Reduction and control of sediment-laden runoff near critical coral reef ecosystems through the implementation of BMP'S in Culebra, Puerto Rico

FINAL REPORT

Submitted to:

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1 SUMMARY

Efforts to support and implement the ***Culebra Community Watershed Action Plan for Coral Reefs and Water Quality*** has led to unprecedented collaborations between the Municipality of Culebra, the Department of Natural and Environmental Resources (DNER), National Oceanic and Atmospheric Administration (NOAA), US Fish and Wildlife Service (FWS), local organizations and the community in general. Observing the need to address chronic sediment laden runoff at critical sites in Culebra, two additional projects were carried out from July, 2015 to March 2016; one at Tamarindo Beach and the other at the south of Ensenada Honda near Fulladosa Bay (Figure 1). These projects represent major

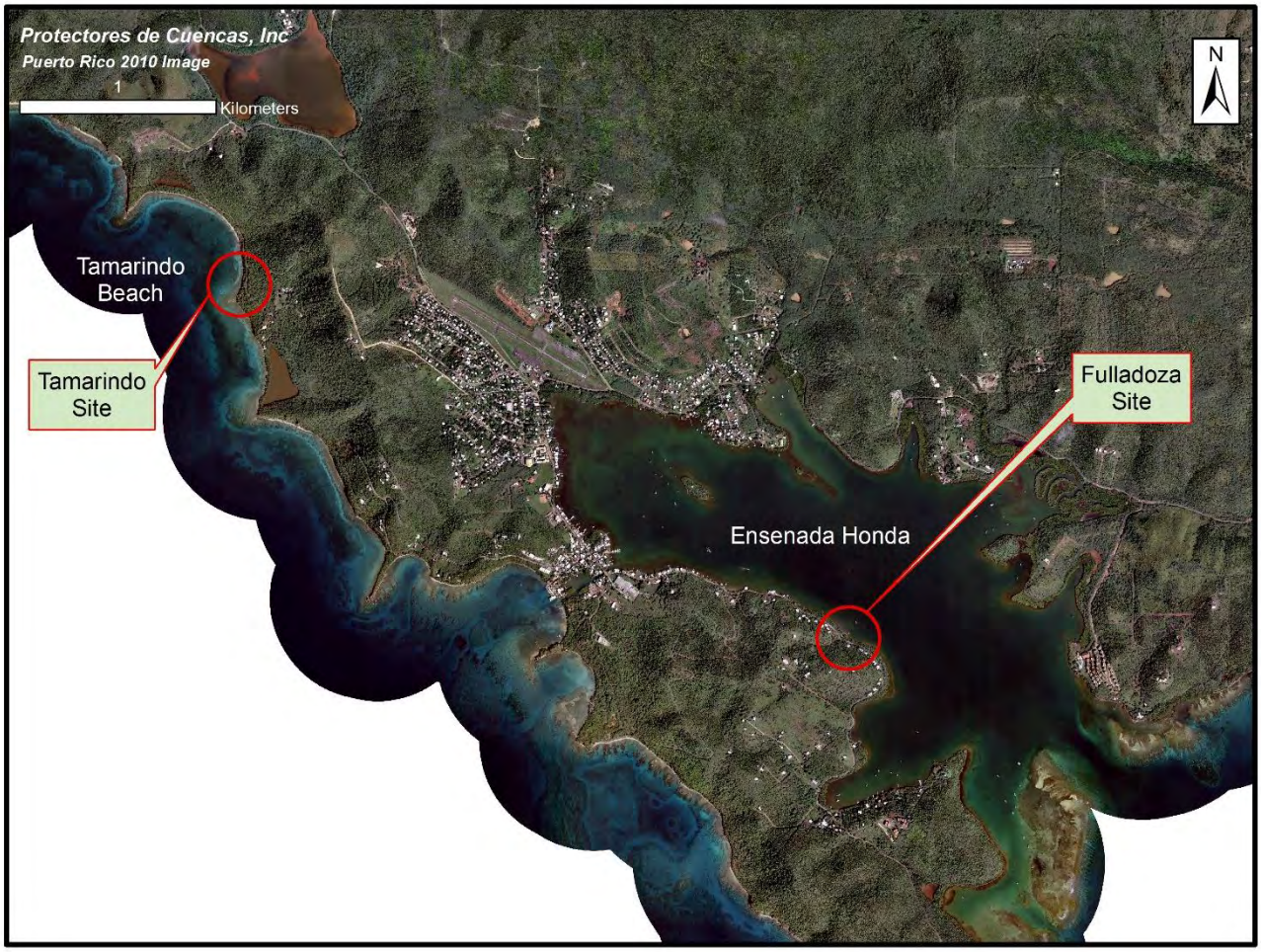


Figure 1. Culebra map with site locations.

sediment and stormwater runoff control practices on unpaved road systems impacting Culebra's coastal and marine resources. The Fulladosa site represents a location draining to Ensenada Honda, a bay recognized as critical habitat due to prevalence and abundance of seagrass beds and coral reefs. At this site there is an increasing sediment plume that is severely impacting seagrass communities. Further, the Tamarindo site, is a project focusing on the restoration needs in the upper and final portion of the road leading to Tamarindo Beach. In this portion of the road, passenger vehicle and service providers have created a new dirt turnaround, increasing the exposed area. This exposed area, in addition to a poorly managed runoff, represents a major sediment source that is impacting critical coral reef habitats and for the coral farms project near Bahia Tamarindo.

The goals of these projects were to address runoff from the adjacent roads and bare soil areas prior to being discharged to the marine environment. These efforts had the endorsements of the Municipality of Culebra, the Conservation and Development Authority of Culebra (ACDEC) and the support of the Department of Natural and Environmental Resources (DNER), as well as from the local community. Furthermore, the Municipality of Culebra agreed to provide long term maintenance to the stabilized roads (see Appendix).

It is important to point out that the majority of the labor for these efforts has been contracted locally from Culebra. These projects received technical assistance from the DNER, the US Fish and Wildlife Service (USFWS) and NOAA. USFWS and DNER also provided native trees to be planted as part of the reforestation program. DNER provided logistical support and accommodation for the work team at their facilities in Culebra. Project sites

were selected in coordination with Horsley Witten Group, NOAA CRCP, the Municipality of Culebra and home owners from the area.

2 INTRODUCTION

Increased levels of land-based sediment loads associated with coastal development is one of the most important factors affecting coastal marine ecosystems in Puerto Rico. Puerto Rico coral reefs are among the most threatened marine ecosystems in the Caribbean. The degradation of coastal water quality in Puerto Rico has caused a decline in the population and health of coral reefs. The ability of reefs to survive is gradually being reduced as fine sediment and nutrient discharges from the land to the coastal waters increase. From the stand point of marine ecosystems conservation, degradation of water quality due to dispersed land-based sources of pollution has negative and sometimes irreversible damage to the integrity of the coral reef communities, sea grasses, mangroves and other highly valued coastal ecosystems.

High rates of sedimentation, excess nutrients, urbanization and sanitary sewage overflow are the main causes of the degradation of marine ecosystems. This phenomenon is mainly due to the lack of sustainable management from the perspective of integrated watershed management. Erosion and habitat degradation are other serious problems that our wetlands, estuaries and coastal waters face. In particular, the removal of vegetation and land clearing activities for construction without proper erosion and sedimentation control practices, impact marine and coastal ecosystems and diminishes the attractive of coastal areas for recreation and tourism. High sediment loads to marine environments resulting from poorly maintained dirt roads without the installation of proper management practices, is a very common problem in Culebra. In order to assess these issues we established two restoration projects, one at Tamarindo Beach and the other near Fulladosa.

Tamarindo Beach is part of the Luis Peña Chanel Marine Reserve, a no-take reserve that has become one of the most popular tourist destinations in Culebra. It is also considered critical habitat for listed green sea turtles, which includes waters extending seaward 3 nm (5.6 km) from the mean high water line of Culebra Island, Puerto Rico. This area is one of the most important ecosystems in the Island, not just for its natural value, but also for the benefit it provides to the local economy. The fact that a successful coral restoration project has increased coral and fish populations, has attracted a wide variety of visitors. This has created a huge demand for space (e.g. parking area, tourist operations), which has resulted in an increase of illegal activities such as unauthorized parking, deforestation, camping and land clearing. The high visitation in this area has resulted in an increased pressure on natural resources therefore increasing the need for implementation of management practices to ensure both the enjoyment of visitors to the area as well as the protection and conservation of this unique coastal resource. The lack of proper planning, management and the absence of erosion and sediment control practices has led to an increase in sediment pulses that affects coral reef ecosystems in Tamarindo.

The Fulladosa site is composed of a municipal dirt road system. This dirt road is very steep and it is one of the major sources of sediment runoff to Ensenada Honda. Approximately ½ mile of dirt road was stabilized to reduce sediment transport to the marine environment of Ensenada Honda. Prior to stabilization of the dirt road, run off was running through the center of the road causing erosion forces to drag sediments to the marine environment. The road was regraded and runoff was conveyed into a continuous swale that runs parallel to the road. The road was also compacted using a 15 ton compacting roller. The swale was

filled with 2-8 inch stones to reduce the energy of the water and to hold some of the sediment resulting from the dirt road. The swale discharges runoff into a series of sediment traps and rain gardens. The purpose of these projects were to implement sediment and erosion control measures to reduce sediment loads into the marine ecosystems. These projects have the ability to improve water quality and contribute to the health of adjacent coral reefs, and ultimately support the Culebra local economy.

