

GOVERNMENT OF ST. VINCENT & THE GRENADINES

**MINISTRY OF FINANCE, ECONOMIC PLANNING,
SUSTAINABLE DEVELOPMENT AND
INFORMATION TECHNOLOGY**

**REGIONAL DISASTER VULNERABILITY REDUCTION PROJECT
DESIGN AND CONSTRUCTION SUPERVISION
FOR THE REHABILITATION
OF THE
CHATEAUBELAIR JETTY**

PRELIMINARY DESIGN REPORT

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6.0 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

Introduction

The Chateaubelair Jetty was functionally destroyed during the December 2013 flood event. The jetty served the Central and North Leeward communities providing a berthing facility for fisheries, tourism, commerce, the Coast Guard and critically, it was a means of delivering emergency supplies and for evacuation.

This report identifies the environmental and social impacts of the loss of the jetty and its replacement. Subsequent to this submission and comments from the Client any additional information received during a community-wide public meeting, will be incorporated in a final environmental and social impact assessment with the Detailed Engineering Design with the final Environmental and Social Management Plan for incorporation in the specifications to the Bid Documents.

Methodology

Data for this report was gathered during field visits completed between Wednesday May 23rd and Friday May 26th 2018 in the northern most coastal community of Chateaubelair. The goal of this visit was to obtain a better understanding of the past uses of the jetty, the impacts associated with its loss and to aid in characterising any likely impacts related to the construction and operation of the proposed new jetty.

During the three-day consultation in St. Vincent, four meetings with government officials and eighteen interviews were completed with various stakeholders, representing the public sector, civil society and the general public in the Chateaubelair community. Collectively, a total of twenty two interviews and meetings were conducted with twenty seven individuals.

The purpose of meeting with the government stakeholders was to:

- 1) Obtain any pertinent information (reports, documents and statistics) that would be useful for conducting the impact assessments in Chateaubelair, as well as contribute to the overall project; and
- 2) Identify other stakeholders within the public or private sector, civil society and the general public who would be persons of interest.

The objectives for conducting the interviews in the Chateaubelair community were to:

- 1) Understand and describe past uses of the Chateaubelair jetty;
- 2) Understand and describe how the loss of the jetty has impacted the community; and
- 3) Characterise any likely impacts associated with the design construction and operation of the proposed new jetty.

On Wednesday May 23rd 2018, four meetings were held with government stakeholders representing four different ministries in the capital, Kingstown. These agencies represented were: the Ministry of Finance, Economic Planning, Sustainable Development and Information Technology - Sustainable Development Unit (3 persons); the Ministry of Tourism, Sports and Culture - Hospitality Unit (1 person); the Ministry of Agriculture, Forestry, Fisheries, Rural Transformation, Industry and Labour - Fisheries Division Unit (1 person); and the Ministry of Transport, Works, Urban Development and Local Government – Infrastructure Unit (1 person). Table 1 provides a list of the government stakeholders who participated in these meetings.

Table 1: List of participants at government meeting

Name	Title	Ministry	Unit	Contact
De Anna Ralph	Project Officer, Social Safeguards	Ministry of Finance, Economic Planning, Sustainable Development and Information Technology	Sustainable Development	dralph@svgcpd.com
Janelle Hadaway	NA	Ministry of Finance, Economic Planning, Sustainable Development and Information Technology	Sustainable Development	NA
Nyasha Hamilton	Project Officer, Social Safeguards	Ministry of Finance, Economic Planning, Sustainable Development and Information Technology	Sustainable Development	nhamilton@svgcpd.com nyakkh@gmail.com T: 784 485 6992 / 456 1111 ext 885 M: 784 432 8596 Skype: nyakkh
Marlon Joseph	Hospitality Officer, North American Market	Ministry of Tourism, Sports and Culture	Hospitality	NA
Jenifer Cruickshank- Howard	Chief Fisheries Officer	Ministry of Agriculture, Forestry, Fisheries, Rural Transformation, Industry and Labour	Fisheries Division	jencruickshankhoward@yahoo.com
Calvin Llewellyn Jr.	Acting Manager of Building Services	Ministry of Transport, Works, Urban Development and Local Government	Infrastructure	M: 784 498 2022

On Thursday May 24th 2018 the majority (12) of the interviews were completed at random by walking through the community and speaking with residents, business owners and any government personnel who were in the immediate vicinity of the Chateaubelair jetty. On Friday May 25th 2018 a more targeted approach was used. Mr. Lawrence Hooper, Teacher at the Chateaubelair Methodist Primary School and community point person for the Sustainable

Development Unit, assisted with identifying and locating persons of interest within the community. Attempts were made to interview these persons in the community; six interviews were completed, two of them were group interviews. Photographs of the Chateaubelair jetty and surrounding community were also taken on Friday.

