Freedom and Ossipee Build-Out Analysis:

Freedom and Ossipee, Carroll County, New Hampshire

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Prepared by FB Environmental Associates, Inc.
in cooperation with the Green Mountain Conservation Group and the
Towns of Freedom and Ossipee, New Hampshire.

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Cover photo: Ossipee Lake (Source: FBE)

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1.0 INTRODUCTION

Ossipee Lake is fed by the West Branch River from the north, the Bearcamp and Lovell Rivers from the west, and the Pine River from the south. The lake's outflow is the Ossipee River, situated at the eastern end of the lake. The Ossipee Lake Watershed is in the catchment of the Saco River and includes an area of about 379 square miles located in Carroll and Grafton Counties, New Hampshire. It contains 82 lakes and ponds that cover about 9,400 acres in thirteen towns. At its widest point the watershed extends approximately 29 miles east and west and 23 miles north and south. Water from the Ossipee Watershed flows into the Saco River, continues throughout Maine and finally empties into the Atlantic Ocean at Saco Beach.

FB Environmental (FBE) performed a build-out analysis for the entire town of Freedom, NH and for the portion of the town of Ossipee within the Danforth Pond and Lower Bays subwatershed of the greater Ossipee Lake watershed (Figure 1). The entire study area encompasses 22,044 acres (excluding waterbodies, which encompass an additional 2,713 acres).

The results of the analysis provide estimates of the numbers of potential lots and new building units the towns may see developed at some point in the future. "Full build-out" refers to the time and circumstances whereby based on a set of restrictions (e.g. environmental constraints and current zoning), no more building construction may occur, or the point at which lots have been subdivided to the minimum size allowed and there is no more "developable" land.

Performing a build-out analysis shows a locality what land is available for development, how much development can occur, and at what densities. Municipalities can use the analysis as a tool for planning development patterns into the future. The build-out analysis is also a valuable tool to help model potential impacts from future development on water and other natural resources, and can be used to help set water quality goals for both impaired and high quality waters.

1.1 CommunityViz Software

The build-out analysis was conducted using ESRI ArcMap version 10.0 geographic information system (GIS) software and CommunityViz version 4.3. CommunityViz is a GIS-based decision-support tool designed to help planners and resource managers visualize, analyze, and communicate about important land-use decisions. The software's 'Build-out Wizard' was used to calculate the development capacity of the study area (numerically and spatially), and its 'Time Scope Analysis' tool was used to project and visualize how future development might occur over time.

