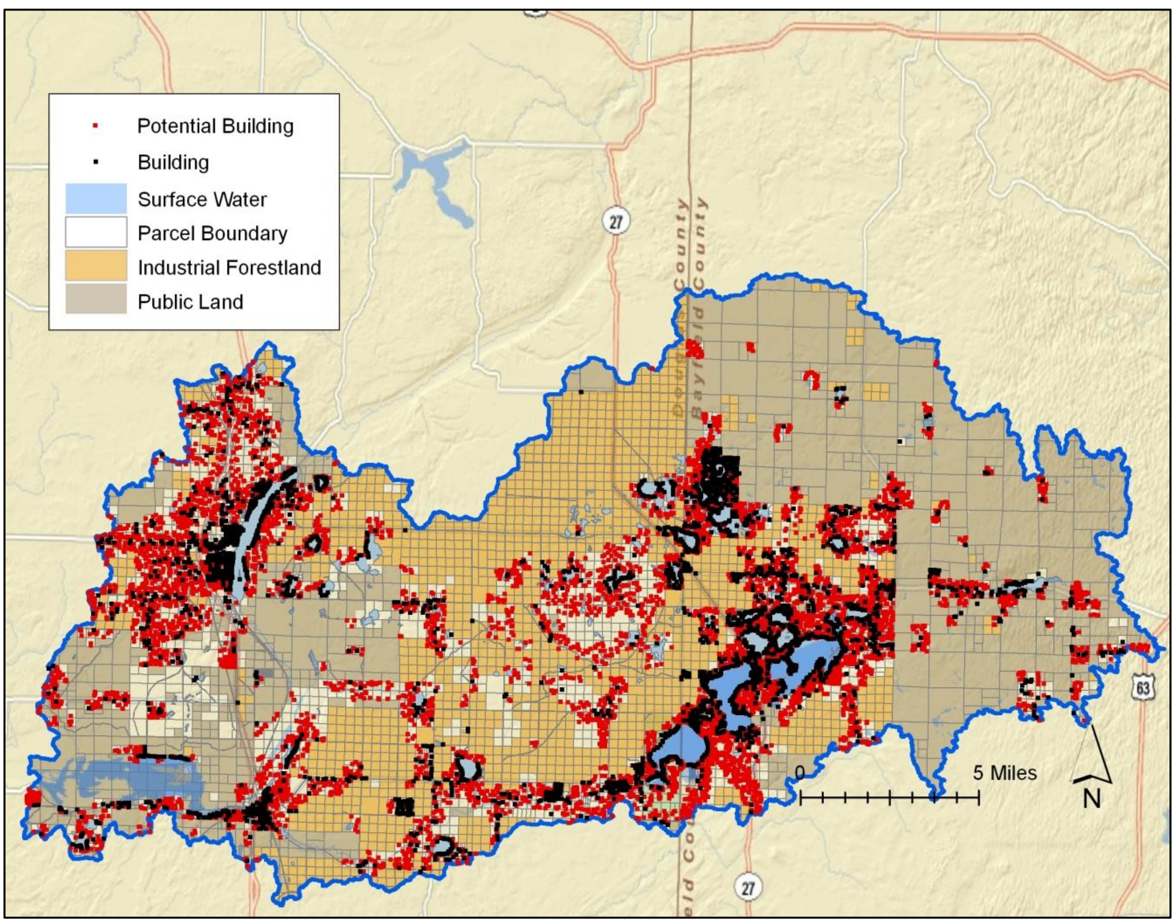


Figure 6. Residential build-out results for the Upper St. Croix watershed.

