Burlington Harbor Marina
234 Penny Lane
Burlington, Vermont

KAS Job #51210387

ENVIRONMENTAL ASSESSMENT (DRAFT FOR PUBLIC COMMENT)

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Prepared for:

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Table of Contents

1.0 INTRODUCTION 1

Purpose and Need 1
Environmental Compliance 2

2.0 ALTERNATIVES INCLUDING PROPOSED ACTION 3

Alternative A (Proposed Action) 3
Alternative B (No Action) 4
Summary of Environmental Consequences 4

3.0 AFFECTED ENVIRONMENT AND POTENTIAL CONSEQUENCES 9

Land Use 9
Geology and Soils 9
Shoreline Erosion 10
Hydrology and Water Resources 10
Water Quality 11
Water Supply 13
Stormwater 14
Wetlands 15
Floodplains 15
Boat Navigation 15
Biological Resources 17
Aquatic 17
Terrestrial 18
Threatened and Endangered Species (Animal, Plant, Aquatic) 19
Hazardous Materials 20
Environmental Database Review 20
Recent Environmental Site Investigations 20
Air and Noise 21
Socioeconomic Issues 23
Cultural Resources 23
Archeologial Resources 23
Historical Resources 24

4.0 CUMULATIVE IMPACTS 25

5.0 FUTURE COMPLIANCE AND PERMITS 26

6.0 LIST OF PREPARERS AND CONTRIBUTORS 27

7.0 REFERENCES 28

Appendices

Appendix A Site Location Map
Site Plans (5 Sheets)
Existing Conditions (Aerial Photo)
Floodplain Boundary (Drawing C2.2A)

Appendix B Navigation Assessment by ATM

Appendix C Wave Assessment by ATM

List of Tables

Table 1. Proposed Marina Compliance with Federal and State Statutes and Executive Orders

Table 2. Summary of Environmental Consequences

Table 3. List of Preparers

Table 4. List of Contributors and Reviewers

1.0 INTRODUCTION

This Environmental Assessment (EA) has been prepared to describe and assess the environmental effects that are likely to result from the construction and operation of a new marina within Burlington Harbor of Lake Champlain in Burlington, Vermont. This EA was prepared in cooperation with the Vermont Fish and Wildlife Department (VTFWD), U.S Fish and Wildlife Service (USFWS), and the Wildlife and Sport Fish Restoration Program (WSFRP).

This EA has been prepared for Burlington Harbor Marina, LLC (developer) in compliance with the National Environmental Policy Act (NEPA) of 1969, as amended and the regulations of the Council on Environmental Quality (CEQ) (40 CFR 1508.9). It includes the effects of the construction of a 160 slip full service marina and upland improvements on the land adjacent to the marina.

PURPOSE AND NEED

Burlington's waterfront is a precious resource, which provides access to Lake Champlain for public use and enjoyment. Visions and plans for improving the waterfront's economic vitality and competitiveness within a sustainable community are outlined in the Waterfront Revitalization Plan (1998), Harbor Management Plan (2002), Master Plan for Burlington's Downtown and Waterfront ("PlanBTV", 2013), and Burlington Parks, Recreation & Waterfront Master Plan ("BPRP", 2015). While there have been many land-use improvements and revitalization projects implemented, water use expansion remains a recognized need. In fact, the plans all called for an additional 300 slips in the harbor based on need and harbor capacity.

The proposed marina will provide a portion of the much needed public recreational (seasonal and transient) dockage in Burlington Harbor, enable greater public access to the water, and provide enhanced access to the attractions of downtown Burlington for the boating community, which pulls from all regions of New England, Canada, and beyond. The capacity of the two existing marinas in the Burlington Harbor – Burlington Community Boathouse and Perkins Pier, are far exceeded. The goal of the proposed marina is to accommodate the increased demands of the boating community through environmentally sustainable development and in a manner which meets the City's waterfront revitalization visions.

The Burlington Harbor Marina, LLC. has applied for two (2) separate Tier 1 Boating Infrastructure Grants (BIG) in order to fund a portion of the transient boating infrastructure at the proposed marina. The proposed upland improvements, which are associated with the proposed marina, will partially be funded through TIF grants from the City of Burlington.

The expansion of Perkins Pier, which is located near the south harbor entrance, is a separate project being implemented by the City of Burlington. This project combined with the proposed marina would complete the goals outlined in PlanBTV and BPRP with regard to slip expansion and dispersion of uses.

Environmental Compliance

Status of the proposed marina with applicable laws and statues are listed below in Table 1.

Table 1. Proposed Marina Compliance with Federal and State Statutes and Executive Orders.

Federal/State Statutes	Compliance
National Environmental Policy Act (NEPA) 40 CFR Parts 1500-1508	In Progress
Clean Air Act 42 U.S.C. §7401 et seq. (1970)	In Compliance
Clean Water Act 33 U.S.C. §1251 et seq. (1972)	In Compliance
Comprehensive Environmental Response, Compensation, and Liability Act (Superfund, CERCLA) 42 U.S.C. §9601 et seq. (1980)	In Compliance
Resource Conservation and Recovery Act (RCRA) 42 U.S.C. §6901 et seq. (1976)	In Compliance
Endangered Species Act 16 U.S.C. §1531 et seq. (1973)	In Compliance
Noise Control Act 42 U.S.C. §4901 et seq. (1972)	In Compliance
Farmland Protection Policy Act 7 U.S.C. §4201 et seq. (1981)	Not applicable
Rivers and Harbors Act of 1899 33 U.S.C. §403 et seq.	In compliance
National Historic Preservation Act 54 U.S.C. §300101 et seq. (1966) Vermont Historic Preservation Act 22 V.S.A. Chapter 14	In Compliance
Executive Orders	**Compliance**
Executive Order 11998: Floodplain Management	In compliance
Executive Order 11990: Protection of Wetlands	Not applicable
Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	In compliance

2.0 ALTERNATIVES INCLUDING PROPOSED ACTION

This EA examines two alternatives: No-action Alternative (Alternative A) and the Proposed Marina (Alternative B).

ALTERNATIVE A (PROPOSED ACTION)

The location of the proposed marina is along the northern waterfront in the City of Burlington, Vermont near the north end of the U.S. Army Corps of Engineers (USACE) breakwater, adjacent to the U.S. Coast Guard (USCG) and City of Burlington Water Department. Appendix A provides a Site Location Map, Site Plans, and Existing Conditions (Aerial Photo) of the proposed marina.

The proposed marina (or "Project Area") consists of an approximately 160-slip full-service public marina facility that will be protected by a perimeter floating wave attenuation system. The plans include a single story 24' x 70' floating marina building (to include marina office space, restrooms, store and chandlery, and an outdoor observation deck on the roof), a 10' x 70' floating bath house (with restroom, shower, and laundry facilities), a 20' x 20' floating fuel hut and a pump-out facility. Two gangways would connect the facility to the shore on concrete abutment landing pads. The total on-water footprint of the marina is approximately 405,545 square feet (or 9.3 acres).

The location of the proposed marina within the harbor is preferable due to protection from the existing breakwater dispersing boat traffic from the inner harbor, compatible neighboring uses, available existing or planned upland infrastructure, and available bathymetry which eliminates the need for dredging and a gradual slope seaward from the basin. The proposed marina plan incorporates environmental conditions at the proposed marina location, market demand factors, and economics. The floating wave attenuator has been designed to minimize the required footprint of the marina. Consideration was given to locating the marina office and boathouse upland; however, it was not feasible due to extreme spatial limitations, proximity to the water treatment facility, zoning regulations, and the presence of environmentally impacted soils.

The Project Area includes upland marina support infrastructure, which consists of a yard area, plaza, and parking. No permanent building structure is proposed on land. Also, a new public park, designated as the "Waterfront North Park", is considered part of the upland area improvements. The total upland area comprises 98,379 square feet (or 2.26 acres) and is described in more detail below.

The yard area will be the staging area for boat launching and hauling (via lift), and will include a waste collection area, maintenance equipment storage, and a fuel underground storage tanks (UST). The yard area will also include parking space for marina personnel. The yard area will not be open to the public per the Water Department security standards. The plaza will be a drop-off area with short-term parking space, which will include spaces designed to Americans with Disabilities Act (ADA) standards. The plaza will also provide for continued access to the existing fishing pier. The primary parking for the proposed marina (designated as the "East Parking Lot") will be a newly constructed lot that is currently permitted as part of the City's ongoing, long-term Waterfront Access North (WAN) project. The proposed parking area is confined to this location due to access and security requirements of the City of Burlington Water Department. A portion of the parking lot will be available to the public and users of

other nearby parks and recreation areas. During marina off-season, the entire parking lot will be available to the public. An existing parking area will be transformed into the Waterfront North Park. This public park is part of the City's WAN project and will include landscape, hardscape, and accessory treatments (such as benches) of equivalent quality to the existing Burlington Waterfront Park. The existing seawall sheet piling that separates the public park and the lake will remain. Also, the Sailing Center Boat Launch/public water access will remain on the north end of the public park.

The proposed marina will be open seasonally during the boating season (e.g., May through October). It will accommodate boats up to 70 feet in length. Forty percent of the dockage slips will available to transient boaters. The docks will remain in place during the winter and will be protected by ice via ice protection dolphins. The proposed marina building and perimeter dock will be open, in season during business hours, to pedestrians and the general public (not solely marina clientele).

Alternative B (No Action)

The No Action Alternative means the proposed activity would not take place. The existing waiting list for seasonal dock and transient slips would continue to increase and economic development opportunities associated with waterfront recreation would continue to be constrained. This alternative is required under CEQ guidance and provides the baseline for comparison of the proposed action alternative.

Summary of Environmental Consequences

Table 2 summarizes the impacts of both alternatives and are discussed in detail in Section 3.0.

Table 2. Summary of Environmental Consequences

Resource		No Action	Proposed Action	Mitigation
Land Use		The City's WAN project would progress without meeting the existing demand for seasonal and transient dockage. Possible long-term adverse effects through the strain on existing and/or unsafe lake access methods. Development of the new waterfront north park would likely be delayed.	Long-term benefit through increased Lake accessibility and consistency with the City's waterfront revitalization goals.	N/A
Geology and Soils	Soils	No impact	Low – Short-term adverse impacts during construction of upland marina support functions.	Development and implementation of construction best management practices.
	Shoreline Erosion	No impact	Negligible – Minimal change to the shoreline is proposed. Existing USACE breakwater offers wave protection. The proposed floating wave attenuator will provide protection for the marina and possibly nearby facility to the north (Community Sailing Center).	N/A
Hydrology and Water	Water Quality	No impact	Low – Short-term adverse impacts to turbidity and water quality is anticipated during installation of helical anchors, which will suspend potentially contaminated sediment. Docks will be left in place during the off-season, which will eliminate seasonal disturbance of the lake bottom.	None – helical anchors are considered to be minimally invasive in terms of sediment disturbance.
			Low –Long-term adverse impacts due to fuel dispensing and storage.	Development and implementation of Spill Prevention, Control and Countermeasure (SPCC) Plan

Table 2. Summary of Environmental Consequences

Resource		No Action	Proposed Action	Mitigation
Hydrology and Water	Water Supply	No impact	Low – Short-term adverse impact to the water supply intake pipe during installation of the marina anchor systems is possible, but not likely if anchor installation is executed properly.	Review and approval of the dock layout and anchoring system by the Department of Public Works prior to construction.
	Stormwater	No impact	Low – Short-term adverse impacts during construction of upland marina support functions due to soil disturbance and increased sediment runoff to the lake. Long-term benefit through net decrease of impervious surface areas.	Development and implementation of Stormwater Pollution Prevention Plan (SWPPP)
	Wetlands	None present	None present	N/A
	Floodplains	No impact	Negligible impacts since the marina on-water structures are designed for flood conditions and meet FEMA's definition of a functionally dependent use which is allowed to be in a flood hazard area. No permanent buildings are proposed in the upland areas and all structures/equipment on land (e.g., emergency generator, transformer, UST) are outside the base flood elevation of 101.6'.	N/A
Boat Navigation		Existing conditions of boating congestion near the center of the harbor would continue.	Negligible impacts due to increased boat traffic. The proposed marina has been sited to ensure safe navigation for recreational and commercial traffic transiting Burlington Bay. Over 500 feet of clear navigation space between the proposed marina and the existing USACE breakwater more than satisfies the industry guidelines on commercial traffic and recreational boaters. Cumulative Impacts: long-term benefit of defining the northern portion of the harbor and providing additional marina amenities is expected to improve navigation within the harbor and alleviate the central harbor congestion.	N/A

Table 2. Summary of Environmental Consequences

Resource		No Action	Proposed Action	Mitigation
Biological Resources	Aquatic	No impact	Low – Short-term adverse impacts to benthic habitat due to lake bottom disturbance during installation of dock anchors.	None – helical anchors are considered to be minimally invasive in terms of sediment disturbance.
	Terrestrial	No impact	Low – Short-term impact to trees and vegetation is anticipated during the development of the upland marina support functions.	Trees of native species will be planted.
	Threatened and Endangered (T&E) Species	No impact	No impact – No known T&E species have been identified within the area of the proposed marina.	N/A
Hazardous Materials		No impact - known contaminants will continue to persist in the soils e.g., arsenic, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and petroleum. Project area is within existing scope of the Corrective Action Plan (CAP) for the Moran Center and Waterfront North.	Low – Short-term adverse impacts to human health and environment during construction of the upland marina support functions due to disturbance of impacted soils.	Amendment of existing CAP to address site-specific human health risk and contaminant migration issues posed by the impacted soils.
Air and Noise		No impact	Low – Short-term adverse impacts during construction of upland marina support functions. Low – higher noise levels would be expected with increased recreational use and activities.	Noise levels will comply with City ordinances and permits.

Table 2. Summary of Environmental Consequences

Resource		No Action	Proposed Action	Mitigation
Socioeconomics		No impact	Expected long-term benefit to local economy due to increase in recreational activities and opportunity to draw visitors off the water and into the City.	N/A
Cultural Resources	Archeological	No impact	No impact	N/A
	Historical	No impact	No impact	N/A

3.0 AFFECTED ENVIRONMENT AND POTENTIAL CONSEQUENCES

The affected environment chapter describes the proposed marina, including the upland areas; relevant physical and biological processes within each area; and the existing conditions of the natural, social, cultural environment that could be affected by the implementation of the proposed action considered in this EA.