3 IMPLEMENTATION

3.1. TAMARINDO

A micro-watershed approach was used as a management unit for this coastal area (Figure 2). The problems identified in Tamarindo were mainly associated with runoff generated from the exposed dirt turnaround (Figure 3) and the extensive areas of unpaved road in areas that drain directly to the Marine Reserve (Figure 4). Existing infrastructure was in a critical state of disrepair with rutting and small undesirable watercourses conveying runoff and sediment down to Tamarindo Beach. This was causing bank erosion that was yielding considerable amounts of sediments directly to coral reef communities (Figures 5).

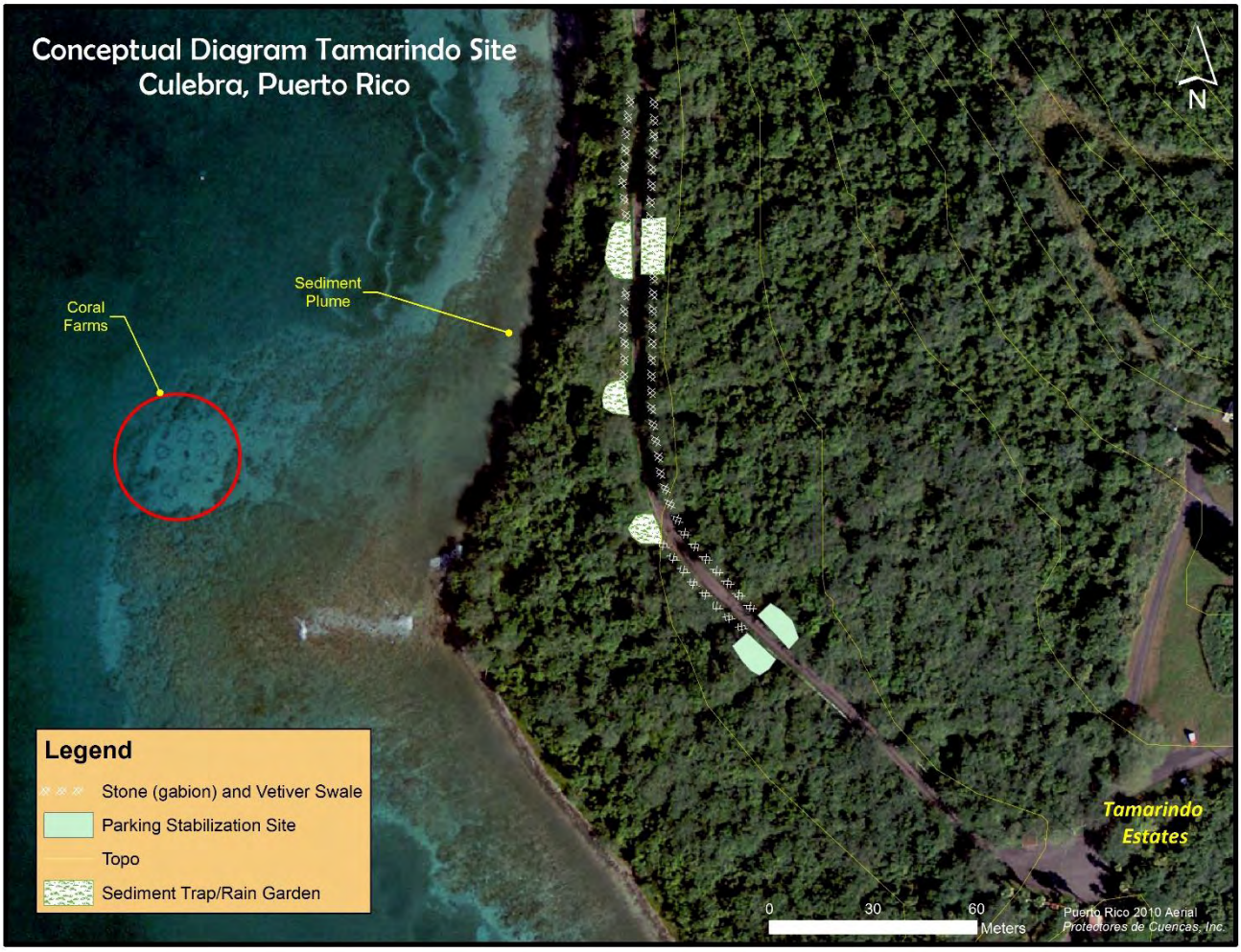


Figure 2. Conceptual diagram of work completed at Tamarindo Beach.

Figure 3. Google Earth August 2015 aerial with turnaround area of Tamarindo in red circle before stabilization.

Figure 4. Picture of turnaround area of Tamarindo before stabilization.

Figures 5. Pictures of existing conditions of the Tamarindo site before stabilization.

After several field evaluations, recommendations from the local community, DNER, FWS and NOAA the following restoration components were established:

a. SEDIMENT STABILIZATION ON UNPAVED SECTIONS OF THE ROAD

The previously paved road at the end of Tamarindo Beach has suffered a lot of changes mostly from rain, heavy traffic and lack of maintenance. This resulted with greater and newer areas of exposed soil, pot holes, and damaged drainages that were eroding the sides of the road yielding sediments to the marine environment. In order to reduce runoff and dissipate its energy, we rehabilitated culvert drainages with riprap and Vetiver swales built parallel to both sides of the road. The implementation of these practices will promote sheet flow towards a series of sediment trap system built with stones after passing through several lines of Vetiver grass with gabion stones (Figure 6). Further, water was conveyed to intercepts at 3 locations. On both sides of the road, we broke up flow paths and reduced concentrated flow over the road, thus converging flows to areas of treatment. Upon finalizing the rehabilitation, we covered most of the exposed soil with a mixture of different sizes of gravel to allow compaction (Figures 7).

Figure 6. Stabilized culvert drainage.

Figures 7. Pictures of some of the work completed.

b. UNPAVED TURNAROUND DRIVEWAY STABILIZATION

There is a huge parking demand on Tamarindo Beach and cars use most of the side of the access road to park, making it very difficult for the big passenger vans to be able to turn around. As a consequence, these large vehicles have created a dirt turnaround area over time (Figure 8). This area of exposed soils receives storm water from the uphill paved access road to Tamarindo Estates apartment complex picking up sediments on its way to the nearshore environment a few meters away, just in front of the coral farm site. Conservation practices implemented to stabilize this site were composed of a series of check dams and bio swales with the combination of excavation of 2 to 4 inches of soil and

Figure 8. Turnaround site before stabilization.

replacing it with a mixture of different size gravel (¼ – 1 ¼ inch). Gravel was also compacted with a 16 ton compacting roller (Figures 9 to 12).

Figure 9. Turnaround site at Tamarindo after stabilization.

Figure 10. Turnaround site at Tamarindo during compaction process.

Figure 11. Turnaround site at Tamarindo during stabilization process.

Figure 12. Turnaround site at Tamarindo after stabilization.

c. CREATION OF A SERIES OF SEDIMENT TRAPS

A sediment trap system was designed to help filter storm water that was causing erosion problems and discharging sediments to Tamarindo Beach. The entire filtration process consists of three stabilization ponds. This practice was designed to lower the erosive force of water, treat residual runoff coming from the road and divert water to forested areas. Water is conveyed to the sediment traps trough gabion stone and Vetiver grass swales. In this design the three sediment traps have a variable size to provide a reduction of sediment and hydraulic energy. This will allow water to pass throughout the system slowly while reducing sediment load. In order to ensure durability, the berms on the three sediment traps were compacted using a 10 ton vibrating compacting roller (Figures 13 to 17). Vetiver

Figure 13. Construction of sediment traps process.

and other native plants were planted in the surroundings to further aid in the filtration process.

Figure 14. Sediment trap prior to be stabilized.

Figure 15. Sediment trap compaction of the berms process.

Figure 16. Sediment trap after stabilization.

Figure 17. Sediment trap after a rain event of 2.5 inch.