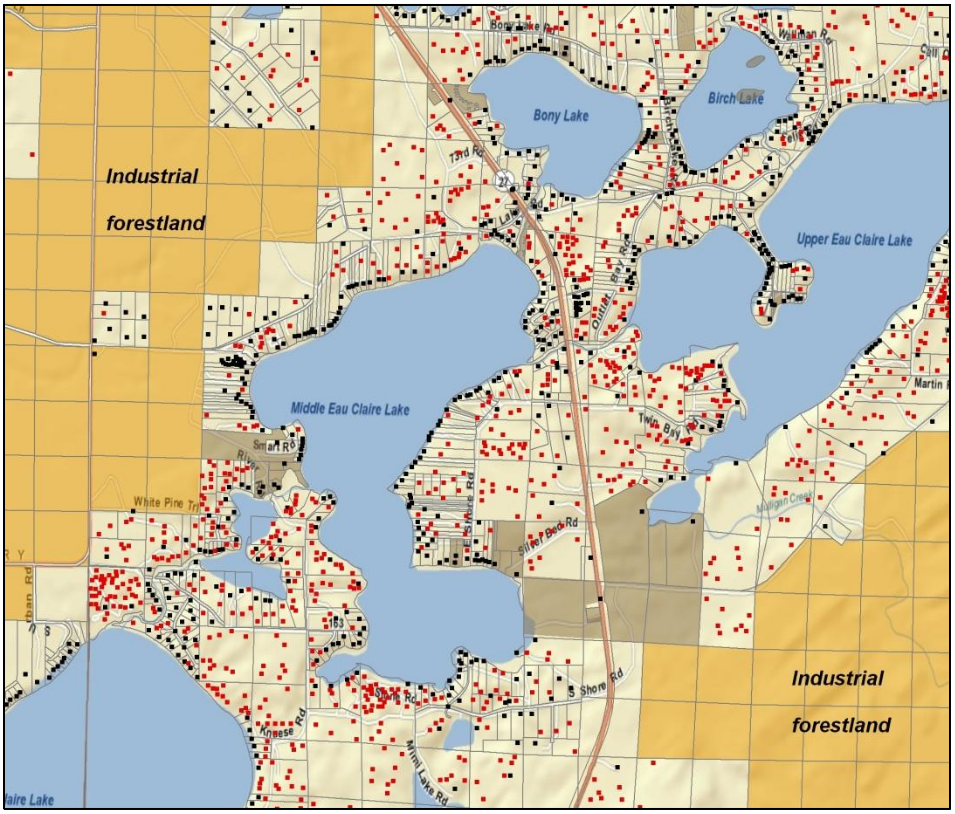


Figure 7. Close-up view of the build-out results in the Town of Barnes in Bayfield County. Due to development constraints and the location of residential zoning districts, most of the potential development is on or near surface water features.

Dwelling Units

Figure 8 shows the results of the number of existing residential units and the projected amount for each of the three scenarios. Scenario 1 allows for the most residential development in the entire watershed because it only incorporates the WWI areas as the individual wetland constraint. Scenarios 2 and 3 include other potential wetlands that are not mapped in the WWI as constraints to development and therefore, allow less development. The range in dwelling units between scenarios is not that significant because we find that much of the additional wetland constraints (hydric soils and buffered DNR wetland points) are under public and industrial forest ownership where development is already restricted.

Also presented in Figure 8 are the results of the number of residential buildings in the direct drainage areas. Nearly 40 percent of potential residential dwelling units are located in Tier 1. Less development can be expected the second and third tiers because those tiers only make up a small portion of the entire watershed.

