GREEN CAY GUT
HEADCUT STABILIZATION PROJECT
Final Report

114-H Green Cay
St. Croix East End, USVI

Prepared for:
NOAA Coral Reef Conservation Program and USDA-NRCS
Green Cay Farm, LLP,
VI Department of Planning and Natural Resources, and
the National Fish and Wildlife Foundation

Prepared by:
Horsley Witten Group, Inc and
St. Croix Environmental Association

August 2017
**Purpose**

This report documents completion of the Green Cay Gut Headcut Stabilization construction project as part of HW’s final project closeout requirements under the NOAA CRCP Order No. DG-133C-12-BA-0056/C-0013.

The following objectives were successfully met by this project:

1. Cessation of active headcut migration and a reduction of sediment loads to Chenay Bay, which is impaired for turbidity;
2. Implementation of a priority watershed restoration project identified in the NOAA-funded 2011 Watershed Management Plan for the St. Croix East End Marine Park;
3. Development of a list of native plants suitable for gut restoration projects in the USVI and support of the island’s only native plant nursery;
4. Creation of an interagency partnership to fund implementation and provide support during project permitting and construction;
5. Completion of proper permitting at the Territorial and Federal Level;
6. Capacity building for the St. Croix Environment Association to manage permitting, construction bidding, construction oversight, and grant administration for a watershed restoration project;
7. Demonstration of a headcut restoration technique using a combination of rock step pool and vegetation that has not been previously used in the VI; and
8. Preparation of engineering design plans for downstream Phase II work.

**Project Background**

In 2011 the St. Croix East End Watershed Management Plan (WMP) was created to identify and develop a plan for reducing land-based sources of pollution to the East End Marine Park. Watershed evaluations suggested that the Southgate watershed contributed nearly 20 percent of the total sediment load to the East End Marine Park. As such, the Southgate watershed was identified as a priority area, with the most significant source of sediment originating from erosion of an active headcut on the East Gut, locally and herein referred to as Green Cay Gut.

Green Cay Gut (also known locally as the East Gut) flows east to west and discharges into Chenay Bay, which is part of the East End Marine Park and is included in the island’s 303(d) list of impaired waters for turbidity and other water quality parameters. The upper reaches of the gut are located on Green Cay Farm, LLC property and were highly incised with active bank erosion, down cutting, and bed scour. There was a severely-eroded, three-lobed headcut approximately 20-40 feet wide and up to 25 feet deep (Figure 1). An additional, smaller headcut was located to the south of the main headcut. The landowners estimated the rate of headcut migration at approximately 10-15 feet per year, which was been confirmed by HW through analysis of aerial imagery. Below this headcut (approximately 1,200 ft) the channel is extremely incised, as evidenced by past attempts to stabilize banks with cars and other debris. There is no clearly defined channel between the headcut and the up-gradient farm pond, except for a low point where overflow crosses the unpaved road.
Later in 2011, the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) provided $12,700 in funding for the St. Croix Environmental Association (SEA) and Horsley Witten Group (HW) to conduct a site survey and develop engineering design plans to repair the active headcut of Green Cay Gut to prevent it from migrating further up-gradient. Repairing the headcut was estimated to reduce Southgate watershed sediment loading by nearly 17%. HW completed site topographic survey, preliminary engineering design plans, and cost estimates that were reviewed by NRCS staff in Puerto Rico. Territorial staff from Building Permits, DEP, and Fish and Wildlife went to the site during various phases of the project.

By 2015-2016, a total of $260,300 in implementation funds had been cobbled together by NOAA Restoration Center and NRCS partners as follows:

- $131,400 in NOAA Coral Reef Conservation Program funds allocated to HW through a contract with the National Fish and Wildlife Foundation (NFWF);
- $49,500 in NOAA Restoration Center funds to HW through the NOAA Coral Reef Conservation Program (CRCP) call contract;
- $54,400 from NRCS directly to the property owners, Green Cay LLC through the EQIP Program;
- $20,000 from DPNR Coastal Zone Management to the St. Croix Environmental Association for this effort;
- $5,000 in house match from DPNR-CZM and the State Historic Preservation Office for the Archeological Phase I survey

US EPA was unable to provide additional support for this project, however, opportunity exists for additional support for educational or additional downstream restoration efforts in the future.

**Figure 1. Site Location**
Permits

The project was approved under the National Environmental Policy Act (NEPA ID No. NA10NOS4630131, dated August 21, 2015). A phased NEPA review determined that the project permitting process would have no adverse environmental impacts. Following acquisition of permits (see below), NOAA confirmed that the site is outside the range of any endangered species and project construction would result in no adverse effect upon essential fish habitat. No sensitive resource areas were impacted by the proposed project.

DPNR performed the Archeological Phase 1 Survey in house with oversight from SEA. Results (report dated February 8, 2016) found no evidence of historic artifacts on site.

HW and SEA prepared and submitted required permit applications on behalf of the property owners. An approved Earth Change Permit (STX-010-16) was issued to the property owners (dated February 11, 2016).

A Nationwide Permit Number 27 (Aquatic Habitat Restoration, Establishment and Enhancement Activities) (SAJ-2015-03108) was issued by the US Army Corps of Engineers (verification letter dated April 6. 2016). It is noteworthy that the headcut at the top of an intermittent channel was considered jurisdictional by the Army Corps.

Copies of all permits can be provided upon request.

Project Design

The emergency repair approach was to excavate back from the edge of the headcut and establish a non-erodible channel with boulder step-pools mimicking steep, intermittent channels in the USVI. “Hard” stabilization consisted of large boulders used to establish a series of step pools to reduce velocities of storm flows. "Soft" engineering practices (e.g., erosion control blankets, and native shrubs, trees, and grasses) were used to stabilize side slopes and recreate a vegetated buffer. Fencing was installed to restrict livestock access.