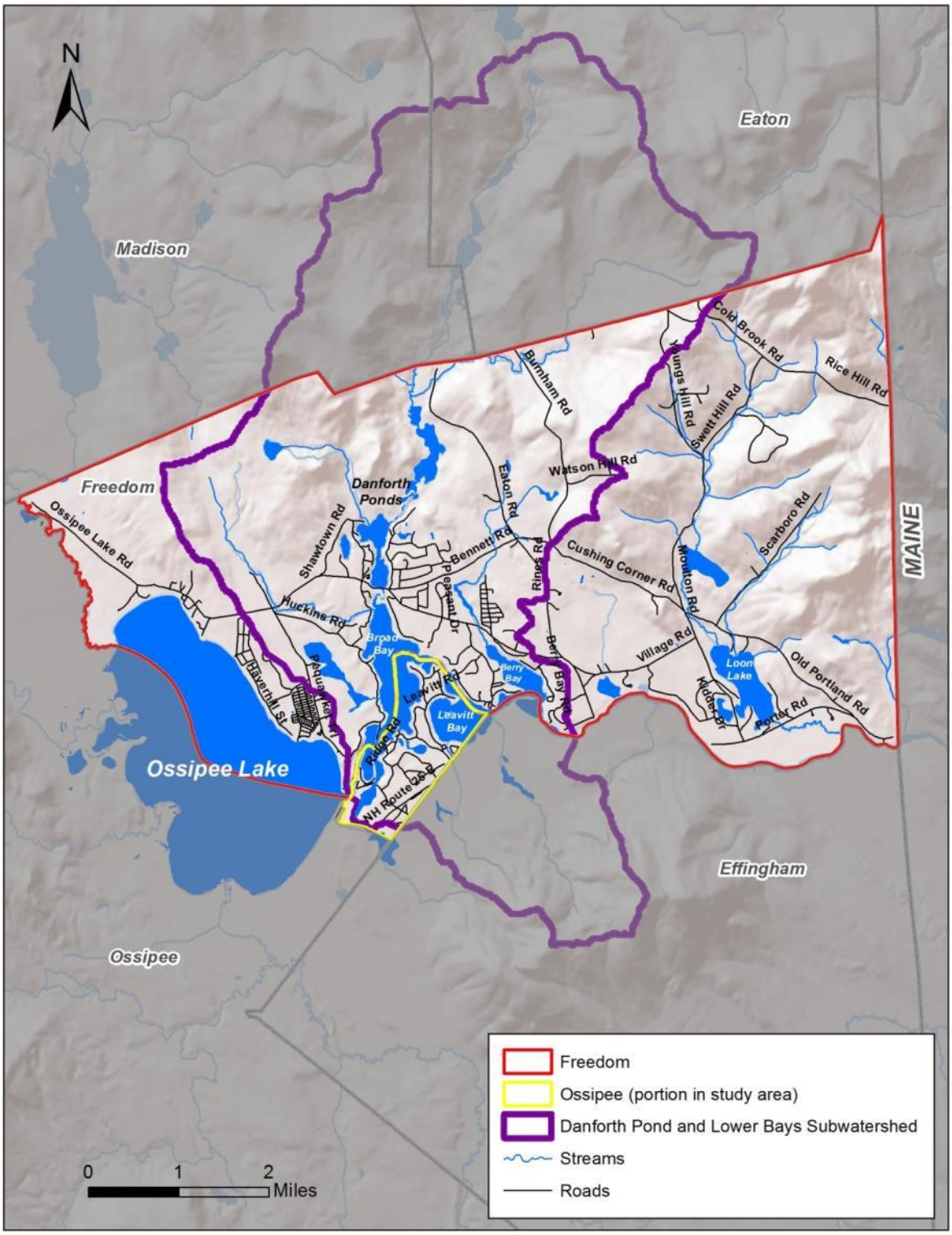

Figure 1. Map showing the study area and the boundary of the Danforth Pond and Lower Bays subwatershed.

Using these tools, this study explores several questions about the future of the watershed:

- How much 'developable land' is present?
- How much new development can theoretically occur, based on current zoning regulations and other constraints? (Build-out Analysis)
- At specified growth rates, how many years might it take to reach full build-out? (Time Scope Analysis)

2.0 METHODS

The build-out analysis was performed according to the following general steps:

1. Collect information on existing conditions in the study area: existing buildings, zoning, and growth rates for Freedom and Ossipee.
2. Collect GIS data and development constraints layers.[1]
3. Based on constraints layers, determine where development may occur.
4. Analyze build-out potential using CommunityViz's Build-Out Wizard tool, combined with input on developable and non-developable land from town officials.
5. Using CommunityViz's TimeScope Analysis tool, determine potential future dates at which full build-out is reached.
6. Present results in tables and maps.

2.1 Existing Buildings

The location and number of existing buildings for the town of freedom was determined by using a spreadsheet (provided by the town) listing lots with and without buildings. This spreadsheet was joined with a point shapefile in ArcMap to create an 'existing buildings' layer, with points representing individual buildings. This layer was quality-checked using high-resolution digital orthoimagery produced from aerial photos collected in 2010 and 2011. Orthoimagery was accessed through New Hampshire's Statewide Geographic Information System Clearinghouse's (NH GRANIT) website. This orthoimagery was in turn used to create an existing buildings layer for the portion of Ossipee within the survey area with a point representing each existing building. In total there are approximately 2,061 dwellings in Freedom and 346 in the portion of Ossipee within the study area. In certain areas (those where it was difficult to discern the presence of a dwelling) orthophotos from NH GRANIT were crosschecked using Google Earth and Bing Maps.

Note that there are several youth camps in Freedom, namely Camps Calumet, Cody, Huckins, and Robin Hood. These camps each contain numerous buildings; however they are only seasonally inhabited. Based on communication with camp officials, the number of buildings used in the build-out were adjusted based on

[1] Development constraints GIS layers for Freedom and Ossipee were obtained from the State's online GIS clearinghouse (NH GRANIT).

how long during the year they were are typically occupied. For example, 52 buildings used only for 3 months roughly amounts to about 13 buildings being used year-round.

2.2 Zoning

Crucial to a build-out analysis is the feasibility of modeling zoning requirements. Certain zoning requirements are too site-specific to be able to incorporate into the analysis. With that in mind, this analysis made use of the following caveats in the determination of build-out zoning restrictions:

- Future lots will be made the smallest size allowable for the zoning district, taking into account minimum lot size and minimum buildable area.
- Potential unit types (e.g., house, commercial building) are not specified.

Zoning information used in the build-out analysis represent restrictions that apply in the sections of each town that fall within the study area boundary (all of Freedom and part of Ossipee) (Table 1). In addition to the zoning restrictions listed below, each watershed town also follows the minimum Shoreland Zoning restrictions required in New Hampshire. Note also that for Freedom the analysis took into account that shorefront districts require 33% more acreage than the underlying zone.

Table 1. Base zoning standards for Freedom and the portion of Ossipee within the study area.

Zone	Building Setbacks	Road Setbacks	Minimum Lot Size	Maximum Lot Coverage
Freedom				
Village Residential	side - 30 ft. rear - 40 ft.	50 ft.	1 acre	N/A
General Residential	side - 30 ft. rear - 40 ft.	50 ft.	2 acres	N/A
Rural Residential	side - 30 ft. rear - 40 ft.	50 ft.	5 acres	N/A
Residential/Light Residential	side - 30 ft. rear - 40 ft.	50 ft.	1 acre	N/A
Ossipee				
Rural	side - 25 ft. rear - 25 ft.	40 ft.	1 ac	25%
Commercial	side - 25 ft. rear - 25 ft.	50 ft.	1 ac	50%

2.3 Population Growth Rates

According to the US Census Bureau, both towns have experienced steady population growth since the middle part of the last century. The populations of the two towns combined have grown from 1,772 people in 1960 to 5,834 people in 2010–a 229% increase. Census totals and Compound annual growth rates (CAGRs) for each town are presented in Table 2. Three iterations of the TimeScope analysis were run for the entire study area based on compound annual growth rates (representing 10-, 20-, and 30-year periods) for Freedom only, as Ossipee occupies only a small portion of the study area.

Table 2. Freedom and Ossipee, New Hampshire population estimates, 1960–2010.

