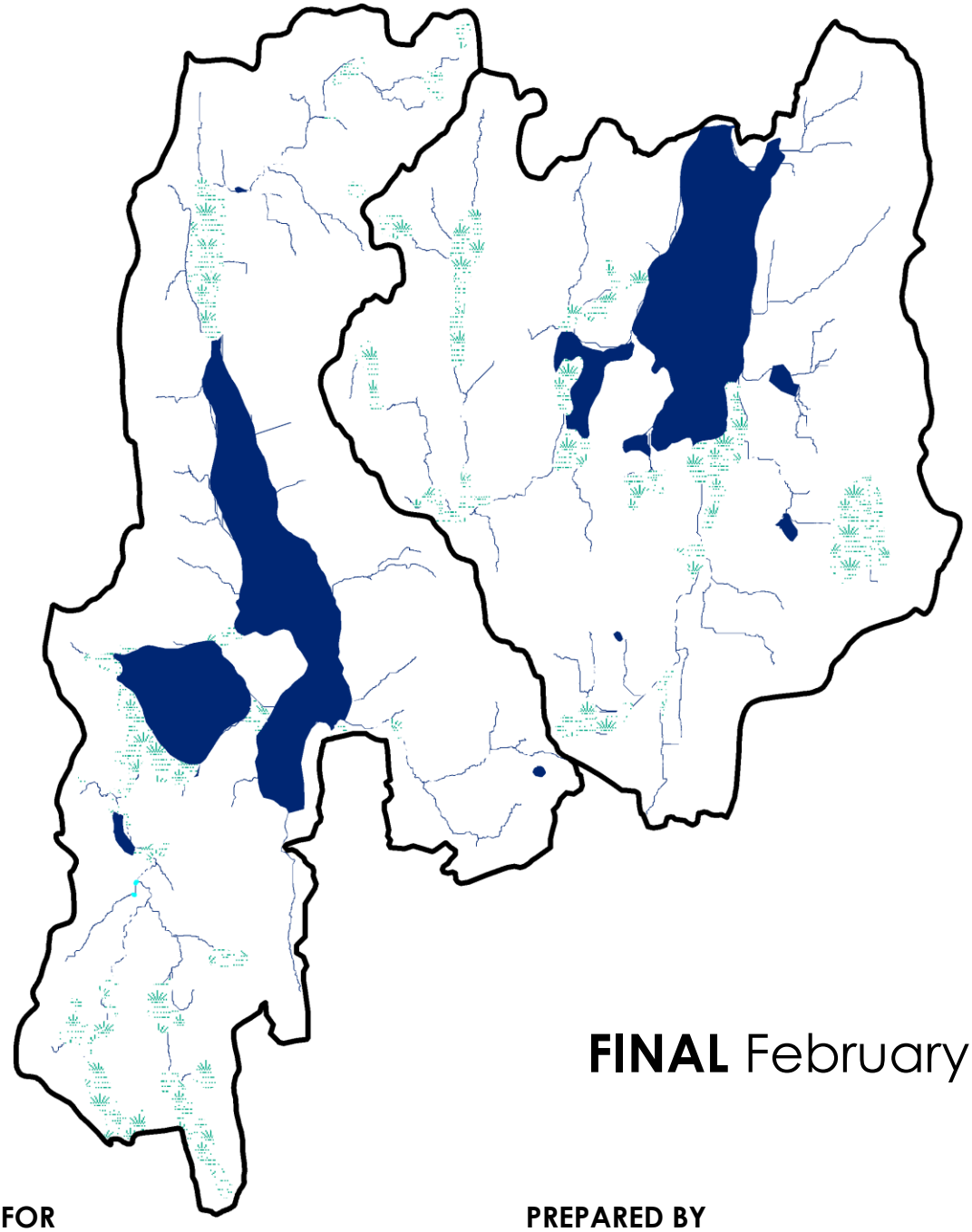
BUILD-OUT ANALYSIS

KNICKERBOCKER LAKE AND ADAMS POND



FINAL February 2018

PREPARED FOR

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EXECUTIVE SUMMARY

With watersheds covering 1,925 acres in the Towns of Boothbay and Boothbay Harbor, Maine, Knickerbocker Lake and Adams Pond serve as primary drinking water sources to three Maine municipalities, including the Towns of Boothbay, Boothbay Harbor, and Southport Island. As primary drinking water sources within a fast-growing coastal area, the water quality and quantity of Knickerbocker Lake and Adams Pond are being threatened by watershed development. Understanding the extent to which watershed development can proceed within the confines of local ordinances can help identify areas of improvement for water quality protection.