3.2. FULLADOSA SITE

This site is a very steep Municipal dirt road (Figure 18). After several site visits with NOAA representatives this site has been selected as a priority for restoration do to the huge sediment load it produces to the Ensenada Honda Bay. This sediment plume has been evidenced by the monitoring component that NOAA has been conducting for the past year. This project has included the participation of Municipality staff as well as most of the home owners from the site. The main problem of this dirt road system is that it was constructed in the flow patterns of a natural dry channel. Most of the runoff that drained naturally through the dry channel has been intercepted by the road and runoff was flowing on the top of the road discharging directly to the Bay without passing through the natural dry channel. The main objective on this project was to redirect runoff to its natural course into the dry channel after passing through a series of

Figure 18. Pictures of existing conditions of the Fulladosa site before stabilization.

treatments. The implemented restoration components (Figure 19), included:

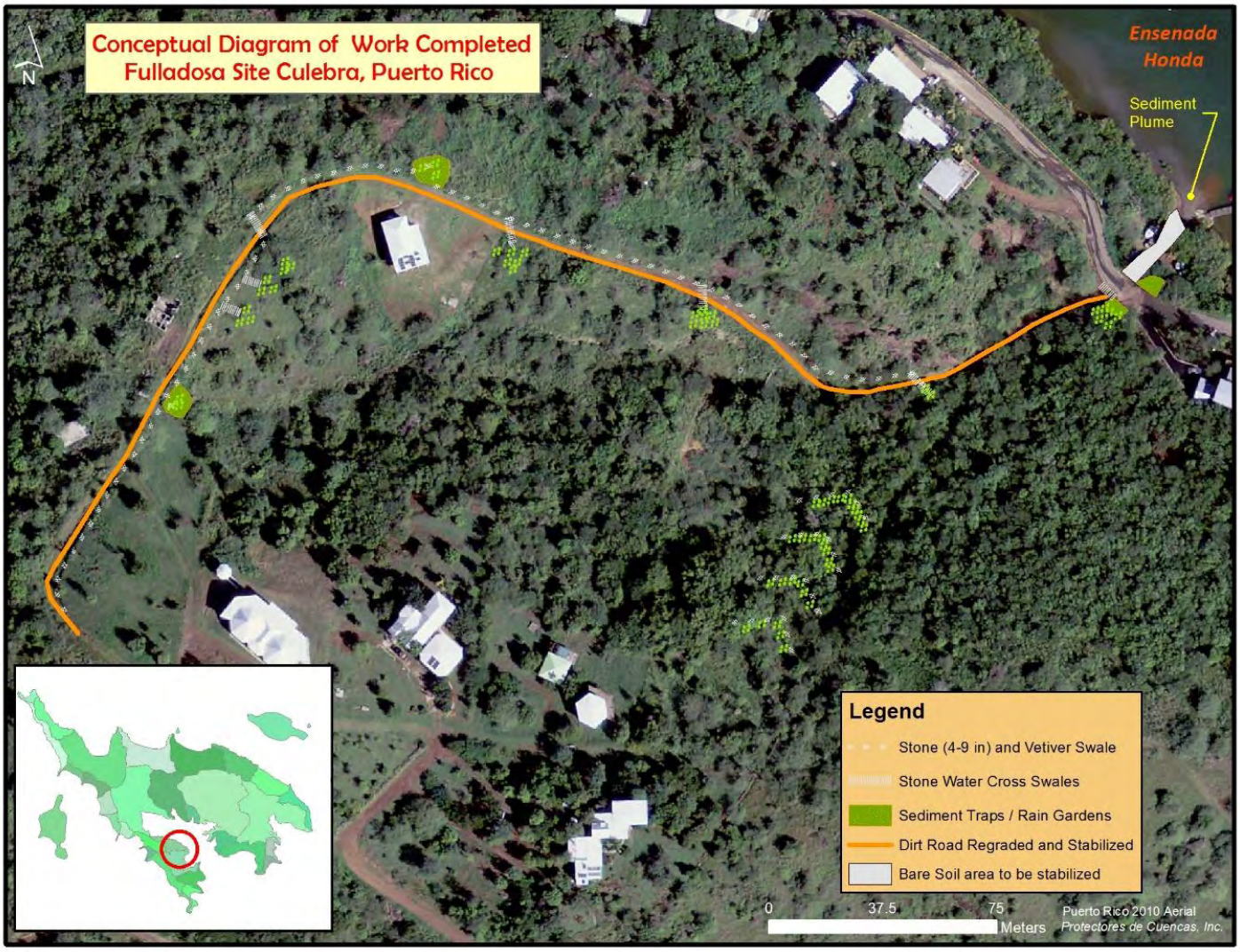


Figure 19. Conceptual diagram of work completed at Fulladosa.

a. LAND SURVEY AND SCHEMATIC DESIGN

A topographic survey (Figure 20) was conducted from the top of the subwatershed down to the coastal area including the dirt road and where erosion and sediment control practices where to be implemented. With this information, a detailed conceptual design was completed (see Appendix). This task was used, among other purposes, to identify water sources, identify current hydrological patters and the necessary grading activities to achieve desired conditions. The topography was performed on a 3 acre of land in 0.15 meter contour intervals to account for minor fluctuations in elevations that may not be detected with 1 meter contour intervals. The conceptual design drawings and preparation task included the design of plans, profile and sections of the restoration site to be used in the construction phase.

Figure 20. Topographic survey at Fulladosa.

b. ESTABLISHMENT OF TEMPORARY EROSION AND SEDIMENT CONTROL PRACTICES

Before starting any restoration work in the area, we installed a series of temporary sediment and erosion control practices at the current road and parking lot and also in the areas that new work was going to take place. Sediment control practices included installing silt fences and planting Vetiver grass to redirect runoff to forested areas (Figure 21).

Figure 21. Example of temporary sediment control practices.

C. STABILIZATION AND CONDITIONING OF DIRT ACCESS ROAD

Approximately ½ mile of dirt road was stabilized to reduce sediment transport to the marine environment of Ensenada Honda. Prior to stabilization of the steep dirt road, run off was running through the center of the road causing erosion forces to drag sediments to the marine environment (Figure 22). This section of the dirt road was regraded toward the outside of the hillside and runoff was conveyed into a continuous swale with check dames at intervals of approximate 25 ft. and the road was compacted using a 20 ton compacting roller (Figure 23-28). The check dams were constructed using 8-12 inch stones to reduce the energy of the water and to hold some of the sediment resulting from the dirt road. The swale discharges runoff into a series of sediment traps and then to forested areas (Figure 29-35).

Figure 22. Pictures of existing conditions of the Fulladosa site before stabilization.

Figure 23-28. Pictures of regrading, compaction and stabilization process at the Fulladosa site.

Figure 29-35. Pictures of completed dirt road stabilization with check dams in place at the Fulladosa site.

d. CREATION OF A SEDIMENT TRAP AND RAIN GARDEN SYSTEM

A series of 2 sediment trap systems were constructed (Figures 36-38 and 39-40). The sediment ponds were design to trap most of the core particulates and the overflow discharges through a cascade composed of combine boulders and smaller stones and various lines of Vetiver grass before entering a forested area in its way to the dry channel.

We have been able to see sediment traps response to rain events, which has allowed us the opportunity to observe and evaluate their effectiveness. This period has set the basis to fine tune all the practices as well as to engage more community members in the maintenance group.

Figure 36-38. Pictures of sediment trap and rain garden construction process and completed rain garden at Fulladosa site.

Figure 39-40. Pictures of second completed sediment trap at the Fulladosa site.

e. FOLLOW UP VISITS TO ENSURE PROPER MAINTENANCE AND EVALUATE FUNCTIONALITY.

Monthly visits for up to 4 months were conducted to ensure that the practices installed are working properly, particularly after rain events. Problems encountered were fixed during this period. We have also removed any unnecessary temporary measures installed after the site was fully stabilized and restoration activities are completed. During this period plants were irrigated and grasses and vines were removed to help in the plant survival.

4 COSTS

The work for Tamarindo and the Fulladosa site projects was performed for a total cost of $81,925 as described in Table 1. From the total cost, approximately $27,500 was used for Tamarindo and $54,425 for the Fulladosa site. A total in-kind (non-cash) match of $64,100 was estimated on this effort from contributing entities including the DNER, PDC, Culebra Municipality, local contractors and community volunteers as described in Table 2 for a total cost effort of $146,025.

Table 1. Summarized Global Costs

CATEGORY	COST
Labor and Manpower	$6,000
Rental Equipment and Materials Transportation	$9,900
Materials (costs include 8-12", 2-4', ¾/1 ½", size stones, Vetiver plants, and other mis. materials)	$30,000
Project Management, Coordination, Design and Engineering	$27,000
Travel (gas, flights, ferry, etc.)	$6,325
Per Diem	$2,700
TOTAL	**$81,925**

Table 2. Estimated In-Kind Match Contributions from Project Partners

ENTITY	ACTIVITY	UNITS	COST/UNIT	TOTAL COST
DNER	Trees at a cost of $20/tree	550	$ 20	$ 11,000
DNER	Lodging for 8 persons at a rate of 1300/Month	10	$ 1,500	$ 15,000
Edwin Falcón	Compacting Roller at a rate of $350/day	3	$ 350	$ 1,050
Edwin Falcón	Dozer at a rate of $650/day	3	$ 650	$ 1,950
Municipality of Culebra	Hours labor	100	$ 30	$ 3,000
Omar Villanueva	Backhoe at a rate of $400/day	30	$ 400	$ 12,000
PDC	Dump truck at a rate of $450/day	18	$ 450	$ 8,100
PDC	Uncompensated hours at a team mean cost/hour	100	$ 75	$ 7,500
PDC	Landscaping Supplies (hand tools, soil enhancements, auger drill, generator, etc.)	45	$ 100	$ 4,500
			TOTAL ESTIMATED	***$ 64,100***

5 APPENDIXES

ESTADO LIBRE ASOCIADO DE PUERTO RICO
GOBIERNO MUNICIPAL DE CULEBRA
CULEBRA, PUERTO RICO 00775

June 13, 2016

Roberto Viqueira Ríos
Executive Director
Protectores de Cuencas, Inc.