In addition to the foregoing a site visit was conducted on 25 May 2018, when the jetty, beach, and surrounding environment was toured and assessed. Stakeholders with interests and knowledge of the jetty were interviewed (including Customs Officer Keith Clarke and Timothy “Ras-I” Francis, a 40-year resident). A comparison of the beach was also made with Petit Bordel, the bay to the south of Chateaubelair. Photographs taken during the site visit are located in Appendix A of the Data Collection and Analysis of Site Report. Notes from the site visit include:

- The beach consists mainly of dark grey coarse-grained sand. There is a small berm present near the high-water line from which the beach transitions on a gradual slope to a small dune feature and vegetation or infrastructure.
- The river runs east of north to the shoreline before turning towards the east and running along the beach towards the jetty. It is presumed that the river is directed towards the east at times of low flow and higher wave events (generally during the dry season between December to April when the littoral transport dominates over riverine transport). Residents report that the river straightens out along the shore alignment during high river flows as it overtops the rock ridge indicated from the water jet probes. This was confirmed through a visual inspection of the sea bed. The area around the main stem of the river mouth is littered with rocks and boulders that are common to rivers in this area as opposed to the areas to the east and west of the main stem which was mainly sand. This indicates that during high flows, the river is directed east of north from the main river stem towards the jetty, the alignment of which is west of north, and while it does not meander towards the root of the jetty, as noted during the site visit, it is directed more to the northernmost end of the jetty indicating the reason for the jetty’s collapse in the flood flow.
- The existing jetty was notoriously weak following construction, with residents claiming that the end of the jetty sank lower than when first constructed and used to move with wave impact prior to failure indicating the instability. Collapse failure occurred during the December 2013 flood event, which was largely reported as an extreme rainfall event.

- Residents have confirmed that the deep channel that presently exists offshore of the existing jetty has always been a feature of Chateaubelair harbour, and that no dredging ever occurred to form this channel. Any nearshore variability in the extent of the channel was however not indicated to the extent shown from the recent bathymetric survey.
- Residents also confirm that more energetic wave conditions exist in Petit Bordel than Chateaubelair. This was demonstrated in a 1997 event when a wave event caused substantial damage in Petit Bordel but left Chateaubelair relatively unscathed.

A meeting was held the subsequent day with Janeel Miller-Findlay, Director and Nyasha Hamilton, Environmental Officer in the Sustainable Development Unit of the Ministry of Finance, Economic Planning, Sustainable Development, and Information Technology. The meeting was centred around existing and available data and information of the site. Ms. Miller-Findlay and Ms. Hamilton referenced the following persons for additional information:

- Maritime Authority (Hyrone Johnson), who may have a hydrographic survey and report on marine life done by a UK agency. Emails were sent to Mr. Johnson on 25 and 31 May requesting information. A hydrographic survey as used in Appendix A in comparison to the recent bathymetric survey was provided with contours at 10 metre intervals, however no report on the marine life has been received up to preparation of this report.
- Physical Planning GIS Unit (Dornet Hull), who in addition to the above may also have hazard maps of the area. Emails were sent to Ms. Hull on 25 and 31 May requesting information if it was available, but nothing has been received up to the preparation of this report.
- NEMO (Michelle Forbes), who also may have hazard maps of the area. Emails were sent to Ms. Forbes on 25 and 31 May requesting information, but nothing has been received up to preparation of this report.
- Eng. Cecil Harris, Senior Engineer with the Ministry of Finance, Economic Planning, Sustainable Development, and Information Technology, to enquire about the presence of the deep channel just offshore the existing jetty and the possibility of there being dredging in the area. Mr. Harris responded, based on information from knowledgeable personnel that there was no dredging in the area within the last 28 years.