Town	1960	1970	1980	1990	2000	2010	30 yr. Avg. Compound Annual Growth Rate (1980-2010)	20 yr. Avg. Compound Annual Growth Rate (1990-2010)	10 yr. Avg. Compound Annual Growth Rate (2000-2010)
Freedom	363	387	720	935	1,303	1,489	2.45%	2.35%	1.34%
Ossipee	1,409	1,647	2,465	3,309	4,211	4,345	1.91%	1.37%	0.31%

2.4 Development Constraints

To determine where development may occur in the study area, build-out calculations deduct land unavailable to development due to physical constraints including environmental restrictions (e.g., soils, steep slopes, wetlands) (Figure 1), zoning restrictions (e.g. shoreland zoning, street Right-of-Ways (ROWs), building setbacks), and practical design considerations (e.g. lot layout inefficiencies). Existing buildings also reduce the available capacity for new development.

GIS data used to model development constraints are listed below:

1) Conserved Land
2) Steep slopes (*>25%*)
3) Wetlands appearing on National Wetlands Inventory (NWI) maps
4) Existing buildings
5) Hydric soils
6) 100-year floodplain as designated on the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps or Flood Hazard Boundary Maps.

The development constraints considered above do not represent the full range of possible restrictions of resources that may be found in the field. For example, rare and endangered species may be present in a given area but are not considered because data regarding their specific location(s) are not available.

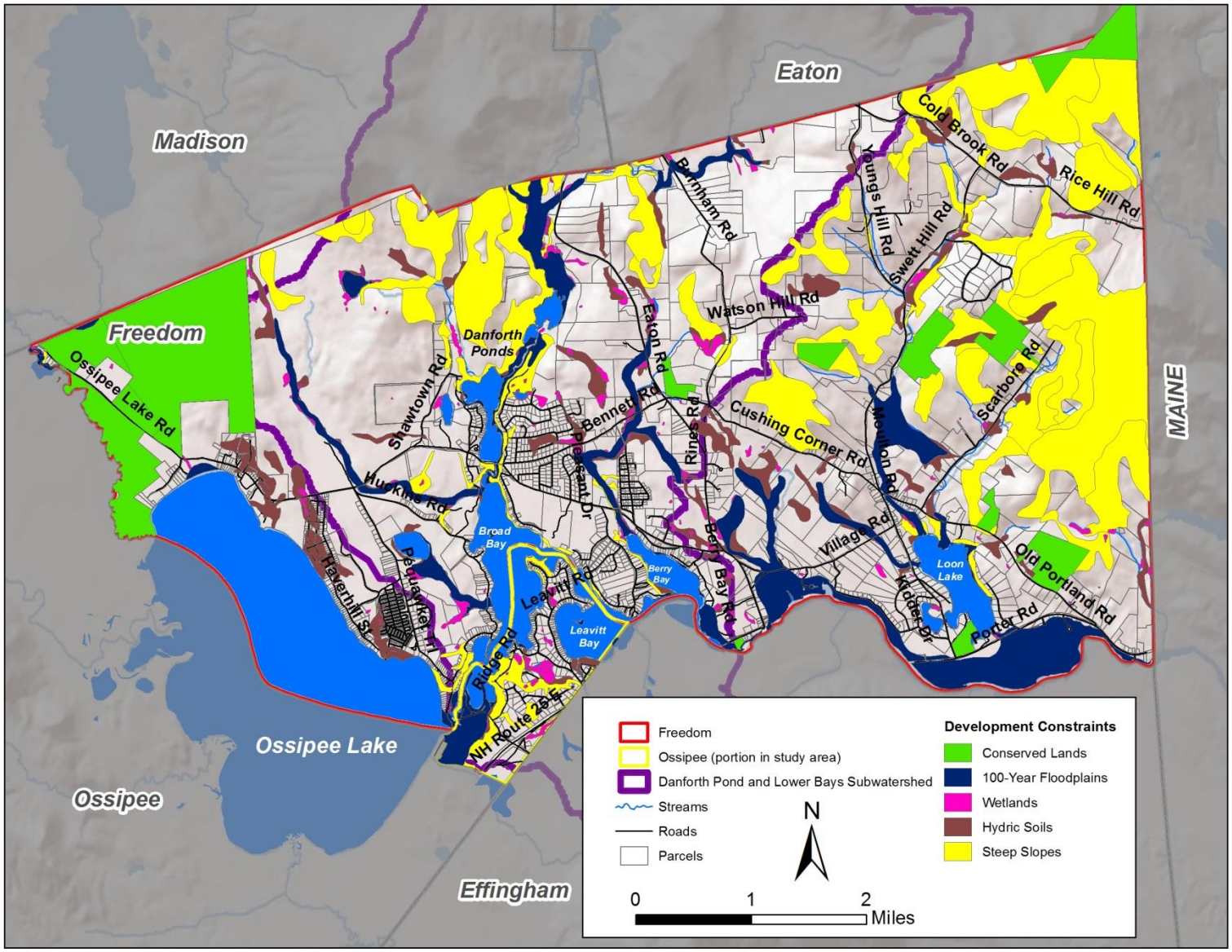

Figure 2. Map showing environmental development constraints within the study area. Note that the constraints shown on the map do not represent all possible development constraints on a given lot.