LAND USE

The Project Area is located within the tax map parcel #043-4-004 (Burlington, Vermont), which is being leased by Burlington Harbor Marina, LLC from the City of Burlington. It is currently used for parking spaces with one structure and some open green spaces. The one structure is a pavilion that is often used as a gathering spot. Green spaces are generally present around the parking spaces. The surrounding areas generally consists of mixed commercial, industrial, residential, and recreational development. The upland areas are situated within the City's WAN, an area which is currently undergoing infrastructure development as part of the overall waterfront transformation. Recreational uses within WAN include the public boat launch adjacent to the US Coast Guard, the Community Sailing Center, fishing pier, skate park, and bike path. Vehicular access to the proposed marina would be via Penny Lane, located off of Lake Street.

Potential Consequences to Land Use

Pedestrian traffic is anticipated to increase (e.g., beneficial) as visitation to the waterfront area increases. The proposed action is in line with the City's continued efforts to transform the waterfront under the Public Trust Doctrine, which defines Public Trust Lands as those reserved for "indoor or outdoor parks and recreation uses and facilities including parks and open space, marinas open to the public on a non-discriminatory basis, water dependent uses, boating and related services".

Use within the area would change from dispersed recreation to that associated with a developed marina. The addition of seasonal slips will reduce the number of boaters that need to trailer their boat to the lake. Access improvements, as well as enhancement of the park will also attract more people to the waterfront area.

Proposed Action: Impacts to land use are considered beneficial and are in line with the City's waterfront revitalization goals.

No-Action: In the absence of the proposed marina, the City's WAN project would progress without meeting the demand for seasonal and transient dockage. Development of the new waterfront park would likely be delayed.

GEOLOGY AND SOILS

A soil classification of the Project Area, according to the Natural Resource Conservation Service (NRCS) on-line database, indicates that the following soils are present on the subject property: predominately fill land with small amounts of Adams and Windsor (AdE) loamy sands with a slope of 30-60 percent. Native soils are classified as Champlain Sea Deposits of pebbly marine sand. Bedrock below the Project Area is Dunham Dolostone (lower Cambrian) according the Vermont Agency of Natural Resources (VTANR) Atlas.

Local topography indicates that the Project Area is generally flat, with a slope of less than 5%. The shoreline has a greater slope of 5 to 15% (VTANR Atlas). Drainage occurs through soil infiltration and surface run-off towards Lake Champlain to the west.

Potential Consequences to Soils

No permanent building structure is proposed on land; therefore, soil excavation will not be extensive. However, there will be substantial excavation during the installation of the USTs. Construction of the upland areas will require the excavation and grading of soils. Approximately 2.26 acres of land will be disturbed and will involve short-term impacts to soils during the construction period. Soil loss may occur directly from disturbance or indirectly via wind or water. The introduction of sediment into the lake from the construction site would negatively impact water quality. To minimize or prevent soil erosion and sediment discharge, construction best management practices (BMPs) will be developed and implemented. Stormwater and sediment runoff control is discussed in more detail under Water Quality. Disturbance of contaminants within the soil is discussed separately under Hazardous Materials.

Proposed Action: Potential impacts to soils are considered low and short-term during the construction phase.

No-Action: In the absence of the proposed marina, there would be no potential impact to soils.

Shoreline Erosion

Shoreline erosion is a concern for aquatic ecosystems since it may affect water clarity or turbidity in near shore areas, as well as provide nutrients for algal growth. Water currents, waves, and water levels are the primary agents that cause shoreline erosion. The existing shoreline of the Project Area consists of a rock revetment and vertical sheet piling. Limited alteration to the revetment is proposed above mean water level to facilitate placement of gangway landings that will lead from the shore to the proposed floating docks.

Potential Consequences of Shoreline Erosion

The floating wave attenuator designed to protect the marina, will also serve to minimize wave energy along the shoreline. Existing shoreline stabilization (rock revetment and sheet piling) will be used at the gangway landings. Predominant winds in the area are from the southerly directions. In fact, given the direction of predominant winds, facilities to the north (in the lee) of the marina during southerly winds would experience a general sheltering effect to the protection afforded from the marina and floating wave attenuator.

Proposed Action and No-Action: In both scenarios, impacts to shoreline erosion are considered negligible.

HYDROLOGY AND WATER RESOURCES

Lake Champlain is bordered by Vermont to the east, New York to the west, and the province of Quebec, Canada to the north. The lake is 435 square miles of surface water measuring 120 miles long and 12 miles wide at its widest point (Flynn, R.H & Hayes, L, 2016). The average depth of the lake is 64 feet, but is 400 feet deep at its deepest point. Burlington Bay is located on the eastern edge of Lake Champlain in Burlington, Vermont. The depth of water within the proposed marina ranges from 12 to 23 feet deep and (Civil Engineering Associates, Inc., 2015).

Shallow groundwater in Burlington generally flows to the west. The groundwater in the Project Area is generally close to the surface, approximately 4 to 7.5 feet below ground surface. There are three private wells within a half mile radius of the Project Area. Two of the private wells are owned by Burlington Electric and are upgradient from the Project Area. One private well is owned by the Intervale is said to be located downgradient of the Project Area near the breakwater within Lake Champlain, but it is likely that this information is not accurate as wells are not allowed to be located immediately in or adjacent to the lake. (VTANR Resource Atlas).

The City of Burlington Water Treatment Facility obtains raw water from the lake, which is the sole source of the supply for Burlington. Water is drawing from an intake screen located on the lake bottom about 4,000 feet into the lake at a depth of 40 feet.

Water Quality

Burlington Bay is part of Basin 5: Northern Lake Champlain basin. The Basin includes the northern section of Lake Champlain, beginning at the Ferrisburgh, Vermont and Charlotte, Vermont town line and ending at the Canadian border. In 2003, a water quality assessment was completed of Basin 5, and it was determined that water quality met the Vermont Water Quality Standards (VWQS), although occasional blooms of algae and cyanobacteria do occur during the summer near the shore (VTDEC Water Quality Division, 2003). In the 2015 State of the Lake Report, phosphorous levels in Burlington Bay were below the VGWS of 0.014 mg/L (Lake Champlain Basin Program, 2015).

Burlington Bay is classified as a Class B water by the VWQS and is managed to achieve and maintain a level of quality that supports the following uses:

- Aquatic Biota, wildlife, and aquatic habitat;
- Aesthetics;
- Public water supply;
- Irrigation of crops and other agricultural uses;
- Swimming and other primary contact recreation; and,
- Boating, fishing, and other recreational uses

In addition to supporting the above uses, water quality criteria for Class B waters include turbidity, dissolved oxygen, E. coli, aquatic biota, wildlife, and aquatic habitat, and nutrients.

Burlington Bay is listed on the Impaired Waters 303(d) list updated in October 2016 for elevated levels of Polychlorinated Biphenyls (PCBs) in Lake Trout *(Salvelinus namaycush)*. Burlington Bay is also listed on the 2016 Priority Surface Waters list for organics, metals, oil, grease, and PCBs for their impact to human health and the environment through secondary contact, aquatic life support, and contact recreation.

Burlington Bay is listed in Part D of the Impaired Waters List for having elevated levels of mercury in Walleye and the amount of phosphorous run-off entering the bay. Total maximum daily loads (TMDLs) were approved for mercury in December 2007 and for phosphorous in June 2016.

Burlington Bay is listed in Part E of the Impaired Waters List due to the presence of Eurasian Watermilfoil *(Myriophyllum spicatum)* in some near shore areas and because of the Zebra Mussel *(Dreissena polymorpha)* infestation. Zebra mussels are found on nearly all of the

available suitable substrate and have started expanding onto soft substrate; native mussels have been nearly extirpated.

Sediments along the lake bottom of the Project Area consist of coarse sediments (sand) in the shallower regions (central and eastern areas of Burlington Harbor) while finer sediments (clay and silt) occur in the deeper regions (McIntosh, A. et al., 1997). Lake sediment testing was conducted next to a dock west of the Moran Plant (north of the Project Area) in 2010 by Waite Environmental Management, LLC (WEM) with assistance from the Johnson Company (JCO). The sediment samples were reported to contain PAHs, arsenic, and PCBs at concentrations in excess of the EPA soil guidance levels. When sediment is disturbed, it degrades water quality and can adversely affect the habitat of aquatic species. Lake water samples were also collected and were not reported to not have any detections of volatile organic compounds (VOCs), PAHs, or PCBs. Metals barium and lead were detected, but below Vermont Water Quality Drinking Standards.

More extensive lake sediment sampling and analysis was completed in the Burlington Harbor in 1997 (McIntosh, A. et al., 1997). Sampling included collecting 20 sediment cores from the inner harbor and analyzing them for metals (aluminum, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, and zinc), PCBs, PAHs, and organochlorine pesticides. No samples were taken directly within the proposed marina Project Area but one sample (BH-29) was collected just south of the area. Analytical reports of the surface sediment cores showed generally heterogeneous distributions of most metals (cadmium, chromium, copper, lead, and zinc), while the distribution of silver appeared to be associated with a source in the southern end of the harbor. Lithogenic metals (aluminum, iron, manganese, and nickel) were found at the deepest inner harbor sites. Most of the organic contaminants exceed NOAA Effects Range Low (NOAA ER-Ls, indicates the concentration below which toxic effects are scarcely observed or predicted) and were generally highest in the southern portion of the harbor (McIntosh, A. et al., 1997).

Potential Consequences to Water Quality

The proposed marina is located within a naturally deep area of the Burlington Bay. Due to the depth of the water the need for dredging is eliminated and impacts to water quality are significantly minimized. The substantial depth also minimizes the impact of larger deep draft boats.

The marina will be constructed of floating docks and perimeter wave attenuator. Docks are constructed of inert materials not harmful to water quality. No fixed structures are proposed that would substantially obstruct water circulation and potentially cause negative impacts to aquatic species. Additionally, the proposed helical anchoring system of the docks will be minimally invasive and does not require jetting as the placement of mass anchors often does. Installation of the anchors will have a minor, one-time impact on turbidity and resuspension of contaminants potentially present in the sediment. Once installed, the docks will remain in the water, thus eliminating the yearly disturbance of the lake bottom as is common with seasonal dock removal and replacement.

The proposed marina will be serviced by municipal potable water and sewer and will offer a free pump out facility for boaters. Gray water and sewage discharge from boats impact water quality by increasing nutrient loading and biological oxygen demand of the local area and through the release of disease causing organisms. Although the Clean Water Act (CWA) makes it illegal to discharge untreated wastes into coastal waters and the Federal Water Pollution Control Act requires recreational boats be equipped with marine sanitation devices

(MSDs), illegal discharges of untreated waste may be common due to the limited number of pump out facilities. The free pump out system will by providing mariners a new, safe, and accessible location to pump out their holding tanks, thereby encouraging the proper management of gray water and sewage. Also, the proposed restrooms, bathhouse, and laundry facilities will provide appropriate facilities for boaters to use instead of simply utilizing the lake itself. Therefore, in terms of unauthorized sanitary waste discharges, the proposed marina will likely have a positive effect on water quality.

Boaters who have a slip at the proposed marina will reduce the risk of introducing invasive species into Lake Champlain because their boats stay in Lake Champlain for the entire season.

The refueling station and UST are potential sources of spills or releases that would negatively impact water quality. The UST has been designed with tie-downs to prevent floatation and to withstand the buoyancy force during a base flood. To prevent the release of petroleum product, from equipment failure/leaks and dispensing at the fuel dock, a Spill Prevention, Control and Countermeasure (SPCC) Plan has been prepared in accordance with the provisions of 40 CFR Section 112.7. The UST and piping will be double-walled to prevent releases from impacting the environment. The UST will also be equipped with automatic leak detection and fuel level monitoring systems. An emergency shut-off valve/switch will be located at the dock and at the UST. Marina personnel will be trained on the SPCC Plan and the trained fuel attendant will conduct boat refueling operations. The dispenser nozzles will be automatic closing, without latch-open devices. Spill kits will be stocked and readily available to immediately clean up small spills. The SPCC also covers off-season decommissioning of the fuel systems.

Proposed Action: The anticipated impacts to water quality is considered low and short-term during the construction. The free pump out facilities will provide a safe way for boaters to properly manage gray water and sewage providing a long-term beneficial effect on water quality. Since the marina will also provide public restrooms, bathhouse, and laundry facilities it will provide boaters an alternative to using the Lake itself. The potential long-term adverse impacts due to fuel dispensing and storage is considered low provided that the SPCC plan is implemented.

No-Action: In the absence of the proposed marina no pump out system, restrooms, bathhouse, or laundry facilities would be available to boaters to use at the Project Area. Other facilities are available within Burlington Harbor, but are not enough to meet the demand of the current volume of boaters.

Water Supply

The water supply intake pipe intersects the northern edge of the proposed marina footprint. The potential effects of the proposed marina were investigated by the Burlington Public Works and found not to be significant (Concerns Regarding a Proposed Marina near the Water Treatment Facility, 2015). Since the proposed marina includes slip dockage only (e.g., no mooring or anchorage areas), the potential for the pipe to be "hooked" or damaged by an anchor is eliminated. Most importantly, prior to construction and anchoring of the docks, the intake pipe should be precisely located to insure the anchors and other attachment methods do not damage the intake pipe.

Potential Consequences to Water Supply

Proposed Action: The anticipated impacts to the water supply is considered low and short-term during the installation of the marina anchoring systems.

No-Action: In the absence of the proposed marina, there would be no impact to the water supply.

Stormwater

Stormwater management is a key issue for the City of Burlington because stormwater, and stormwater runoff, directly impact the water quality of Lake Champlain. In a 2008 stormwater presentation by the Mayor of Burlington's stormwater task force, it was noted that 60% of the city's stormwater infrastructure is a combined system (sewer and stormwater). Normally this water is directed to Burlington's main water treatment plant where the water is treated and then discharged into Lake Champlain. However, when there are large rain events the volume of stormwater becomes too great for the treatment plant to handle, the water gets released untreated at combined sewer overflow pipes.

Impermeable/impervious surfaces (e.g., asphalt, concrete, traditional stone/brick/concrete pavers) common in urban settings impacts the environment by allowing stormwater that has picked up pollutants to be discharged directly into rivers and lakes. Impervious surfaces also generate large amounts of runoff, which can cause flooding and erosion. Runoff may also result in the water table/aquifer not being adequately recharged. Finally, another effect of impervious surfaces is the formation of stagnate water puddles which can become breeding places for undesirable insects such as mosquitos. Therefore, providing permeable surfaces in the landscape is key in reducing environmental impacts to stormwater.