Study Limitations

The sample used in the study relied on a key informant approach and is therefore very small. It is reflective but not statistically representative of the views of the wider communities across the North and Central Leeward areas. After circulation of this document for comment at a public meeting the responses to satisfy the requirement would be utilised in the completion of the Final Design Report. It is expected that additional information will be gathered from a wider cross section of the affected communities during that consultation. In addition, there are some key informants who were identified by the government representatives who have yet to be interviewed. These are:

Table 2: List of additional stakeholders

Name	Title	Agency
Kris Issacs	Senior Fisheries Officer	Fisheries Division
Alliford Roband	NA	Tourism
Bishon John	CEO	Port Authority
Nicole Hazel	NA	Tourism
Devon Gonsalves	NA	Infrastruncture Unit

Whilst conducting the interviews in Chateaubelair, persons were also asked to identify anyone in the community who were key stakeholders. The majority of persons identified were interviewed with the exception of two individuals: “Mama Joy” an elderly local resident of Chateaubelair and Mr. Tarry Dougan with the Tourism Department.

A two-page report on the “Description of the Fishing Operation in Chateaubelair” was submitted in June. Basically the fish production information is after the 2013 flood event after which the jetty facility was limited for efficient fish landing. This was indicated by only 6 vessels landing fish in relation to the “20 or so” that operate on a daily basis. Replacement of the jetty would encourage a significant increase in the production averaging 49,369.75 lbs. between 2014 and 2017 with a peak of 70,079 lbs. in 2015. Information on landing prior to 2014 limits the comparison for the future development. Further, reinstatement of the fishing complex provided by the Japanese could provide an increase in production along with the reinstatement of the jetty, which from recent production and capacity for increase with the full compliment of boats operating at Chateaubelair, could increase in the vicinity of three-fold based on the boats that previously operated.

Statistics on other operations such as yachts and commercial vessels were not available. However with a new facility the issue would more be a marketing one and not necessarily based on prior operations, which certainly in post 2013 jetty facility would not be a basis for projections.

Study Location

The Chateaubelair Jetty serviced the North and Central Leeward areas of St. Vincent. However, it was located within the Chateaubelair community, which will bear the brunt of any construction or operation impacts. According to the 2012 Population and Housing Census Preliminary Report, Chateaubelair has 5756 residents of which 3037 are male and 2719 are female, with a total of 1669 households. The average household size is 3.4. Figures 1 through 6 provide a photographic display of homes, businesses and services within close proximity to the jetty. Other photographs are included in the Data Collection and Analysis of Site Report

Figure 3: Elevated view of the Chateaubelair community showing the homes and business closet to the jetty



Photo Credit: Barry Defreitas

Figure 4: Photo from the jetty showing close proximity of houses



Photo Credit: Barry Defreitas

Figure 5: Chateaubelair Community Centre, which houses a pre-school on the first floor; businesses in close proximity to the jetty



Photo Credit: Barry Defreitas

Figure 6: Examples of homes closest to the jetty



Photo Credit: Barry Defreitas

Figure 7: Church in close proximity to the jetty



Photo Credit: Barry Defreitas

Demographic Characteristics

A total of eighteen interviews were conducted in the Chateaubelair community. Of those eighteen interviews, sixteen were completed individually and two were completed in groups; each group consisted of three persons. A total of twenty two individuals were interviewed, 73% were male. According to the Population and Housing Census 2012 report the sex ratio in Chateaubelair is 1.12, therefore it will be necessary to obtain more input from females during the upcoming visit to the community.

The age distribution amongst the respondents is shown in Table 3. Half of the respondents were between the ages of 41-50

Table 4 shows, 50% had also resided in Chateaubelair for their entire lives. These respondents were therefore well placed to comment on the impacts of the loss of the jetty to their community.

Table 3: Age distribution in the sample

Age Range	Number of Individuals	Percentage
20-30	1	4.5
31-40	2	9.1
41-50	11	50.0
51-60	2	9.1
Over 60	1	4.5
No Response	5	22.7
Total	22	100.0

Table 4: Length of residence in Chateaubelair

Length of Residency	Number of Individuals	Percentage
Entire Life	11	50.0
< 1 year	1	4.5
10 years	1	4.5
> 30 years	1	4.5
Non-resident	2	9.1
NR	6	27.3
Total	22	100.0

In addition to Chateaubelair, 22.7% of the respondents resided in nearby communities (Table 5).

Table 5: Other communities represented in the sample

Resident	Number of Individuals	Percentage
Chateaubelair	17	77.3
Petite Bordel	1	4.5
Barroulie	1	4.5
Fitz Hughes	1	4.5
No Response	2	9.1
Total	22	100.0

The respondents worked in a wide range of occupations in the community (Table 6).