FB Environmental Associates (FBE) was contracted by the Boothbay Region Water District to conduct a build-out analysis of the Knickerbocker Lake and Adams Pond watersheds (hereafter "watershed"). "Build-out" is a theoretical condition which represents the period when all available land suitable for residential, commercial, and industrial uses has been developed to the maximum conditions permitted by local ordinances. A build-out analysis is a planning tool that identifies areas with development potential and projects future development based on a set of conditions (e.g., zoning regulations) and assumptions (e.g., population growth rate). The results of the build-out analysis can be used for planning purposes to help guide future development activities in the watershed, as well as target specific areas for conservation. Note that the analyses presented herein provides a full build-out scenario based on Boothbay's current and proposed zoning standards (which are subject to amendment) and should be viewed as an estimates only.

Approximately 337 parcels were identified within or partially within the watershed, ranging in size from less than one acre to 200 acres. The largest parcel completely within the watershed was 65 acres. The build-out analysis showed that 62% of the watershed is buildable under current zoning regulations. The General Residential and C3 districts have the most land acreage available for development at 638 and 232 acres, respectively. FBE identified 233 existing buildings within the watershed, and the build-out analysis projected an additional 665 buildings could be constructed in the future, resulting in a total of 898 buildings in the watershed. Three iterations of the TimeScope analysis were run using CAGRs for 10-, 20- and 30-year periods from 2000-2010 (0.53%), 1990-2010 (0.82%), and 1980-2010 (1.01%), respectively. Full build-out is projected to occur in 2337 at the 10-year CAGR, 2210 at the 20-year CAGR, and 2162 for the 30-year CAGR.

An initial alternative scenario was run that incorporated proposed zoning changes within the watershed. This first alternative scenario analysis showed that 62% of the watershed remains buildable, but an additional 704 buildings could be constructed in the future, resulting in a total of 937 buildings in the watershed. The Residential (including Water Supply Protection) and Boothbay Village Mixed Use districts have the most acreage available for development at 911 and 55 acres, respectively.

FBE ran a second alternative scenario under current zoning (i.e., not the proposed zoning used in the first alternative scenario) where an additional 454 acres near Knickerbocker Lake and Adams Pond were conserved. The second alternative analysis showed that with the addional watershed area treated as conserved, 41% of the watershed would be buildable. Under this scenario, an additional 445 buildings could be constructed in the future, resulting in a total of 678 buildings within the Knickerbocker Lake and Adams Pond watershed.

1. INTRODUCTION

The Knickerbocker Lake and Adams Pond watersheds are located within the Towns of Boothbay and Boothbay Harbor, Maine (FIGURE 1). Adams Pond and Knickerbocker Lake serve as primary drinking water sources to three municipalities, including the Towns of Boothbay, Boothbay Harbor, and Southport Island. The watersheds cover approximately 1,925 acres. Knickerbocker Lake drains south to Campbell Creek, which drains to Boothbay Harbor. Adams Pond drains north to the Back River, a tributary to the tidal outlet of the Sheepscot River.

Concerned with protecting the water quality of Knickerbocker Lake and Adams Pond for drinking water and recreational purposes, the Boothbay Region Water District hired FB Environmental Associates (FBE) to perform a build-out analysis of the Knickerbocker Lake and Adams Pond watersheds (hereafter "watershed"). The results of the analysis provide estimates of the numbers of potential lots and new building units the watershed may see developed at some point in the future. "Full build-out" refers to the time and circumstances whereby 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 in the future and understanding development impacts to water quality.

2. METHODS

2.1 COMMUNITY VIZ SOFTWARE

FBE conducted the build-out analysis using ESRI ArcMap version 10.5 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. FBE utilized the software's 'Build-out Wizard' to calculate the development capacity of the study area (numerically and spatially), as well as the 'Time Scope Analysis' tool to project and visualize how future development might occur over time.

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

- Collect data on existing conditions in the study area: existing buildings, zoning, and growth rates.
- Collect and/or create GIS data and development constraints layers.
- Obtain input on developable and non-developable land from town officials and other project stakeholders (e.g., citizens).
- Analyze build-out potential using CommunityViz's Build-Out Wizard tool.
- Determine potential dates in the future at which full build-out is reached using CommunityViz's TimeScope Analysis tool.

2.2 DISCLAIMER AND DATA LIMITATIONS

The data used in the analysis represented stock data sets obtained from the Maine Office of GIS (MEGIS) online data catalog. Many of these data layers were created from remotely-sensed data (e.g., aerial photography, digital orthophotos, and satellite images) and large landscape-level mapping projects (e.g., Soil Units). As a result, the data layers are intended to be viewed at certain scales (generally 1: 24,000/ 1: 25,000) due to accuracy levels. MEGIS maintains a continuing program to identify and correct errors in these data but make no claims as to the validity or reliability or to any implied uses of these datasets. As a result, the data presented herein should be used for planning purposes only. If greater data precision is required, this report should be supplemented with field surveys or other on-the-ground methods of data collection. There may also be minor data discrepancies throughout this document due to the variety of source materials and mapping standards used. The reader is encouraged to refer to the original referenced sources if specific data inconsistencies need to be resolved.