An alternative to traditional impervious materials are permeable pavers, which are specially fabricated paving units with interconnected pore spaces within the material. This channels stormwater into the underlying soil which forces slow percolation and filtering of pollutants during periods of heavy rainfall.

Potential Consequences to Stormwater Quality

Construction of the upland areas could expose soil to erosion that can result in discharge of sediment to the lake during that phase of work. Sediment degrades water quality and large amounts of sediment can adversely affect the habitat of aquatic species. Construction operations also generate pollutants such as hydraulic fluid or diesel that if released to the environment could degrade waters of the Burlington Bay. Prior to construction, a Notice of Intent (NOI) to obtain and comply with the stormwater General Permit will be required. The permit requires all dischargers where construction activities disturbs one acre or more to develop and implement a Storm Water Pollution Prevention Plan which specifies BMPs that would prevent construction pollutants from contacting stormwater and with the intent of keeping products of erosion from moving off-site into the lake.

The creation of the Waterfront North Park will convert an impervious parking lot into green space which will allow for stormwater to infiltrate into the ground instead of contributing to direct runoff into Lake Champlain. Permeable pavers will be used in the yard area, plaza, and East Parking Lot. Overall, there will be a net reduction of impervious area by 7,939 square feet.

Proposed Action: Impacts to stormwater are anticipated to be low. Short-term adverse impacts during construction of upland marina support functions may increase sediment runoff to the lake and will be minimized by implementation of a SWPPP and BMPs. A long-term benefit of reduced stormwater runoff is expected based on the net decrease of impervious surface area.

No-Action: In the absence of the proposed marina, there would be no impacts to stormwater.

Wetlands

No jurisdictional wetlands were identified within the Project Area. A Class III wetland was identified to the north of the Project Area past the Lake Champlain Community Sailing Center in the 2011 Corrective Action Plan for the Moran Plant and Waterfront North. The wetland is approximately 600 feet to the north of the Project Area.

Potential Consequences to Wetlands

Proposed Action and No-Action: Not applicable

Floodplains

Executive Order 11998 (Flood Plain Management) requires that a Federal agency avoid direct and indirect support of development within the 100-year floodplain whenever there is a practical alternative. The Federal Emergency Management Agency (FEMA) uses Flood Insurance Rate Maps (FIRMS) to identify the regulatory 100-year flood plain for the National Flood Insurance program (NFIP). Local flood hazard area permitting is part of the City of Burlington's permitting review under the Natural Resources Protection Overlay District.

With projects on Lake Champlain, the boundary of the FEMA Special Flood Hazard Area is the base flood elevation of 101.6' (NAVD 1988). The proposed wave attenuator, associated docking and floating structures, and gangway anchors/landings for the proposed marina would be located below the 101.6' boundary. However, these floating structures are considered as functionally dependent uses, which is defined by FEMA as a use which cannot perform its intended purpose unless it is located or carried out in close proximity to the water. Therefore, the on-water structures are permitted to be in the flood hazard area, provided that the structures are protected by methods that minimize flood damages during the base flood and there are no additional threats to public safety. The proposed marina satisfies this requirement as the on-water structures are designed to raise and lower with the water level. Also, the utility lines (e.g., water, sewer, electrical, and fuel) will be able to withstand the elevation changes between the floating dock and the land-side landing.

The upland components of the marina (e.g. Emergency generator, electrical meter disconnect, and UST) are outside the flood zone boundary. Drawing C2.2A is a close-up of the yard area which clearly shows the 101.6' boundary (Appendix A).

Potential Consequences to Floodplain

Lake Champlain regularly experiences flooding events during the annual cycle of spring melt runoff and less frequently during extreme weather events.

Proposed Action and No-Action: In both scenarios, impacts to floodplains are considered negligible.

BOAT NAVIGATION

The proposed wave attenuators and associated docking is located in between the USACE breakwater and the USCG breakwater (see Existing Conditions (Aerial Photo), Appendix A). Approximately 700 feet south of the Project Area is the Community Boathouse Marina. The distance between the Community Boathouse Marina and the USACE breakwater is approximately 726 feet, allowing for boat traffic to navigate in both directions.

The Burlington harbor, safe navigation, and vessel traffic as it pertains to the proposed marina was assessed by Applied Technology and Management (ATM) using standard industry guidelines (report is provided in Appendix B). Guidelines are based on the beam width of the largest vessel navigating the harbor, which for Burlington are the Ferries. Ferry operators in the area indicated a maximum beam width of 45 feet. The American Society of Civil Engineers (ASCE), Engineering Manual 50, recommends that the maximum beam width be multiplied by a factor of 5.6 to accommodate 2-way traffic, clearance between maneuvering lanes, and clearance for depth limiting conditions. The USACE Coastal Engineering Manual, EM 1110-2-1100 (USACE CEM) recommends multiplying the maximum beam width by a factor of 5.4 based on the same accommodations.

The floating wave attenuator and additional ice protection dolphins of the Project Area form the perimeter of the marina facility. At its nearest point to the Burlington Harbor USACE breakwater, the proposed marina forms an approximately 500 feet clear navigation area, which is roughly double both USACE CEM and ASCE industry standard guidelines.

No docking is proposed on the outside of the floating attenuator. This will eliminate potential conflict for boaters/vessels transiting past the proposed marina and separate the berthed vessels form the navigation channel.

Water access to the proposed marina is controlled through a single entrance on the south side of the marina. The proposed marina entrance is situated to allow entering and exiting vessels to maneuver safely into open waters "queuing areas" rather than into the main vessel traffic channel. This marina entrance is also distant from other uses on the harbor, including adjacent marinas (over 600 feet away), existing City moorings (over 400 feet away), and boat ramp facilities. A map of the general navigation vessel flow is provided in Appendix B.

ATM also provided an evaluation of how the proposed marina may affect the wave interactions in relation to the overall harbor operations (Appendix C). Specifically, the potential for a "funneling effect" of waves by the proposed marina wave attenuator and the USACE breakwaters was reviewed. ATM concluded that the proposed marina would serve to protect and decrease wave activity in the lee of its footprint and that the potential for increased/complex wave interaction in the harbor is considered unlikely and insignificant under most conditions.

Potential Impacts to Boat Navigation

As documented in the ATM report (Appendix B), the proposed marina has been sited to ensure safe navigation for recreational and commercial traffic transiting Burlington Bay. The proposed marina will narrow the navigation space of the northern section of the harbor; however, over 500 feet of clear navigation space between the proposed marina and the existing USACE breakwater would remain. This exceeds industry guidelines on commercial traffic and recreational boaters. To better understand impacts of the proposed marina facility, test buoys were deployed in 2015 within the facility footprint. In cooperation with the ferry services and operators, no navigational or safety issues were reported due to ferries using these test buoys as indicators of potential navigation areas and channels that mimic the location of the proposed facility.

ATM also documented (Appendix C), that the potential for the proposed marina to effect the wave interactions in the harbor, which could negatively impact other users within the harbor, is considered negligible.

Proposed Action and No-Action: In both scenarios, impacts to boat navigation are considered negligible.

Cumulative Impacts to Boat Navigation:

The existing harbor uses are concentrated in the center of the harbor and create conflicting travel paths between ferries, tour boats, research vessels, slip holders, dinghy's coming ashore from moorings to dinghy docks, fuel dock patrons, ramp launched boats, and touch and go's at the City Boathouse restaurant and Ferry Dock bar. No clear channels within the harbor direct vessels to and from the center. The proposed marina alleviates this central harbor congestion by dispersing the use to the northern harbor entrance, creating a defined northern harbor channel, providing a convenient fuel and pump out dock with ample tie up and queuing space, and providing launch service reducing the number of dinghy's travelling to the inner harbor. Therefore, the proposed marina will define the channel in the Burlington Bay area where, historically, a hodgepodge of moorings, anchored vessels, etc. set no clear and safe passage through the area.

The City has documented hundreds of loitering vessels circling the inner harbor in hopes of a slip or mooring opening. The proposed marina will provide 40% of the slips for transient boaters and have clear signage along with marketing and public information campaigns that will inform the boating public of the availability of slips at the north harbor entrance.

The proposed marina will not provide access for personal water crafts but will define the entrance to the north harbor and separate the small/personal water craft uses currently launched at the Community Sailing Center to the north. In addition, the Sailing Center's future plans include moving its dock and launching facilities to the north out of the harbor and away from the harbor channel.

Cumulative Impacts of Proposed Action: The cumulative consequences to boat navigation are anticipated to be beneficial and long-term.

Biological Resources

Biological resources within the proposed marina area are limited and not well studied compared to other areas on Lake Champlain. This is due to the Project Area being located within an urban environment, which is generally characterized by common species and low-quality growing conditions.

Aquatic

Aquatic vegetation was not observed within the Project Area. The VTDEC Watershed Division produced 'A Key to Common Vermont Aquatic Plant Species' which lists 21 submerged plant species (5 of which are invasive), 9 floating leave species (3 of which are invasive), and 8 emergent plant species (3 of which are invasive) which are commonly found in lakes and ponds throughout Vermont (VTDEC Watershed Management Division Lakes and Ponds Program, 2016). Some of these plant species may be present near the Project Area. An invasive plant species that is known to impact Burlington Harbor is Eurasian milfoil (*Myriophyllum spicatum*). Eurasian milfoil outcompetes native aquatic plants and reduces the diversity of native aquatic plants. Overall, growing conditions for aquatic vegetation in Lake Champlain consist of cool waters and long, severe winters which result in reduced biodiversity.

The Project Area is comprised of open waters and the wildlife that could potentially occur in the area include both avian and aquatic species. Seventy-eight native and fifteen non-native

fish species have been identified in Lake Champlain (Lake Champlain Basin Program, 2017). Almost all of those species can be found within Burlington Harbor at certain times of year. Common species that are believed to be within the harbor year-round include: yellow perch (*Perca flavescens*), rock bass (*Ambloplites rupestris*), smallmouth bass (*Micropterus dolomieu*), brown bullhead (*Ameiurus nebulosus*), golden shiners (*Notemigonus crysoleucas*), freshwater drum (*Aplodinotus grunniens*), white suckers (*Catostomus commersonii*), pumpkin seed sunfish (*Lepomis gibbosus*), tessellated darters (*Etheostoma olmstedi*), log perch (*Percina caprodes*), emerald shiners (*Notropis atherinoides*), white perch (*Morone Americana*), and American eels (*Anguilla rostrate*). During the colder seasons (spring and fall) cold water species like brown trout (*Salmo trutta*), Atlantic salmon (Salmo salar*)*, and lake trout (*Salvelinus namaycush*) can be found within the harbor (email from fisheries biologist, Bernie Peintka).

Waterfowl and shore birds use Lake Champlain for breeding and as a stopping point during spring and fall migrations along the Atlantic flyway (LCBP, 2017). The Lake Champlain Basin program compiled a list of birds that are found within the Lake Champlain Basin (2014). Birds that are commonly found within Burlington Harbor include gulls and ducks.

Research conducted south of the proposed marina at Oakledge Park by St. Michaels College between 2008 and 2011 identified invertebrates present within Lake Champlain. Invertebrates included: midges, caddisflies, freshwater shrimp, water penny, mayflies, and aquatic caterpillars. One of the most prevalent species observed was the zebra mussel (*Dreissena polymorpha*) which was discussed above in the 'water quality' section.

Potential Consequences to Aquatic Vegetation and Wildlife

Proposed Action: Potential impacts to aquatic vegetation and wildlife are considered low and short-term during the construction phase.

No-Action: In the absence of the proposed marina, there would be no potential impact to aquatic vegetation and wildlife.

Terrestrial

The vegetation in the upland area of the Project Area generally consist of grassy areas surrounding the parking areas and buildings with a couple of non-native trees (Chanticleer Callery Pear (*Pyrus calleryana 'Chanticleer'*) and Silver Linden (*Tilia tomentosa*)). During the development of the waterfront park, some of these trees will need to be removed but will be replaced with native species.

Wildlife found within the Project Area tend to be generalist species that have adapted to living in an urban environment with disturbance regimes caused by human activity, such as grey squirrels *(Sciurus carolinensis)*, raccoons *(Procyon lotor)* , pigeons *(Columbidae sp.)*, and gulls *(Laridae sp.)*.

Potential Consequences to Terrestrial Vegetation and Wildlife

Proposed Action: Potential impacts to terrestrial vegetation and wildlife are considered low and short-term during the construction phase.

No-Action: In the absence of the proposed marina, there would be no potential impact to terrestrial vegetation and wildlife.

Threatened and Endangered Species (Animal, Plant, Aquatic)

Plant and animals that are defined as 'threatened' or 'endangered' are protected under the endangered species act and/or are protected under the Vermont Endangered Species rule. In order to determine if any threatened or endangered species (plant or animal) are located within the Project Area, KAS reviewed the Threatened and Endangered Species in Vermont (USFWS, 2016) and queried the USFWS IPaC system project review database to identify any federally listed threatened and endangered species within and adjacent to the Project Area (IPaC Turst Resources Report generated on March 1, 2017). A database review was also conducted of the Agency of Natural Resources (ANR) Natural Heritage Index (NHI) for threatened and endangered species within and adjacent to the Project Area.

Based on the database reviews listed above, no threatened or endangered species, plant and animal, were identified within the Project Area. The USFWS IPaC review did indicate that there were thirteen birds of concern within the Project Area which are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. Birds of concern included: American Bittern (*Botaurus lentiginosus*), Bald Eagle (*Haliaeetus leucocephalus*), Black Tern (*Chlidonias niger*), Black-Billed Cuckoo (*Coccyzus erythropthalmus*), Black-crowned Night-heron (*Nycticorax nycticorax*), Canada Warbler (*Wilsonia Canadensis*), Common Tern (*Sterna hirundo*), Olive-sided Flycatcher (*Contopus cooperi*), Perigrine Falcon (*Falco peregrinus*), Pied-billed Grebe (*Podilymbus podiceps*), Short-eared Owl (*Asio flammeus*), Willow Flycatcher (*Empidonax traillii*), and Wood Thrush (*Hylocichla mustelina*). Due to the Project Area being located in an urban developed area, it is unlikely that any of the birds of concern will be impacted by the proposed marina.

