Gibsons Sea Level Report

Notice to Readers

This report was prepared as a voluntary community service with the author's observations of tides and weather system effects, based on his 32 years' experience as a certified instructor in command of training vessels based in Vancouver and Gibsons.

While information presented herein is believed to be accurate, it should not be used as a basis for construction without review, design, and supervision by a currently practicing registered professional engineer.

Written and produced by:

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Summary

An expected 1 metre rise in sea level coupled with the current range of high tides and seasonal progression of low pressure weather systems over Gibsons will damage shoreline public infrastructure and private property unless measures are designed and implemented for adaptation to a higher sea water level.

Tides of 4.8 metres and over, up to 5.1 metres, are predicted at Gibsons harbour by Fisheries and Oceans Canada on 34 days through to 31st December this year. A combination of atmospheric low pressure coupled with wind effects have already produced a sea level that was 0.9 metres above the predicted tidal height, as was recorded at Point Atkinson on 16th December 1982.

For Gibsons Harbour this year's predicted tidal heights are up to 5.1 metres. If the already experienced atmospheric effect of 0.9 metres and the expected sea level rise of 1.0 metres are combined, a sea level of 7.0 metres could result.

This report contains information about sea level impacts that has been provided to the Town of Gibsons from 2006 through 2018. However the author has seen no evidence of understanding or strategic planning for the physical and economic impacts from the expected rise in sea level. Moreover there have been media reports about assignment of public infrastructure resources in favour of private interests.

To avoid substantial flooding and wave impact damage requires adaptation and upgrading of public infrastructure, as well as by some 50 private properties.

This is a large multi-year undertaking requiring planning and financing involving other levels of government, as some facilities were built by the federal government and provincial building standards are involved. In May 2019 Engineers and Geoscientists BC published reports of seawater flood adaptation strategies already under implementation in Vancouver and Surrey.

Small coastal towns like Gibsons and Sechelt seem to be at a disadvantage in budgeting and managing the resources needed to plan, design and administer the required scope over several years of construction, and federal/provincial assistance would appear to be needed. Investment by the federal government will be necessary to upgrade the breakwaters and public dock that it built to create a protected working harbour with facilities and moorage for 500 commercial and recreational vessels.

Action is needed now to plan, design, and build upgrades of public and private facilities with structural and mechanical capacities for a sea level of 7.0 metres over the next 5 years, and to apply these requirements immediately to new construction.

2006 February 15, Report to Mayor and Council, Town of Gibsons

Re: Impact of high tides on Gibsons sea walk

On Saturday 4th February a high tide of 15.4 feet (4.7 m) at 0931 hours coincided with the close proximity of a storm centre to produce sea levels that rose over the Gibsons sea walk at 2 locations.

With the forecast of this event I was in position to take photographs at that time. My photographs record waves over the sea walk near the Town sea walk access south of Coles Marine Ways. The sea walk was also covered near Hyak Marine where there was also some flooding of waterfront properties.

I draw this to Council's attention because this was at least a foot lower than the highest sea levels that could be anticipated. In actual fact higher tides were listed in the tide tables for the six preceding days:

29th January	0629	15.7 feet	(4.8 m)
30th January	0700	16.1 feet	(4.9 m)
31st January	0730	16.1 feet	
1st February	0759	16.4 feet	(5.0 m)
2nd February	0829	16.4 feet	
3rd February	0859	16.1feet	

The same storm system coinciding with these higher tides would have produced much more severe flooding.

A similar sequence of tidal height occurred in early December, and there were 2 other days when storm systems missed the high tide by only a few hours. This is the pattern that is repeated each December and January. It is just a matter of time before a more serious event occurs.

My recommendation is that the Town includes in its planning the raising of the level of the sea walk. The Town may also want to ensure it limits or avoids liability to purchasers of sea front properties that are subject to flooding. These sea levels also need to be considered in the plan for expansion of Gibsons Harbour.

John Roper, P.Eng.

With following photos

Topping breakwater with light wind

Over the sea walk near Hyak proposed development site

Over the sea walk north of Gibsons Public Dock (many waterfront residences)

Storm Surge Almanac for Southwestern British Columbia: Fall/Winter 2011-2012

Pre-season discussion of tidal and climate conditions affecting extreme water levels on the BC coast

Prepared for Fisheries and Oceans Canada and the British Columbia Ministry of the Environment
Scott W. Tinis, Ph.D.
October 7, 2011

Page 10:

Tides

The highest tides of the year, known as the perigean spring tides, occur near the summer and winter solstices. High tides during this period reach (or slightly exceed) 5.0 m at Point Atkinson and 3.1 m at Victoria. Water levels of this magnitude leave coastal areas extremely vulnerable to flooding by storm surge. To illustrate the importance of these periods of extreme tidal height, a concurrent storm surge of 0.6 m would cause a total water level equivalent to the 1982 record at Point Atkinson (and the 2003 record at Victoria), even without the presence of El Niño-induced elevated coastal sea levels.