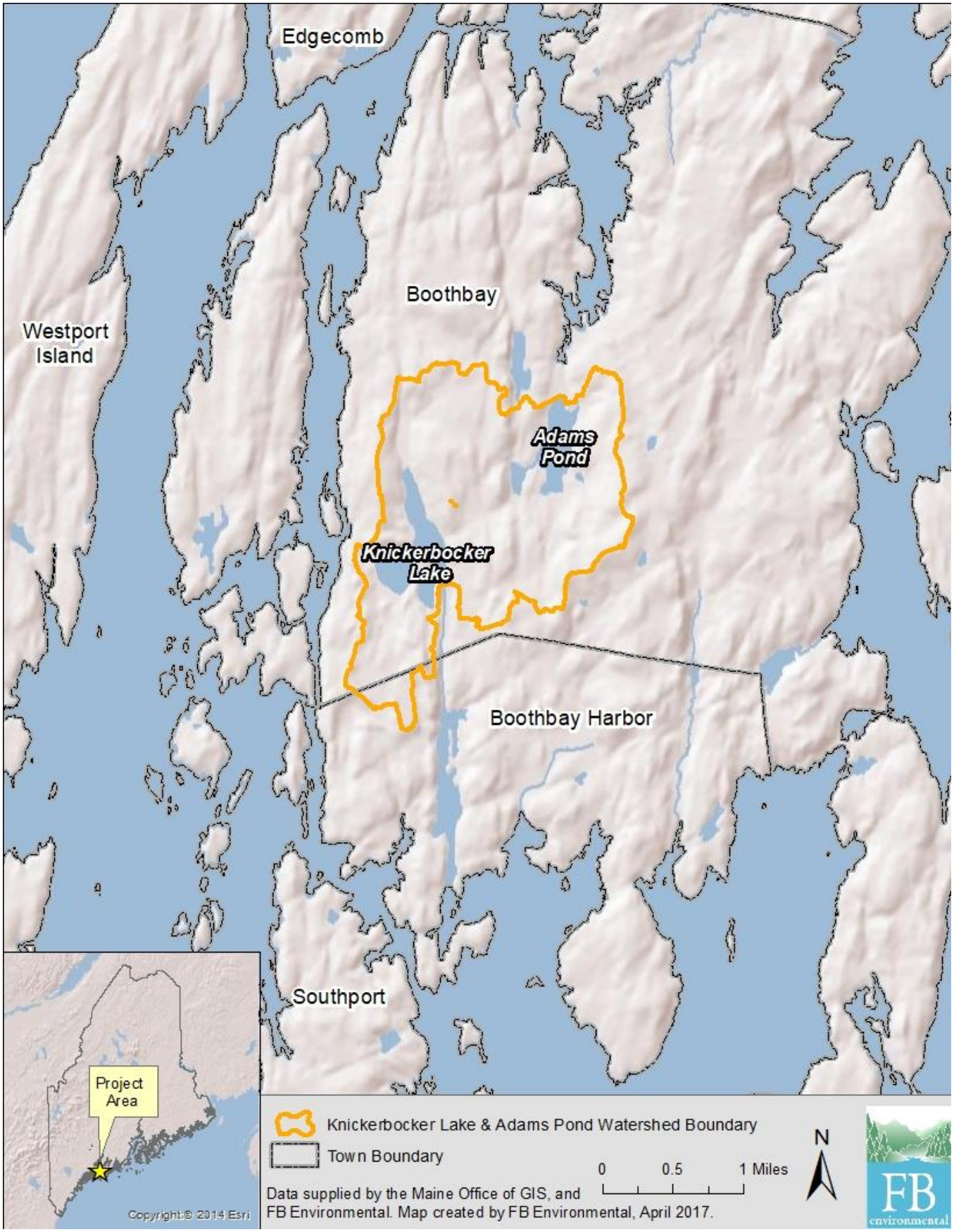

FIGURE 1. The Knickerbocker Lake and Adams Pond watershed, Boothbay, Maine.

2.3 EXISTING BUILDINGS

FBE used 2015 aerial imagery (obtained from ESRI via its ArcMap software) to create a GIS layer of existing buildings within the study area. Examination of aerial imagery resulted in the creation of a shapefile with 233 points representing principal structures (secondary structures were not included). In areas where it was difficult to discern the presence of a dwelling (typically due to shadows or the presence of trees), ESRI orthophotos were cross-checked using Google Earth and Bing Maps.