AGREEMENT TO FOSTER COLLABORATIVE EFFORTS TO STABILIZE UNPAVED ROADS THROUGH THE INSTALLATION OF SEDIMENT AND EROSION CONTROL PRACTICES IN THE MUNICIPALITY OF CULEBRA, PUERTO RICO

Sediment-laden runoff from unpaved roads, impervious surfaces and bare soils is considered to be one of the most critical stressors to Culebra's coastal habitats, especially its coral reefs. Addressing this environmental threat through restoration and infrastructure improvements and preventing future impacts through improved policies are the critical steps to ensure a sustainable future for Culebra. Protectores de Cuencas (PDC) is a community based nonprofit organization helping to restore and protect watersheds and associated ecosystems such as coral reefs across Puerto Rico. PDC has extensive experience implementing conservation practices on agricultural and non-agricultural natural resources, implementing interagency agreements and integrating collaboration and fostering community involvement through all these processes.

The underlying objective of the present agreement is to foster collaborative efforts to stabilize unpaved roads through the installation of sediment and erosion control practices in the Municipality of Culebra. The project will focus its efforts on the stabilization of unpaved roads maintained by the Municipality of Culebra to be completed, upon field assessment, by PDC and implementation of erosion and sediment quality controls. These efforts will provide direct benefit to coastal and coral reef habitats of Culebra as these practices assist in reducing runoff and sediment contribution to coastal waters. The endangered species and critical habitats will directly benefit from this initiative.

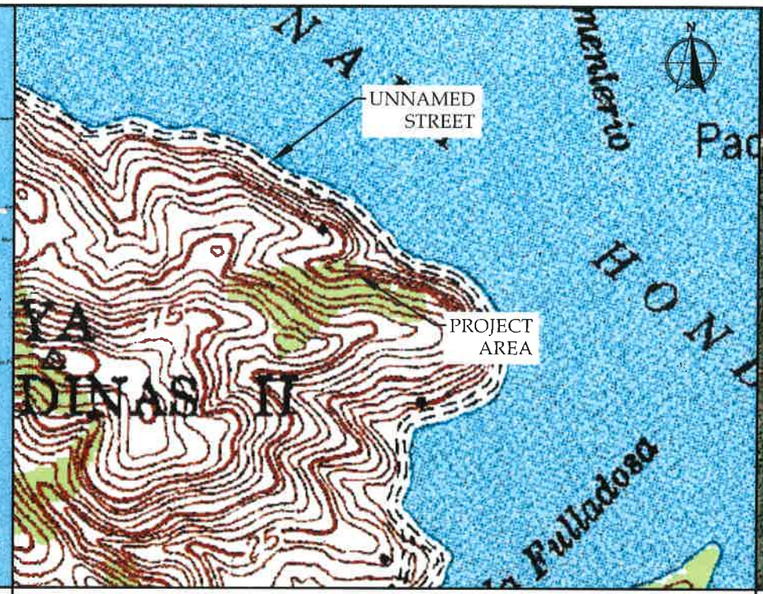
The Municipality of Culebra agrees to the following:

- Allow permit and access to public municipal roads to perform sediment and erosion control practices.
- Provide technical assistance.
- Assist in coordination efforts leading up to the installation of sediment and erosion control practices.
- Provide long term maintenance of the stabilized roads.

Gratefully,

Hon. Ivan Solís
Mayor of Culebra

LOCATION MAP SCALE 1:40,000



VICINITY MAP SCALE 1:5,000

AERIAL PHOTO SCALE 1:5,000

RUNOFF AND EROSION CONTROL MEASURES
FULLADOZA SITE
CULEBRA, PUERTO RICO

JOSE D. MIRANDA, P.E.
LICENSE NO. 18045

THE CONSULTING ENGINEER CERTIFIES THAT THESE PLANS MEET ALL THE CURRENT REGULATION REQUIRED BY THE PUERTO RICO ENVIRONMENTAL QUALITY BOARD, THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AND THE DESIGN GUIDELINES OF THE PUERTO RICO ELECTRIC POWER AUTHORITY AND THE PUERTO RICO AQUEDUCT AND SEWER AUTHORITY.

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COVER SHEET		G-101
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NO.	REMARKS	DATE	BY	APPV'D.

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DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES OF PUERTO RICO

ESTADO LIBRE ASOCIADO DE PUERTO RICO
DRNA
DEPARTAMENTO DE RECURSOS NATURALES Y AMBIENTALES

RUNOFF AND EROSION CONTROL MEASURES AT FULLADOZA SITE

CULEBRA, PUERTO RICO

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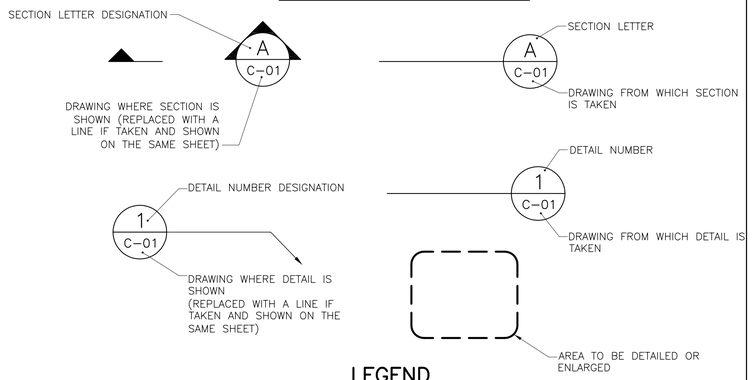
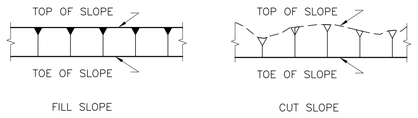
REVISED BY: J. MIRANDA	DATE: OCT/23/2015		
SUBMITTED BY: GLME COOP	DATE: OCT/23/2015	FILE:	01_G-102_FULLADOZA.DWG

DRAFTING SYMBOLS



LEGEND

EXISTING	PROPOSED	DESCRIPTION
B-#		TEST BORING LOCATION AND NUMBER
△		CONTROL POINT
		TREE
5.22	42.90	SPOT ELEVATION
		FLOW DIRECTION
		CONCRETE LIGHTING POLE
		LIGHTING POLE
		WATER VALVE
		MANHOLE
		ORDINARY HIGH WATER MARK
4.0	4.0	CONTOUR LINE ONE (1.00) METER INTERVAL
		CONTOUR LINE HALF (0.50) METER INTERVAL
O O O O		CHAIN LINK FENCE
X X X X X X		BARB WIRE FENCE
		CENTERLINE
E E E		ELECTRIC LINES
RF RF RF		FIRE PROTECTION WATER LINE
RW RW RW		WATER DISTRIBUTION LINE
U/E U/E U/E		UNDERGROUND POWER LINE
S S S		SANITARY LINE
SS SS SS		STORM SEWER LINE



NOTE:

1. ALL SYMBOLS ARE NOT NECESSARILY USED ON THIS PROJECT.

ABBREVIATIONS

ITEM	DESCRIPTION
AB	ANCHOR BOLT
ALUM	ALUMINUM
ALT	ALTERNATE
AWS	AMERICAN WELDING INSTITUTE
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
ACI	AMERICAN CONCRETE INSTITUTE
AUTO	AUTOMATIC
AUX	AUXILIARY
@	AT
AVG	AVERAGE
APVD	APPROVED
BF	BLIND FLANGE
BOT	BOTTOM
C	CHANNEL(BEAM)
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CHK	CHECK, CHECKED
CJ	CONSTRUCTION JOINT
CLR	CLEAR
CL	CENTERLINE, CLEARANCE
CTR	CENTER
CONC	CONCRETE
CONT	CONTINUOUS
CPLG	COUPLING
CF	CUBIC FEET
CU IN	CUBIC INCHES
CY	CUBIC YARD
DET	DETAIL
DIP	DUCTILE IRON PIPE
DIA	DIAMETER
DP	DRAIN PIPE
DWG	DRAWING
E	EASTING COORDINATE
EA	EACH
EL	ELEVATION
ELB	ELBOW
ELEC	ELECTRICAL
ENG	ENGINEER
EQPT	EQUIPMENT
EW	EACH WAY
EWEF	EACH WAY EACH FACE
EXP	EXPANSION
EXP AB	EXPANSION ANCHOR BOLT
EXP JT	EXPANSION JOINT
EXIST	EXISTING
FC	FLEXIBLE COUPLING
FCA	FLANGED COUPLING ADAPTER
FF	FINISHED FLOOR
FFE	FINISHED FLOOR ELEVATION
FG	FINISHED GRADE
FL	FLOW LINE OR FLOOR
FLG	FLANGE
FIN	FINISH
FT	FOOT OR FEET
FTG	FOOTING
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GC	GROOVED COUPLING
GCF	GROOVED COUPLING FITTING
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
HGT, HT	HEIGHT
HORIZ	HORIZONTAL
HP	HORSEPOWER
HWL	HIGH WATER LEVEL
ID	INSIDE DIAMETER
IN	INCHES
INSTM	INSTRUMENT
INV	INVERT
IE	INVERT ELEVATION
IF	INSIDE FACE
JT	JOINT
KIP	THOUSAND POUNDS
KW	KILOWATT
L	LENGTH
LB	POUND
PCF	POUNDS PER CUBIC FEET
LF	LINEAR FEET
LT	LEFT
LWL	LOW WATER LEVEL
MAX	MAXIMUM
MECH	MECHANICAL
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MWS	MAXIMUM WATER SURFACE
N	NORTHING COORDINATE
NIC	NOT IN CONTRACT
NO.	NUMBER
NPT	NATIONAL PIPE TREADS
NTS	NOT TO SCALE
NWL	NORMAL WATER LEVEL
OC	ON CENTER
OF	OUTSIDE FACE
OD	OUTSIDE DIAMETER
OSHA	OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
OPNG	OPENING
OHWM	ORDINARY HIGH WATER MARK
P	PIPE
PC	POINT OF CURVATURE
PE	PLAIN END
PI	POINT OF INTERSECTION, POINT OF INFLECTION
PL	PLATE (STEEL)
POB	POINT OF BEGINING
POE	POINT OF ENDING
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH GAUGE
Q	FLOW
RAD	RADIUS
RDCR	REDUCER
REINF	REINFORCED, REINFORCING OR REINFORCE
REQ'D	REQUIRED
RST	REINFORCING STEEL
RTN	RETURN
S	SLOPE
SEC	SECONDARY,SECOND (TIME)
SECT	SECTION
SCHED	SCHEDULE
SHT	SHEET
SPEC	SPECIFICATIONS
SQ	SQUARE
SQ FT	SQUARE FOOT
SQIN	SQUARE INCH
SS	STAINLESS STEEL,STORM SEWER
STA	STATION
STD	STANDARD
STRUC	STRUCTURE, STRUCTURAL
STL	STEEL CONSTRUCTION
SYMN	SYMMETRICAL
T & B	TOP AND BOTTOM
TC	TOP OF CURB
T & G	TONGUE AND GROOVE
TAN	TANGENT
TE	TOP ELEVATION
TEMP	TEMPERATURE
THD	THREAD
TP	TURNING POINT
TS	TOP OF SLAB
TT	THRUST TIE
TW	TOP OF WALL
TYP	TYPICAL
USCS	UNIFIED SOIL CLASSIFICATION SYSTEM
V	VENT, VERTICAL, VOLTS
VERT	VERTICAL
W/	WITH
WS	WATER SURFACE
WS	WATERSTOP
WTR	WATER