The repair area under this project was limited to the immediate headcut and adjacent uplands (total disturbed area approximately 10,500 SF or 0.24 acre; approximately 180 ft long by 30-75 ft wide and did not include any stream restoration activities downstream). This repair project did not alter existing hydrologic conditions at the site or create changes in runoff patterns in the contributing drainage area. The conveyance channel was designed to convey storm flows produced during the 1.5-year recurrence interval event, as recommended by NRCS. This event approximates what is commonly referred to as the “channel forming discharge” event or the “bankfull” event. Boulder step-pool structures were sized based on stability requirements for the 100-year storm event flows of approximately 700 cubic feet per second.

Appendix A includes the set of construction plans for reference.
2011 Preliminary estimations of width of headcut area (pre-site survey)

2013 Site topographic survey

Sloughing side slopes

Lack of defined channel up-gradient

Historic efforts to control bank erosion observed downstream

Highly incised channel downstream

Figure 2. Green Cay Headcut Before Stabilization Project
Construction

The project team put the project out to bid in July, 2016 and held a pre-bid meeting on site February 27, 2016 to answer contractor’s questions. Marco St. Croix, Inc. was selected as the contractor and construction began in early September, 2016. Due to rain delays, construction was not substantially completed until January, 2017. During the construction period, SEA provided routine construction oversight. HW and NRCS performed site inspections at key times during the construction process, such as during the installation of first step pool. Regular construction reports were submitted by HW to the contractor, owners, and members of the project team throughout the duration of the project. Due to unanticipated buried debris and some improvised grading, HW slightly revised the layout and number of step pools. This was issued as a revised site plan in October, 2016.

A final punchlist was provided by HW after a site walk was completed in January, 2016. A certification of completion was provided to the property owner on March 14,2017 by HW certifying that the project was in substantial compliance with the approved “GREEN CAY GUT HEADCUT REPAIR EAST END, ST. CROIX, VI, CONSTRUCTION PLANS” dated June 2016 and REVISED SITE PLAN dated 10/10/16. An AS-BUILT MARKUP dated 1/4/17 provided adequate representation of the extent of stonework and fencing.

Planting

Geographic Consulting Inc (GCI) was separately contracted to finalize a landscape plan for the site based on local expertise and plant availability. Planting started shortly after approved installation of step pools, and final installation of erosion control blankets and fencing. Native trees, shrubs and vines were planted along with fast-growing grasses on the banks of the Green Cay Head Cut Repair Project during the week of December 26-30, 2016. A wide variety of native plant material was established to: control soil erosion, stabilize banks and enhance the buffer forest habitat on site. All plants for this project were grown on St. Croix in GCI’s native plant nursery. A total of 377 plants were established on the banks including 114 trees and shrubs in 1 gallon pots, 214 4” grass plugs, 36 trees and shrubs in 3-gallon pots and 13 native vines. Additional details of the species, quantities and sizes of all plants appear in Attachment B. GCI watered and replaced dead plants during a 6-month plant warranty period.

See Attachment B for GCI’s final report and more information on why particular species are suitable for these types of restoration projects.
Figure 3. Construction of the stabilization project
Cost Summary

Total project implementation cost includes design, permitting, and construction (Table 2). Construction costs include both material and contractor labor, but also administration and oversight efforts. There are likely some additional costs not captured here, such as grant administration and coordinate efforts of all the project partners, particularly for effort associated with securing funding. Long-term maintenance is also not included.

**Table 2. Approximate Total Project Cost***

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site topographic survey and preliminary design (2011)</td>
<td>$12,700</td>
</tr>
<tr>
<td>75% engineering design plans</td>
<td>$13,500</td>
</tr>
<tr>
<td>Permitting (meetings, applications, response to questions, notifications)</td>
<td>$25,000</td>
</tr>
<tr>
<td>Construction plans and material specifications</td>
<td>$13,800</td>
</tr>
<tr>
<td>Construction Admin (bidding, contractor selection, contracting, grant admin)</td>
<td>$13,650</td>
</tr>
<tr>
<td>Construction Oversight (on site inspections, submittals, RFI, revisions, as-built, closeout, Phase II design)</td>
<td>$42,350</td>
</tr>
<tr>
<td>Construction **</td>
<td>$137,000</td>
</tr>
<tr>
<td>mobilization</td>
<td>$13,700</td>
</tr>
<tr>
<td>site clearing and grubbing</td>
<td>$15,000</td>
</tr>
<tr>
<td>excavation and haul away</td>
<td>$38,000</td>
</tr>
<tr>
<td>fine grading and compaction</td>
<td>$20,200</td>
</tr>
<tr>
<td>3/4&quot; stone</td>
<td>$4,000</td>
</tr>
<tr>
<td>12&quot; stone</td>
<td>$5,500</td>
</tr>
<tr>
<td>boulders</td>
<td>$28,850</td>
</tr>
<tr>
<td>fencing/gate</td>
<td>$6,750</td>
</tr>
<tr>
<td>erosion control</td>
<td>$5,000</td>
</tr>
<tr>
<td>Landscaping</td>
<td>$12,000</td>
</tr>
<tr>
<td>Watering &amp; Plant Replacement</td>
<td>$3,000</td>
</tr>
<tr>
<td><strong>Total Implementation Cost</strong></td>
<td><strong>$260,300</strong></td>
</tr>
<tr>
<td><strong>Total Project Cost (including 2011 preliminary design effort)</strong></td>
<td><strong>$273,000</strong></td>
</tr>
</tbody>
</table>

* Does not include NRCS, NOAA, or Green Cay Farm time associated with meetings, plan review, permitting, or site inspections
** General estimates based on Marco invoices

Maintenance

The property owners have entered into a long-term maintenance agreement with NRCS as part of the EQIP grant program. Table 3 includes a list of key maintenance inspection, repair options, and a proposed frequency of inspection.