2.4 ZONING

Crucial to a build-out analysis is the feasibility of modeling zoning requirements (Table 1). Certain zoning requirements are too site-specific to enable incorporation to the analysis. Given this, the analysis makes use of the following qualifications in determining build-out zoning restrictions:

- Future lots were made the smallest size allowable for the zoning district.
- Potential unit types (e.g., residential house, commercial building) were not specified.

TABLE 1. Base zoning standards for Boothbay and Boothbay Harbor, Maine. The Water Reservoirs Protection District is abbreviated as WRPD.

Zone	Building Setback (ft.) Front	Side/Rear	Minimum Lot Size (acres)
Boothbay			
C2 District	State = 50 Town = 33	20	0.92
C2 District (WRPD)	State = 50 Town = 33	20	4.00
C3 District	State = 50 Town = 33	20	0.92
C3 District (WRPD)	State = 50 Town = 33	20	4.00
General Residential District	State = 50 Town = 33	20	0.92
General Residential District (WRPD)	State = 50 Town = 33	20	4.00
Village District	33	10	0.92
Boothbay Harbor			
General Residential	60	25	0.92

2.5 POPULATION GROWTH RATES

According to the US Census Bureau, Boothbay has experienced steady population growth since the middle part of the last century (TABLE 2). The Town's population has increased from 1,617 people in 1960 to 3,120 people in 2010 – a 93% increase. FBE ran three iterations of the TimeScope analysis for the Town based on compound annual growth rates representing 10-, 20-, and 30-year periods.

TABLE 2. US Census Bureau population and associated growth rates for Boothbay, Maine, 1960-2010.

1960	1970	1980	1990	2000	2010	30 yr. Avg. Annual Growth Rate 1980-2010	20 yr. Avg. Annual Growth Rate 1990-2010	10 yr. Avg. Annual Growth Rate 2000-2010
1,617	1,814	2,308	2,648	2,960	3,120	1.01%	0.82%	0.53%

2.6 DEVELOPMENT CONSTRAINTS

To determine where development may occur in the study area, build-out calculations deduct land unavailable for development due to physical constraints, including environmental restrictions (e.g., wetlands), zoning restrictions (e.g., shoreland zoning, street Right-of-Ways, and building setbacks), and practical design considerations (e.g., lot layout inefficiencies). Existing buildings also reduce the capacity for new development (Figure 2).

Except for existing buildings, FBE obtained all development constraints datasets from MEGIS. GIS data used to model development constraints are listed below. FBE added several properties identified by Susan Mello of the Boothbay Region Water District to the "Conserved land" layer.

- Conserved land
- Waterbodies and watercourses appearing in the National Hydrography Dataset
- Wetlands appearing on NH Wetlands Basemap
- Existing buildings

Note that steep slopes and hydric soils were not included in the development constraints as it is unclear in the zoning ordinance how to best incorporate these to the analysis (as well as deal with them in the field). Also, the development constraints considered above do not represent the full range of possible restrictions or resources that may be found in the field. For example, rare and/or State-listed species may be present, but are not considered because data regarding their specific location(s) are not available. Small, unmapped wetlands may also be present that would further restrict development.

2.7 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 the town. However, build-out analyses require some simplifying assumptions. FBE used the following three assumptions in the build-out analysis, based on Boothbay and Boothbay Harbor's zoning requirements.

- **Building setbacks** were estimated based on the average front and rear setbacks specified by the towns' 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. FBE estimated the dimensions of the minimum building footprint to be 30 feet x 30 feet. This number was added to the average front/rear setback for each zone to estimate the "Minimum Separation Distance" used in CommunityViz.
- **Wetland and Stream setbacks** of 75 feet, per Boothbay's Zoning Ordinance, were used in the analyses.
- **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 zone. They are entered as a percentage, where 100% means complete efficiency (no density lost) and 0% means no buildings are estimated for a zone. FBE used an efficiency factor of 66% for the build-out.