Table 6: Respondent occupations

Organization/Work Type	Job title	Number of Individuals	Percentage
Government Primary School/ Chateaubelair Methodist School	Teacher	3	13.6
Self-Employed	Fisher man; fisher woman	3	13.6
Customs	Clerk	1	4.5
Immigration	Officer 1	1	4.5
Coast Guard	Chief Petty Officer	1	4.5
Ministry of Tourism	Hospitality Officer	1	4.5
Business Operator/Owner	Shop Owner	2	9.1
Town Board	Sanitation Worker	1	4.5
Farmer	Farmer	2	9.1
Sailor	Sailor	1	4.5
House Keeping	Housekeeping	1	4.5
No Response		5	22.7
Total		22	100.0

Jetty Usage

The respondents were asked to describe the individuals or groups that used the jetty before it was destroyed.

Table 7 shows that just over 60% of the sample stated that tourists were the main users of the jetty, followed by fishers and yachties. As a consequence, the main use of the jetty was for recreation, tourism and fishing as well as Customs and Immigration. None of the respondents noted the use of the jetty in emergency situations (Table 8).

Table 7: Users of the jetty prior to its destruction

Type of Use	Frequency	Percentage
Tourist/Excursionists	14	63.6
Fishers	11	50.0
Yachties / boaters	8	36.4
Locals / general public (sea bathers)	7	31.8
NR	5	22.7
Coast Guard	2	9.1
Government Offices (e.g. Planning Division, Customs, Tourism)	2	9.1
Farmers	2	9.1
Ferries	1	4.5
Entertainers	1	4.5
Contractors	1	4.5
Businesses	1	4.5
Trading vessels	1	4.5

N=22

Table 8: Main uses of the jetty prior to its destruction

Type of Use	Frequency	Percentage
Fishing	15	68.2
Tourism	15	68.2
Customs	14	63.6
Immigration	14	63.6
Recreation	16	72.7
Transport	1	4.5
Trade (with St. Lucia)	1	4.5

N=22

More than half of the respondents, 63.6% indicated that they used the jetty daily. These uses varied but primarily focused on fishing (Table 9)

Table 9: Respondents use of the jetty

Use	Frequency	Percentage
Fishing	10	45.4
Trade	7	31.8
Transport	7	31.8
Tours & Excursions	6	27.3
NR	4	18.2
Recreation/Socialising	4	18.2
Yachting	3	13.6
Emergency Port	2	9.1
Port of Entry	2	9.1
Drug Busts	1	4.5
Funerals	1	4.5
Government functions	1	4.5

N=22

It was difficult for the respondents to give estimates of the financial impact of losing the jetty; 36% said that the loss affects the overall livelihood, expenses and well-being of the community. A few numerical estimates were offered as follows:

- Approximately XCD \$200,000/year
- XCD \$1,000/month
- XCD \$2,000/week (this was for tour guides)
- 85% revenue has been lost

The report from Fisheries, subsequently received could indicate a fisheries loss in the vicinity of XCD \$100,000.00

They were far more able to describe the non-financial losses (Table 10), notably the loss of socialisation and community spirit, and the inconvenience of having to travel to other ports. One respondent observed that they had lost an emergency exit.

Table 10: Losses experienced because of the destruction of the jetty

Non-financial Losses	Frequency	Percentage
Less socialisation, exchange of culture and knowledge, loss of community spirit	5	22.7
Inconvenience / Loss of accessibility (e.g. fishing from sand and rocks, having to travel to other ports for excursions)	5	22.7
NR	5	22.7
Decline in recreational activities	4	18.2
Reduction in trading	2	9.1
None	2	9.1
Unable to secure boats and nets	2	9.1
No longer an emergency exit	1	4.5
Unsure	1	4.5

N=22

When the jetty had been operable, there had been a few problems (Table 11), and these were mostly associated with the engineering and design of the jetty.

Table 11: Problems experienced during the operation of the jetty

Issues	Frequency	Percentage
Poor engineering / design (too short, too small, no fenders, not modern)	7	31.8
None	7	31.8
NR	4	18.2
No lighting	3	13.6
Unsure	2	9.1
No freshwater access for tourists	1	4.5

N=22

The respondents confirmed that there were no fees charged for the use of the jetty.