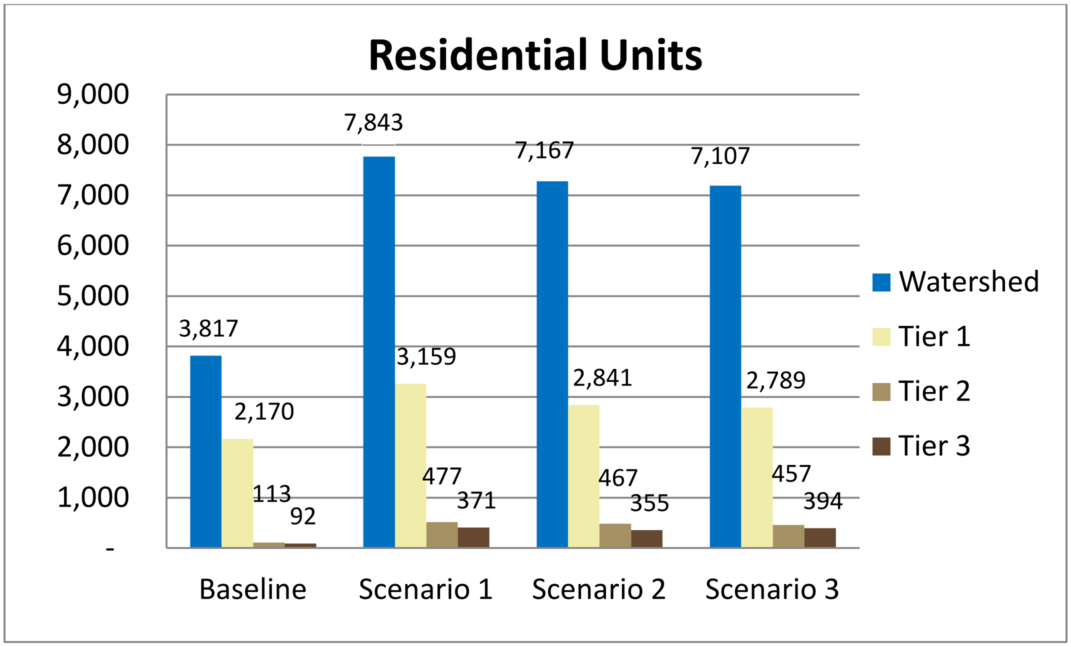


Figure 8. Number of new dwelling units for each scenario.

Contributing Areas

The contributing areas were analyzed. These lands are directly connected to surface water features and make up a significant portion of the watershed. Tier 1 areas – the most connected lands – take up nearly 58,000 acres or 27% of the watershed. Tiers 2 and 3 are less connected to surface water features and take up only 6,200 and 5,500 acres respectively.

Land Use

The alternative land use scenarios to current landscape in the whole watershed and for each of the contributing area tiers were compared. Results for the three scenarios are shown in TABLE 16. The entire watershed's existing developed area is roughly 9,600 acres, or 3% of the watershed. This includes roads, yards, structures, and other impervious surfaces. The projected land uses patterns for complete build-out for Scenario 1 yielded an increase of 1,784 developed acres or roughly 5.5%t impervious. The amount of additional impervious surface at the entire watershed scale decreases slightly with Scenarios 2 and 3 at 5.4% because of the added wetland constraints.

Presently, in all three tiers there are 3,980 acres of developed land, or roughly 5.4 percent impervious. The projected amount of development and additional impervious surface for all three scenarios yields 4,893 acres, 4,785 acres, and 4,771 acres respectively. Even though the total land area of the tiers accounts for about 33 percent of the entire watershed, 50 percent of potential new residential development takes place within connected areas.

Type	Connectivity	2009	Scenario 1	Scenario 2	Scenario 3
Developed	Entire Watershed	9,601	11,385	11,236	11,221
	Connected Areas	3,980	4,893	4,785	4,771
Forest	Entire Watershed	142,555	141,138	141,219	141,237
	Connected Areas	41,411	40,730	40,778	40,794
Non Forest	Entire Watershed	17,255	17,027	17,088	17,096
	Connected Areas	19,912	19,769	19,816	19,814

Table 5. Current and projected land use (in acres) in the entire watershed and within each direct drainage tier for the three build-out scenarios.

Conclusions and Recommendations

The results of this GIS build-out analysis show that there is a significant amount of development potential in Upper St. Croix watershed. If every available lot subdivided and developed to the maximum extent allowable, the current zoning could result in a total of 7,843 new homes, more than doubling the current number. This number represents a significant growth for the area, but not an overwhelming change. The findings in this report show that the current zoning in the watershed aims to concentrate development in meaningful patterns in an effort to reflect appropriate land use policies. However, a great portion of the development potential occurs in resource-sensitive areas. More importantly, the build-out analysis shows that much of land in the watershed is off limits to development because of environmental and physical constraints. However, a large portion of the remaining developable lands are in close proximity to surface water features. If the most connected drainage lands completely develop at the maximum density allowed under the current zoning, roughly 3,159 new homes could be built in the most connected lands to surface water features. Other portions of the watershed not only residentially-zoned areas, but also in forestry-zoned districts, are ripe for development. For example, industrial forest companies, like Plum Creek or Wausau Paper currently own nearly 58,000 in the watershed. Most of their forestland is zoned F-1, which allows for residential development on 4.5 acres in Douglas County. If these companies decide to divest and develop some of their more amenity-rich tracts of land, it could open the door to hundreds, if not, thousands of additional developable lots.

Implementation of land use policies, regulations, non-regulatory strategies are a critical component for protecting valuable aquatic resources and water quality. In addition to benefits for aquatic resources, planning, zoning, and other conservation tools are used for ensuring the management of wildlife habitat, providing for sustainable development, protecting property values, and maintaining community character. The following are land use and voluntary land protection recommendations.

- Pursue Direct Drainage Overlay Zone – prevent potentially polluting sources from locating in susceptibility areas. Overlay zoning is an effective approach that does not require major revisions to the existing ordinances. The overlay district can share common boundaries with the base zone or cut across base zone boundaries. For example, the direct drainage areas can be placed over the existing base zoning districts as an overlay zone with special provisions, like setting impervious surface limits, in addition to those from the underlying base zone (Figure 9).