Point Atkinson

The historical recorded high water level at Point Atkinson occurred on December 16, 1982 when the water gauge measured a total water level of 5.61 m (4.71 m tide + 0.90m anomaly). The factors that led to the historical high water level were a combination of high seasonal tide, strong winds, low atmospheric pressure and a coastal sea-level height anomaly of approximately 0.2 m driven by one of the most intense El Niño events on record.

Complete report pdf available

2013 March 01 C-Change project measures rising sea levels for Gibsons

John Gleeson, Staff Writer, The Coast Reporter

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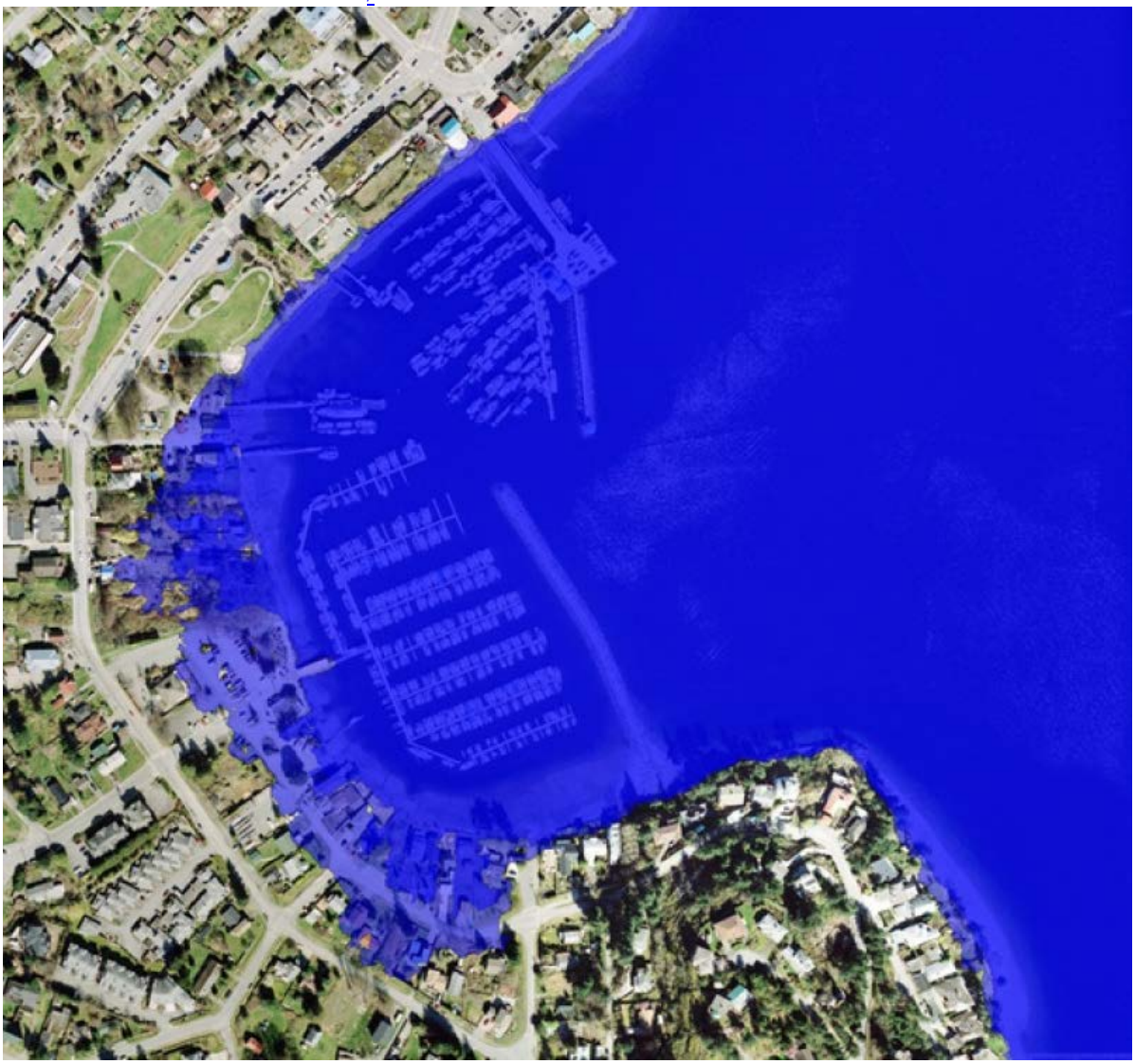