We recommend completing an inventory of buffer plantings 1 to 2-yr after planting to evaluate establishment success and to identify invasive species removal needs.

Green Cay Headcut Stabilization
### Table 3. Inspection and Maintenance Frequency

<table>
<thead>
<tr>
<th>Inspection</th>
<th>Maintenance/ repair options</th>
<th>Frequency of inspections</th>
<th></th>
</tr>
</thead>
</table>
| Look for evidence of erosion at top of channel, along sides of stone step pools, and at bottom of channel. | • Evaluate cause of erosion (e.g., runaround of weirs, side slope erosion, etc)  
• Check with engineer to determine if more stone is needed, size, and placement.  
• Repair as directed                                                                                           | X                        | X   | X   |
| Check for gulling and erosion on side slopes or upland contributing area | Smooth area and re-seed or install erosion control matting                                                                                                      | X                        | X   | X   |
| Check step pool undercutting, settling and sediment accumulation          | • The channel should be self-cleaning, however if excessive sediment is filling up stone, address it at the source-stop upstream erosion  
• Do not need to remove sediment accumulated in pools  
• Add more stone to weirs if settling is occurring and weir/pool inverts are not maintained  
• If evidence of undercutting, consult with engineer. May need to dig out, add new filter fabric ¾” and 12” stone  
• If trees are in the center the channel that have potential to get very large and reduce cross-sectional capacity of channel, then remove them | X                        |     | X   |
| Make sure fence and gate are secure and horses cannot get in              | Repair enclosure as needed                                                                                                                                  | X                        |     | X   |
| Check establishment of buffer plantings vs weeds and invasives            | • Replant bare spots and replace dead trees  
• Remove tan tan and other invasives  
• Only cut vegetation in stone step pools if there is an anticipated loss of cross-sectional capacity | X                        |     | X   |
Lessons from the field

- It was particularly difficult to secure funding from multiple partners AND assure coordinated timing of disbursement of funding. Each partner required specific outcomes from the project, which required flexibility in the division of outcomes across the partners.

- Permitting of a restoration project in a dry, intermittent channel was challenging and more time consuming (and costly) than anticipated. There are some opportunities to streamline the process and to address inconsistencies. The US Army Corp of Engineers considered this active headcut to be a jurisdictional wetland, which is not consistent with determinations made for other guts on the island. Army Corps officials were unable to come over from Puerto Rico to look at the site, nor did this particular type of activity easily fit into one of the existing Nationwide permit categories. Equally, the Earth Change permit issued through DPNR-DEP does not have a category for gut restoration/stabilization activities; therefore a full Level 3 application was submitted. There was some back and forth regarding the need to complete a flood permit and water quality certification, neither of which is applicable to a non-development project. That being said, all permitting agencies were extremely cooperative in moving the process forward. Establishing a permitting process specifically for restoration activities may help DPNR and future applicants.

- NRCS approval of engineering designs and implementation was done through the Puerto Rico office, since there is not an NRCS engineer in the USVI office. This added an additional layer of coordination and grant management for the USVI –based staff. Having technical expertise on island would be extremely helpful for future NRCS-supported restoration projects.

- Make sure limits of disturbance (LOD) are clearly marked in the field prior to clearing and grading activities. A section of the LOD was placed in an incorrect location, which led to additional grading and required stabilization.

- Be sure to specify volcanic-derived stone vs. limestone for drainage projects. Even though it was clearly called out in the construction specifications, it came up during the pre-bid meeting as an obvious “cost-saving” option.

- Hydroseeding was not overly successful given the poor soils on site. We recommend required soil amendments in these situations for better grass growth. Bare areas remain where soils were excessively clayey (covered with erosion control blanket).

- The 12” stone was in short supply, making it difficult to shape the step pools correctly.

- The contractor had difficulty installing the erosion control matting and in many places it did not have proper contact with the ground surface due to weeds, large chunks of clay/rock, etc.

- Unsecure fencing led to a number of plants getting eaten by horses, so be sure to secure fencing prior to planting investments.

- Wet and dry season don’t seem to particularly accurate labels. Be sure to include on-site watering and a minimum 6-month plant warranty period in landscaping contracts.
Attachment A

GREEN CAY GUT HEADCUT REPAIR EAST END, ST. CROIX, VI, CONSTRUCTION PLANS” dated June 2016 with REVISED SITE PLAN dated 10/10/16
GENERAL NOTES:

1. ALL ELEVATIONS SHOWN ON VICINITY MAP ARE APPROXIMATE AND BASED ON ORTHOMETRIC IMAGERY AND AN AERIAL SURVEY PROVIDED BY THE VIRGIN ISLANDS DEPARTMENT OF NATURAL RESOURCES (VI DPNR) (2007).