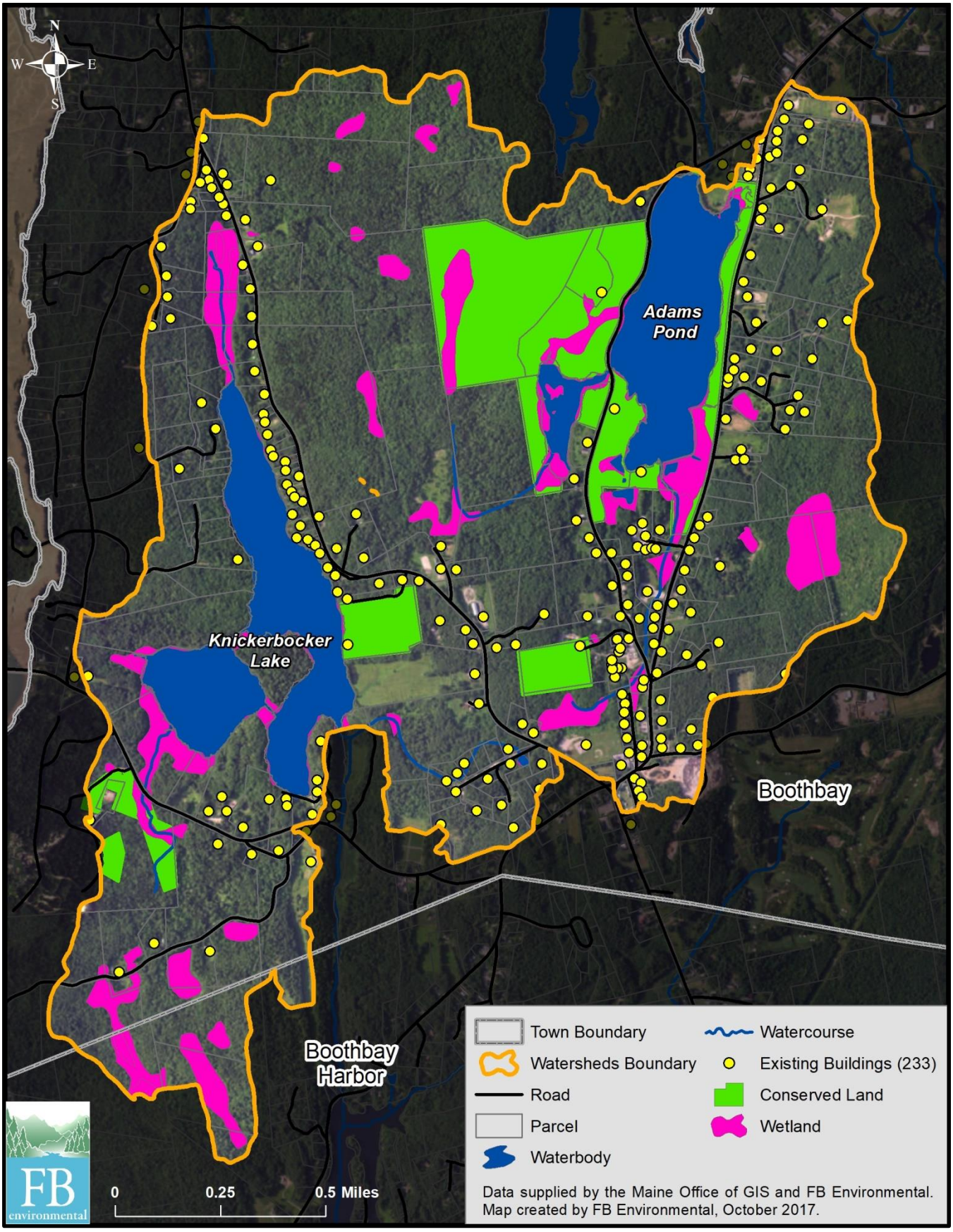

FIGURE 2. Development constraints in the Knickerbocker Lake and Adams Pond watershed, Boothbay, Maine.

3. RESULTS

3.1 PARCELS AND ZONING

There were 337 parcels within or partially within the watershed, ranging in size from less than one acre to 200 acres. The largest parcel completely within the watershed encompasses 65 acres.

3.2 BUILDABLE AREA

The build-out analysis showed that, under current zoning regulations, 62% of the watershed is buildable. The General Residential and C3 districts have the most acreage land available for development at 638 and 232 acres, respectively (TABLE 3, FIGURE 3).

TABLE 3. Amount of buildable land within the Knickerbocker Lake and Adams Pond watershed.

Zone	Total Area (Acres)	Buildable Area (Acres)	Percent Buildable Area
General Residential	927	638	69
C3 District	360	232	64
C2 District	77	67	87
General Residential (WRPD)	186	55	29
General Residential (BH)	61	34	56
Village	23	11	47
C3 District (WRPD)	37	6	16
C2 District (WRPD)	9	1	7
Total	**1,681**	**1,043**	**62**

3.3 PROJECTED BUILDINGS

The digitization of existing buildings within the towns identified 233 principal buildings. Based on the current input parameters, the build-out analysis projected an additional 665 buildings could be constructed in the future, resulting in a total of 898 buildings (TABLE 4, FIGURE 3). Note that the analysis shows buildings projected on several parcels currently held as stormwater buffers or in-lieu fee by the Coastal Maine Botanical Gardens. For the analysis, we did not restrict development on these parcels as the 2009 Declaration of Restrictions document states that the area must remain undeveloped in perpetuity *unless* permission is granted from the Maine Department of Environmental Protection.