- Consider conservation easements to protect sensitive areas in the direct drainage areas and throughout the watershed. A conservation easement is an incentive-based legal agreement voluntarily placed on a piece of property to restrict the development, management, or use of the land in order to protect a resource. It is an effective, avenue for protecting watersheds natural resources. In this case, the build-out results can be used to help identify some of the watershed's most vulnerable areas to development (Figure 10).

- Conservation subdivision designs should be promoted throughout the watershed and especially within direct drainage tiers and districts already zoned for residential development. A conservation design (cluster development) is a type of "Planned Unit Development" in which the underlying zoning and subdivision ordinances are modified to allow buildings (usually residences) to be grouped together on part of the site while permanently protecting the remainder of the site from development (Figure 11). This type of development provides great flexibility of design to fit site-specific resource protection needs while allowing for the same number of residences under current zoning and subdivision regulations. The conservation subdivision concept could potentially preserve the rural character of the watershed and limit the potential for runoff associated with higher density development near the shoreline regions.

- A transfer of development rights program should be considered to help limit the amount of development within direct drainage areas. Transfer of Development Rights (TDR) is a voluntary, incentive-based program that allows landowners to sell development rights from their land to a developer or other interested party who then can use these rights to increase the density of development at another designated location (Figure 12). In this case, the preservation zone would be the delineated direct drainage areas so that the immediate riparian areas would be protected from future development and impervious surfaces.

- Work with the towns in the watershed to develop their own subdivision ordinance to be more restrictive than the county's. Each town could, for example, adopt a subdivision ordinance that classifies all new lots under a certain size as a major land division, thus requiring minimum standards to be met related to impervious surfaces, building placement, and sanitation. Together with zoning, this approach could help to shape the layout, design, and density of future development in the watershed.