When asked what concerns they had regarding the construction of a new jetty, the majority, 86.4%, had no immediate concerns. However, two respondents were concerned that the construction would lead to congestion; and one each raised the possibility of sedimentation of the river and the materials that would be used for blasting.

The respondents had several recommendations for the construction of the new jetty as listed in Table 12. Half of the respondents would like the jetty to be extended; just over 30% want it to be more resilient; and 27% said that the lighting should be improved. Improving the accessibility, inclusion of washrooms and installing a cover on the jetty would also be appreciated.

Table 12: Recommendations to be considered in the redesign of the jetty

Recommendations	Frequency	Percentage
Extend / enlarge the jetty	11	50.0
Make jetty more resilient/re-enforced (e.g. place piling deeper/higher than 3ft)	7	31.8
Improve lighting	6	27.3
Improve accessibility (on- and off-loading) (e.g. ramp/platform)	5	22.7
Improve river defenses	5	22.7
Install fenders	3	13.6
Jetty should have a modern, attractive design	3	13.6
Jetty should be L-shaped (facing away from river)	3	13.6
Install guard rails	2	9.1

Recommendations	Frequency	Percentage
Include facilities / amenities (e.g. washrooms, water station)	2	9.1
Jetty should be made for commercial use	2	9.1
Be mindful of river during construction	1	4.5
Use rust-resistant materials	1	4.5
Consult locals	1	4.5
Consider including some type of covering	1	4.5
Jetty should be T-shaped	1	4.5
Jetty should better accommodate yachts (coming closer to shore)	1	4.5

N=22

Potential Environmental and Social Impacts

The destruction of the Chateaubelair Jetty affected residents in communities across the central and north Leeward areas of St. Vincent. When the “no action” option is considered, this would lead to a prolonging of the existing problems currently experienced by the residents and visitors to the area. It would mean a continued loss of livelihoods and recreation opportunities. Fishers and farmers are currently limited in their ability to readily land (fisheries) or transport goods and services locally and regionally, while tour operators would continue to be limited in their ability to transfer services and people. One respondent estimated that tour operators are losing as much as XCD \$2, 000 per week with the loss of the jetty.

A possible three-fold increase in fisheries production could allow for a value of landings to triple with an increase in landings by increasing the number of vessels operating to previous levels, to a value in the vicinity of XCD \$650,000.00.

As a Port of Entry, the ongoing inability of the port to fully function would extend the loss of revenue generated from tourism. One of the respondents estimated current losses at approximately XCD \$200,000 per year.

There are also safety concerns. The current state of the jetty presents a hazard for locals as well as tourists, especially the “yachties” who still dock at the jetty. Of grave concern is the fact that the jetty cannot now be used for the purpose of emergency evacuation or the delivery of emergency supplies. With many of the roads and bridges in disrepair, the community has

become especially vulnerable to natural hazards impacts (e.g. hurricanes, volcanic eruption); the loss of the jetty further compounds the community's vulnerability and safety.

There are several potential positive impacts that accrue from the reconstruction of the jetty. There is the fact that the new jetty will alleviate the many aforementioned problems. In addition, during the construction phase temporary work will be provided for a range of professionals such as masons, carpenters, electricians, and engineers to name a few. At this stage, it is not known how many personnel will be employed during the construction phase of the jetty. Another potential impact of the construction phase employment is that there could be an increase in persons seeking housing in the nearby communities. This can be both a positive and negative factor, in that locals can gain additional income from rent, but it could also be a strain on the existing housing stock.

However, construction work is disruptive because it involves an increase of heavy duty vehicles, dust, noise and vibrations which would impact the persons living and working adjacent to the jetty. Noise and vibrations are generated by the construction vehicles and equipment as well as the various activities associated with construction. While most of this will be contained within the construction zone onsite, there is typically an increase in vehicular traffic in the areas surrounding the site. Temporary vehicular and pedestrian traffic diversions or slowed vehicular traffic can occur during the construction phase. This requires users to change the timing or routes of travel, or they can be delayed in their arrival at destinations or in their conducting of business. Vibrations as a result of piling in particular can cause structural damage and hence must be investigated and controlled within acceptable limits which may be felt but not pose damage.

Dust issues arise due to usage of construction materials, particularly those including fine material, such as fills, aggregates and cement. This can pose a health concern to those susceptible to asthma and bronchial disorders. Frequently, persons living or operating businesses near to construction sites are forced to keep their windows and doors closed to minimize the dust that will get inside. It is noted that there are several homes and businesses, a church and a pre-school in close proximity to the jetty.