2.5 Build-out Assumptions

To determine how many building units can be built on the available buildable land, various density and other design factors are considered, based on the zoning requirements for each town. Any build-out analysis requires simplifying assumptions. Below is a list of assumptions used in the build-out analysis, based on zoning requirements in Freedom and Ossipee. These assumptions are an important component of the model because it facilitates prediction of whether development can occur on a given lot given the types of standards for development in a given town. For example, zoning districts with large minimum lot sizes (e.g. 5 acres, Rural Residential) will result in different a development pattern in the future compared to a zoning district with smaller minimum lot sizes (e.g. 1 acre, Village Residential).

- **Building setbacks** were estimated based on the average front and rear setbacks specified in each town's zoning ordinances (Table 1). Setbacks are measured from building center points in CommunityViz. To account for this, building footprints need to be estimated to avoid building overlap. The dimensions of the minimum building footprint were estimated to be 30 feet x 30 feet. This number was then was added to the average front/rear setback for each zone to estimate the "Minimum Separation Distance" used in CommunityViz.
- **Minimum lot size requirements** used were based on requirements for each zone (Table 1).
- **Efficiency factors** adjust density values to account for common density losses. Lot efficiency refers to the amount of land on a parcel that is available for construction after addressing such considerations as drainage facilities, parcel contiguity, ROWs, setbacks, road frontage, conservation restrictions, and anything else that can reduce the amount of buildable land within a given zone. They are entered as a percentage, where 100% means complete efficiency (no density lost), and 0% means no buildings will be estimated for a particular zone. Through discussion with officials from the Town of Freedom, for the current build-out it was decided that a 25% efficiency factor would be applied to all "landlocked" lots (i.e., lots which are not bordered by roads) as development of these lots is difficult due to constraints to access. A 70% efficiency factor was applied to all other lots to account for the factors listed above.

3.0 BUILD-OUT RESULTS

3.1 Buildable area

An estimated 9,443 acres (42%) of the entire 22,227 acre study area was identified as developable by the build-out analysis. This amounts to 43% of Freedom, and 21% of the portion of Ossipee within the study area. In Freedom, the Rural Residential and General Residential zones have the most land available for development. In the portion of Ossipee within the study area, the Rural District has greatest amount of buildable land (Table 3, Figure 3).

Table 3. Buildable area by zone for Freedom and Ossipee, New Hampshire.

Zone	Total Area (acres)	Total Buildable Area (acres)	Percent Buildable Area
Freedom			
Rural Residential	11,861	5,581	47
Rural Residential (Shorefront)	711	219	31
General Residential	6,480	2,290	35
General Residential (Shorefront)	1,213	625	52
Residential/Light Commercial	1,118	503	45
Village Residential	191	99	52
Freedom Village Condos	68	0	0
General Residential (Totem Pole Park)	42	0	0
Ossipee			
Rural District	574	117	20
Commercial	19	9	47

3.2 Projected Buildings

The number of building units within the study area is projected to increase by 2,152 units from 2,563 units in 2014 to 4,715 units at full build-out; an 84% increase (Table 4, Figure 4 & 5). (Note that the analysis assumes that development will occur on parcels closest to existing roads first.) New building units are projected to occur in most zones within the study area. The Rural Residential and Residential/Light Commercial zones are projected to experience the largest percent increase in new buildings in Freedom. In the portion of Ossipee within the study area, the commercial district is projected to experience the largest increase in new buildings. No additional buildings are projected for Freedom's Freedom Village Condos and Totem Pole Park.

3.3 TimeScope Analysis

Three iterations of the TimeScope analysis were run using compound annual growth rates for 10-, 20-, and 30-year periods. These periods represent from 2000-2010 (1.34%), 1990-2010 (2.35%), and 1980-2010 (2.45%), respectively (Table 2). At the 10-, 20-, and 30-year growth rates, full build-out is projected to occur by 2064, 2043, and 2041, respectively (Figure 6).