C-Change researchers' visual projection for Gibsons Harbour in 2100 at high tide with extreme storm surge, considered a one-in-100-year event.- Photo submitted

By 2100, Gibsons Harbour could be hit by more than $5 million in property damages and loss due to ocean-related climate change, according to data collected in a major research study.

The C-Change project, based out of the University of Ottawa, is studying the impact of rising ocean levels on Gibsons and three other coastal Canadian communities, as well as four in the Caribbean.

"What you have is something that virtually no other community in Canada now has available to it," Ralph Matthews, professor of sociology at UBC and one of five Canadian academics involved in the project,

told Gibsons council on Feb. 19. "You have an interactive model to see, based on your community and the knowledge for this region, what exactly the issues will be for climate change and rising oceans."

Presented by graduate student Nathan Vadeboncoeur, the initial findings measured the physical impact on properties from rising sea levels, based on the latest science.

Projecting a one-metre estimated rise in sea level by 2100, researchers added storm surge effects to determine total potential impact at high tide.

"In Gibsons, we're fairly fortunate that it's protected and a little out of the way of the main Strait of Georgia, and so the wave effects will be a lot less than a community like Sechelt," Vadeboncoeur said. "Generally the harbour is the only part of Gibsons that will see a discernible impact."

In current dollars, the value of all land exposed to sea level rise is about $20 million under the projections, but total loss and damage was estimated at only $4.3 million in private property and about $1 million in public property.

Factoring in the cost of retrofits to the Town sewer line and harbour breakwater, "we're looking at something on the order of $10 million in potential damages and retrofits associated with sea level rise in the Town of Gibsons -and this is over 80 or 90 years," Vadeboncoeur said.

Also presented was a residents' survey that found 86 per cent of respondents were in support of spending tax dollars to address climate change impacts, but sea level rise and storm surge were ranked the lowest among 13 potential hazards. Highest ranked was drinking water contamination.

Councillor Gerry Tretick noted the findings could cause serious concern for some landowners about their property values and home insurance rates.

"Because all of this is sort of speculative on a scientific basis, I'm just wondering how careful we have to be about what we say and do," Tretick said.

The study's findings will be based on "what reputable science suggests will be the increased level of ocean rise for this area," Matthews replied. "For Gibsons it is less a problem for individual homeowners, as there are not that many living in very low-lying areas, but you have a great deal of water and sewage infrastructure by the harbour. Some of that is in an area which reasonable assumptions suggest could be threatened.

"It's not something that's going to happen tomorrow, but it's something that this council and its successors should start to consider."

Researchers are also studying the Lower Sunshine Coast as a whole and will present those findings later in the year. Preliminary data has been shared with emergency personnel from the region, with Davis Bay flagged as a potential high-impact area.

Added note by this author: The expectation of sea level rise and value of potential damages now appear to have been substantially understated in the current view.

2014 December 12, Report to Mayor and Council, Town of Gibsons

Re. Risk of Flooding from High Tides coinciding with Low Atmospheric Pressure

Accepted standard atmospheric pressure at sea level is 29.92 inches Hg. *(See added terminology clarification below)*

This exerts a downward pressure on the sea surface of 14.7 pounds per square inch (9.8 tonnes per square metre).

When a low pressure system is over our coast this downward pressure is reduced and sea levels rise correspondingly.

Tides are created by the moon's gravitational pull which is increased when the moon is closer to the earth in November through February.

Tidal height predictions based on standard atmospheric values are published under the authority of Canadian Hydrographic Service of Fisheries and Oceans Canada and can be found at www.waterlevels.gc.ca/eng/station?sid=7820 .

Last week low atmospheric pressure produced water levels that were higher than the tidal predictions and on 10th December this caused sea water to flow over the sea walk into two sites where major developments are proposed. On this date the tidal height was predicted at 8.54am to be 15.7 feet (4.78 metres) and the atmospheric pressure was observed to be 977 millibars.