There is also the potential for negative impacts on existing road infrastructure. The use of the existing roads by the construction vehicles to access the development site can sometimes cause deterioration.

Construction also poses potential risks to the safety of both residents and construction workers. There are risks associated with worker health and safety on the site such as falls,

and injuries that might arise from the inappropriate use of machinery and chemicals. The increase in construction vehicles is also dangerous to pedestrians, particularly small children, who may not exercise due caution when traversing the construction area. There is also the possibility of persons wandering onto the site and getting hurt.

Overall, the installation of a new jetty would mean increased safety to the residents and tourists who use the facility. It would mean the return of access for the supply of emergency supplies and use for evacuation in the event of a disaster. Individuals would regain their lost income from fishing etc., tourism would be boosted, and the Government of St. Vincent and the Grenadines could earn income from Port Fees.

With respect to impacts on the marine environment the Smith Warner (2014) report includes 1-D longshore sediment transport modelling for Dark View. The net sediment transport is generally predicted to the SW, with varying rates (between 10-60,000 m³/year) at the centre and western end of Dark View. It is probable that Chateaubelair rates would be similar. This sediment motion from normal wave action would occur within the surf zone (shallower than what is known as the “depth of closure”). The Smith Warner report lists the depth of closure in Dark View is at approximately -3m, which is similar to other listed values on the west coast of the Caribbean islands (e.g. Robinson et al, 2012).

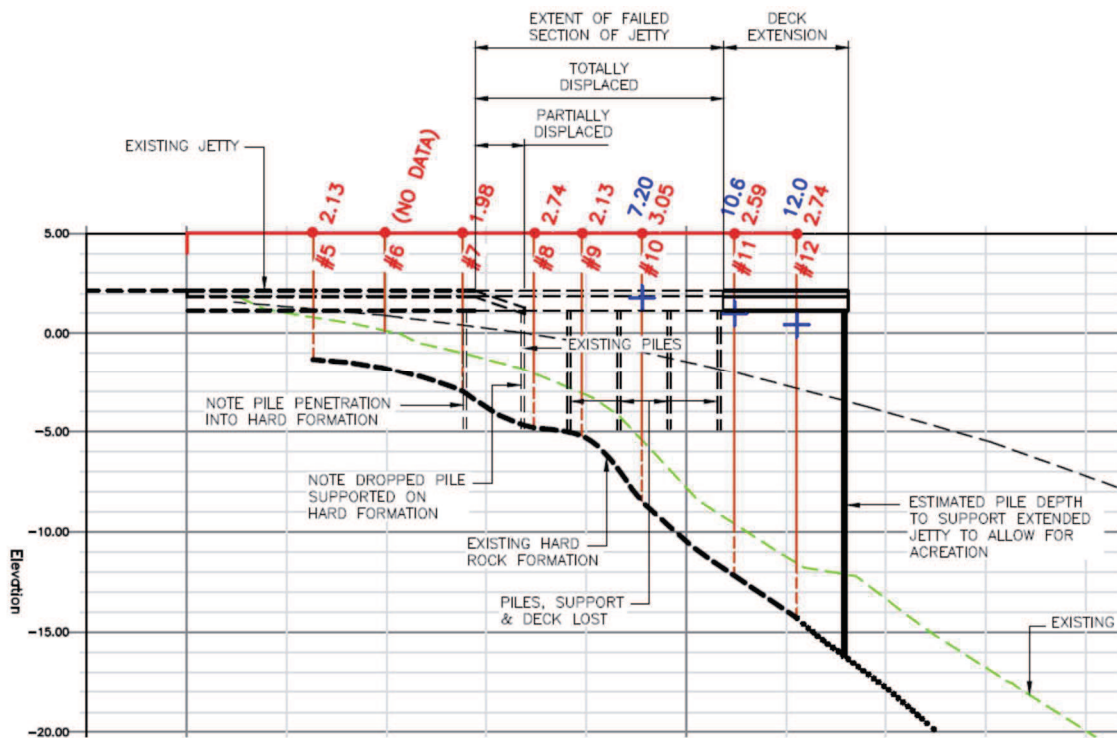
Generally, jetties have little effect on littoral processes given their wide pile spacing and open trestle design. This has been demonstrated by numerous studies that have surveyed beaches with varying longshore sediment transport, notably in North Carolina and California (e.g. Everts and DeWall (1975), Noble (1978)). On many open coast jetties, a gentle advancement of the shoreline position can be expected from the piles’ effects on wave dampening and sediment accumulation. It should be noted (and has been considered in the design) that the pilings themselves are also subject to localised scour.