NOTE:

1. ABBREVIATIONS SHOWN ON THIS SHEET APPLY TO THE ENTIRE SET OF DRAWINGS. LISTING OF ABBREVIATION DOES NOT IMPLY ALL ABBREVIATIONS HAVE BEEN USED ON THIS PROJECT. FOR ADDITIONAL ABBREVIATIONS REFER TO TECHNICAL SPECIFICATION SECTION 010900.

NO.	REMARKS	DATE	BY	APPV'D.

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RUNOFF AND EROSION CONTROL MEASURES AT FULLADOZA SITE

CULEBRA, PUERTO RICO

SHEET TITLE: LEGEND, SYMBOLS AND ABBREVIATIONS

DWG NO. G-103

DRAFT BY: GLME COOP	DATE: OCT/22/2015	SHEET NO. 3	
DESIGNED BY:	DATE:		
REVISED BY: J. MIRANDA	DATE: OCT/23/2015		
SUBMITTED BY: GLME COOP	DATE: OCT/23/2015	FILE: 01_G-103_FULLADOZA.DWG	

GENERAL NOTES:

1. THESE PLANS HAVE BEEN PREPARED FOLLOWING THE CONTRACT SPECIFICATIONS. IN THE EVENT OF AN OVERSIGHT, OMISSION, OR DISCREPANCY, CONTRACTOR SHALL FOLLOW ANY WRITTEN DIRECTIVE ISSUED BY THE OWNER.

2. ALL DISTANCES, COORDINATES AND ELEVATIONS ARE SHOWN IN METERS, UNLESS OTHERWISE INDICATED.

3. HORIZONTAL CONTROLS USED ON THESE DRAWINGS ARE REFERENCED TO NAD 83 (NA 2011, EPOCH 2010).

4. VERTICAL CONTROLS ARE REFERENCED TO MEAN SEA LEVEL (PRVD 2002).

5. CONTRACTOR SHALL COORDINATE WITH ALL CONCERNING GOVERNMENT AGENCIES AND OFFICES INCLUDING BUT NOT LIMITED TO ENVIRONMENTAL QUALITY BOARD, P.R. DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AND MUNICIPAL AGENCIES, PRIOR TO STARTING ANY CONSTRUCTION ACTIVITY.

6. CONTRACTOR SHALL COMPLY WITH PUERTO RICO ENVIRONMENTAL QUALITY BOARD REGULATIONS.

7. CONTRACTOR SHALL COMPLY WITH THE OSHA STANDARD REQUIREMENTS.

8. THE CONTRACTOR SHALL OBTAIN ALL PERMITS FOR AND ABIDE BY APPLICABLE STORM WATER RUNOFF AND/OR DISCHARGE REQUIREMENTS IN ACCORDANCE WITH THE REQUIREMENTS OF THE STATE AND FEDERAL AGENCIES. CONTRACTOR SHALL MINIMIZE AND CONTROL SOIL EROSION AND SEDIMENT RUNOFF. DISTURBED SURFACES SHALL BE RESTORED PER APPLICABLE REQUIREMENTS.

9. REMOVAL OF THE CONCRETE, ASPHALT OR ANY OTHER DEBRIS DISPOSAL SHALL COMPLY WITH GOVERNMENT GUIDELINES AND REGULATIONS AND PERMIT CONDITIONS.

10. THE CONTRACTOR SHALL CONTACT FISH AND WILDLIFE SERVICE OFFICE OR THE HERITAGE PROGRAM OF THE DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES IF ENDANGERED PLANT OR ANIMAL SPECIES ARE FOUND OR SUSPECTED TO OCCUR AT THE CONSTRUCTION SITE.

11. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL VERIFY LOCATION OF ALL EXISTING UTILITIES WHICH WILL OR MIGHT IMPACT THE CONTRACTOR'S WORK. IF THERE IS ANY DISCREPANCY BETWEEN THE PLANS AND THE ACTUAL FIELD CONDITIONS, THE CONTRACTOR SHALL NOTIFY THE ENGINEER BEFORE PROCEEDING WITH ANY WORK AND BEFORE ORDERING ANY MATERIALS AFFECTED BY THE DISCREPANCY.

12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE SAFETY, INTEGRITY AND STABILITY OF BUILDINGS, EMBANKMENTS, EXISTING PIPELINES OR ANY OTHER STRUCTURES OR UTILITIES IN THE VICINITY OF CONSTRUCTION OPERATION. THE USE OF SHEET PILING, FENCING OR ANY OTHER DEVICES TO ENSURE THE PROTECTION OF STRUCTURES OR UTILITIES SHALL BE INSTALLED AT CONTRACTOR'S EXPENSE.

13. HEAVY EQUIPMENT TO BE USED IN CONSTRUCTION SHALL BE IN GOOD CONDITION WITH ZERO OIL LEAKAGE.

14. CONTRACTOR SHALL ENSURE THE APPROPRIATE USE AND STORAGE OF EQUIPMENT AND MATERIALS USED DURING CONSTRUCTION IN ORDER TO AVOID ACCIDENTS WITH PEOPLE RELATED AND NOT RELATED TO CONSTRUCTION PROCESS.

15. TEMPORARY STOCKPILE AREA SHALL BE COORDINATED WITH OWNER.

16. CONTRACTOR SHALL AVOID DAMAGE DURING CONSTRUCTION TO EXISTING AND PRIVATE UTILITIES INCLUDING BUT NOT LIMITED TO POWER LINES, POTABLE WATER, STORM WATER, SANITARY SEWER, TELEPHONE AND CABLE T.V.. PRIMARY SERVICES INCLUDING BUT NOT LIMITED TO POTABLE WATER, ELECTRICITY, PHONE, WASTEWATER AND STORMWATER DRAINAGE SHALL BE MAINTAINED.

17. CONTRACTOR SHALL NOT LEAVE OPEN TRENCH AFTER DAILY END OF CONSTRUCTION.

18. FENCES, GATES, ROADWAYS DRIVES, GROUND SURFACES, ETC..., SHALL BE LEFT IN A CONDITION EQUAL TO OR BETTER THAN THAT FOUND.

19. UPON COMPLETION OF CONSTRUCTION, FINISHED GRADES SHALL BE BROUGHT BACK TO PRE-CONSTRUCTION CONDITION OR SHALL BE AS SPECIFIED IN CONSTRUCTION DRAWINGS, WHICH EVER THE CASE.

NO.	REMARKS	DATE	BY	APPV'D.