On 11th December the tidal height was predicted at 9.20am to be 15.7 feet (4.78 metres) and the atmospheric pressure was observed to be 975 millibars. With this prediction I was present at 9.20am at the above locations and took photographs to record the actual water level. While there I observed debris over the sea walk at the two locations carried by the previous high tide.

Predictions for the period of 22nd through 30th December show daily very high tides, with the highest tides of the year at 16.7 feet (5.09 metres) occurring on Friday 26th at 9.06am, and on Saturday 27th at 9.46am.

If coinciding with the low atmospheric pressures of last week these tides would cause flooding at the Hyak Marine and Shoal Bay Properties. Conversely if coinciding with high atmospheric pressure no flooding would occur.

I advise that Council members consider the impact of flooding by high sea levels at proposed development sites such as these which, if disregarded, will impact not only public health and safety, but also be damaging to the structures and require costly repairs. The Town also needs to plan for the impact of rising sea levels on its own infrastructure as well as action to protect taxpayers by placing some form of regulation on owners of waterfront lands to limit possible liability for flooding over town owned infrastructure.

John Roper, P. Eng.

Clarification of Terminology:

Normal Temperature and Pressure is defined as air at 20^{o}C (293.15 K, 68^{o}F) and 1 atmosphere (101.325 kN/m^{2}, 101.325 kPa, 14.7 psia, 29.92 in Hg. In aviation and television weather reports, pressure is given in inches of mercury ("Hg), while meteorologists use millibars, the unit of pressure found on weather maps, and the average pressure at sea level is 1013.25 millibars.

2016 January 20, Report to Mayor and Council, Town of Gibsons

I recorded the sea water level in Gibsons harbour at 10.09am Saturday 16th January 2016 when the high tide predicted by Fisheries and Oceans Canada was 16.1 feet (4.91 metres) for normal barometric pressure.

At that time the barometer reading of 985 millibars plus an outflow wind estimated at 15 knots (28 km/hr) produced a sea water level of 17.4 feet (5.30 metres) as indicated on the private tide gauge at Gibsons Marina. The sea water level was within a centimetre or so of the sea walk level at the proposed development site at Hyak.

"The historical recorded high water level at Point Atkinson occurred on December 16, 1982 when the water gauge measured a total water level of 5.61 m (4.71 m tide + 0.90 m anomaly). The factors that led to the historical high water level were a combination of high seasonal tide, strong winds, low atmospheric pressure and a coastal sea-level height anomaly of approximately 0.2 m driven by one of the most intense El Niño events on record."

This paragraph is contained in a Storm Surge Almanac for Southwestern British Columbia that was prepared for Fisheries and Oceans Canada and the British Columbia Ministry of the Environment by Scott W. Tinis, Ph.D., October 7, 2011.

The simple arithmetic for 16th January in Gibsons Harbour is that the 0.9 metre anomaly that occurred in 1982 would have produced a sea water level of 5.81 metres (19.1 feet). This level does not include any provision for an expected rise in sea levels estimated in the range of 0.3 to 0.9 metres and I refer you to the 20th November seminar "Wading Through Sea-Level Rise: How Will Engineers and Planners Adapt to Changing Coastal Water Level" and other educational events and articles by the Association of Professional Engineers of BC.

As you are currently evaluating development proposals in Gibsons harbour, I and other tax paying residents and business owners, would like to know what sea level has the Town established as a basis for designing developments and infrastructure? Also what measures are in place to limit financial liability of the Town and its taxpayers against potential losses from inadequate provision against sea water flooding over the anticipated lifetime of any waterfront construction?

John Roper, P. Eng.

2016 January 16 sea level with west breakwater

Sea level with sea walk at Hyak

17 ½ feet (5.3 m) at Gibsons Marina private gauge

As there had been no contact, discussion or response to my 2014 December letter, in the public interest this letter was copied to community newspapers and was posted by: The Local Weekly January 20, 2016 in Letters To The Editor, without photos.

Without any contact or discussion there was the following response by the Town of Gibsons, also published in the Local Weekly

Dear Mr. Roper, thank you for contacting us with your information and concerns. The Town's current approach (since the OCP Update of March 2015) is as follows:

With regards to elevation requirements and sea level rise the OCP's Development Permit Area #1 (Geotechnical Hazards) indicates that new buildings and structures need to be located at least 2.5 m above the current sea level. This is a new provision that includes an anticipated sea level rise of 1 m by the year 2100. This elevation requirement can be varied based on expert advice depending on life span of the structure or local conditions. The Development Permit Area #1 guidelines provide more details.