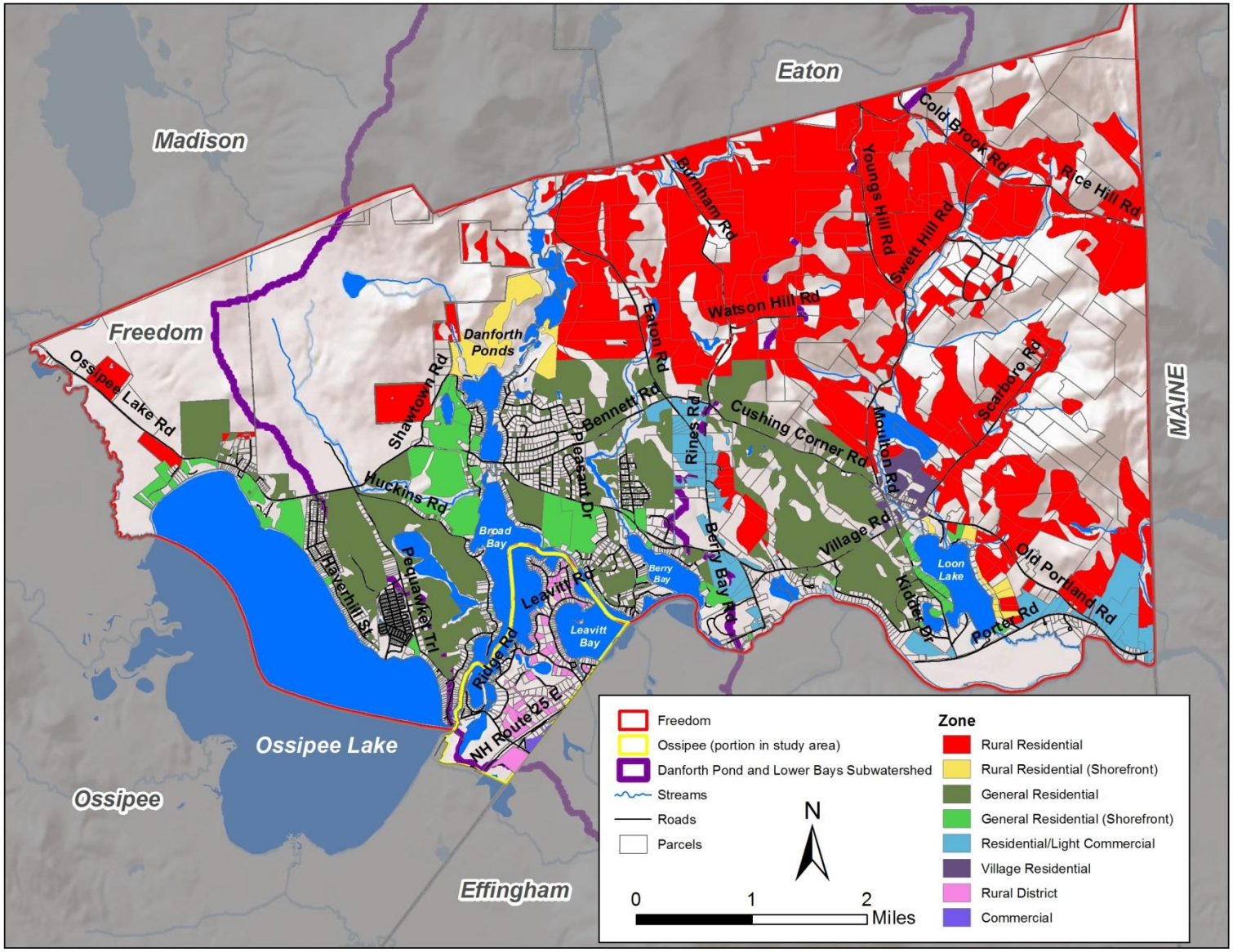

Figure 3. Colored areas indicate buildable area by zone for Freedom and Ossipee, New Hampshire. Non-colored areas are considered non-buildable due to development constraints.

Table 4. Projected buildings by zone in Freedom and Ossipee, New Hampshire.

Zone	No. Existing Buildings	No. Projected Buildings	No. Buildings at Full Build-Out	Percent Increase
Freedom				
Rural Residential	185	753	938	407
Rural Residential (Shorefront)	110	55	165	50
General Residential	795	843	1,638	106
General Residential (Shorefront)	510	82	592	16
Residential/Light Commercial	91	269	360	296
Village Residential	58	61	119	105
Freedom Village Condos	11	0	11	0
General Residential (Totem Pole Park)	457	0	457	0
Ossipee				
Rural District	339	83	422	24
Commercial	7	6	13	86
Totals	**2,563**	**2,152**	**4,715**	**84**

4.0 PHOSPHORUS IN OSSIPEE LAKE LOWER BAYS WATERSHED

4.1 Method for Estimating Phosphorus Load in the Build-Out Scenario

An increase in watershed development could lead to more phosphorus (P) entering Danforth Pond and the Lower Bays from the surrounding watershed each year. Phosphorus serves to "fertilize" the lake and decreases water clarity. Excess phosphorus can also harm fish habitat and lead to nuisance and/or toxic algae blooms. The Lake Loading Response Model (LLRM) was used to estimate the additional annual phosphorus load that could result from full build-out in the watershed.

Step 1: Adapting build-out results to the watershed boundaries: The build-out analysis described in the previous sections covers the Town of Freedom, plus the portion of the Town of Ossipee within the watershed. The watershed boundaries do not match the build-out boundaries, excluding portions of the Town of Freedom, and including portions of the towns of Eaton, Effingham, and Madison. The LLRM must conform to watershed boundaries, so the results from the build-out analysis had to be adapted to the watershed.

For the land area where the build-out analysis and LLRM model overlap, the number of future buildings was taken directly from the build-out analysis. The land areas which do not overlap were assumed to be qualitatively similar in future development potential, therefore a proportional number of buildings were applied to those areas of the watershed. That is, a ratio of buildings to land area was determined in the non-overlapping build-out areas, and then multiplied by the non-overlapping land area in the watershed.