TABLE 4. Projected increases in numbers of buildings by zone within the Knickerbocker Lake and Adams Pond watershed.

Zone	Existing Buildings	Projected Buildings	Total No. Buildings	Percent Increase
C2 District	16	45	61	281
C2 District (WRPD)	6	2	8	33
C3 District	85	146	231	172
C3 District (WRPD)	7	8	15	114
General Residential (B. Harbor)	0	22	22	n/a
General Residential	69	415	484	601
General Residential (WRPD)	41	22	63	54
Village	9	5	14	56
Total	**233**	**665**	**898**	**285**

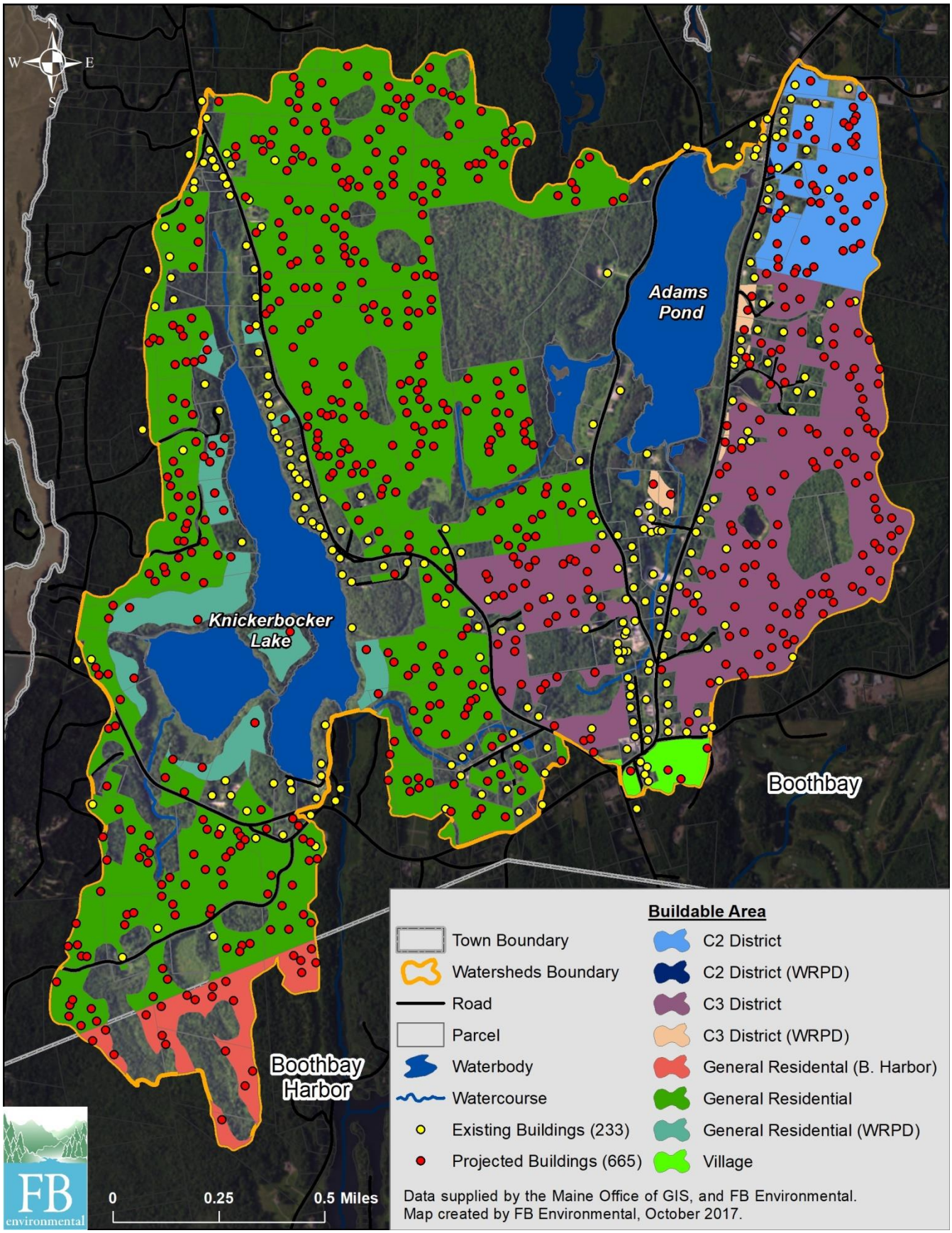

FIGURE 3. Buildable area by zone and projected buildings in the Knickerbocker Lake and Adams Pond watershed, Boothbay, Maine. "WRPD" abbreviates Water Resources Protection District.