The *Federally Listed Endangered and Threatened Species in Vermont* (USFWS, 2016) provides a record of terrestrial species listed by county in the state of Vermont. Chittenden County is listed within the known range of the federally endangered Indiana bat (*Myotis sodalis*) and the federally threatened northern long-eared bat (*Myotis septentrionalis*). The Indiana Bat is found in Charlotte, Hinesburgh, and St. George within Chittenden County, but outside of the Project Area. The northern long-eared bat is found statewide and utilizes caves and inactive mine shafts for winter hibernation and trees for summer roosting habitat. Preferred summer roosting habitat includes dead or dying trees of any species, live trees with loose bark, or trees where there bark gets direct solar radiation (USFWD, 2015). Some trees are going to be cut down within the Project Area, but they are smaller healthy trees that do not have loose bark and therefore are not believed to be suitable roosting habitat for either endangered bat species.

Additionally, KAS reached out to Jon Kart and Bob Popp of VTFW who confirmed that no threatened or endangered species were present within the Project Area.

In accordance with NEPA, Section 7 of the ESA of 1973, as amended 16 USC 1531 et seq, and the Vermont Endangered Species Law (10 VSA chapter 123), species analysis was conducted for this project. Any unauthorized take of a state or federally protected species, including unintentional, or incidental take, requires a permit from the USFWS and/or the FWD.

Potential Consequences to Threatened and Endangered Species

Proposed Action and No-Action: In both scenarios, impacts to threatened and endangered species are considered negligible.

HAZARDOUS MATERIALS

Environmental Database Review

A review of the following environmental databases maintained by the EPA and the VTDEC was conducted in order to determine hazardous materials within or adjacent to the Project Area: DEC designated hazardous waste sites, DEC and EPA Brownfields sites, EPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), DEC registered underground storage tanks (USTs), and DEC and EPA registered hazardous waste generation facilities (RCRA generators). According to the database review, four DEC hazardous waste sites, one RCRA Generator, two DEC brownfield sites, and one UST site were identified within 1,000 feet of the Project Area.

Recent Environmental Site Investigations

A Phase II Environmental Site Assessment of the Project Area was conducted by KAS in March 2016. The assessment included the advancement of eight soil borings, specifically in the areas where upland improvements are proposed (waterfront north park, east parking lot), soil sampling and analysis, and groundwater sampling and analysis. Analytical results indicated that soils beneath the Project Area are impacted by arsenic, polychlorinated biphenyls (PCBs), and total petroleum hydrocarbons (TPH). Groundwater was analyzed for volatile organic compounds (VOCs) via EPA Method 8260B, but no VOCs were detected above laboratory detection limits.

A Phase I Environmental Assessment was prepared of the Project Area by KAS in January 2016. The assessment indicated the area was reportedly developed for commercial and industrial use as early as the 1860's when the VT and Canada railroad expanded. The surrounding properties along the waterfront were historically used as lumber yards, rail transport, junk yards, mills and/or bulk petroleum storage facilities.

Recognized environmental conditions (RECs) were encountered, summarized as follows:

1. The presence of a hazardous waste site on the adjacent properties to the north (Moran Plant) and southeast (Alden Waterfront) with associated documented soil and/or groundwater contamination on or in the immediate vicinity of the property;
2. The noted presence of a fill pipe along the south side of the Burlington Water Department Pump Station building which lies immediately adjacent to the property;
3. The documented presence of fill material with contaminants indicative of "urban fill" in the immediate vicinity of the property; and,
4. The historical presence of a "coal house" and use of coal on or immediately adjacent to the subject property.

A recognized environmental condition is defined in ASTM E 1527 as the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: 1) due to release to the environment, 2) under conditions indicative of a release to the environment; or, 3) under conditions that pose a material threat of a future release to the environment.

The current and historical presence of a railway line in the immediate vicinity of the Project Area is considered to be a deminimis condition. De minimis conditions are not recognized environmental conditions. The closed hazardous waste site identified as Burlington Electric SMS #90-0540 is considered to be a historical REC.

The Project Area has a long history of industrial use which has led to documented subsurface contamination. Soil and groundwater data collected in the immediate vicinity of the area has indicated that contamination is present at specific locations. A CAP was prepared in August 2011 for the adjacent property owner to the north and this plan includes portions of the Project Area.

Potential Consequences of Hazardous Materials

During the construction phase of the upland areas, impacted soils will be disturbed. A CAP has been prepared to address human health risk and contaminant migration issues posed by the impacted soils. To minimize the need for off-site disposal of soils, the soils will be reused on-site. Clean fill or topsoil will be placed over the soil and will serve as a protective barrier. The work will be done in accordance with the Vermont Department of Environmental Conservation (VTDEC) approval.

The proposed marina will provide waste disposal collection receptacles, which will encourage proper disposal of waste generated by boaters. Hazardous materials may also be generated by the operation, maintenance, and repair of boats conducted in the yard area. This area will be limited to minor repairs and maintenance by approved professionals. No major boat repairs such as sanding and painting of hulls or major fiberglass work will be conducted in this area. In fact, the goal is to obtain Clean Marina status and as such BMPs will be implemented, which include use of environmentally safe cleaning products and containment of residuals from minor repair work.

Proposed Action: Impacts to hazardous materials are considered low and short-term during the construction phase.

No-Action: In the absence of the proposed marina, there would be no hazardous materials disturbed or generated.

Air and Noise

Burlington Bay currently serves as a major layover and resupply stop for travelers between the Hudson River, Erie Canal, and the St. Lawrence River (PlanBTV, 2013). This means that there is a high level of boat traffic, especially during summer and fall. Boats typically will have either a gasoline or diesel motor which they will use as they approach the marina or as they are leaving the marina. Boats are not anticipated to idle once they have docked because power is available from the marina. Emissions from boat engines would be minimal and temporary. Equipment used for the construction of the marina or used annually for marina maintenance would also be minimal and temporary in nature.

The 1990 Clean Air Act Amendments (CAAA) authorized the Environmental Protection Agency (EPA) to create National Ambient Air Quality Standards (NAAQS) in order to protect public health and public welfare. The NAAQS provided a framework to regulate emissions of hazardous pollutants (EPA, 2017). In Vermont, the VTDEC is responsible for monitoring and enforcing all air quality standards. The CAAA requires individual states to provide state implementation plans (SIP) to ensure the attainment and maintenance of NAAQS (VTDEC, 2017). Conformity with Vermont's SIP was not addressed in this EA due to the Project Area being located in Chittenden County, which the EPA has designated to be in compliance with all NAAQS (EPA). Therefore, this area is exempt from conformity regulations.

The CAAA also required to the EPA to set specific standards for pollutants that are considered harmful to public health and the environment. Primary standards provide public health protection, including the health of "sensitive populations" (i.e. children, elderly). Secondary standards provide protection for public welfare including protection against decreased visibility and from the effects of pollutants on animals, crops, vegetation, and buildings (EPA, 2017). Currently there are standards for six primary pollutants:

- Carbon Monoxide
- Lead
- Nitrogen Dioxide
- Ozone
- Particle Pollution
- Sulfur Dioxide

The construction, operation, and maintenance of a 160 slip marina is not itself a source of the contaminants listed above due to the high volume boat traffic that already exists in Burlington Harbor.

The project itself is not a source of noise and is anticipated to comply with all city ordinances. Boats will make noise when they are in use due to the gasoline or diesel engines used to run them, but there is already a high volume of boat traffic within Burlington Harbor. Other sources of noise within the area include the water treatment plant, water pump house, public roadways, active boat launch, active rail line, commercial and industrial buildings. All of these sources are located in between the proposed marina and residential housing which are identified as being the most sensitive receptors.

Potential Consequences of Air and Noise

The operation and maintenance of the marina fueling station has the potential to impact ambient air quality, but with the proper controls impacts can be significantly reduced. In Vermont, the 1997 Air Pollution Control Regulations require stage I vapor recovery at gasoline dispensing facilities. Stage I vapor recovery refers to the recovery of gasoline vapors created when a tank truck delivers gasoline to a dispensing facility ("Gasoline Vapor Recovery | Department of Environmental Conservation"). These vapors are collected and stored back on the tanker truck, which brings the vapor to a gasoline distribution terminal. Once the vapor is at the terminal, they are usually incinerated (VTDEC, 2017). Vapors can also be generated when pumping fuel from the dispenser into the boats engine. The impacts from the vapors created during fueling would be minimal and temporary due to the short amount of time it takes to refuel and that once complete the fuel pump is shut off. Strong wind patterns in the area will also help to dilute and disperse these vapors.

Proposed Action: Impacts to air quality and noise are considered low and short-term during the construction phase. Long-term impacts from the operation of the proposed marina is anticipated to be low as noise levels would be expected to increase with increased recreational use.

No Action: In the absence of the proposed marina, there would be no impacts to air quality or noise.

SOCIOECONOMIC ISSUES

Burlington is home to approximately 42,000 people, and is expected to grow 0.5 – 2.9% by 2030 (City of Burlington, 2015). The Burlington community is a diverse mix of college students, full-time residents, seniors, and refugees and is considered an urban center of Vermont. Burlington's population is young compared to other communities in the area, with 63% of its residents being below 35 years old (PlanBTV, 2013). The various Burlington waterfront plans and initiatives, which are based on public input, indicate that increasing outdoor recreation opportunities are important to the local community. The proposed marina is in line with the visions for improving the waterfront's economic vitality and competitiveness within a sustainable community.

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations was issued on February 16, 1994. The purpose of this executive order is to make sure that federal agencies are aware of the environmental and human health effects that federal actions may have on minority and low-income populations with the goal of achieving environmental protection for all communities. The executive order requires federal agencies to identify and address disproportionately high environmental or human health effects that their programs or policies may have on minority or low-income populations. The executive order also is intended to promote nondiscrimination in federal policies and to provide access to public information and public participation for minority and low-income populations.

Potential Consequences of Socioeconomic Issues

Proposed Action: The proposed marina is anticipated to provide long-term positive socioeconomic benefits to the local economy by providing additional recreational opportunities within Burlington Bay and the surrounding area. The proposed marina would not result in any human health or environmental effects, and would not disproportionately affect any minority or low-income populations.

No Action: In the absence of the proposed marina, possible socioeconomic benefits would not be realized.

CULTURAL RESOURCES

Archeologial Resources

An underwater archeological resource assessment of the Project Area was conducted by the Lake Champlain Maritime Museum in October 2014. The assessment was completed in order to determine if any National or State Historic Places eligible properties were located on the lake bottom of Lake Champlain within the project area. No archeological sites were identified within the area, but seven were identified to the west and south. Archeological sites included the Canal Boat (VT-CH-575), Floating Dry Dock (VT-CH-576), Timber Crib (VT-CH-577), Plywood Motor Boat (VT-CH-791), Skiff (VT-CH-792), Canal Boat (VT-CH-598), and Pre-1875 Cribbing Structure which lies adjacent to VT-CH-592. During the assessment, several pieces of modern debris were observed but no significant cultural resources were observed. The report concluded that no future archeological work is required for the Project Area.

An application was submitted to the Vermont Division for Historic Preservation (VTDHP) in order to complete a historic preservation review of the Project Area on January 31, 2017. The VTDHP concurred with the underwater archeological resource assessment and after

completing a desktop review of the Project Area, did not have any concerns with the proposed action.

As part of the scoping process, outreach was made to four Native American Tribes that may have had cultural sites in or near the project area. Responses have been received from Elnu Abenaki Tribe, and the Nulheagan Band of the Coosuk, neither of which indicated they have concerns within the Proposed Action.

Potential Consequences to Archeological Resources

Proposed Action and No-Action: In both scenarios, impacts to archeological resources are considered negligible.

Historical Resources

A cultural resource survey was conducted in January 2012 for the Downtown Waterfront Area of Burlington, Vermont by Mary O'Neil, Senior Planner and CLG Coordinator, for the City of Burlington. The cultural resource survey was conducted in accordance with legislation and implementing regulations require federal agencies to identify significant cultural resources and take into account the potential impacts of federally funded, licensed, or approved activities on such resources. These include section 106 of the National Historic Preservation Act of 1966 (NHPA), as revised (36 CFR Part 800), NHPA Section 110 amended in 1980, and the Vermont Historic Preservation Act established in 1975 (Title 22 V.S.A Chapter 14).

The Project Area was included in the 349 acre study area of the downtown waterfront area. Although it is known that Burlington's waterfront had industrial, commercial, and maritime operations, little has been written about Burlington's working waterfront. It is known that the shoreline of Burlington Harbor has been significantly modified, with modifications beginning with the Construction of the Curtis Holgate's South Wharf at the foot at Maple Street. Rutland and Burlington Railroad Company filled additional land circa 1850 to accommodate railroad tracks. Cribbing and filling continued along the waterfront, usually with marble or gravel, throughout the 1850's (O'Neil, 2012).

While it is known that extensive filling has occurred, there is no definition or mapping of these areas and the total extent of the shoreline fill is not known. Areas that have been filled in could potentially yield significant resources related to wharfing and filling.

Currently, the Project Area is not located within a historical district, but the recommendation was made in the cultural resource survey that a more comprehensive assessment of the waterfront area is needed. It was also recommended that Depot Street, Lake Street, Penny Lane, and the western most fringes of Main Street, College Street, and Cherry Street could be assembled into the "Historic Waterfront District" and surviving structural resources would be identified and placed within a larger historical context.

The National Registrar of Historic Places is a national list of cultural resources. A cultural resource can include building, site, structure, object, or district. In order to be eligible for listing, a resource must possess a quality of significance to American history, architecture, engineering, and culture and possess integrity of location, design, setting, materials, workmanship, feeling, and culture (Quaide, 2001). In addition, the resource must meet one of the following four criteria established by the National Park Service:

- Be associated with an event that has made significant contributions to the broad patterns of history;

- Associated with the lives of significant persons of the past;
- Embodiment of the characteristics of a type, period, method of construction, or representation of the work of a master, or procession of high artistic values, or representation of substantial and distinguishable entity whose components may lack individual distinction; and,
- Yielding or demonstrating the potential to yield information important in prehistory or history.

After reviewing the National Registrar of Historic Places it was determined that there are no historic places within the Project Area. There are four places that are near the Project Area including: the General Butler Shipwreck to the south of the Project Area, Burlington Bay Horse Ferry Shipwreck to the north of the Project Area, the Burlington Breakwater, and the Lakeside Historic District south of the Project Area.

Potential Impacts to Historical Resources

Proposed Action and No-Action: In both scenarios, impacts to historical resources are considered negligible.