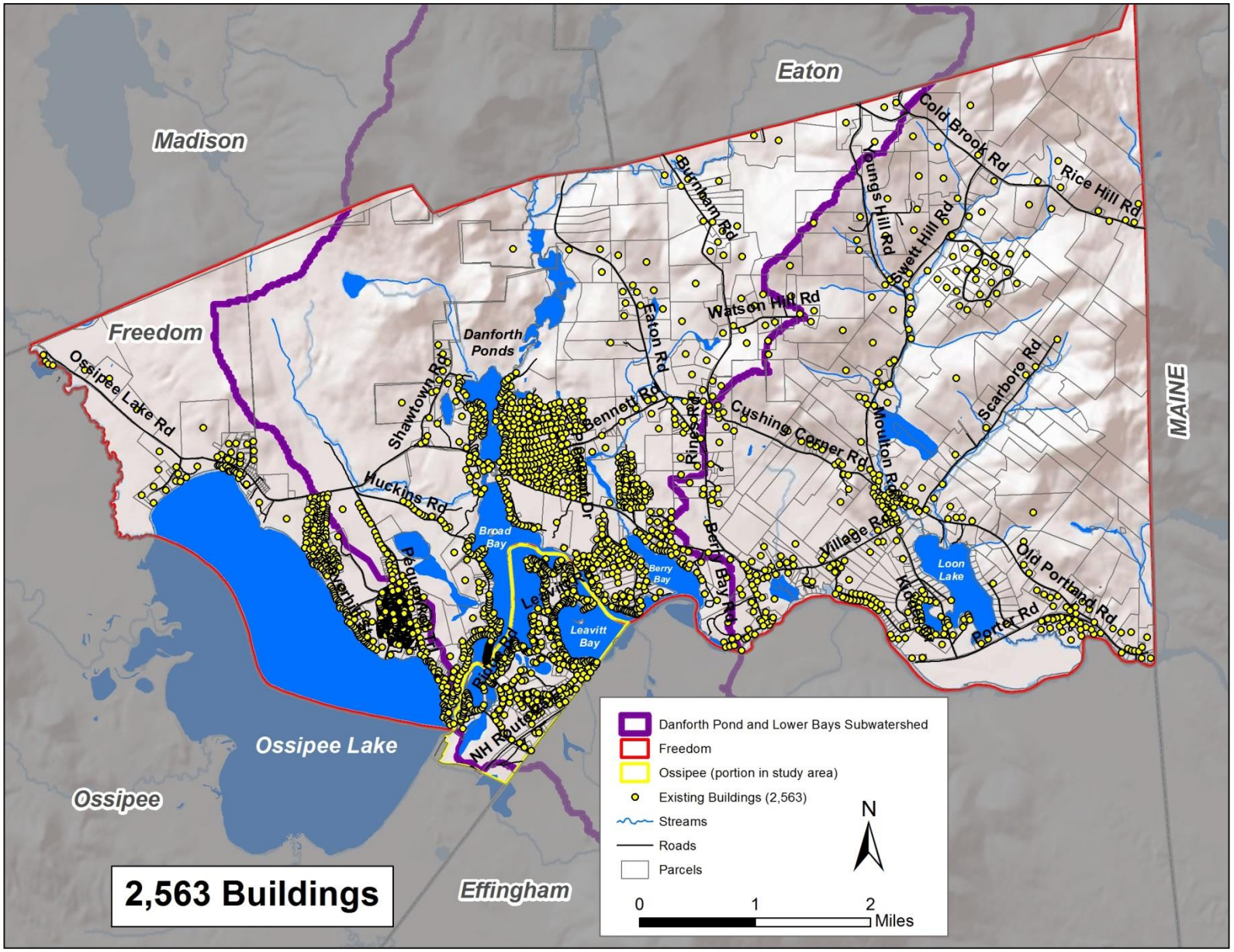

Figure 4. Existing buildings within the study area.