In terms of financial liability, the Development Permit guidelines as well as the Zoning Bylaw require that a save harmless covenant be registered on title confirming that the Town will not be held responsible for development in flood plains.

More backgrounds and policies regarding Climate Change and Sea Level Rise can be found in sections 6.7 and 6.8 of the Official Community Plan. Climate Change and Sea Level Rise are a serious concern for our future and in the coming years the Town will continue to further develop strategies for new development and infrastructure to adapt to a changing environment.

I hope this answers your questions.

Andre Boel,

Director of Planning,

Town of Gibsons

Unfortunately the statement “that new buildings and structures need to be located at least 2.5 m above the current sea level” is meaningless as “current sea level” is continuously varying and this letter failed to provide a specified measurable elevation for safety of structures from sea water ingress.

As to further developing strategies to adapt to a changing environment, there has been no further contact, nor have I seen any further published information about any process or program for adaptation.

2016 March, flooding at Winn Road and proposed development site

In March 2016 I received the following undated photos by others which record a higher sea water level, flooding part of Winn Road and over the sea walk into private property that is planned for development.

Flooding of Winn Road

Flooding into private proposed development property

2016 October 20: The Coast Reporter

The storms that moved through the area last weekend coincided with extreme tides leading to waves crashing over seawalls in areas like Armours Beach, as seen here around 5 p.m. on Oct. 14. - John Roper Photo

2018 November 09 Report to Gibsons Mayor: Armours Beach

As you know I have a long standing interest in improvements for activities at Armours Beach, and I am concerned about the risk for serious damage with upcoming very high tides coupled with winter storms.

One of the boom logs that had broken loose has been re-attached but not securely and I perceive a risk of this massive log coming loose again and battering the pier supports and sea wall to destruction.

The next period of very high tides starts 24th November and this needs immediate attention.

2017 February 05 at Armours Beach

This loose boom log was battering the pier support and the chained end was pulling the sea wall apart. This log needs to be shackled to its neighbour and to new shore side anchor with heavy chain loops.

Hazards at Armours Beach (2018, previously unpublished)

With recent high tides and winds, a boom log weighing several tons has broken loose but is still tethered by a chain and lies on the beach close to the deteriorated sea wall. The existing town notice announced Phase 2 – September 2018 Construction of Shoreline Retaining Wall, but that has not even started yet.

The existing lock block wall and adjacent structures now face damage or possible destruction from upcoming extremely high tides coupled with strong winds producing high waves. The loose boom log, raised by the tide and powered by wave energy could batter the wall and ramp into pieces in a short time and wash away the recently refinished foreshore area.

The sequences of extremely high tides start 1st November and every 28 days thereafter with higher and higher tides, reaching an unprecedented height of 16.7 feet on 26th, 27th and 28th December. In all there will be 21 days from now until year end when predicted tides will reach potentially damaging heights when coupled with high winds from the customary flow of intense Pacific weather systems arriving on our coast.

Armours Beach Historical Review:

Gibsons Yacht Club founded ***Learn to Sail*** in Gibsons Harbour for youth and operated it for decades with volunteer members. In 2010 GYC formed a committee to develop the concept of family boating activities at Armours Beach. It was determined the existing building was beyond repair and a new structure was proposed consisting of a deck over racks for kayaks and sailing dinghies with a new ramp and float outside the swimming area.

At the Annual General meeting 21 February 2012, in response to meetings with GYC committee members Russ Ayersberry, Carl Armstrong and John Roper, Parks Director Wendy Gilbertson gave a presentation of the vision for Armours Beach and advised a grant of $400,000 had been applied for. GYC member Matt Evans displayed his artist's conception.

The following motion was moved, seconded, and passed by secret ballot with 90% in favour: ***The Gibsons Yacht Club supports in principle the contribution of $50,000 to the Town of Gibsons towards the construction of the Armours Beach Marine Activity Centre.*** Additional financial contributions were offered by individual members and businesses to match the GYC commitment.

But while members were engaged in trying to solve difficulties in continuing ***Learn to Sail,*** the Town formed a committee to guide the Armours Beach restoration without consideration of GYC and its members. With the deaths of committee members Carl Armstrong and Russ Ayersberry, the GYC information was passed to the Gibsons CAO but there was no response. Instead the Town proceeded, without inviting GYC participation, to produce a terraced park and has ignored the long standing tradition of family swimming and boating activity at Armours Beach

2017 November 09 Sea Level Rise Incorporated into Flood Hazard Guidelines

Posted on November 9, 2017 by Engineers and Geoscientist British Columbia

An amendment to BC's *Flood Hazard Area Land Use Management Guidelines* incorporating sea level rise into building setbacks and flood construction in coastal areas will come into effect January 1, 2018. Local governments are required to consider the Flood Hazard Area Land Use Management Guidelines in development and land-use management planning and approval decisions for flood hazard areas.