4.0 CUMULATIVE IMPACTS

Since the late 1980's, the Burlington Waterfront has been transitioning from its industrial past to a public space that provides the public access to Lake Champlain. Current developments that are in place or proposed include the expansion of the Perkins Pier Marina, construction of the Burlington Harbor Marina, Community Sailing Center upgrades, repurposing of the Moran Plant, bike path rehabilitation and potentially moving the Ferry route south of Perkins Pier. These developments move the City of Burlington closer to its goal to transforming Burlington's Waterfront into a multi-use area for the public to use and enjoy, while at the same time being conscious of the ecological resources that the waterfront provides.

Due to the previous industrial use of the waterfront, soils and groundwater beneath portions of the waterfront are impacted by various contaminants. While the proposed develops do not remove all of the contaminants, they do limit human contact with contaminated materials and allow the space to be utilized by the public. The industrial uses of the waterfront also made it unsuitable habitat for many species of terrestrial and aquatic animal and plant species. The proposed developments aim to create urban forests, parks and green spaces that can create connective corridors for different species to utilize, limit stormwater runoff and shoreline erosion, and increase pervious surfaces in order to improve water quality.

These developments are also believed to help manage the amount of boat traffic that already exists in Burlington Bay and accommodate increased traffic in the future. The proposed marina will help to define a flow for boat traffic and alleviate congestion within the Bay. It will also provide services to boaters including waste water pump out stations and restroom facilities to safely treat and dispose of waste.

All together, these developments improve public access to Lake Champlain and the waterfront, improve transient boaters access to downtown Burlington, improve overall water quality by providing additional restrooms and waste facilities, reduce stormwater runoff and reduce congestion in both Burlington Bay and on City streets and parking lots. The cumulative impacts of these developments are considered to be beneficial and long-term.

5.0 FUTURE COMPLIANCE AND PERMITS

A project review was conducted by the VTDEC and Natural Resource Board for the proposed action. The following are permits that are anticipated to be needed during construction and operation:

- Wastewater System & Potable Water Supply Permit Jurisdictional Opinion:
  - Wastewater System and Potable Water Supply Permit;
- Agency of Natural Resources- Department of Environmental Conservation:
  - Hazardous Waste Handler Site ID;
  - Disposal of Inert Waste, Untreated Wood & Stumps;
  - Demolition Waste;
  - Underground Storage Tanks;
- Watershed Management Division
  - Flood Plains, Northwest Region;
  - Shore land & Lakeshore Encroachment;
  - Section 401 Water Quality Certification;
  - Stormwater: Developments;
- Department of Public Safety:
  - Construction Permit Fire Prevention, Electrical, Plumbing, Accessibility (ADA). This is covered under the City of Burlington's permitting process;
  - Tier II Hazardous Chemical Report;
- Department of Health: Program for Asbestos Control & Lead Certification;
- Agency of Agriculture: Weights and Measures, Gas Pumps, Scales; and,
- Vermont Energy Code Assistance Center: Vermont Building Energy Standards.

6.0 LIST OF PREPARERS AND CONTRIBUTORS

This document was prepared by KAS, Inc. with contributions from the Vermont Fish and Wildlife Department and the U.S Fish and Wildlife Department. Preparers and contributors are listed below in Table 3 and Table 4.

Table 3. List of Preparers

KAS, Inc.		
Jeremy Roberts	Senior Project Advisor	Document review; project management
Clare Santos	Environmental Engineer	Document preparation
Monica Beers	Staff Scientist	Document preparation; natural resources data collection; historic and cultural resources review

Table 4. Contributors and Reviewers

Vermont Fish and Wildlife Department	
Mike Wichrowski	Facility and Lands Administration
Bernie Pientka	Fisheries Biologist
Jon Kart	Permit Specialist
Robert Popp	Department Botanist
Mark Ferguson	Natural Heritage Zoologist
U.S Fish and Wildlife Service	
Bill Perry	Biologist/Grant Specialist

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Appendix A

1) Site Location Map
2) Site Plans (5 Sheets)
3) Existing Conditions (Aerial Photo)
4) Floodplain Boundary (Drawing C2.2A)

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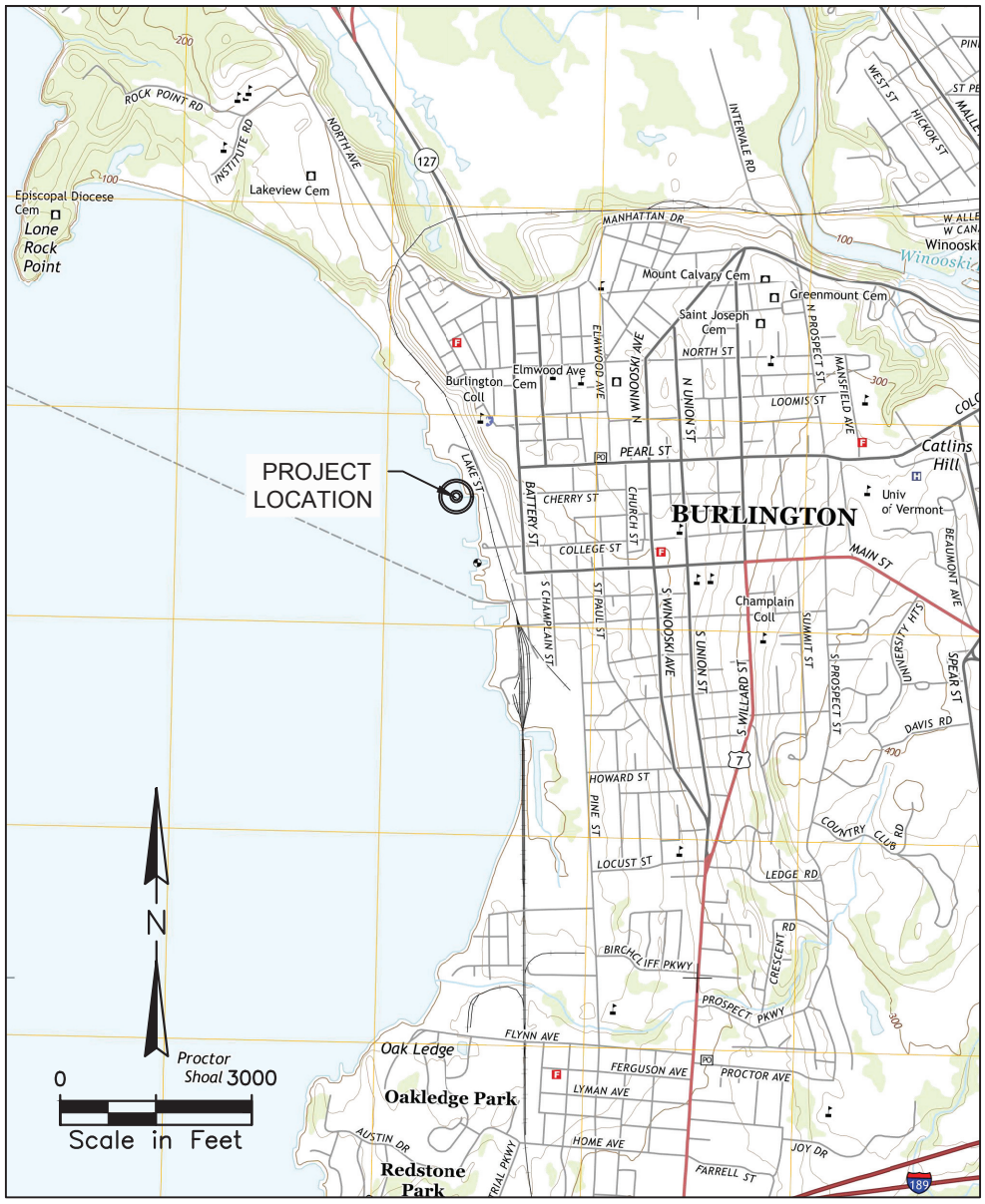
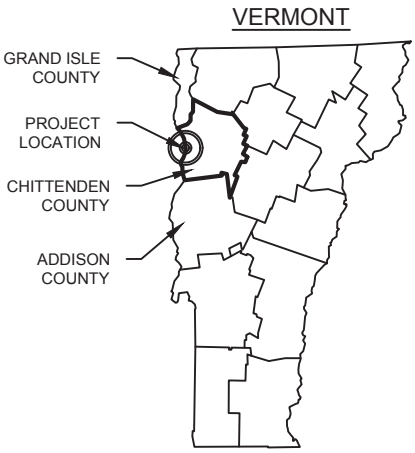
BURLINGTON HARBOR MARINA

BURLINGTON, VERMONT





NOTES:

1. IMAGE BASED ON THE 2015 USGS BURLINGTON QUADRANGLE MAP THAT WAS DOWNLOADED FROM USGS .
2. ELEVATIONS REFERENCE THE NORTH AMERICA VERTICAL DATUM OF 1988, NAVD88.

Minor revisions to text made by KAS, Inc. for the purpose of the Environmental Assessment (March 2017)

APPLIED TECHNOLOGY & MANAGEMENT
941 Houston Northcutt Blvd. Suite 201
Mt Pleasant, SC 29464
(843) 414-1040

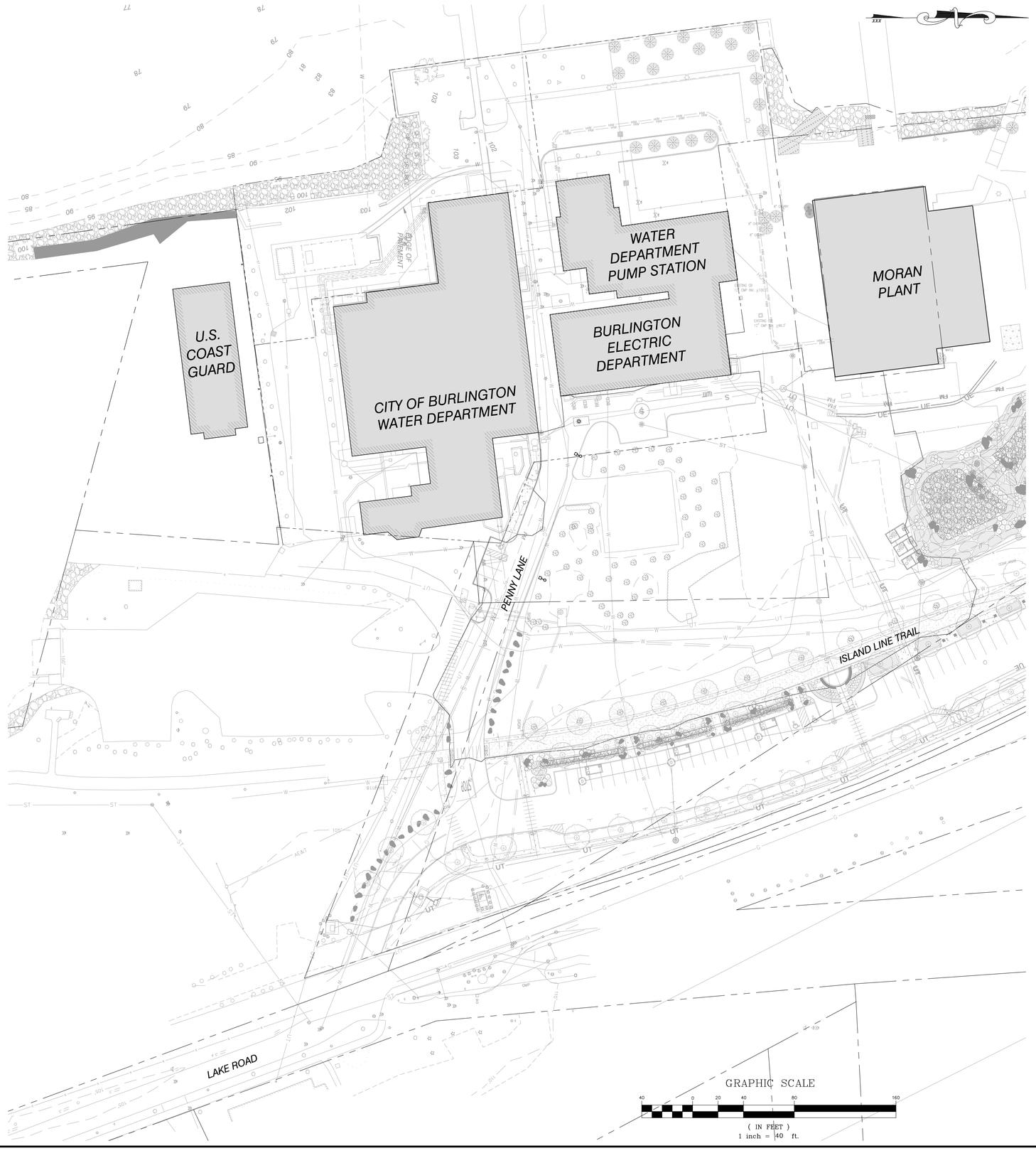
SITE LOCATION MAP

Burlington Harbor Marina, LLC
Burlington, VT

REVISIONS

JOB NO: 15-2828	CHECKED BY: HH
DATE: 28-Dec-2016	DRAWN BY: MM
SCALE: Shown	SHEET: 1

G:\Charleston Shares\Shared\Projects\15-2828 Burlington Harbor Marina\2016-Permitting\Permit Drawings\15-2828-BurlingtonMarina-20161116-14ft.dwg (1) 12/28/16
NOTE: THESE DRAWINGS AND DESIGNS ARE STRICTLY CONFIDENTIAL AND PROTECTED BY INTERNATIONAL COPYRIGHT LAW. DETAILS MUST NOT BE DISCLOSED, REPRODUCED OR COMMUNICATED TO A 3rd PARTY IN ANY FORM OR MANNER WITHOUT THE PRIOR WRITTEN APPROVAL OF APPLIED TECHNOLOGY & MANAGEMENT.



NOTES

1. UTILITIES SHOWN DO NOT PURPORT TO CONSTITUTE OR REPRESENT ALL UTILITIES LOCATED UPON OR ADJACENT TO THE SURVEYED PREMISES. EXISTING UTILITY LOCATIONS ARE APPROXIMATE ONLY. THE CONTRACTOR SHALL FIELD VERIFY ALL UTILITY CONFLICTS. ALL DISCREPANCIES SHALL BE REPORTED TO THE ENGINEER. THE CONTRACTOR SHALL CONTACT DIG SAFE (888-344-7233) PRIOR TO ANY CONSTRUCTION.
2. THIS PLAN IS NOT A BOUNDARY SURVEY AND IS NOT INTENDED TO BE USED AS ONE.
3. PROPERTY LINE INFORMATION IS APPROXIMATE AND BASED ON EXISTING TAX MAP INFORMATION. THIS PLAN IS NOT A BOUNDARY SURVEY AND IS NOT INTENDED TO BE USED AS ONE.