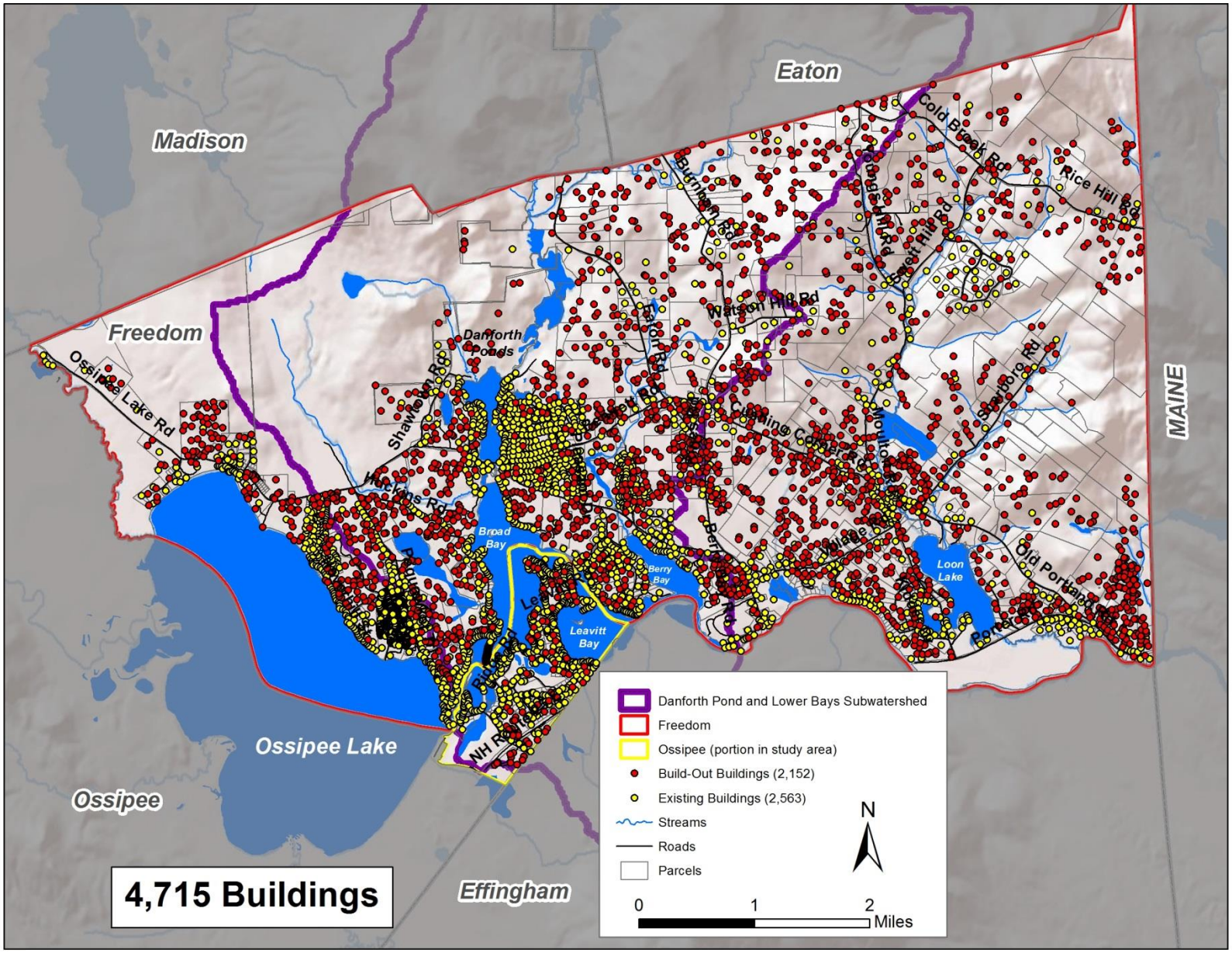

Figure 5. Projected buildings within the study area at full build-out.

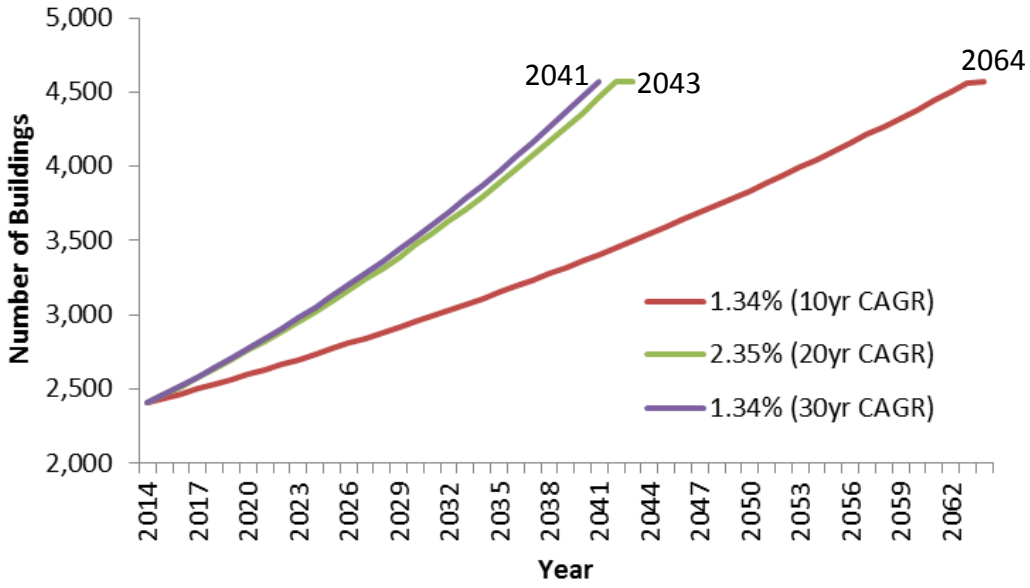

Figure 6. Full build-out projections of the study area using 10-, 20-, and 30-year compound annual growth rates (Table 2).

Step 2: Calculating developed land coverage under the full build-out scenario: Each new building was considered to generate new residential and road land uses. Specifically, 0.5 acres of low-density developed land (Urban1 within LLRM) was assigned for each building. In addition, 0.25 acres of roads (Urban3) were assigned to each building. By comparison, under existing conditions in the Cold Brook subwatershed there are 0.29 acres/building of mixed mid and low density residential land use, and 0.46 acres/building of roads. In Square Brook, there are 0.46 acres/building of mixed residential land use, and 0.33 acres/building of roads. These were the only two basins with complete building data, due to the way basin boundaries intersected the build-out area.

Step 3: Incorporating land use changes and septic system loading into LLRM for P loading predictions: The future developed land uses were added into the LLRM, and a corresponding area of undeveloped land was removed for the full build-out scenario. The undeveloped land use of "hayfield" was eliminated first, and if additional undeveloped land was needed, "forest" category was used, which was considered the most realistic development pattern. In addition to land use changes, one new septic system was entered into the model per new building, maintaining the same ratio of new and old systems, as well as year-round and seasonal systems.

4.2 Phosphorus Load Results

For current conditions, the LLRM predicted an in-lake total phosphorus concentration for the lower bays of 7.2 ppb, which is very close to a composite empirical data point (the average of three bays mid-summer epilimnetic concentration) of 7.1 ppb. The phosphorus mass load modeled by LLRM was 4,066 kg/year. Of this

P load, 1,222 kg/year came from runoff, 56.6 kg/year came from septic systems, and 2,696 kg/year came from inflow from Ossipee Lake. The upstream watersheds of Ossipee Lake, therefore, provide two thirds of the phosphorus load to the Lower Bays.