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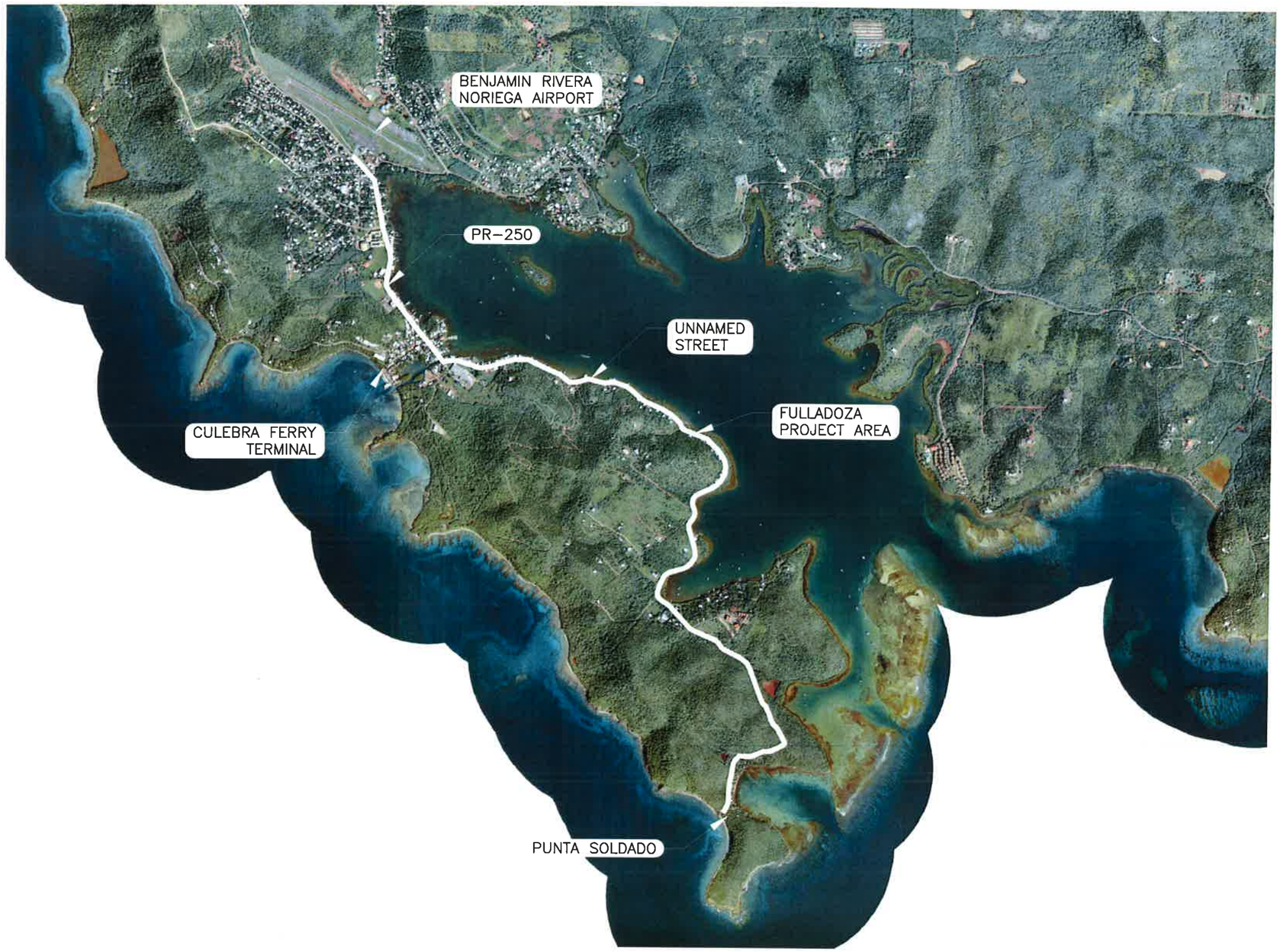
RUNOFF AND EROSION CONTROL MEASURES AT FULLADOZA SITE

CULEBRA, PUERTO RICO

SHEET TITLE: GENERAL NOTES

DWG NO.: G-104

DRAFT BY: GLME COOP	DATE: OCT/22/2015	SHEET NO.: 4	
DESIGNED BY:	DATE:		
REVISED BY: J. MIRANDA	DATE: OCT/23/2015		
SUBMITTED BY: GLME COOP	DATE: OCT/23/2015	FILE: 01_G-104_FULLADOZA.DWG	



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RUNOFF AND EROSION CONTROL MEASURES AT FULLADOZA SITE

CULEBRA, PUERTO RICO

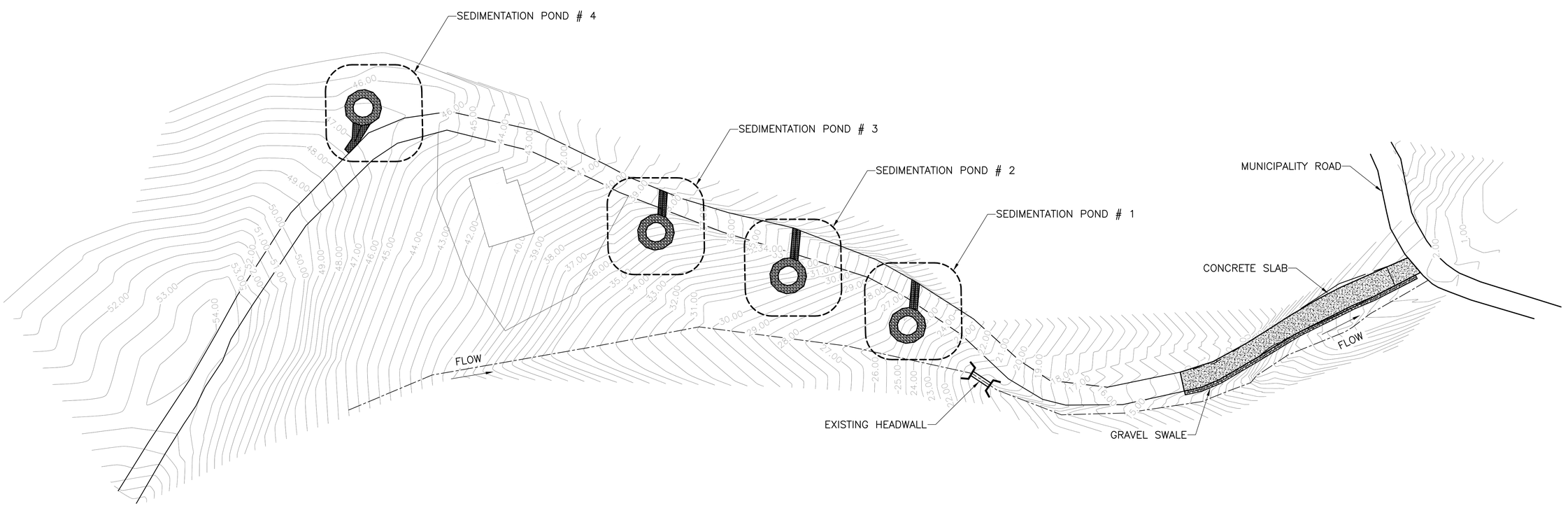
PROJECT SITE LOCATION

GLME COOP	OCT/22/2015	
J. MIRANDA	OCT/23/2015	
GLME COOP	OCT/23/2015	91_G-105_FULLADOZA.DWG

NTS

G-105

5



NO.	REMARKS	DATE	BY	APPV'D.

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RUNOFF AND EROSION CONTROL MEASURES AT FULLADOZA SITE

CULEBRA, PUERTO RICO

SHEET TITLE: PROJECT KEY MAP

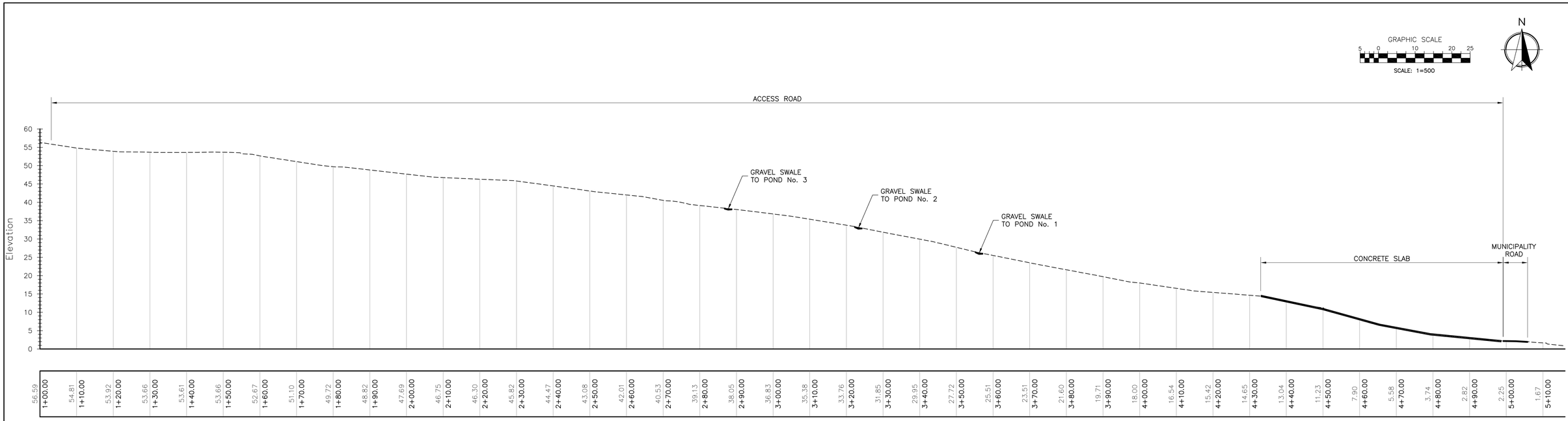
1:500

DWG NO: C-101

DRAFT BY: GLME COOP	DATE: OCT/22/2015
DESIGNED BY:	DATE:
REVISED BY: J. MIRANDA	DATE: OCT/23/2015
SUBMITTED BY: GLME COOP	DATE: OCT/23/2015