SITE ENGINEER:

CIVIL ENGINEERING ASSOCIATES, INC.
10 MANSFIELD VIEW LANE, SOUTH BURLINGTON, VT 05403
802-864-2323 FAX: 802-864-2271 web: www.cea-vt.com

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DRAWN
SAL

CHECKED
DSM

APPROVED
DSM

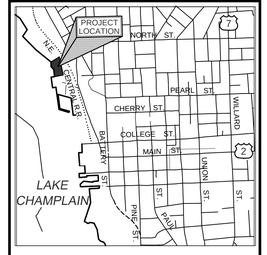
OWNER:

BURLINGTON HARBOR MARINA LLC
1 CHURCH STREET
BURLINGTON VT 05401

PROJECT:

BURLINGTON HARBOR MARINA

234 PENNY LANE
BURLINGTON VT 05401



LOCATION MAP
1" = 2000'

DATE	CHECKED	REVISION
1/24/17	DSM	MISC. CHANGES

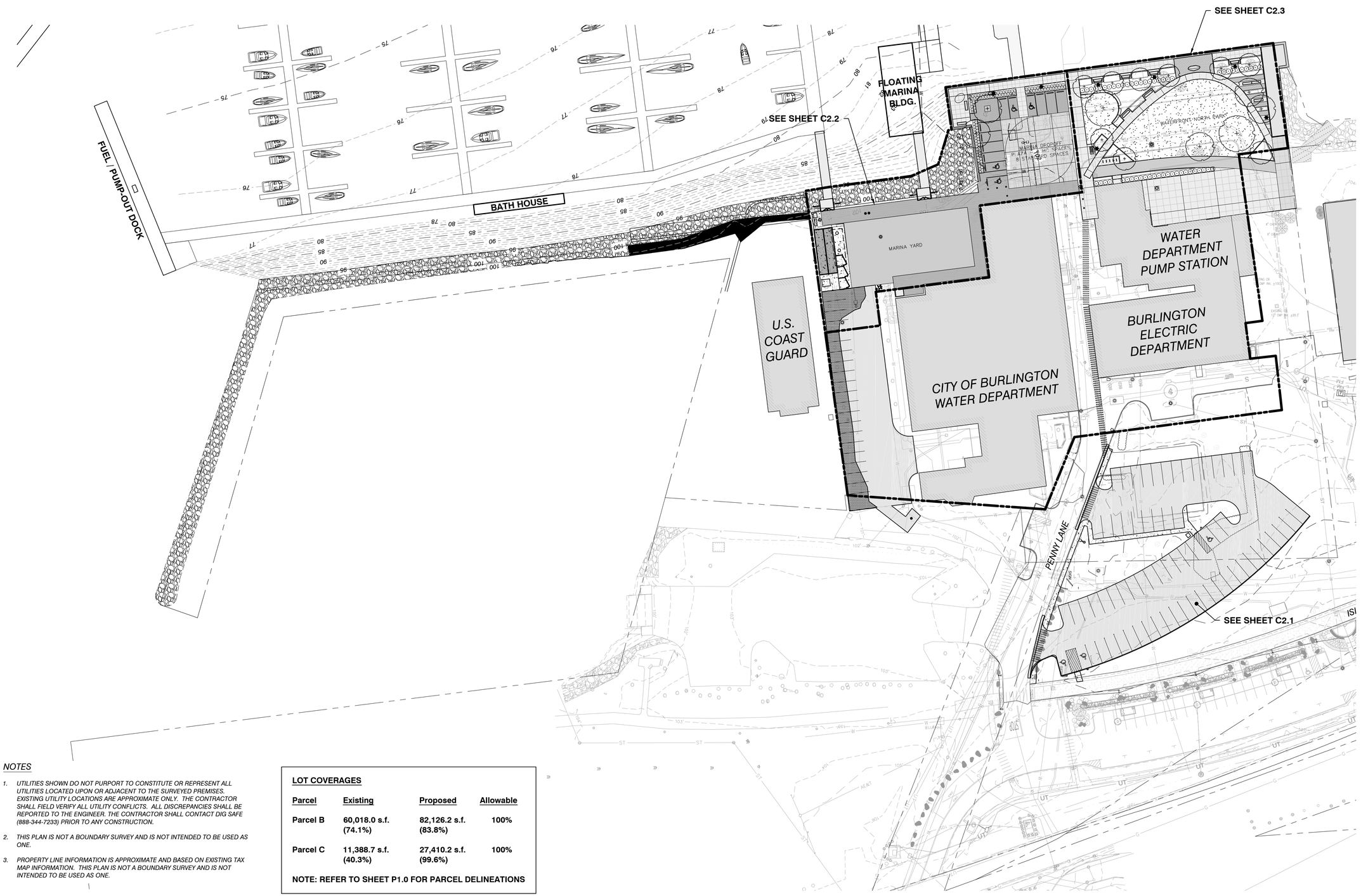
EXISTING CONDITIONS OVERALL SITE PLAN

DATE
JAN. 13, 2017

SCALE
1" = 40'

PROJ. NO.
14115

DRAWING NUMBER
C1.0



NOTES

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3. *PROPERTY LINE INFORMATION IS APPROXIMATE AND BASED ON EXISTING TAX MAP INFORMATION. THIS PLAN IS NOT A BOUNDARY SURVEY AND IS NOT INTENDED TO BE USED AS ONE.*

LOT COVERAGES

Parcel	Existing	Proposed	Allowable
Parcel B	60,018.0 s.f. (74.1%)	82,126.2 s.f. (83.8%)	100%
Parcel C	11,388.7 s.f. (40.3%)	27,410.2 s.f. (99.6%)	100%

NOTE: REFER TO SHEET P1.0 FOR PARCEL DELINEATIONS

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

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OWNER:

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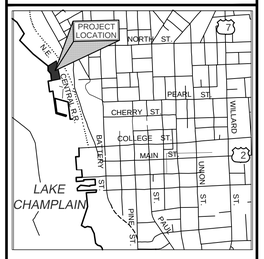
1 CHURCH STREET
BURLINGTON VT 05401

PROJECT:

BURLINGTON HARBOR MARINA

234 PENNY LANE
BURLINGTON VT 05401



LOCATION MAP
1" = 2000'

DATE	CHECKED	REVISION
1/24/17	*DSM*	*MISC. CHANGES*
1/27/17	*DSM*	*PL REVISED FOR PARKING*

PROPOSED CONDITIONS OVERALL SITE PLAN

DATE: *JAN. 13, 2017*
SCALE: *1" = 40'*
PROJ. NO.: *14115*

DRAWING NUMBER: *C2.0*

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OFF STREET PARKING REQUIREMENTS

MARINA	
96 SEASONAL SLIPS (0.5 / SLIP) (PER WAIVER)	48 SPACES
MARINA	
EAST LOT	42 SPACES
SOUTH LOT (EMPLOYEE)	4 SPACES
PLAZA LOT (HDCP ACCESS.)	2 SPACES
	48 SPACES
BIKE PARKING	
SHORT TERM (100 USERS x 0.1)	10 SPACES
LONG TERM (1/10) (EMPLOYEE)	1 SPACES
TOTAL REQUIRED	11 SPACES
TOTAL PROVIDED	11 SPACES

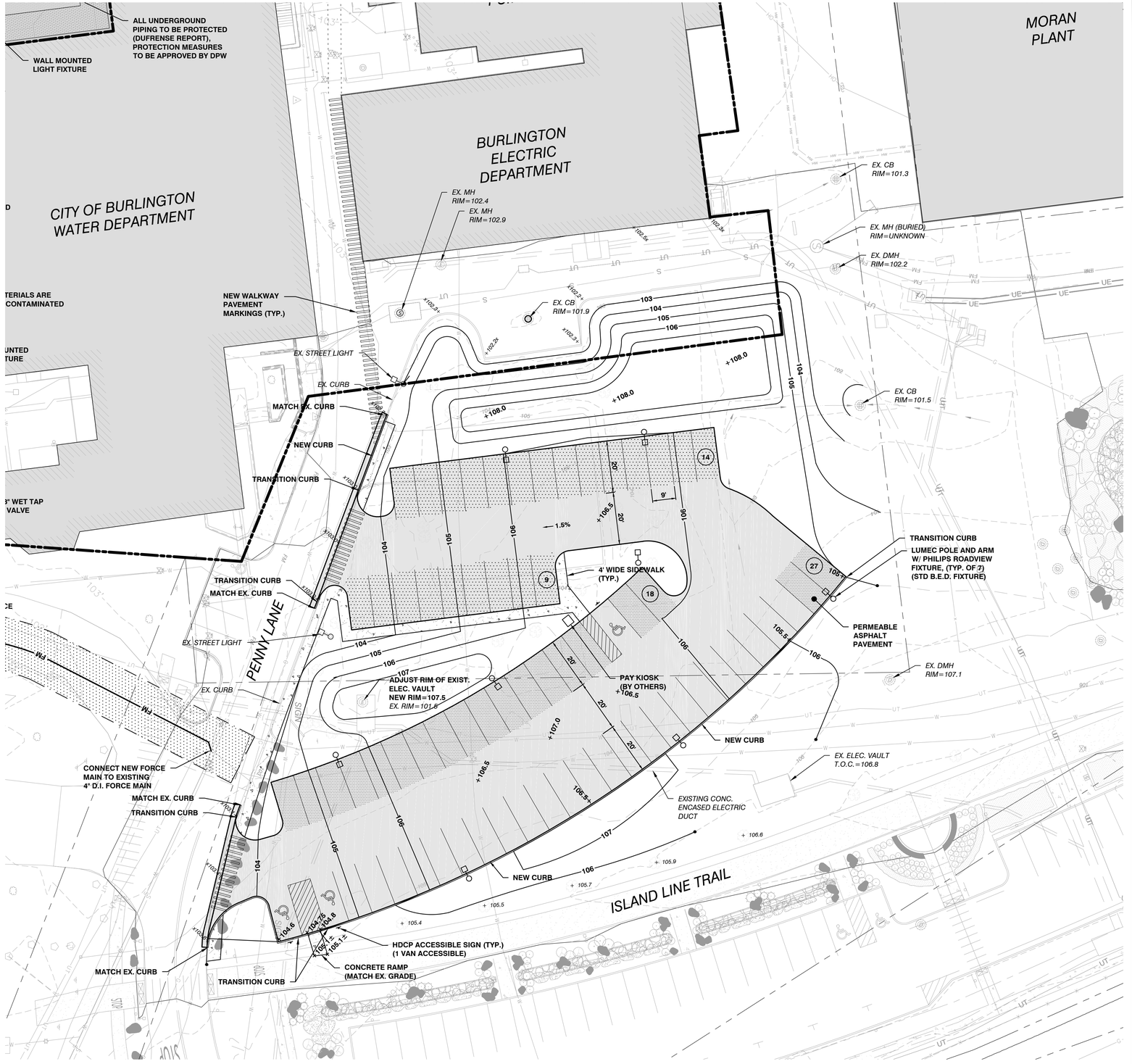
WFN (EAST LOT) PARKING SUMMARY
MIN. REQUIRED SPACES
42 MARINA
26 COMMUNITY SAILING CENTER
68 REQUIRED SPACES
68 PROPOSED SPACES
73 PREVIOUSLY PERMITTED SPACES

3 ACCESSIBLE SPACES REQUIRED (TOTAL)
3 ACCESSIBLE SPACES PROVIDED (TOTAL)
1 VAN ACCESSIBLE SPACE REQUIRED
1 VAN ACCESSIBLE SPACES PROVIDED

EAST LOT PARKING RESERVED SPACES

23 SPACES FOR EXCLUSIVE MARINA USE MAY TO OCT.

19 SPACES FOR EXCLUSIVE MARINA USE WEEKENDS AND HOLIDAYS - MAY TO OCT.



GRAPHIC SCALE
20 0 10 20 40 80
(IN FEET)
1 inch = 20 ft.

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APPROVED: DSM

OWNER:

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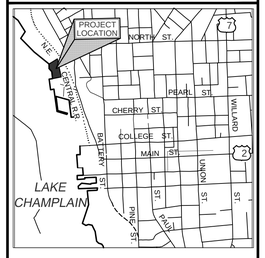
1 CHURCH STREET
BURLINGTON VT 05401

PROJECT:

BURLINGTON HARBOR MARINA
234 PENNY LANE
BURLINGTON VT 05401



LOCATION MAP
1" = 2000'