2. ROAD LAYOUT AND PROPERTY BOUNDARIES SHOULD BE CONSIDERED APPROXIMATE.

GREEN CAY GUT HEADCUT REPAIR
EAST END, ST. CROIX, VI
CONSTRUCTION PLANS

JULY 11, 2016
CONSTRUCTION ACTIVITIES

1. INSTALL EXCLUSIONARY FENCE W/ GATE.
2. INSTALL CHECKDAM OR TEMPORARY SEDIMENT BASIN AT BOTTOM OF HEAD CUT, TO CONTROL SITE RUN-OFF.
3. SURVEY AND STAKE CENTERLINE OF THE PROPOSED DRAINAGE CHANNEL AND POOLS.
4. INSTALL STONE CHANNEL ABOVE THE ADJACENT, SMALLER HEADCUT. APPROVED LOCATIONS PROTECTED BY SILT FENCE.
5. PLACE SEDIMENTATION BARRIERS (STRAWBALES, SILT FENCE, ETC.) AS SHOWN ON THE PLANS AND STAKED OUT IN THE FIELD. IN NO EVENT WILL THE DRAINAGE CHANNELS OR TRENCHES BE DUG OR AFFECTED.
6. CONFIRM SIDE SLOPE GRADING PRIOR TO STABILIZATION.
7. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ALL GRADE STAKES SET BY THE SURVEYOR. GRADE STAKES SHALL BE REGISTERED PROFESSIONAL LAND SURVEYOR. THE CONTRACTOR IS RESPONSIBLE FOR COORDINATING WITH THE SURVEYOR FOR ALL SITE SURVEY WORK.
8. AMEND THE SOIL, AS NECESSARY.
9. PLACE SEDIMENTATION BARRIERS AS SHOWN ON THE PLANS AND STAKED OUT IN THE FIELD. IN NO EVENT WILL THE DRAINAGE CHANNELS OR TRENCHES BE DUG OR AFFECTED.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ALL GRADE STAKES SET BY THE SURVEYOR. GRADE STAKES SHALL BE REGISTERED PROFESSIONAL LAND SURVEYOR. THE CONTRACTOR IS RESPONSIBLE FOR COORDINATING WITH THE SURVEYOR FOR ALL SITE SURVEY WORK.
11. THE CONTRACTOR SHALL INSTALL A DEVICES ARE INSTALLED AND FUNCTIONING PROPERLY TO MINIMIZE EROSION FROM ANY IMPENDING WEATHER EVENTS.
12. IDENTIFICATION.
13. THE CONTRACTOR SHALL CONTAIN ALL SEDIMENT ONSITE. ALL EXITS FROM THE SITE WILL BE SWEPT AS NECESSARY INCLUDING DUST, SEDIMENTATION CONTAINMENT, AND TRENCH WORK.
15. THE PURPOSE OF THE PROJECT IS TO STABILIZE THE EXISTING EAST END GUT HEADCUT AND TO MINIMIZE THE AMOUNT OF EROSION DURING CONSTRUCTION.
16. THE CONTRACTOR SHALL PROVIDE ON SITE OR MAKE READILY AVAILABLE THE NECESSARY EQUIPMENT AND SITE PERSONNEL TO COMPLETE THE ABOVE ACTIVITIES.
17. THE CONTRACTOR SHALL MAKE ALL NECESSARY CONSTRUCTION NOTIFICATIONS AND APPLY FOR AND OBTAIN ALL NECESSARY PERMITS AND APPROVALS PRIOR TO THE START OF CONSTRUCTION.
18. THE CONTRACTOR SHALL CONTAIN ALL SEDIMENT ONSITE. ALL EXITS FROM THE SITE WILL BE SWEPT AS NECESSARY INCLUDING DUST, SEDIMENTATION CONTAINMENT, AND TRENCH WORK.
19. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THAT THE PROPOSED IMPROVEMENTS SHOWN ON THE PLANS DO NOT AFFECT OR INTERFERE WITH PROPOSED GRADE CONTOUR INTERVALS SHOWN AT 1 FOOT.
20. THE CONTRACTOR SHALL ASURE POSITIVE DRAINAGE INTO PROPOSED CHANNEL.
21. STORMWATER WILL BE ALLOWED TO PASS THROUGH THE PROJECT SITE DURING CONSTRUCTION. TEMPORARY SEDIMENTATION TRENCHES, SEDIMENT BARRIERS, AND DRAINAGE TRENCHES WILL NOT BE LEFT:
22. GENERAL PLANTING NOTES: (BY OTHERS)
23. GROWING SEASON.
24. HEALTHY FOR ONE (1) GROWING SEASON. CONTRACTOR TO MAINTAIN ALL PLANTING AND SEEDED AREAS UNTIL FINAL PROJECT COMMISSIONING.
25. ALL PLANTS SHALL BE PLANTED WITHIN ONE (1) WEEK OF PURCHASE. IF PLANTS ARE TO BE STORED AT THE SITE PRIOR TO INSTALLATION.
26. ALL PLANT MATERIAL SHALL CONFORM, IN ALL RESPECTS, TO THE GUIDELINES OF "THE AMERICAN STANDARD FOR NURSERY STOCK," ENSURING THE PLANTS ARE NATURALLY HEALTHY, GROWING WELL, AND HAVE NO SIGNS OF DISEASE, INSECT, OR WORM PEST INFESTATION.
27. ALL PLANTS SHALL BE PLANTED UPRIGHT AND NOT AT AN ANGLE. PLANTING HOLES SHALL BE DUG LARGE ENOUGH AND DEEP ENOUGH TO ACCOMMODATE THE ENTIRE ROOT MASS. THE PLUGS SHALL BE PLANTED WITH NO TWISTED OR BALLED ROOTS AND MAKING SURE TO BURY THE MATERIAL COMPLETELY.
28. ALL PLANT PLUGS SHALL BE PLANTED WITH NO ROOTS EXPOSED ABOVE THE GRADE LINE. THE SOIL SHALL BE HAND PACKED AROUND THE ENTIRE PLANT AND REMOVE BURLAP WRAP FROM AT LEAST THE TOP HALF OF THE ROOTBALL AND TURN DOWN ANY EXTRA BURLAP INTO THE HOLE MADE SURE TO BURY THE MATERIAL COMPLETELY.
29. PLANTS SHALL BE PLANTED WITH NO ROOTS EXPOSED ABOVE THE GRADE LINE. THE SOIL SHALL BE HAND PACKED AROUND THE ENTIRE PLANT AND REMOVE BURLAP WRAP FROM AT LEAST THE TOP HALF OF THE ROOTBALL AND TURN DOWN ANY EXTRA BURLAP INTO THE HOLE MADE SURE TO BURY THE MATERIAL COMPLETELY.
30. PLANTS SHALL BE PLANTED WITH NO ROOTS EXPOSED ABOVE THE GRADE LINE. THE SOIL SHALL BE HAND PACKED AROUND THE ENTIRE PLANT AND REMOVE BURLAP WRAP FROM AT LEAST THE TOP HALF OF THE ROOTBALL AND TURN DOWN ANY EXTRA BURLAP INTO THE HOLE MADE SURE TO BURY THE MATERIAL COMPLETELY.
31. PLANTS SHALL BE PLANTED WITH NO ROOTS EXPOSED ABOVE THE GRADE LINE. THE SOIL SHALL BE HAND PACKED AROUND THE ENTIRE PLANT AND REMOVE BURLAP WRAP FROM AT LEAST THE TOP HALF OF THE ROOTBALL AND TURN DOWN ANY EXTRA BURLAP INTO THE HOLE MADE SURE TO BURY THE MATERIAL COMPLETELY.
SURVEY NOTES