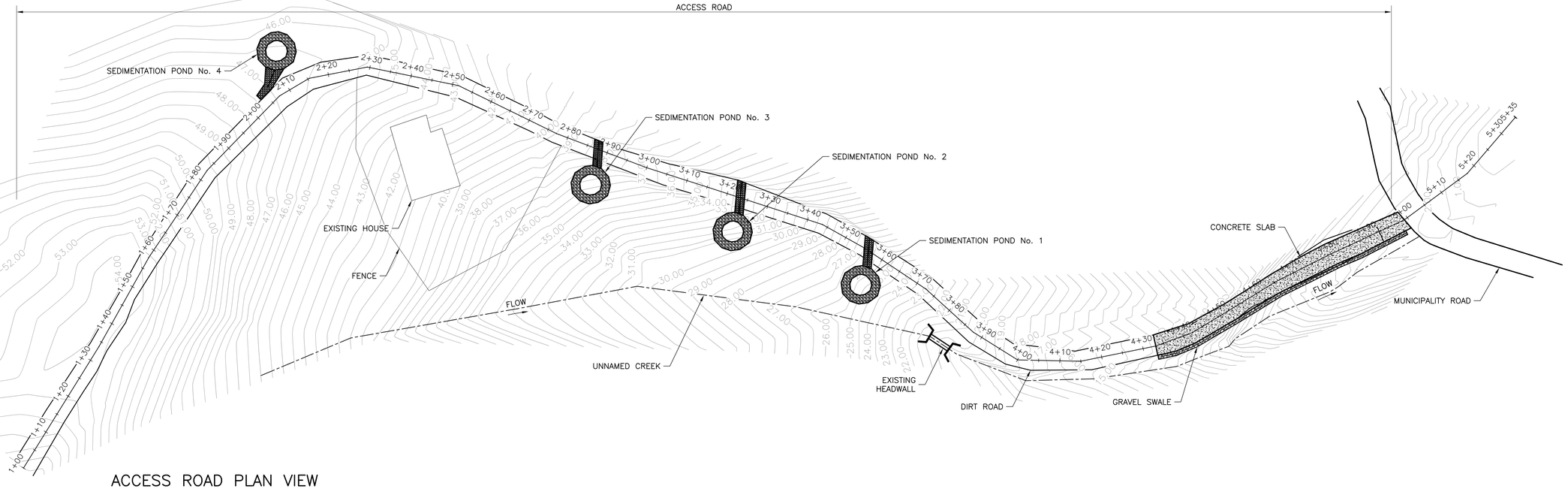
SHEET NO. 6

FILE: 02_C-101_FULLADOZA.DWG



ACCESS ROAD PROFILE VIEW

SCALE: 1=500



ACCESS ROAD PLAN VIEW

SCALE: 1=500

NO.	REMARKS	DATE	BY	APPV'D.

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SHEET TITLE: ACCESS DIRT ROAD PLAN AND PROFILE

1:500

DWG NO. C-102

DRAFT BY: GLME COOP	DATE: OCT/22/2015	SHEET NO. 7	
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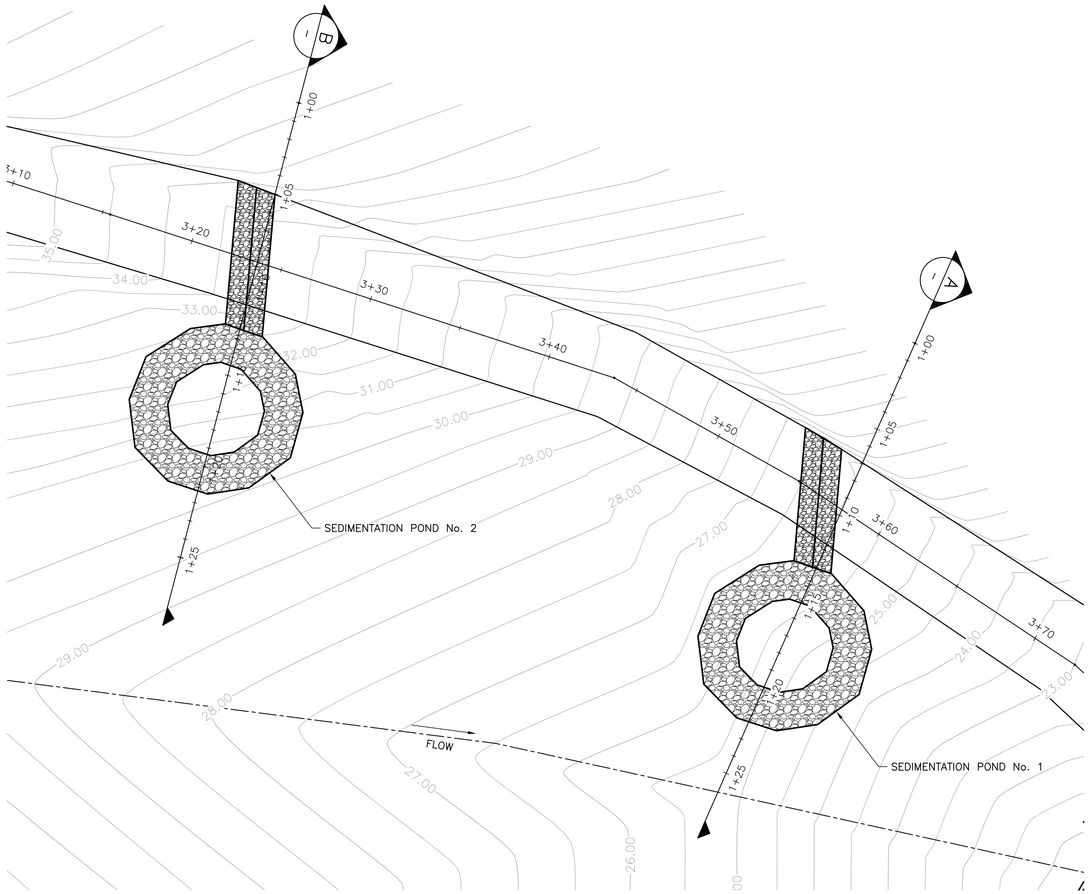
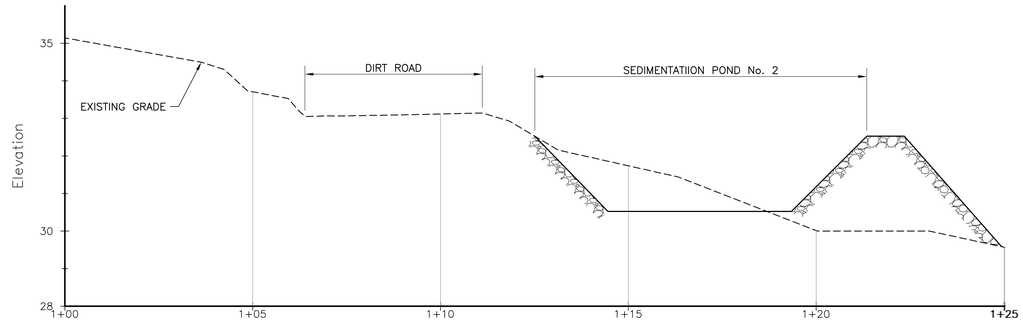


SEDIMENTATION POND NO. 1 AND NO. 2 PLAN VIEW

SCALE: 1=200



SEDIMENTATION POND No. 2 SECTION VIEW

SCALE: 1=75

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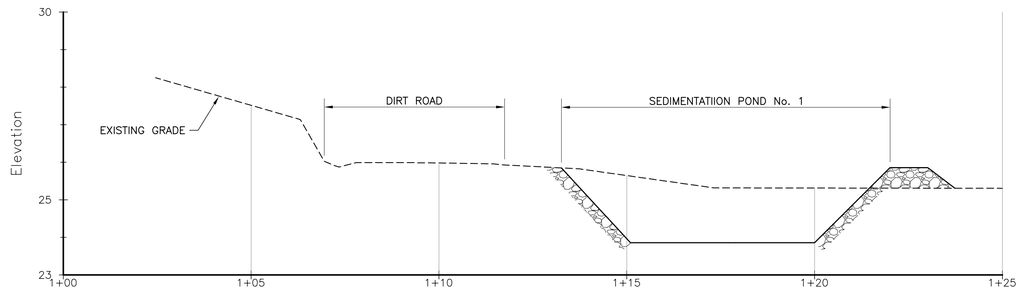

SEDIMENTATION POND No. 1 SECTION VIEW

SCALE: 1=75

A
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N

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SCALE: 1=75

GRAPHIC SCALE
2 1 0 1 2 3 4 5 6 7
SCALE: 1=150

NO.	REMARKS	DATE	BY	APPV'D.