DATE	CHECKED	REVISION
1/24/17	DSM	MISC. CHANGES

PROPOSED CONDITIONS PARTIAL SITE PLAN

DATE: JAN. 13, 2017
SCALE: 1" = 20'
PROJ. NO.: 14115

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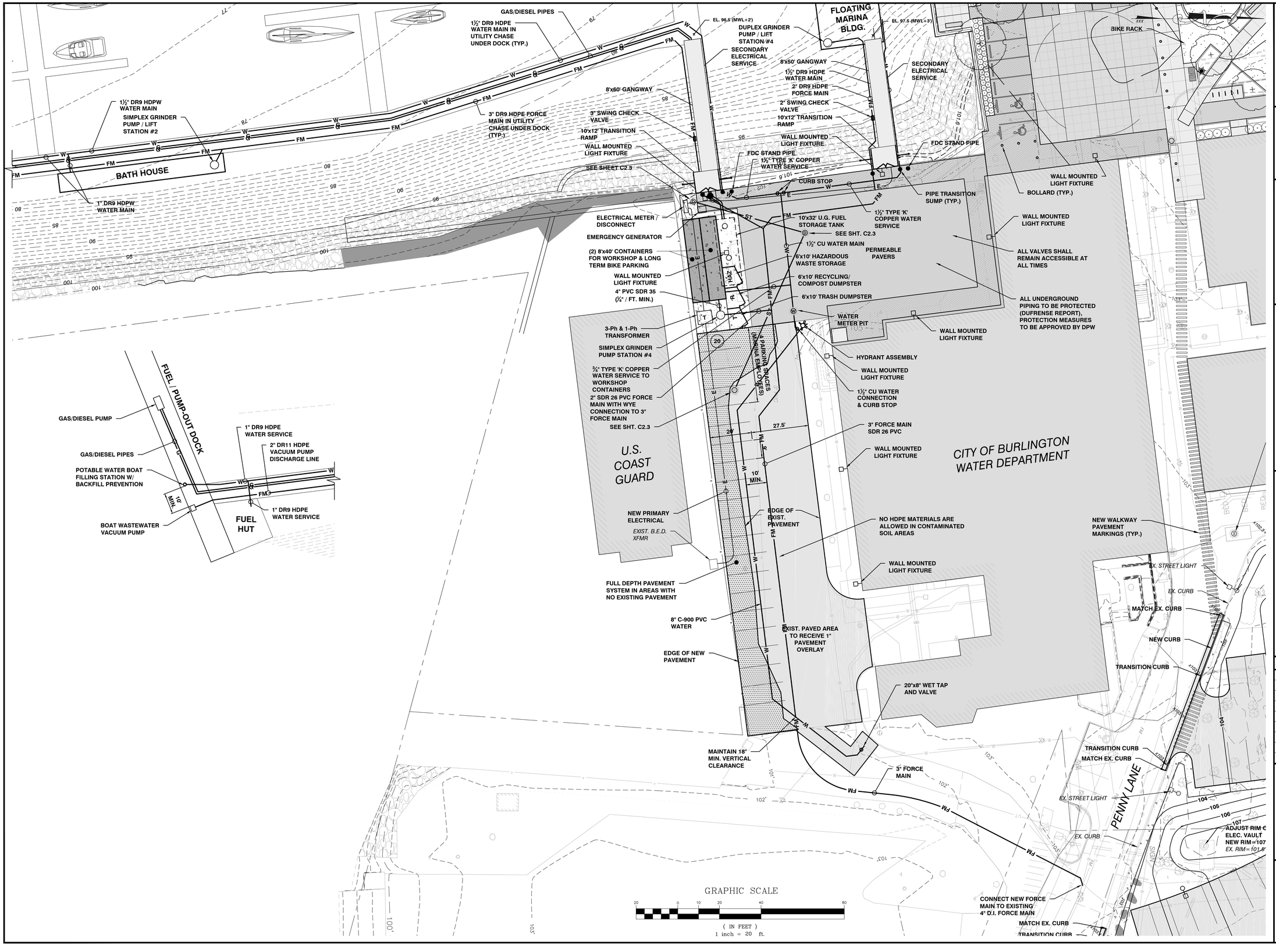

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PROJECT:

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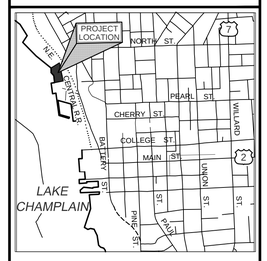
234 PENNY LANE
BURLINGTON VT 05401



LOCATION MAP
1" = 2000'

DATE	CHECKED	REVISION
1/24/17	DSM	MISC. CHANGES
3/14/17	DSM	RELOCATE WORK OUTSIDE FLOODPLAIN
3/30/17	DSM	MODIFIED PUMP OUT FORCE MAIN

PROPOSED CONDITIONS PARTIAL SITE PLAN

DATE: JAN. 13, 2017
SCALE: 1" = 20'
PROJ. NO.: 14115

DRAWING NUMBER: C2.2

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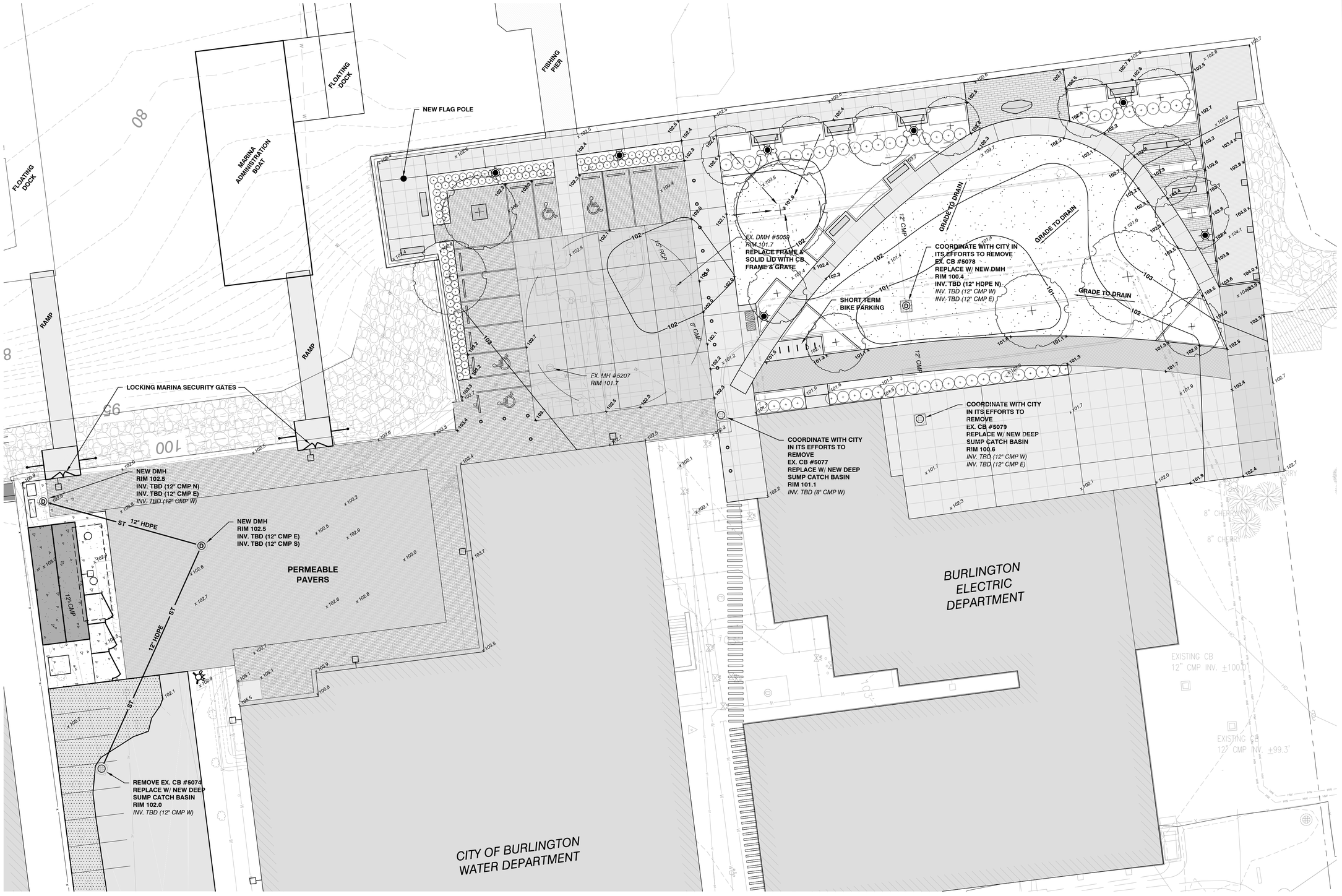

GRAPHIC SCALE

15 0 15 30 60

(IN FEET)
1 inch = 15 ft.

SITE ENGINEER:

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BURLINGTON VT 05401

PROJECT:

BURLINGTON HARBOR MARINA

234 PENNY LANE
BURLINGTON VT 05401

LOCATION MAP
1" = 2000'

DATE	CHECKED	REVISION
1/24/17	DSM	MISC. CHANGES

PROPOSED CONDITIONS PARTIAL SITE PLAN

DATE
JAN. 13, 2017
SCALE
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PROJ. NO.
14115

DRAWING NUMBER
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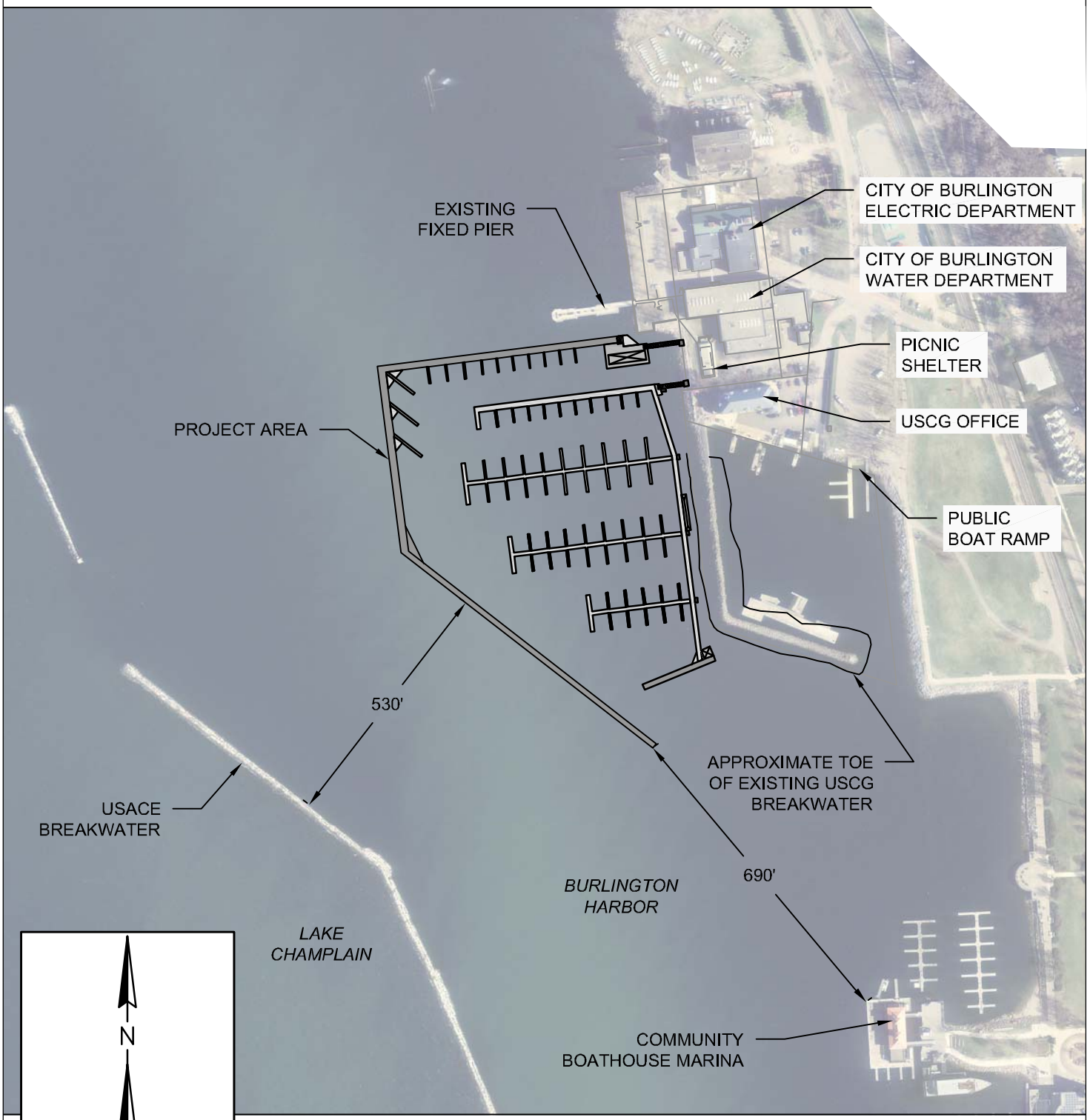

NOTE:
1. AERIAL PHOTOGRAPH DATED 2015 DOWNLOADED FROM THE VERMONT CENTER FOR GEOGRAPHIC INFORMATION.

APPLIED TECHNOLOGY & MANAGEMENT
941 Houston Northcutt Blvd. Suite 201
Mt Pleasant, SC 29464
(843) 414-1040

Burlington Harbor Marina
Existing Conditions

Burlington Harbor Marina, LLC
Burlington, VT

REVISIONS

JOB NO: 15-2828	CHECKED BY: HH
DATE: 21-Nov-2016	DRAWN BY: MM
SCALE: 1" = 300'	SHEET: 2

O:\Projects\15-2828 Burlington Harbor Marina\2016-Permitting\Permit Drawings\15-2828-BurlingtonMarina-20161116-14ft.dwg (2) 11/21/16
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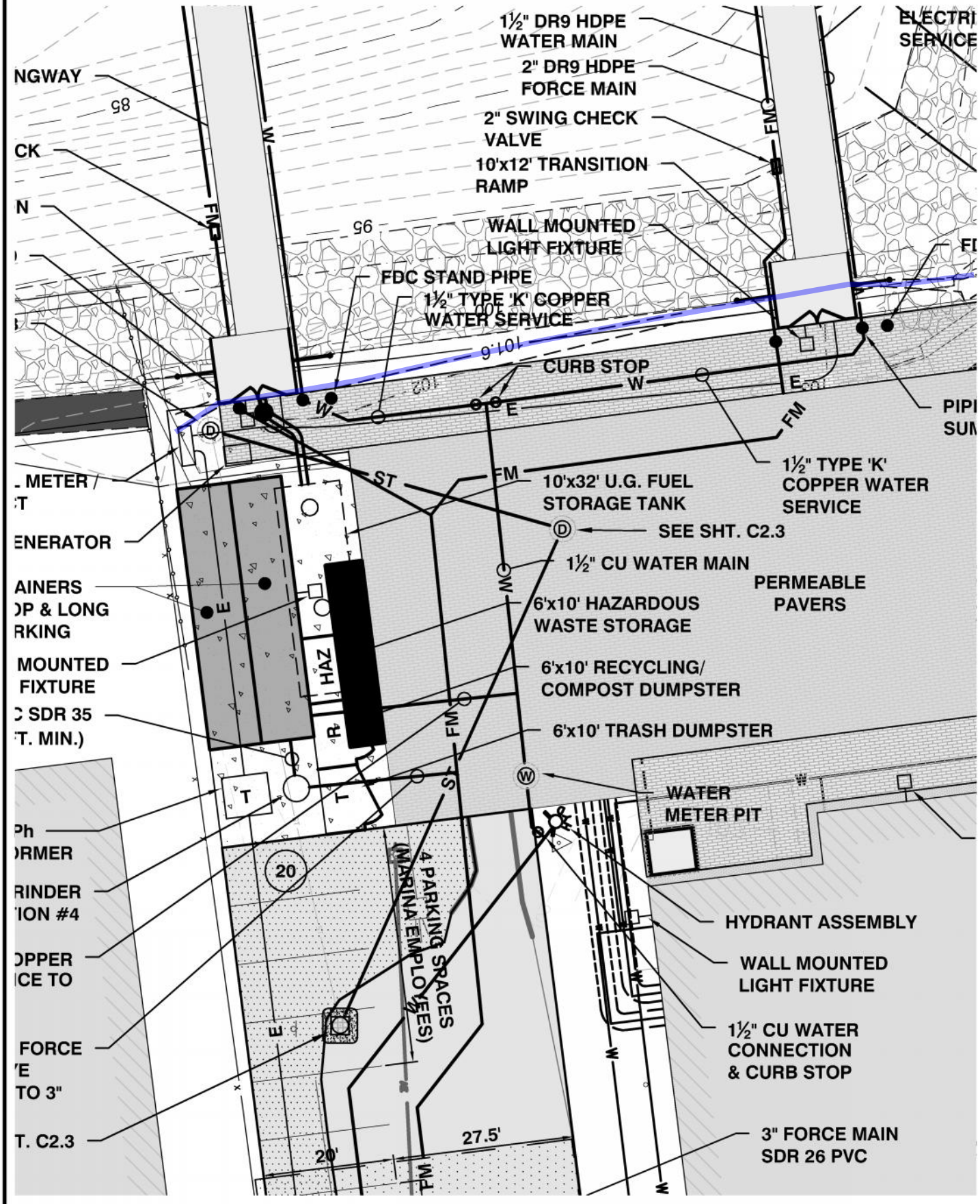