1. THE TOPOGRAPHY AND EXISTING SITE CONDITIONS DEPICTED HEREON ARE THE RESULT OF AN ON THE GROUND FIELD SURVEY CONDUCTED BY THE HORSLEY WITTEN GROUP, INC. JANUARY 2012.

2. HORIZONTAL DATUM IS ASSUMED.

3. THE ELEVATIONS DEPICTED HEREON ARE BASED ON AN ASSUMED DATUM.

4. THE PROPERTY LINES AND RIGHTS OF WAY DEPICTED HAVE BEEN TAKEN FROM PLANS OF RECORD AND ARE APPROXIMATE ONLY.

5. PROPERTY LINES BETWEEN ABUTTING PROPERTY OWNERS ARE APPROXIMATE ONLY.

6. THIS PLAN DOES NOT SHOW ANY RECORDED OR UNWRITTEN EASEMENTS WHICH MAY EXIST. HOWEVER, THIS DOES NOT CONSTITUTE A GUARANTEE THAT NO SUCH EASEMENTS EXIST.


8. REFERENCE PLANS:
   8.2. SEPARATION OF PLOT NO. 114H FROM REMAINDER PLOT NO. 114 BY: RUPERT N. PELLE P.E. DATED: 02-08-07

This plan does not show any recorded or unrecorded easements which may exist. However, this does not constitute a guarantee that no such easements exist.

The property is located within F.I.R.M Zone A as shown on Community Panel No. 780000 0073 dated April 16, 2007.

Reference Plans:


This plan does not show any recorded or unrecorded easements which may exist. However, this does not constitute a guarantee that no such easements exist.

The property is located within F.I.R.M Zone A as shown on Community Panel No. 780000 0073 dated April 16, 2007.

Reference Plans:


This plan does not show any recorded or unrecorded easements which may exist. However, this does not constitute a guarantee that no such easements exist.

The property is located within F.I.R.M Zone A as shown on Community Panel No. 780000 0073 dated April 16, 2007.

Reference Plans:


COIR FABRIC INSTALLATION DETAIL

PLANTING IN COIR FABRIC DETAIL (BY OTHERS)

BOULDER RETAINING EMBANKMENT WALL

C - 5

NOT TO SCALE

AFTER INSTALLATION, FOLD FABRIC BACK INTO PLACE AND STAPLE DOWN AS REQUIRED

NOTES:

1. DIG THE HOLE PER PLANTING DETAILS.

2. SOIL BEDDING MATERIAL OVER

3. STAPLING PATTERN AS PER MANUFACTURER'S RECOMMENDATIONS.

4. JOINING SECTIONS OF

5. FOLD FABRIC BACK AND PIN DOWN TO CREATE A HOLE IN THE MAT.

NOTES:

1. KEEP FABRIC IN PLACE.

2. AFTER PLANTING, FOLD FABRIC BACK INTO PLACE AND STAPLE DOWN AS REQUIRED

3. LIME, FERTILIZE AND SEED BEFORE INSTALLATION. PLANTING OF SHRUBS, TREES, ETC. SHOULD OCCUR

4. COMPACTED ENGINEER APPROVED BACKFILL WILL BE A MINIMUM OF 95% OF MAXIMUM DRY DENSITY.

5. CHINKING STONES TO EXPOSED STONE - 2' DEPTH

6. STABILIZE DISTURBED 3:1 (OR COMPACTED ENGINEER APPROVED BACKFILL WILL BE A MINIMUM OF 95% OF MAXIMUM DRY DENSITY)

7. TREE PLANTING ON SLOPE DETAIL (BY OTHERS)

8. PLANTINGS ALONG

9. BREAK FRACTURES. CONTRACTOR TO APPROVE SOURCE OF STONES AND BOULDERS.

10. SCHEDULE

11. PLANTING HOLE 4" 2' DEPTH

12. SIZE OF MATERIAL TO BE PLANTED

13. PLANT MATERIALS TO BE PLANTED

14. PLANTING SCHEDULE FOR EXISTING SOD/GRASS SEED

15. STABILIZE DISTURBED 3:1 (OR COMPACTED ENGINEER APPROVED BACKFILL WILL BE A MINIMUM OF 95% OF MAXIMUM DRY DENSITY)

16. CHINKING STONES TO EXPOSED STONE - 2' DEPTH

17. STABILIZE DISTURBED 3:1 (OR COMPACTED ENGINEER APPROVED BACKFILL WILL BE A MINIMUM OF 95% OF MAXIMUM DRY DENSITY)

18. TREE PLANTING ON SLOPE DETAIL (BY OTHERS)

19. PLANTINGS ALONG

20. BREAK FRACTURES. CONTRACTOR TO APPROVE SOURCE OF STONES AND BOULDERS.

21. SCHEDULE

22. PLANTING HOLE 4" 2' DEPTH

23. SIZE OF MATERIAL TO BE PLANTED

24. PLANT MATERIALS TO BE PLANTED

25. PLANTING SCHEDULE FOR EXISTING SOD/GRASS SEED

26. STABILIZE DISTURBED 3:1 (OR COMPACTED ENGINEER APPROVED BACKFILL WILL BE A MINIMUM OF 95% OF MAXIMUM DRY DENSITY)

27. TREE PLANTING ON SLOPE DETAIL (BY OTHERS)

28. PLANTINGS ALONG

29. BREAK FRACTURES. CONTRACTOR TO APPROVE SOURCE OF STONES AND BOULDERS.

30. SCHEDULE

31. PLANTING HOLE 4" 2' DEPTH

32. SIZE OF MATERIAL TO BE PLANTED

33. PLANT MATERIALS TO BE PLANTED

34. PLANTING SCHEDULE FOR EXISTING SOD/GRASS SEED

35. STABILIZE DISTURBED 3:1 (OR COMPACTED ENGINEER APPROVED BACKFILL WILL BE A MINIMUM OF 95% OF MAXIMUM DRY DENSITY)
NOTES:

1. REVISED EXISTING TOPOGRAPHY FROM ROB CINTRON ON OCTOBER 10, 2016

2. PROPOSED EROSION CONTROL TO BE FIELD LOCATED
Attachment B

Geographic Consulting Inc Final Landscape Planting Report
Native trees, shrubs and vines were planted along with fast-growing grasses on the banks of the Green Cay Head Cut Repair Project during the week of December 26-30, 2016. A wide variety of native plant material was established to control soil erosion, stabilize banks and enhance the native forest habitat on site. All plants for this project were grown on St. Croix in Geographic Consulting’s native plant nursery. A total of 377 plants were established on the banks. Specifically; 114 trees and shrubs in 1 gallon pots, 214 4” grass plugs, 36 trees and shrubs in 3-gallon pots and 13 native vines. Additional details of the quantities and sizes of all plants appear in Table 1.

Table 1 Names, sizes and quantities of the plants established at the Green Cay headcut restoration project.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Botanical Name</th>
<th>1 gallon</th>
<th>3 gallon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Century Plant</td>
<td>Agave eggersiana</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Pigeon berry</td>
<td>Boureria succulenta</td>
<td>47</td>
<td>9</td>
</tr>
<tr>
<td>Jamaican Caper</td>
<td>Capparis cynophallophora</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Fiddlewood</td>
<td>Citharexylum fruticosum</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Geiger Tree</td>
<td>Cordia nitida</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>Sea Grape</td>
<td>Cocoloba uvifera</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Orange Manjack</td>
<td>Cordia rickseckeri</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Calabash</td>
<td>Crescentia cujete</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Maidenberry</td>
<td>Crossapetalum rhacoma</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Frangipani</td>
<td>Plumeria alba</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Fish Poison</td>
<td>Piscidia carthagenensis</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Water Mampoo</td>
<td>Pisonia subcordata</td>
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<td>2</td>
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<tr>
<td>Pink Poui</td>
<td>Tabebuia heterphylla</td>
<td>17</td>
<td>0</td>
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<tr>
<td><strong>SUBTOTAL</strong></td>
<td></td>
<td><strong>114</strong></td>
<td><strong>36</strong></td>
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<table>
<thead>
<tr>
<th>Vines</th>
<th></th>
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<tbody>
<tr>
<td>Morning glory</td>
<td>Ipomea pes-caprea</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Beach Bean</td>
<td>Canavalea rosea</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>SUBTOTAL</strong></td>
<td></td>
<td><strong>7</strong></td>
<td><strong>6</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Grasses</th>
<th>4&quot; plugs</th>
<th></th>
<th></th>
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</thead>
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<tr>
<td>Guinea grass</td>
<td>Urochloa maxima</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Foxtail grass</td>
<td>Setaria spp.</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Zoysia grass</td>
<td>Zoysia spp.</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Hurricane grass</td>
<td></td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Stiffleaf</td>
<td>Eustachys petraea</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Crows foot grass</td>
<td>Dacyloctenium aegyptium</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>SUBTOTAL</strong></td>
<td></td>
<td><strong>214</strong></td>
<td></td>
</tr>
</tbody>
</table>
Grand Total - All sizes, all species 377

Plant Installation
Native woody plants in one-gallon pots and extra-large grass plugs were established in linear transects on the North and South banks of the stream after construction. A mixture of grasses and native trees, shrubs and, vines was utilized in each transect. Plants were spaced at approximately 6 feet on center within rows. Rows are also spaced approximately 6 feet apart. There are 10 transects in total, oriented along the contour of the sloped banks. The transect locations are depicted in Figure 1. The number of plants in each transect is described in Table 2.

Table 2 Quantities of plants installed in each of the 10 transects on the Green Cay Gut banks. The Transect locations are indicated in Figure 1.