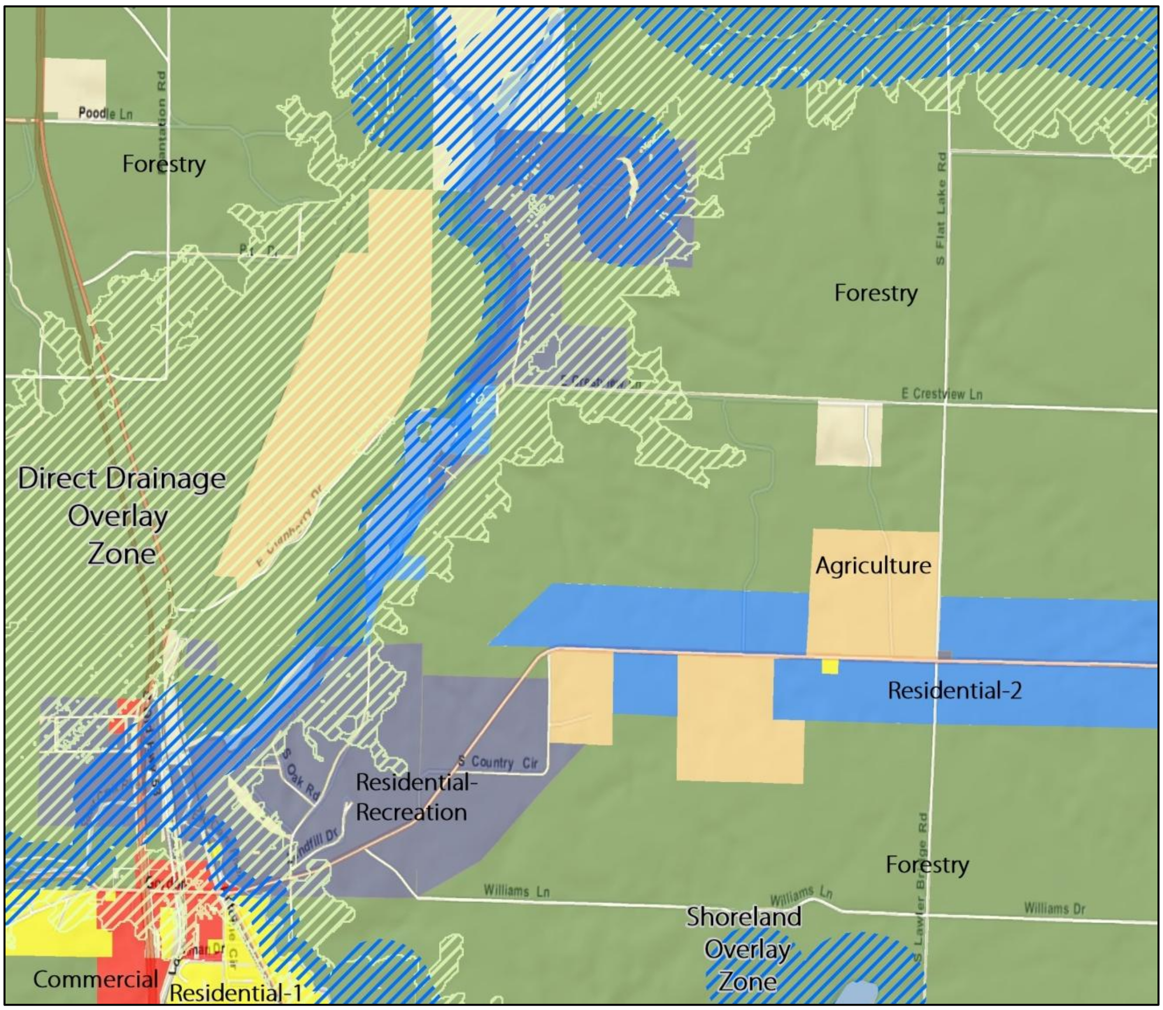


Figure 9. Example: a direct drainage overlay has special provisions in addition to the requirements of the base county zones in order to protect water quality and riparian habitat.

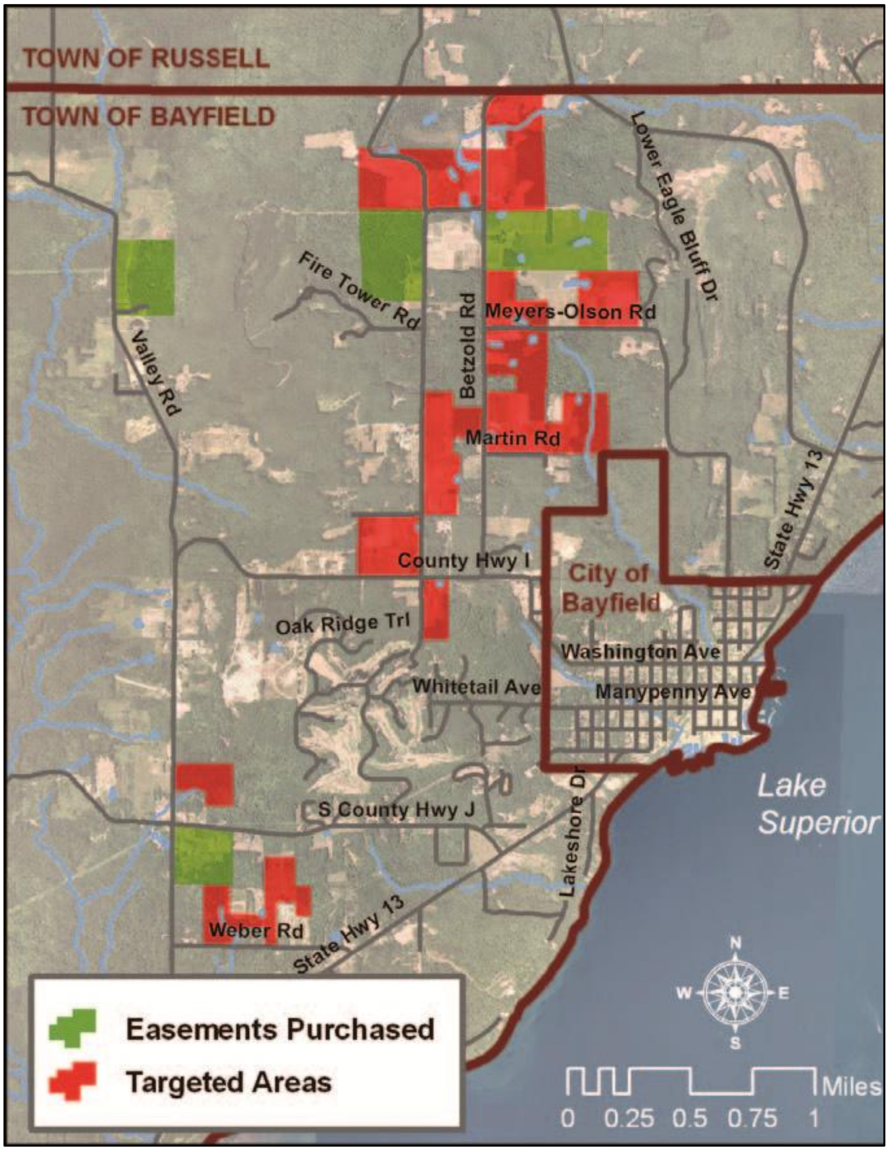


Figure 10. An example from Bayfield County where a program is set up to protect local orchards.