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RUNOFF AND EROSION CONTROL MEASURES AT FULLADOZA SITE

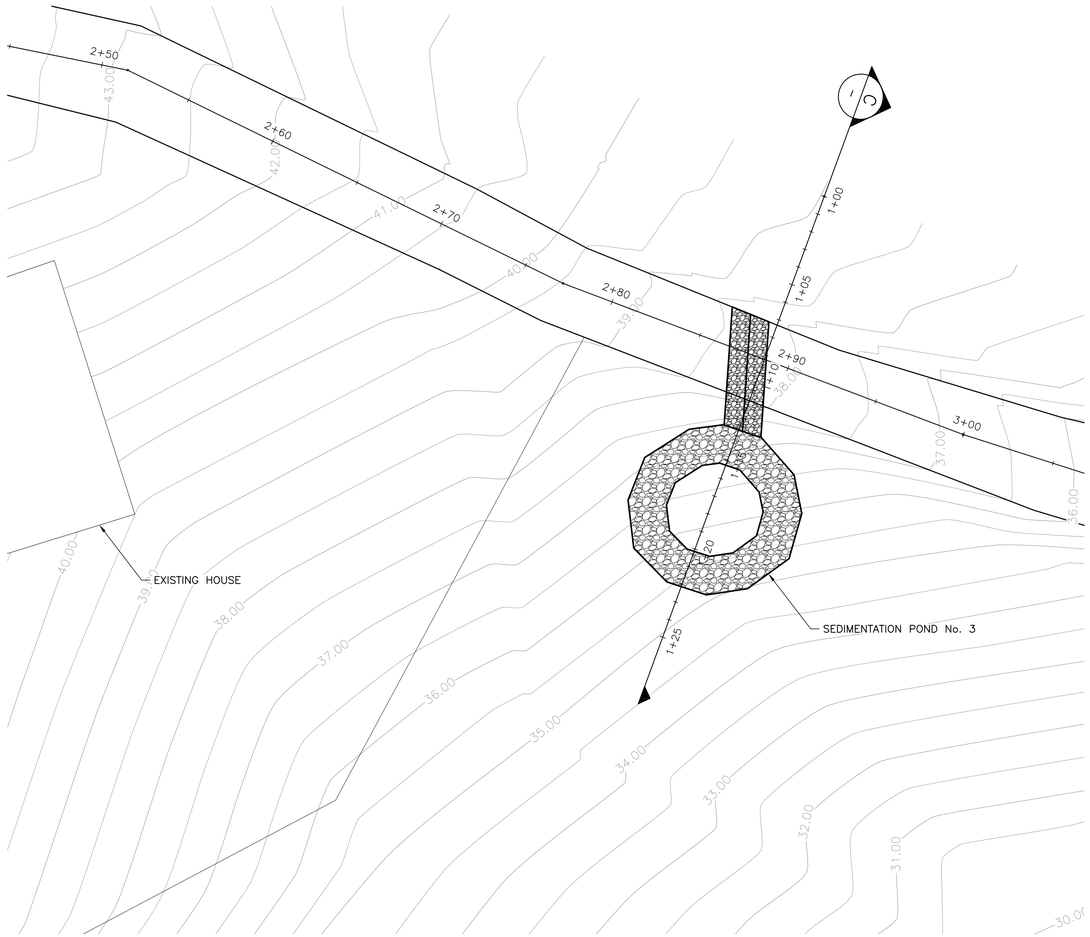
CULEBRA, PUERTO RICO

SHEET TITLE
SEDIMENTATION POND No. 1 AND No. 2 PLAN AND SECTION

AS SHOWN

DWG NO.
C-103

DRAFT BY: GLME COOP	DATE: OCT/22/2015	SHEET NO.	8
DESIGNED BY:	DATE:		
REVISED BY: J. MIRANDA	DATE: OCT/23/2015		
SUBMITTED BY: GLME COOP	DATE: OCT/23/2015	FILE:	02_C-103_FULLADOZA.DWG



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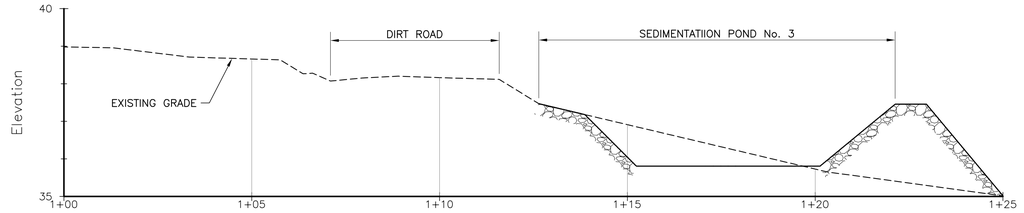

SEDIMENTATION POND No. 3 SECTION VIEW

SCALE: 1=75

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1

N

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SCALE: 1=75

GRAPHIC SCALE
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SCALE: 1=150

NO.	REMARKS	DATE	BY	APPV'D.

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RUNOFF AND EROSION CONTROL MEASURES AT FULLADOZA SITE

CULEBRA, PUERTO RICO

SHEET TITLE: SEDIMENTATION POND No. 3 PLAN AND SECTION

AS SHOWN

DWG NO. C-104

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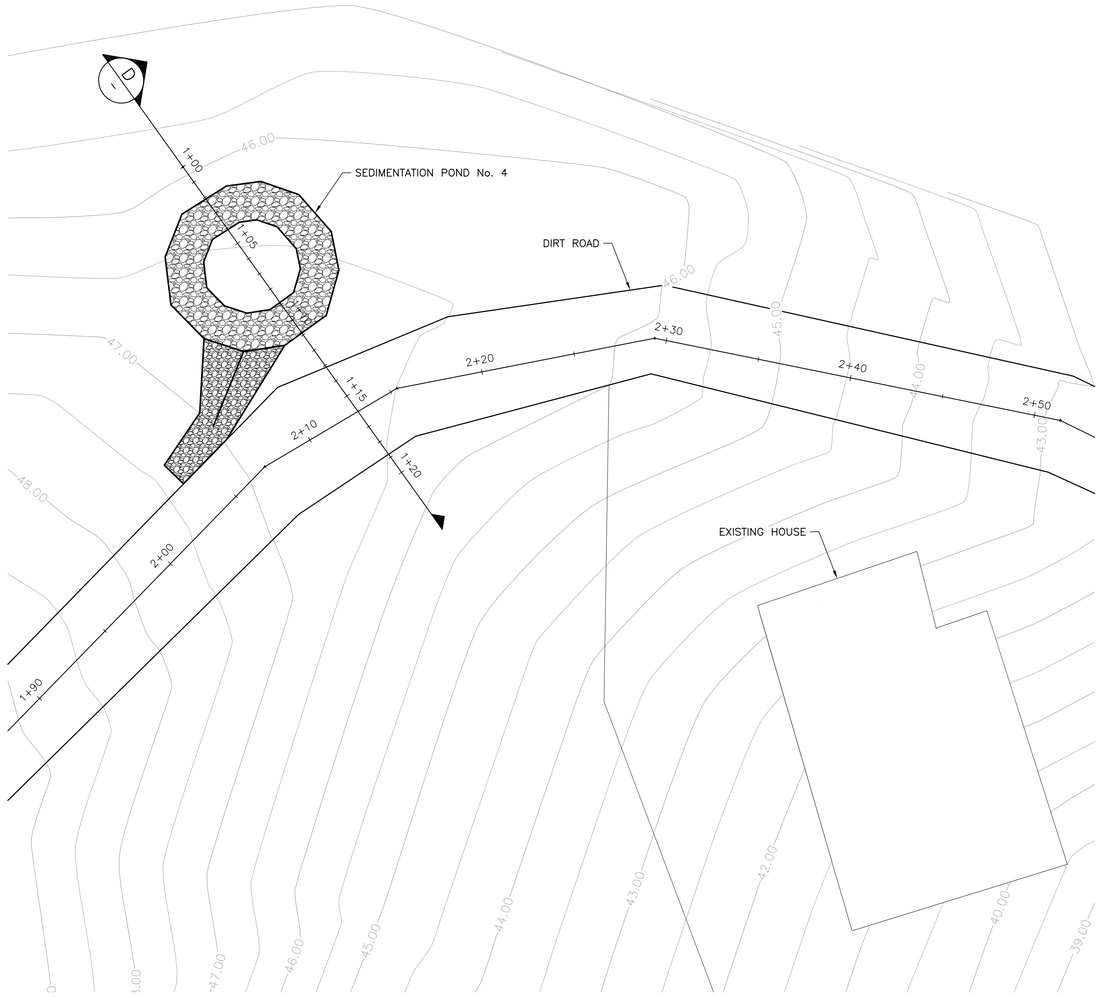

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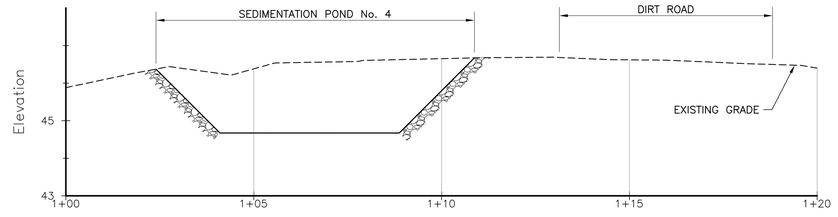

SEDIMENTATION POND No. 4 SECTION VIEW

SCALE: 1=75

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N

GRAPHIC SCALE

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SCALE: 1=75

GRAPHIC SCALE

2 1 0 1 2 3 4 5 6 7

SCALE: 1=150

NO.	REMARKS	DATE	BY	APPV'D.

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SHEET TITLE
SEDIMENTATION POND No. 4
PLAN AND SECTION

AS SHOWN

DWG NO.
C-105

DRAFT BY: GLME COOP	DATE: OCT/22/2015	SHEET NO.	10
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REVISED BY: J. MIRANDA	DATE: OCT/23/2015		
SUBMITTED BY: GLME COOP	DATE: OCT/23/2015	FILE:	02_C-105_FULLADOZA.DWG