3.4 TIMESCOPE ANALYSIS

Three iterations of the TimeScope analysis were run using compound annual growth rates (CAGR) for 10-, 20- and 30-year periods from 2000-2010 (0.53%), 1990-2010 (0.82%), and 1980-2010 (1.01%), respectively (TABLE 2). Full build-out is projected to occur in 2337 at the 10-year CAGR, 2210 at the 20-year CAGR, and 2162 for the 30-year CAGR (Figure 4). Note that the growth rates used in the TimeScope analysis are town-wide. They have been applied to a small section of the town.

Also, it is important to note that using census data to project population increase and/or development has inherent limitations. As such, the TimeScope analysis might overestimate the time required for the watershed to reach full build-out. Numerous social and economic factors influence population change and development rates, including policies adopted by both federal and local government. The relationships between the various factors may be complex and therefore difficult to model.

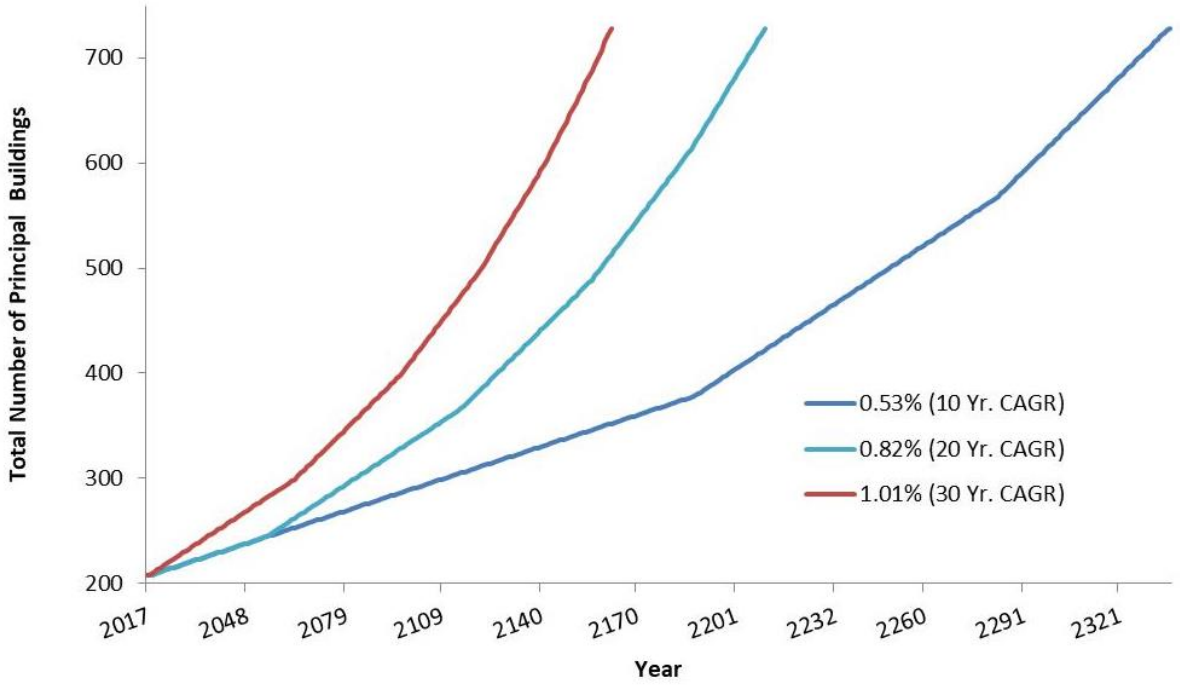

FIGURE 4. Full build-out projections of the Knickerbocker Lake and Adams Pond watershed (based on compound annual growth rates reported in TABLE 2.

4. ALTERNATIVE SCENARIO #1

For the first alternative scenario, the proposed zoning changes would create new zones within the watershed: Residential, Water Supply Protection, Boothbay Village Center, Boothbay Village Fringe, and Boothbay Village Mixed Use. A small portion of the Adams Pond watershed will be in the Commercial Corridor and Manufacturing Business zones.

4.1 ZONING

Zoning requirements relevant to the first alternative scenario build-out are presented in TABLE 5.

TABLE 5. Proposed zoning standards for Boothbay and Boothbay Harbor, Maine.