The amendment is based on a 2011 technical report commissioned by the Province, which recommended incorporating sea level rise into planning and development to ensure a standard of public safety into the future. The amendment recommends that coastal communities allow 1.0 m sea level rise by 2100 and 2.0 m sea level rise by 2200 (relative to the year 2000 and considering regional uplift and subsidence). It provides recommended flood construction levels and setbacks that local governments are required to consider when making bylaws for designated sea level rise planning areas. The definition of and methodology for the determination of flood construction levels and setbacks for coastal areas have also been modified.

The amendment is available on the Provincial government website. It is supplemented by the 2011 report Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Guidelines for Management of Coastal Flood Hazard Land Use, and the 2011 companion report, Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use - Draft Policy Discussion Paper

As identified by Engineers and Geoscientists BC's professional practice guidelines Flood Mapping in BC and Legislated Flood Assessments in a Changing Climate in BC, those acting in the role of Qualified Professional must review and reference relevant legislation, such as the *Flood Hazard Area Land Use Management Guidelines*, and appropriately educate the client regarding pertinent aspects while providing services such as determining flood construction levels, flood plain mapping and flood assessments.

Starting in 2013, consultation on the amendment to the *Flood Hazard Area Land Use Management Guidelines* occurred prior to implementation, seeking feedback from technical experts, local government professional staff, First Nations, and other stakeholders. Engineers and Geoscientists BC participated, providing review of and input on the amendment.

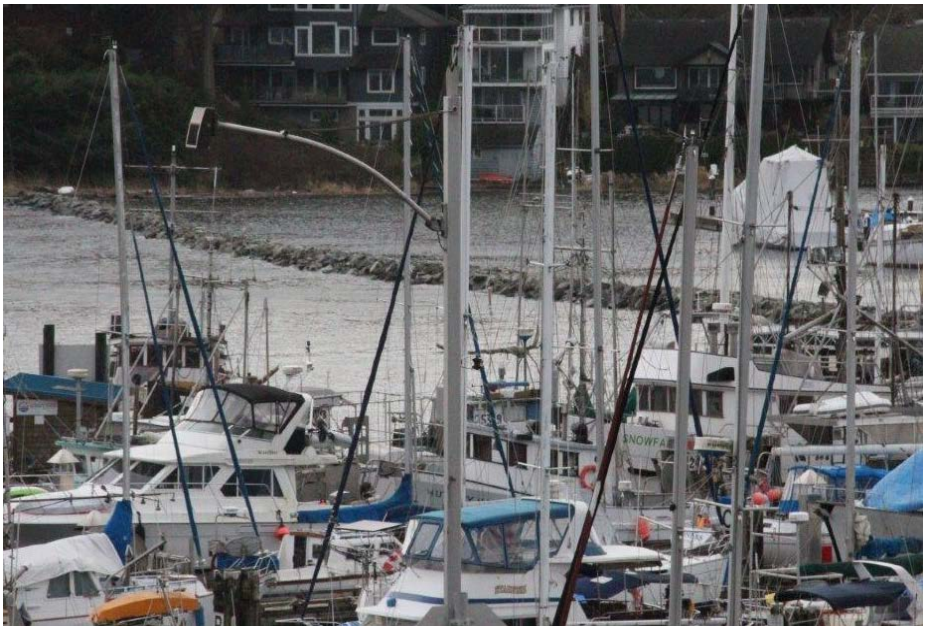
2018 December 22 Report to Gibsons Association of Business and Community

Thursday 20th December weather: cloud and sun, wind south west 40knots (74 km/ hr) estimated, barometer 973 millibars, temperature +12C, high tide of 15.1 feet at 1433 (2.33pm).

With this low barometer, plus wind direction and strength significant shoreline impacts were predicted at the high tide between 2 and 3 pm, even though the tidal height of 15.1 feet was well below the 16.7 feet predicted for next week.
I first proceeded to Armours Beach.

A wave surges onto the sea walk with the water level about 1 foot below the top of the steps. I did not go onto the dock for better photos as I considered this to be unsafe.

Looking north past Armours Beach to wave impact on shoreline homes



View from Gibsons Way at School Road to public dock showing water level close to top of breakwater. This high water level of about 2 feet above the predicted 15.1 feet (4.6 metres) was caused by the low air pressure of 973 millibars. So the actual water level was about 17 feet (5.2 metres).