Under full build-out scenario, the P load from runoff within the Lower Bays watershed would increase 39% to 1,695 kg/year, and loading from septic systems would increase 99% to 113 kg/year. Using only the build-out scenario assumptions for this watershed, it was not possible to model the overall change in phosphorus loading to Lower Bays, because the change in Ossipee Lake water quality under build-out conditions was unknown. For a realistic estimate of a full build-out scenario for the Lower Bays, it would be necessary to conduct a build-out analysis for the entire Ossipee Lake watershed, a very large area covering many towns.

A placeholder value, however, can be obtained by increasing the Ossipee Lake load by 40%, roughly the same level of increase predicted in the Lower Bays watershed. Doing so would take the Ossipee Lake contribution to 3,774 kg/year, and would boost the total load to the Lower Bays to 5,675 kg/year, and TP concentration would be 10.1 ppb. However, it is stressed that this is merely a placeholder, and a properly completed build-out analysis may show much higher or lower overall loading to the Lower Bays under a comprehensive future build-out scenario that encompasses all Ossipee Lake watershed towns. In addition, different towns may project full build-out conditions over very different time frames, which is an important consideration in lake protection planning. Detailed results by source category are presented in Table 5.

Septic system loading is estimated to grow faster than the runoff load under the future development scenario. Future loading from septic systems can be greatly reduced by ensuring that all new systems are well separated from the lake, streams, and wetlands horizontal setbacks, and well separated vertically above the seasonally high groundwater table in suitable soil. When properly located, designed, installed, and maintained, septic systems are very effective at reducing phosphorus loading.

4.0 SUMMARY AND RECOMMENDATIONS

The build-out analysis for the study area provides estimates about the potential for new residential development, including the number of new buildings (Table 4) and the amount of land area that could be developed in the watershed based on current zoning standards (Table 3, Figure 2). The build-out also presents information about where the development is expected to occur (Figures 4), and how total phosphorus exported from the watershed is expected to increase in Ossipee Lake as a result of this development (Table 5). The build-out analysis provides a full build-out scenario based on current zoning standards, and should be viewed as an estimate only. It should be treated as a planning tool that can be utilized to guide future development activities in the watershed as well as to target specific areas for conservation.

Table 5. Phosphorus loading by source category and in-lake P loading in build-out scenarios.

	Current Conditions *kg/year*	From Lower Bays Build-out Analysis *kg/year*	Build-out Analysis, plus 40% Increase in Ossipee Lake P Load *kg/year*
Direct Loads			
Atmospheric	63	63	63
Internal	12	12	12
Waterfowl	17	17	17
Septic Systems	57	113	113
Watershed Loads			
Lower Basins Watershed	1,222	1,695	1,695
Upstream Watersheds via Ossipee Lake	2,696	Not Modeled	3,774*
Phosphorus Load to Lake (kg/year)	**4,066**	**Not Modeled**	**5,674***
In-Lake Phosphorus Concentration (ppb)	**7.2**	**Not Modeled**	**10.1***

* Ossipee Lake watershed build-out conditions were not modeled; therefore the 40% increase in P load presented here is merely a provisional placeholder. A proper build-out for the Ossipee Lake watershed may show a much higher or lower future P loading estimate for Ossipee Lake, and thus the Lower Bays.

The greatest amount of existing development is concentrated around the waterbodies within the southwestern portion of the study area (i.e., Ossipee Lake, Danforth Ponds, and Leavitt Bay) (Figure 3). The build-out analysis shows that the Rural Residential, Residential/Light Commercial, General Residential, and Village Residential zones within Freedom have significant potential for new development (Table 4). For the entire study area the analysis estimates that 2,152 new buildings could be added by the years 2041, 2043 or 2064, (dependent upon growth rate used) affecting the 9,443 acres of buildable land remaining in the watershed (Figure 2).

Future development will increase the amount of runoff that drains to Ossipee Lake and its tributaries, and therefore will result in greater amounts of phosphorus entering the lake. Under the full build-out scenario, phosphorus loading to Ossipee Lake could increase by 39%, from 1,222 kg/year currently to 1,695 kg/year. Significant increases in phosphorus loading, as predicted in the build-out, can result in dire consequences for sensitive lake systems that by nature are phosphorus-limited. Any new increases of phosphorus in a lake can "tip the scales" of nature to favor increased algal growth, and thus decreased water clarity. The increased phosphorus may also increase the presence of other aquatic plant growth in the shore zone, including undesirable invasive plants.

Development standards that result in no net increase of stormwater should be considered for all new development, including low impact development (LID), which utilizes smart site design principles to capture and treat polluted runoff from rooftops, driveways and other impervious surfaces so that they don't end up in nearby streams and lakes. Similarly, phosphorus control standards which require the installation of best management practices (BMPs), including LID, could be adopted to limit the amount of phosphorus allowed to

be exported from an individual property. Other tools such as conservation or cluster subdivisions should also be encouraged in order to protect open space, wildlife habitat, water quality, and to discourage sprawl.

5.0 ACKNOWLEDGMENTS

Thanks to the Town of Freedom Planning Board and the Green Mountain Conservation Group for their contributions in helping to make this analysis as accurate as possible, both in reflecting on-the-ground conditions and projecting future build-out scenarios. Special thanks to Anne Cunningham, who spent many hours quality-checking numbers and providing much useful feedback. Lastly, this build-out analysis would not have been possible without the generous support of the citizens of Freedom and Ossipee.

6.0 REFERENCES

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