Zone	Building Setback (ft.)		Minimum Lot Size (acres)
	Front	Side/Rear	
Boothbay			
Residential District	State = 50 Town = 33 Private = 8	20	0.92
Residential (Water Supply Protection)	State = 50 Town = 33 Private = 8	20	4
Boothbay Village Mixed-Use District	State = 50 Town = 33 Private = 8	Side = 10 Rear = 20	0.69
Boothbay Village Fringe District	State = 50 Town = 33 Private = 8	Side = 10 Rear = 20	0.46
Boothbay Village Center District	10	Side = 10 Rear = 20	0.46
Commercial Corridor District	State = 75 Town = 60 Private = 8	20	0.92
Manufacturing/Business District	State = 50 Town = 8 Private = 8	Side = 25 Rear = 10	0.46
Residential District	State = 50 Town = 33 Private = 8	20	0.92
Boothbay Harbor			
General Residential	60	25	0.92

4.2 BUILDABLE AREA

The build-out analysis for the proposed zoning changes (alternative scenario #1) showed that 62% of the watershed is buildable. The Residential (including Water Supply Protection) and Boothbay Village Mixed Use districts have the most acreage available for development at 911 and 55 acres, respectively (TABLE 6). This did not change significantly from the original build-out of the watershed under current zoning.

TABLE 6. Amount of buildable land within the Knickerbocker Lake and Adams Pond watershed under the proposed zoning changes (alternative scenario #1).

Zone	Total Area (Acres)	Buildable Area (Acres)	Percent Buildable Area
Residential	1241	850	68
Residential (Water Supply Protection)	227	61	27
Boothbay Village Mixed Use	95	55	58
General Residential (Boothbay Harbor)	61	34	56

Zone	Total Area (Acres)	Buildable Area (Acres)	Percent Buildable Area
Commercial Corridor	25	19	76
Boothbay Village Fringe	19	18	93
Boothbay Village Center	14	11	80
Total	**1,681**	**1,043**	**62**

4.3 PROJECTED BUILDINGS

Based on the current input parameters for the proposed zoning changes (alternative scenario #1), the build-out analysis projected an additional 704 buildings could be constructed in the future, resulting in a total of 937 buildings within the Knickerbocker Lake and Adams Pond watershed (TABLE 7). This did not change significantly from the original build-out of the watershed under current zoning.

TABLE 7. Projected increase in numbers of buildings by zone within the Knickerbocker Lake and Adams Pond watershed under the proposed zoning changes (alternative scenario #1).

Zone	Existing Buildings	Projected Buildings	Total No. Buildings	Percent Increase
Boothbay Village Center	6	16	22	267
Boothbay Village Fringe	4	24	28	600
Boothbay Village Mixed Use	33	48	81	145
Commercial Corridor	11	9	20	82
General Residential (Boothbay Harbor)	0	23	23	n/a
Residential	125	552	677	442
Residential (Water Supply Protection)	54	32	86	59
Total	**233**	**704**	**937**	**302**

5. ALTERNATIVE SCENARIO #2

The second alternative scenario treated several parcels (totaling 454 acres near Knickerbocker Lake and Adams Pond) as conserved. For this scenario, the build-out analysis was run under the current zoning ordinance (i.e., not the proposed zoning used in the first alternative scenario).

5.1 BUILDABLE AREA

The build-out analysis for the second alternative scenario showed that with the addional watershed parcels treated as conserved, 41% of the watershed is buildable. The General Residential and C3 districts have the most acreage land available for development at 408 and 172 acres, respectively (TABLE 8).

TABLE 8. Amount of buildable land within the Knickerbocker Lake and Adams Pond watershed with an additional 454 acres restricted to development (alternative scenario #2).

Zone	Total Area (Acres)	Buildable Area (Acres)	Percent Buildable Area
General Residential	927	408	44
C3 District	360	172	48
C2 District	77	67	87
General Residential (WRPD)	186	15	8
General Residential (BH)	61	13	21
Village	23	11	47
C3 District (WRPD)	37	6	16
C2 District (WRPD)	9	1	7
Total	**1,681**	**692**	**41**

5.2 PROJECTED BUILDINGS

With the additional conserved lands, the build-out analysis for the second alternative scenario projected an additional 445 buildings could be constructed in the future, resulting in a total of 678 buildings within the Knickerbocker Lake and Adams Pond watershed (TABLE 9).

TABLE 9. Projected buildings within the Knickerbocker Lake and Adams Pond watershed with an additional 454 acres restricted to development (alternative scenario #2).

Zone	Existing Buildings	Projected Buildings	Total No. Buildings	Percent Increase
C2 District	16	45	61	281
C2 District (WRPD)	6	2	8	33
C3 District	85	107	192	126
C3 District (WRPD)	7	7	14	100
General Residential (B. Harbor)	0	10	10	n/a
General Residential	69	259	328	375
General Residential (WRPD)	41	10	51	24
Village	9	5	14	56
Total	**233**	**445**	**678**	**191**

REFERENCES

Boothbay (2007). Zoning Ordinance of the Town of Boothbay. Town of Boothbay, Maine. May 2, 2016 Revision.

Boothbay Harbor (1999). Chapter 170: Land Use. Available online at: http://ecode360.com/8627687