Higher tides are predicted next week and the same weather conditions would produce a water level approaching 19 feet. (5.8 m):

Dec 23	0650	16.1ft (4.9 m)	Dec 24	0733	16.4ft (5.0 m)
Dec 25	0816	16.4ft	Dec 26	0859	16.7ft (5.1 m)
Dec 27	0942	16.7ft	Dec 28	1025	16.7ft
Dec 29	1109	16.4ft	Dec 30	1152	16.1ft
Dec 31	1236	15.7ft (4.8 m)			

2019 February 02 Report from Gibsons Waterfront Defence Association

By email to Mayor of Gibsons: I received a copy of your recent reply to the Gibsons Waterfront Defence Association.

This morning I took the attached photo to record the tide line left on 20th December 2018 before it washed away. Saturday 2nd February 2019 weather: partly cloudy, wind northwest 15, +5C, 978 millibars rising

Here are marked tidal heights on the fence erected at the site of a proposed large waterfront development

Lowest red spray is the actual tideline left by the 15.1 foot (4.6 metre) tide of 20th December when the barometer was 973 millibars and the wind was a strong southwest inflow at about 35 knots.

Lowest red tape is the level if the tide, under the same weather conditions, was 16.7 feet (5.1 metre) as actually did occur on 26th, 27th and 28th December 2018.

Next tape up is the level of a 16.7 feet (5.1 metre) under same weather conditions with a 1 foot (0.3 metre) sea level rise.

Next tape up is the level of a 16.7 feet (5.1 metre) under same weather conditions with a 2 foot (0.6 metre) sea level rise.

The upper tape is the level of a 16.7 feet (5.1 metre) under the same weather conditions with a 3 foot (0.9 metre) sea level rise.

It remains a major deficiency that there is no official recording station in Gibsons Landing Harbour to relate water level observations to tidal heights referred to chart datum. As an experienced mariner my estimate is that the top level tape is 22 feet (6.7 metres) above chart datum.

If your staff is prepared as they say, you should already have harbour area plans with contours for sea level rise of the magnitudes advised by Engineers BC, as well as surveys and plans for impacted infrastructure, and also policies and procedures to limit Town liability for sea water flooding of private property. This was also reported today to the Gibsons Waterfront Defence Association.

It was later learned that this communication was not received due to an email address suspension which did not generate any notice for redirection.

2019 February 14 Alert to Gibsons Waterfront Defence Association: Outflow Wind Warning

In view of what was recorded on February 9th in the following photos, a warning was issued when extreme atmospheric conditions were observed just a few days later.

Waves topping the breakwater that protects public moorage , as well as many waterfront homes

Swimmimg float and ramp at Armours Beach left unsecured and vulnerable to damage.

Please forward to concerned parties. At 4.30pm we are recording an extremely low barometer at 966 millibars and severe outflow wind warning for south Howe Sound. The upcoming tides are not very high but this low could raise the water level by about 34 inches (0.9 Metres) based on previous observations, plus substantial wave action depending on wind strength and direction.

Upcoming tides for Friday 15th February

Time	Height in Metres	Feet
03:09	4.2	13.8
07:34	3.7	12.1
12:19	4.3	14.1

Weather forecast for Howe Sound issued at 4pm today by Environment Canada.

Wind warning in effect. Tonight. Snow and local blowing snow. Amount 5 to 10 cm. Wind north 30 km/h except 70 gusting to 90 over southern sections. Temperature steady near minus 1.

We'll take a look at waterfront conditions tomorrow at noon.

Noon 15th February: Sea conditions eased as the barometer rose and winds were not as strong as forecast. However it is apparent that with sea level rise waves will overtop this breakwater with damage to 400 Gibsons Marina berths and their moored yachts, unless the federal government constructed breakwater is built higher.