Figure 11. An example of a conservation subdivision design from Walworth County. Minimum lot sizes were reduced, but design allowed for 70 acres of common open space, the protection of a stream corridor, and natural stormwater management.

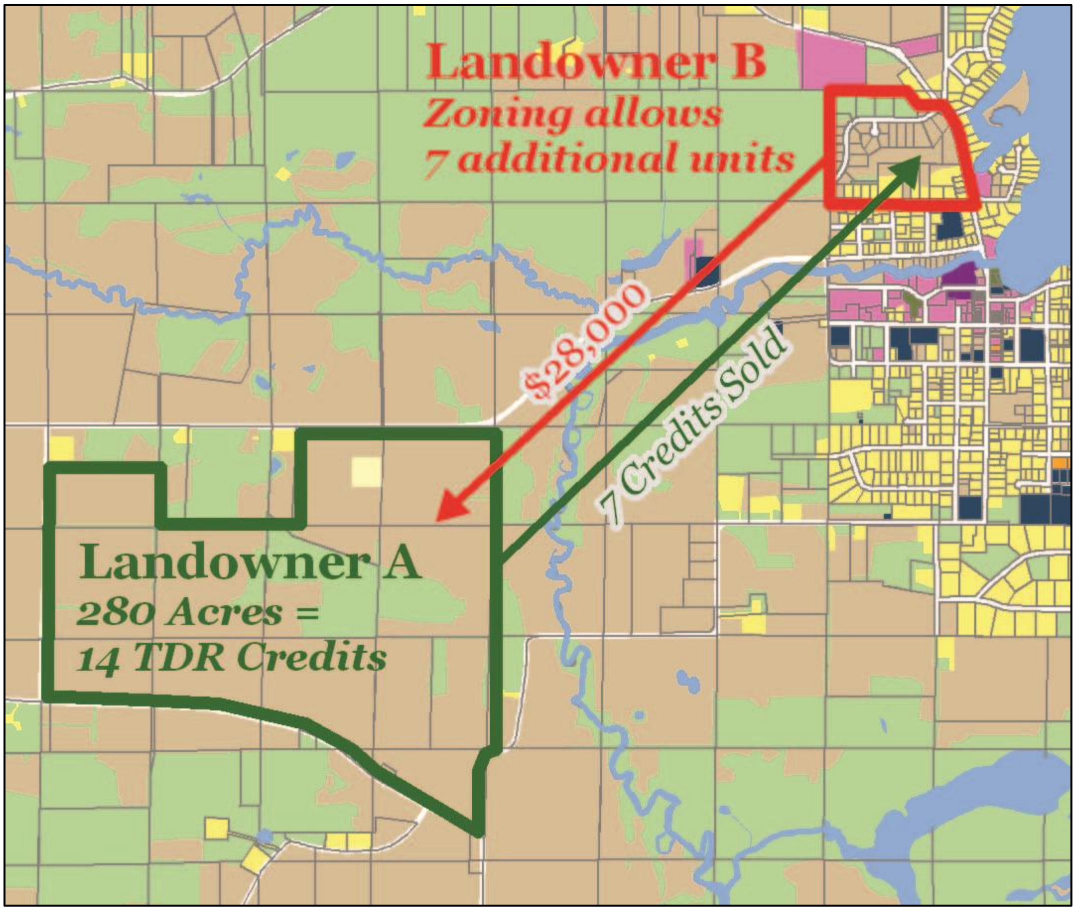


Figure 12. Landowner A, a farmer, would like to get additional economic return from his property. In exchange for restrictions on his land, landowner A sells the development rights that are part of his property. This permanent prevention of development helps the community reach its farmland preservation goals. Landowner B would like to develop her property in the receiving area which already has public services. Landowner B finds that she would earn a larger profit by purchasing TDR credits from Landowner A, thereby allowing her to build more housing units.