<table>
<thead>
<tr>
<th>Transect</th>
<th>No. of plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1</td>
<td>33</td>
</tr>
<tr>
<td>N2</td>
<td>44</td>
</tr>
<tr>
<td>N3</td>
<td>11</td>
</tr>
<tr>
<td>N4</td>
<td>9</td>
</tr>
<tr>
<td>N5</td>
<td>9</td>
</tr>
<tr>
<td>S1</td>
<td>15</td>
</tr>
<tr>
<td>S2</td>
<td>13</td>
</tr>
<tr>
<td>S3</td>
<td>24</td>
</tr>
<tr>
<td>S4</td>
<td>27</td>
</tr>
<tr>
<td>S5</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>218</td>
</tr>
</tbody>
</table>

Larger native plants in three-gallon pots were also established at strategic points. The trees were planted by first digging holes with an 18” hydraulic auger mounted on a skid steer. The trees were then hand-planted and back-filled with native soil, in accordance with Best-Management Practices.

Grasses and native trees, shrubs, vines were selected for this project for three purposes; 1) stabilize newly constructed stream banks, 2) prevent soil erosion and 3) enhance the quality of the native dry forest habitat. The habitat at the start of the project was relatively low quality with low native plant diversity and many exotic species. This project established 163 native plants (including trees, shrubs and vines) from 14 unique genera and two species within the genus *Cordia*. The green lines in Figure 1 indicate where the grasses were concentrated.

Each native plant provides a particular enhancement to the habitat as a whole. For example, geiger tree, orange manjack, pink poui and agave each flower at different times of the year with blooms that produce abundant nectar for birds and insects. This nectar is a critical food source to native wildlife during the dry season. Pigeonberry and fiddlewood produce copious amounts of juicy, berry-like fruit that are eaten birds and bats. Water mampoo and pink poui flowers are
favorites for hummingbird. Together, these plants increase the native plant diversity of the site and provide enhanced wildlife habitat. In addition to holding soil and enhancing native forest habitat, many of these tree species are also attractive. Eight of the species planted on site are featured in the publication, "Native Trees for Community Forests” for their use as ornamentals in landscaping.

A variety of grasses was also planted. The 214 grass plugs have been effective in mitigating soil erosion. The grasses were installed within the rows described in Table 2, as well as erosion prone portions of the site. Large bunch grasses like guinea grass and stiff leaf Eustachy’s grass were planted within the transects with the small trees and vines. Zoysia grass and other species were concentrated in areas most prone to soil erosion (Table 1 describes the quantities of grass plugs planted, by species). In particular, the upland portion of the site on the east side had areas of uneven terrain on relatively steep slopes. We planted the majority of our 4” grass plugs in this area because it could not easily be covered with erosion matting. The location of the grass plugs is depicted in Figure 1 with a broad green line.

**Plant Descriptions and Benefits**

The trees, shrubs, and vines used in this project are all locally produced, native species. The species were carefully selected for their unique characteristics that make them well suited to restorations of stream banks on the dry east-end of St. Croix. In general, they are all drought tolerant and produce large root systems. The root systems will stabilize the bank into the future, but also ensure the plants are less likely to die during the difficult establishment phase.

From an ecological perspective, guts or streams have always been a magnet for the flora and fauna of the Virgin Islands dry forest. The gut at this site has not provided quality habitat in many years. This diverse native planting will help return the site to a functioning ecosystem. Table 3 describes some attributes of the featured plants.
Table 3 Descriptions and benefits of some of the native plants installed at the Green Cay Head Cut Repair Project