2019 May/June “INNOVATION” published by Engineers and Geoscientists British Columbia

Page 31: **Annacis Island Wastewater Treatment Plant Stage 5 Expansion**

“ Additionally, Brown and Caldwell Consultants designed structural and mechanical capacity for one metre of sea level rise to reduce the impacts of climate change as well as enhanced electrical partitioning for critical infrastructure to increase reliability during power failure.“

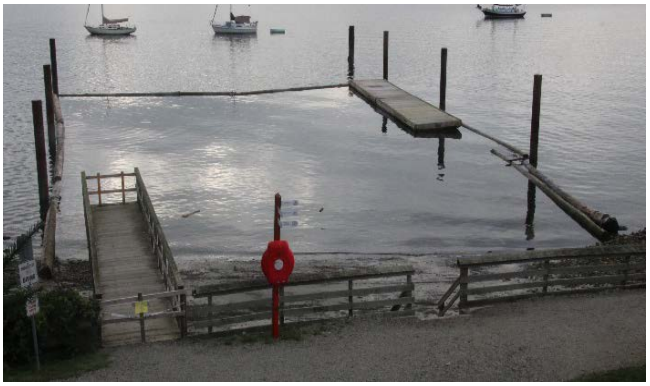
Page 31: **Surrey Coastal Flood Adaptation Strategy**

“As the climate changes, coastal communities like Surrey can expect more flooding due to storm surge and sea level rise. Managing this risk requires adaptation – actions that reduce exposure and vulnerability of people and property to climate related hazards. Through a public planning approach, which incorporates engineering analysis built upon sophisticated coastal, riverine and hydrologic modelling, the Surrey Coastal Flood Adaptation Strategy tackled the hard questions. By engaging nearly 2000 residents, stakeholders, and partners on long term adaptation approaches , near term infrastructure investments were developed to address today’s demands while being consistent with long term needs. **A construction program valued at $187 million has been developed to increase resilience of critical infrastructure.** Through collaboration, innovative solutions became clear, including a sea dam with a 5 lane transportation bridge to reduce cost and provide environmental enhancement.”

(Emphasis added by this author.)

2019 September 21 Gibsons Harbour: A construction program is needed to reduce impacts of climate change and achieve structural and mechanical capacity of breakwaters and docks for sea level rise.

2019 September 21 Situation Review



At Armours Beach the float remains out of position, the ramp is missing, and the sea wall looks in danger of collapsing. New pilings were placed, but a log boom is missing, this one is not securely attached, and there is no shore anchor for it.

Private properties valued at over $5 million where the sea walk was overtopped and remains damaged and unrepaired. .

Many private waterfront homes behind the breakwater have already experienced flooding and are exposed to the future higher sea level.

Sea walk remains damaged and unrepaired.

Conclusions

Evidence was presented to the Town of Gibsons in 2006 that sea levels were already surging over the existing sea wall and threatening private property and infrastructure. In 2011 *The Storm Surge Almanac* was published with a recorded storm surge height of 0.9 metres at nearby Point Atkinson. In 2013 the *C-CHANGE* study showed the area at risk of future sea water flooding but underestimated the consequences.

Since then several incidents have been observed and recorded that show the consequences are more imminent and more damaging than previously thought. In 2017 Engineers and Geoscientists BC posted an amendment to BC's *Flood Hazard Area Land Use Management Guidelines* incorporating sea level rise into building setbacks and flood construction in coastal areas that came into effect January 1, 2018. Subsequently the planning and financing of large infrastructure adaptation projects by coastal cities proceeded and construction has started.

Gibsons harbour was created by federal government construction of a breakwater to protect its public dock, and a second breakwater to create public moorage in perpetuity. Sea level has topped the first breakwater, and wave action has topped the second slightly higher breakwater. At risk from a higher sea level are the berths for some 500 vessels as well as the value of the vessels themselves. Construction to raise the height of these breakwaters needs to be performed by the federal government as well as possibly raising of the height of the public dock itself. Also needed is establishment of a benchmark that can be used by engineers and builders to establish a safe height for future construction, as well as an official tide gauge to monitor and record the actual sea water levels.

In recent years the Town has invested in some facilities that appear to be within the sea water flood zone, and it now faces a need to repair and upgrade its sea walk, water and sewer facilities, and public beaches for public health and safety.

Some 50 private properties have varying degrees of risk depending on their setback and foundation height. Many lots and structure now have multi-million dollar values despite some lower lying lots and structures already experiencing sea water flooding. Are these properties considered to exist in a geotechnical risk area and are building permits for renovation or new construction required to demonstrate design of foundations for flooding and erosion as well as structure elevation and setback for occupied spaces to be secure against future sea water flooding? With current property values the upgrading of existing structures alone is a major economic undertaking.

There is increasing awareness that, despite many personal efforts, climate change is accelerating, and postponing action is no longer an option if very costly losses and consequences are to be avoided. How and when will this small coastal community receive the assistance it needs from federal and provincial governments to develop and implement plans and procedures over the next five years for its adaptation to sea level rise to safeguard its future physical and economic sustainability?