CIVIL ENGINEERING ASSOCIATES, INC.
10 MANSFIELD VIEW LN., SO. BURLINGTON, VT 05403
802-864-2323 FAX: 802-864-2271

Scale: 1" = 20' Drawn by SAL

Date 3/14/17 Checked by DSM

BURLINGTON HARBOR MARINA

BURLINGTON VERMONT

Project No. 14115

DRAWING C2.2A

Appendix B

Navigation Assessment by ATM

APPLIED TECHNOLOGY & MANAGEMENT

P.O. BOX 20336
CHARLESTON, SC 29413-0336
TEL: 843-414-1040
FAX: 843-414-0155

www.appliedtm.com

To: Mr. Jack Wallace (Burlington Harbor Marina, VT)

From: Heath Hansell, PE

Copy: Kirby Marshall

Date: November 21, 2016

Re: Burlington Harbor Marina – Navigation Impacts Assessment

Applied Technology and Management (ATM) developed the below discussion outlining standard industry guidelines for marine and harbor facility design, safe navigation, and vessel traffic as it pertains to the proposed Burlington Harbor Marina.

Marine Facility Design, Navigation, and Vessel Traffic

The proposed Burlington Harbor Marina facility has been designed to meet or exceed typical industry guidelines, recommendations, and standards of practice for safe navigation of vessels within the interior of the facility, entering and exiting, as well traffic areas surrounding (outside) the facility footprint. The attached exhibit shows an overview of the proposed facility, surrounding harbor area, and items related to marine navigation.

Design channel width is based on the beam width (B) of the largest vessels transiting the area. Ferry vessels are typically the largest vessels navigating the inner harbor. Burlington, VT area ferry operators indicate a maximum beam of ~45 ft for their largest vessels. ATM considered two separate harbor design guidelines when determining safe channel distance:

1. The American Society of Civil Engineers, Engineering Manual 50, Planning and Design Guidelines for Small Craft Harbors (ASCE 50). ASCE 50 figure 2.8 provides recommendations for traffic clearances based on steerage conditions. Assuming:
    - 45 ft beam, two-way traffic,
    - poor steerage conditions (potential conditions for large ferry vessels within the harbor)
    - one side of channel exhibits depth limiting conditions (USACE breakwater toe require bank clearance)

    Recommendations include:

    - 1.8*B maneuvering lane width (x2 for two lanes)
    - 1.5*B vessel clearance (distance between maneuvering lanes)
    - 0.5*B bank clearance for depth limiting conditions (along breakwater side of channel)

    Therefore, the total recommended channel width based on ASCE 50 guidelines is 5.6*B, or 252 ft (5.6x45=252 ft).

2. The United States Army Corps of Engineers Coastal Engineering Manual, EM 1110-2-1100 (USACE CEM). USACE CEM Table V-5-9 provides criteria for channel width based on vessel controllability scenarios (i.e. steerage, similar to ASCE 50). Assuming:
    - 45 ft beam, two-way traffic,
    - poor vessel controllability conditions (potential conditions for large ferry vessels within the harbor)
    - one side of channel exhibits depth limiting conditions (USACE breakwater toe requires bank clearance)

    Recommendations include:

    - 2.0*B maneuvering lane width (x2 for two lanes)
    - 0.8*B vessel clearance (distance between maneuvering lanes)
    - 0.6*B bank clearance for depth limiting conditions (along breakwater side of channel)

    Therefore, the total recommended channel width based on USACE CEM guidelines is 5.4*B, or 243 ft (5.4x45=243 ft).

The floating wave attenuator and additional ice protection dolphins of the proposed Burlington Harbor Marina forms the perimeter of the facility. At its nearest point to the Burlington Harbor USACE breakwaters, the proposed marina forms a ~500 ft clear navigation area, which is roughly double both USACE CEM and ASCE 50 industry standard guidelines. Additional navigation area will allow increased safe maneuverability and provide for additional vessel traffic due to potential congestion.

The proposed marina entrance is situated to allow entering/exiting vessels to maneuver safely into open water “queuing areas” rather than directly into main vessel traffic patterns/channel. The attached exhibit shows the various main traffic flow areas, safe queuing areas for existing and proposed amenities/facilities, and relevant marine access points.

To better understand impacts of the proposed marina facility, test buoys were deployed in 2015 within the facility footprint. In cooperation with the ferry services and operators, no navigational or safety issues were reported due to ferries using these test buoys as indicators of potential navigation areas and channels that mimic the location of the proposed facility.

Sincerely,

Heath Hansell, PE
Coastal / Marina Engineer

References:

United States Army Corps of Engineers, 2008. Coastal Engineering Manual, EM 1110-2-1100 Part V

American Society of Civil Engineers, 2012. Planning and Design Guidelines for Small Craft Harbors

Attachment

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NOTES:
AERIAL IMAGE SOURCED FROM GOOGLE EARTH, DATED 05/13/2015
ORIGINAL SITE PLAN PROVIDED BY CIVIL ENGINEERING ASSOCIATES, INC. DATED 07/13/2015

REQUIRED CHANNEL WIDTH PER USACE EM 1110-2-1100

REQUIRED CHANNEL WIDTH PER ASCE 50

243'

500'

252'

PROPOSED SAILING CENTER

BURLINGTON HARBOR MARINA

PUBLIC BOAT RAMP

PUBLIC BOAT RAMP QUEUING AREA

250'

INTERIOR FUEL & PUMPOUT QUEUING AREA

100'

88'

EXTERIOR/GENERAL QUEUING

75'

270'

SUBMERGED REEF/ CRIBBING

500'

GENERAL NAVIGATION VESSEL FLOW

APPROXIMATE CITY MOORING LOCATIONS

726'

GENERAL OPEN WATER QUEUING AND AUXILIARY NAVIGATION AREAS

BURLINGTON HARBOR/ LAKE CHAMPLAIN

FERRY DOCKS/ TERMINAL

N

0 300

Scale in Feet

941 Houston Northcutt Blvd #201
Mt Pleasant, SC 29464
(843) 414-1040

Burlington Harbor Marina
Burlington, Vermont

REVISIONS

JOB NO: 15-2828	CHECKED BY: KM
DATE: 11/22/2016	DRAWN BY: WFH
SCALE: 1" = 300'	SHEET NO: 1

Appendix C

Wave Assessment by ATM

APPLIED TECHNOLOGY & MANAGEMENT

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To: Mr. Jack Wallace (Burlington Harbor Marina, VT)

From: Heath Hansell, PE

Copy: Kirby Marshall, Tim Mason, PE

Date: July 12, 2016

Re: Floating Attenuator Effects on Local Wave Climate

Due to concerns regarding potential impacts of the proposed Burlington Harbor Marina and associated floating wave attenuator, Applied Technology and Management (ATM) developed the below discussion summarizing general coastal dynamics and typical wave-structure interactions pertinent to overall harbor operations.

Wave Reflection

As an incident wave approaches and impacts a floating attenuator, wave energy is generally broken into three distinct categories:

1) transmitted wave energy –travels under and through (via horizontal floating attenuator sway motion if not pile or rigidly anchored) the system resulting in smaller waves in the lee of the floating attenuator;
2) dissipated wave energy – absorbed by the floating body (think of the wave having to "lift" the floating object as it passes) and transferred via anchoring system; as well as turbulent dissipation through friction, vortex shedding, etc. as energy travels past the system;
3) reflected wave energy – any energy not transmitted or dissipated is necessarily reflected

Floating attenuators generally exhibit much less reflection than fixed breakwaters. Vertical fixed wave screens can theoretically reflect up to 100% of wave heights at the face of the screen. Rubble mound breakwaters (similar to the Coast Guard basin breakwater and outer Burlington Harbor breakwaters) typically exhibit reflection on the order of 35%. A general discussion of wave reflection can be found in the USACE Coastal Engineering Manual (CEM, Part II, Chapter 7-4).

Simplified analysis of floating attenuators assumes the object is "fixed" at the water surface and behaves similarly to that of a fixed wave screen (partially penetrating barrier). This maximizes wave reflection which is the primary response to the wave impacting the structure. However, a floating attenuator can move in heave with wave motion and will dissipate wave energy and reduce reflections. Koutandos, et al (2005) performed measurements to study reflection and transmission characteristics of floating attenuators in regular waves which were free to move vertically (realistic heave motion). Due to the energy dissipation of the free to heave attenuator, the reflection coefficients ($C_r = H_r/H_i$) are significantly less and range from 0.1 to 0.25, indicating reflected wave heights with a maximum height of 25% of the incident wave height.

- Operational (annual conditions typically encountered during the approximate May-October boating season) wave conditions inside the rubble breakwaters of Burlington harbor generally exhibit significant wave heights (H_s) less than 1.0 ft, with periods on the order of 2 seconds.

- Based on the conservative maximum C_r value from Koutandos, (0.25) and conservative maximum annual wave heights expected (1.1 ft), conditions in proximity to the floating attenuator could potentially increase from 1.1 ft to 1.38 ft. This is an insignificant increase in regards to safety and navigability (and integrity of any affected structures in the immediate vicinity) during operational conditions.

- Reflected wave heights are typically insignificant even within the immediate vicinity of the floating attenuator due to larger incident waves generally governing conditions.

- The reflected wave spectra will be phase and directionally shifted from incident waves so adding the reflected wave heights to incident wave heights (as in above bullet) is conservative since different wave trains may exhibit both constructive and destructive interference.

- Due to wave-wave interactions, reflected wave effects dissipate relatively quickly and are generally indistinguishable in typical wave spectra, or "chop" conditions when reflections may occur.

- Extreme event wave conditions will follow similar trends, except with even smaller reflection coefficients due to decrease in efficiency of typical floating attenuators with increases in wave heights and periods.

- During extreme conditions, it is not anticipated that any recreational traffic will be operating on the lake in close proximity to the proposed attenuators (location where observed reflections are most prevalent due to superposition of incident and reflected waves).

Wave Diffraction

Additional concerns were raised about the potential for a "funneling effect" of waves by the proposed Burlington Harbor Marina attenuator and outer Burlington Harbor detached rubble breakwaters. It is assumed this "funneling effect" is in regards to what is known as wave diffraction (in addition to previous concerns discussed regarding reflection). This hydrodynamic effect is detailed in the USACE Coastal Engineering Manual (Part II, Chapter 7-2).

When waves approach a fixed structure (such as rubble breakwaters) or a gap between topographic headlands, the waves can bend, or diffract, in response to the structure. Wave refraction can cause similar effects due to bathymetric changes. Decreased wave heights in the lee of the structure will cause a lateral transfer of wave energy from areas of higher to lower wave heights, causing waves to diffract and decrease in height. Floating attenuators can have similar effects since they also decrease wave heights in lee of the structures. Depending on the incident wave angle, wavelength, and configuration of structures, waves can propagate past and around these areas in various ways.

- Waves propagating through the theoretical "gap" (~500 ft channel oriented NW-SE) between the proposed Burlington Harbor Marina and existing rubble breakwaters will exhibit some minor diffraction localized near the channel boundaries.

- Per CEM methodology and accepted wave dynamics, these diffraction effects will cause waves to be re-directed more towards the channel boundaries (not "funneled" inward) and decrease in height. Details regarding diffraction dynamics can be found in the CEM, Part II-7-2.

- Predominant winds in the area are from the southerly directions. Accordingly, the proposed Burlington Harbor Marina would have no impact on facilities to the south during southerly wind-wave conditions that are common throughout the year, including the typical boating season. Facilities to the north (in the lee) of the proposed marina during southerly winds would experience a general sheltering effect due to the protection afforded from the Burlington Harbor Marina and associated floating wave attenuator.

- Concerns were raised regarding wave effects at the City Boathouse, approximately 700 ft southeast of the proposed Burlington Harbor Marina. During normal, southerly wind-wave conditions, there would be no impact at the City Boathouse. During the more rare northwesterly wind and wave conditions, potential wave diffraction effects would likely be negligible or favorable (reduced wave heights) at the City Boathouse due to the distance of the facility, scale of effects, and wave interference relative to overall governing operational conditions.

Summary Points

- The construction of the proposed Burlington Harbor Marina, including the perimeter floating attenuator, would, in the overwhelming majority of cases, serve to protect and decrease wave activity in the lee of its footprint.

- Based on the above discussions, any potentially reflected waves from the floating attenuator pose no significant safety or navigation concerns for Burlington Harbor.

    - Wave heights may increase in the immediate proximity of the structure ~3 inches during normal operational conditions due to reflection from the proposed attenuator.

    - During a 50-year storm, reflections may increase heights up to ~6 inches, where wave heights of 2.0 ft or greater will govern sea state conditions and reflection effects will be negligible.

- In an overwhelming majority of cases, nearby facilities will see a decrease in wave heights due to protection afforded from the proposed Burlington Harbor Marina. The potential for any minor increase in wave heights at nearby facilities due to complex wave interactions in the harbor is considered unlikely and insignificant under most conditions.

Sincerely,

Heath Hansell, MS PE
Coastal / Marina Engineer

References:

E. Koutandos, P. Prinos, X. Gironella, 2005. Floating Breakwaters under regular and irregular wave forcing: reflection and transmission characteristics. Journal of Hydraulic Research. Vol. 43, No. 2 (2005), pp. 174-188

USACE, 2006 Coastal Engineering Manual, EM 1110-2-1100. Part II, Chapter 7.