<table>
<thead>
<tr>
<th>Genus &amp; species</th>
<th>FAMILY</th>
<th>Common name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Agave eggersiana</em></td>
<td>Asparagaceae</td>
<td>St. Croix Century Plant</td>
<td>The St. Croix agave, or century plant is among St. Croix’s rarest and most unique plants and is found nowhere else in the world. The succulent shrub can reach 8 feet across. The century plant’s flowers are an essential part of the dry forest, providing large quantities of nectar to countless birds, bats and insects. It has exceptional drought and wind tolerance. Despite the name century plant, it lives only 10 or so years and then produces flowers on a 20 foot spike and dies. This endangered plant is in even greater peril today due to introduced agave weevils. Conservation is essential. 6 feet tall</td>
</tr>
<tr>
<td><em>Bourreria succulenta</em></td>
<td>Boraginaceae</td>
<td>Pigeon berry</td>
<td>One of the most common trees in the dry forests of the Virgin Islands. It produces fruits and flowers throughout the year, and is an abundant food producer, as the name implies. 30 feet tall</td>
</tr>
<tr>
<td><em>Canavalea rosea</em></td>
<td>Fabaceae</td>
<td>Beach bean</td>
<td>A pantropical coastal vine with an attractive flower. The vines can spread to 20 feet long in every direction and is grown into a dense, low mat. Seeds are dispersed by water. 3 feet tall, spreading to 40 feet diameter.</td>
</tr>
<tr>
<td><em>Capparis cynophallophora</em></td>
<td>Capparaceae</td>
<td>Jamaican caper</td>
<td>One of the most beautiful trees in the Virgin Islands. The small flowering tree is becoming a popular ornamental. The crown is naturally compact and the pink blooms are showy. The shiny leaves remain, dark-green and glossy even in severe drought. 30 feet tall.</td>
</tr>
<tr>
<td><em>Citharexylum fruticosum</em></td>
<td>Verbenaceae</td>
<td>Fiddle wood</td>
<td>Another common tropical hardwood tree that is an abundant producer of nectar and fruit throughout the year. 40 feet tall.</td>
</tr>
<tr>
<td><em>Coccoloba uvifera</em></td>
<td>Polygonaceae</td>
<td>Seagrape</td>
<td>The most iconic coastal tree in the Caribbean has exceptional tolerance to drought, wind and salt. The abundant, grape-like fruits are an essential part of the Caribbean coastal habitat. 60 feet tall.</td>
</tr>
<tr>
<td><em>Cordia rickseckeri</em></td>
<td>Boraginaceae</td>
<td>Orange manjack</td>
<td>The tree produces large nectar-rich, orange blooms in the dry season, providing resources for wildlife when they are otherwise scarce. The unique tree is native to only the dry forests of Puerto Rico and the Virgin Islands. 25 feet tall.</td>
</tr>
<tr>
<td><em>Cordia sebestena</em></td>
<td>Boraginaceae</td>
<td>Large leaf geiger</td>
<td>A close relative to the orange manjack that also produces nectar-rich flowers. Geiger's fruit are white and even larger than its cousins’ and are a favorite food for bats. 25 feet tall.</td>
</tr>
<tr>
<td><strong>Crescentia cujete</strong></td>
<td>Bignoniaceae</td>
<td>Calabash</td>
<td>This unusual, attractive native tree produces long-spreading, distinct branches. Flowers are borne directly on the main branches and trunk only and have an unpleasant odor. The large fruit has a hard shell and can grow to a remarkable 16” in diameter. The woody shells are used in local craft making. <strong>30 feet tall.</strong></td>
</tr>
<tr>
<td><strong>Ipomea pes-caprea</strong></td>
<td>Convolvulaceae</td>
<td>Beach morning glory vine. Goat-foot vine</td>
<td>Another pantropical creeping vine that tolerates salt well enough to grow in beach sand. It produces an enormous root system, and even roots out of nodes in the vine. It does not climb enough to smother other vegetation. Seeds are carried by water, making it likely that lower portions of the gut will be colonized also. <strong>3 feet, spreading over 60 feet in diameter.</strong></td>
</tr>
<tr>
<td><strong>Piscidia carthagenensis</strong></td>
<td>Fabaceae</td>
<td>Fish poison tree</td>
<td>This often scraggly-looking tree suddenly bursts into beauty when it becomes covered in showy pink flowers. The unusual fruit are ruffled green pods making it recognizable from a great distance. The native Tainos and Carib people used the bark and roots to stupefy fish. <strong>45 feet tall.</strong></td>
</tr>
<tr>
<td><strong>Pisonia subcordata</strong></td>
<td>Nyctaginaceae</td>
<td>Water mampoo</td>
<td>This common, fast-growing, with smooth bark and large trunk is an attractive ornamental when large. Its habit of growing partially exposed roots give it an almost bonsai look. <strong>40 feet tall.</strong></td>
</tr>
<tr>
<td><strong>Plumeria alba</strong></td>
<td>Apocynaceae</td>
<td>White frangipani</td>
<td>This genus produces the flowers from which the Hawaiian lays are made. This Caribbean species is highly ornamental with long linear leaves clustered at the end of branches. The flowers grow in showy white clusters. <strong>20 feet tall.</strong></td>
</tr>
<tr>
<td><strong>Tabebuia heterophylla</strong></td>
<td>Bignoniaceae</td>
<td>Pink poui</td>
<td>A common hard wood species known for is large, trumpet-shaped pink flowers. It is resistant to wind, salt and drought. Green seed pods open when mature and papery winged seeds are dispersed by the wind. <strong>45 feet tall.</strong></td>
</tr>
</tbody>
</table>
Figure 1. Location and orientation of the 10 transects on which plants were established and Green Cay. Grasses for erosion prevention are depicted in green.
Table 4 Plant number and species for the large plants installed at Green Cay. These numbers correspond to the numbers in the map in Figure 2.

<table>
<thead>
<tr>
<th>Map #</th>
<th>Plant species</th>
<th>Map #2</th>
<th>Plant species2</th>
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<tbody>
<tr>
<td>1</td>
<td>Cordia rickseckeri</td>
<td>21</td>
<td>Citharexylum fruticosum</td>
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<td>2</td>
<td>Ceiba pentandra</td>
<td>22</td>
<td>Cordia rickseckeri</td>
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<tr>
<td>3</td>
<td>Piscidia carthagenensis</td>
<td>23</td>
<td>Canavalea rosea</td>
</tr>
<tr>
<td>4</td>
<td>Piscidia carthagenensis</td>
<td>24</td>
<td>Cordia rickseckeri</td>
</tr>
<tr>
<td>5</td>
<td>Bourreria succulenta</td>
<td>25</td>
<td>Bourreria succulenta</td>
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<td>6</td>
<td>Citharexylum fruticosum</td>
<td>26</td>
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<td>7</td>
<td>Cordia rickseckeri</td>
<td>27</td>
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<td>8</td>
<td>Bourreria succulenta</td>
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<td>9</td>
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<td>10</td>
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<td>11</td>
<td>Bourreria succulenta</td>
<td>31</td>
<td>Cordia rickseckeri</td>
</tr>
<tr>
<td>12</td>
<td>Crossapetalum rhacoma</td>
<td>32</td>
<td>Canavalea rosea</td>
</tr>
<tr>
<td>13</td>
<td>Cordia rickseckeri</td>
<td>33</td>
<td>Canavalea rosea</td>
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<td>14</td>
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<td>Cordia rickseckeri</td>
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<td>Plumeria alba</td>
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<td>Cordia rickseckeri</td>
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<td>Ipomea pes-caprea</td>
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<td></td>
<td></td>
<td>42</td>
<td>Pisonia subcordata</td>
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</table>
Figure 2: Locations of large plants in 3 gallon pots or greater. The numbers correspond with table 4.
References