Intuitively, beaches subject to higher littoral transport should see a comparatively greater effect from the obstruction presented by the piles in the nearshore waters. It is suspected that the beach dynamics leading to longshore potential in Chateaubelair are minor, especially compared to those cited in the above studies. The existing structure, which is of a closed causeway design along the beach and into the shallow tidal zone, has not caused noticeable erosion on either side of the jetty. As an open-pile design such as being considered for the jetty replacement, there should be less possibility of beach erosion as compared to the existing jetty. In conclusion, as long as the piles are spaced as proposed, it is expected that there will be little to no effect on the littoral transport and resulting shoreline.

There are some concerns and risks etc. It appears that the sea bed around the existing jetty was shallower when the jetty was first constructed, as the contractor reportedly drove 20 ft piles into sand. The same 20 ft piles would not have been able to touch the sea bed based on the present survey (see figure below), which likely contributed to its failure. Yet the potential exists for the sand to return towards the end of the jetty, which may lead to difficulty of vessels with deeper draft to access the jetty.

However, it is noted that the current sea bed slope below -4 to -5m depths, on which the accretion occurred is relatively steep ($40^{\circ} - 45^{\circ}$). The stability of cohesionless grains (such as sand) on a slope is related to the angle of repose – if the slope exceeds the angle of repose then the slope is considered unstable and likely to avalanche, and moves in a condition where offshore flows at the river flood stage will further destabilise the sand to below its normal angle of repose. The normal angle of repose of sand is $\sim 30 \pm 3$ deg (Van Rijn, 2018). Hence any accumulation of sand on top of the existing sand layer will be unstable and should eventually cascade into the deeper channel. It is presumed that this had occurred prior which may have led to the collapse of the existing jetty. The lack of any trace of the jetty piles or superstructure following collapse leads to the theory of a disturbance event (such as the 2013 flood or a large coastal storm) causing the seabed slope to collapse and effectively removing the supporting sand layer from under the existing jetty. The sand and the failed jetty then cascaded into the deeper channel, where the sand covered the failed sections of jetty.

The water depths at the end of the previous jetty in the current bathymetry would have been in the range of 7 to 10 m in the current bathymetric conditions. As noted above, sediment transport from wave events would occur in the active zone, (between 0-3m depths) which would have caused a very much shallower sea bed prior than brought about by the flood flows in December 2013. Hence there is no expectation of any significant sediment transport from waves at the current depth. There is a greater possibility of river sediment deposition at the end of the jetty during flood events somewhat below the December 2013 event. Rivers tend to deposit larger boulders and stone immediately in the nearshore area, and finer sand and silts further out at sea, as observed visually while diving during the site visit. The finer material would then get distributed by wave-induced currents throughout the littoral zone. It is expected that the deeper channel will maintain sufficient depths as long as the sea bed slope is greater than the angle of repose, while alongside the jetty the depths may fluctuate somewhat with coastal and riverine storm events. While the potential for shoaling in between the 5-10 m depth contours is unlikely during the 50-year design life, the potential for future maintenance dredging should not be ruled out completely. A better understanding of the likelihood of



dredging will be achieved by analysis of pre and post-construction topographic and bathymetric surveys and regular monitoring on an annual basis.

The initial diving surveys did not identify any flora and fauna within the general area around and immediately offshore the existing jetty, which was expected in the light of the significant disturbance of the surface around and offshore of the jetty and the current offshore slope due to the slipping resulting from flood scour in December 2013. As a construction impact mitigation measure silt curtains will be installed as necessary to minimise negative impacts on marine life.

The address of a full range of environmental and social impacts are included in the Environmental and Social Management Plan in the following section, including the following:-

- Structure and responsibility for the project
- Proposed Mitigation Matters
- Monitoring Plan
- Monitoring Procedures
- Incidents and Complaints Procedure
- Corrective Action Request Procedure
- Monthly Environmental Audit Procedure
- Emergency Preparedness and Response Plan

- Occupational Health and Safety Procedures
- Fire Prevention and Response Plan
- Oil Spill Prevention and Response Plan
- Traffic Management