Fugro USA Land, Inc.
CPRA Lidar 2019
Ground Control and Checkpoints
Area of Interest 3
Survey Completed on:
April 18, 2019

Submitted to:
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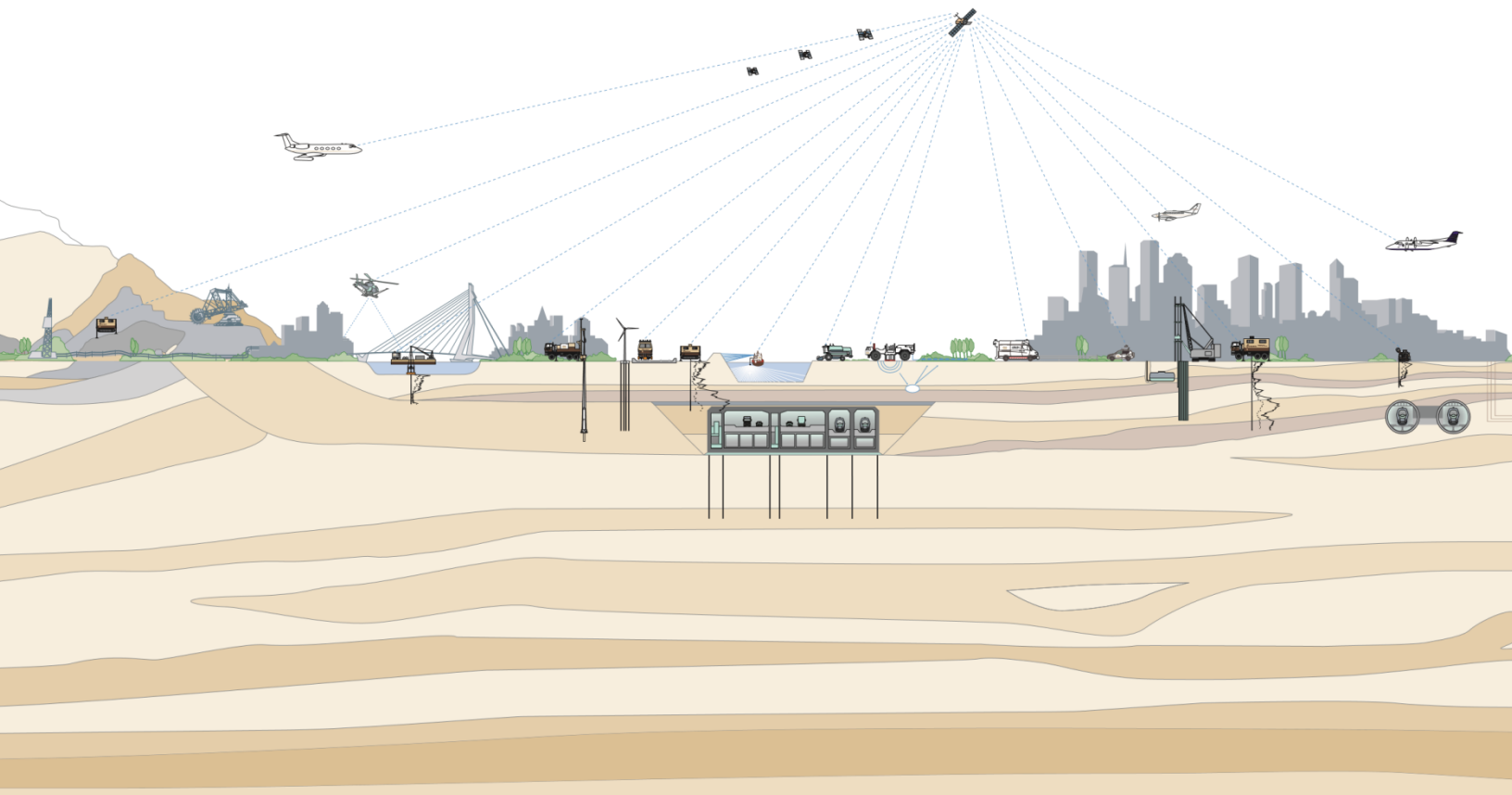
FUGRO Job No. 04.33780163



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1 COMPANY INFORMATION

Fugro is an internationally-acclaimed consulting firm that specializes in the provision of technical data and information required to design, construct, and maintain large structures and infrastructure in a safe, reliable, and efficient manner. We have been at the forefront of providing geospatial knowledge for over 50 years. Our complete geospatial approach assists our clients through the entire life span of a project: We begin with feasibility and continue through to post-construction and maintenance. Our comprehensive, integrated survey services have been used by a diverse set of industries including oil and gas, rail, electric utility, and government agencies. Access to Fugro's global resources allows us to deliver optimal solutions for projects of every scale.

Fugro is a global company with approximately 10,500 employees in 60 countries, including an active office in Lafayette, Louisiana. Fugro USA Land, Inc. is a wholly-owned subsidiary of Fugro NV, a Dutch corporation whose shares are publicly traded on the Amsterdam Mid-Cap Exchange. Throughout the world the multiple Fugro offices work as One Fugro to provide the most experience and best possible solutions for our clients. Fugro holds a strong market position due to in-house developed technologies, high value services, and a strong international and regional presence. Our highly-qualified specialists work with modern technologies and systems at locations all over the world.

John Chance Land Surveys, Inc. was established in 1957 under the name "John E. Chance & Associates" and joined the Fugro Family of Companies in 1992. Our mission is to serve as a purveyor of geospatial knowledge and to provide customized geospatial solutions designed to accurately measure and characterize the earth for customer projects. We have continuously provided survey services within the Gulf Coast region for 60 years.

Fugro provides registered, licensed Professional Land Surveyors in Louisiana, Alabama and Texas. We provide an ecological and regulatory services group able to conduct wetland delineations, oyster assessments, threatened and endangered species surveys, and other ecological studies. In addition, this group is able to obtain necessary federal, state, and local permits. Fugro also offers hydrographic survey services for underwater projects such as oyster assessments, bathymetric hazard surveys, and coastal restoration projects. Furthermore, we provide high-precision FLI-MAP aerial LiDAR technology for linear projects such as rail, pipeline, and transmission line route surveys. As needed, 3D laser scanning services are also available.

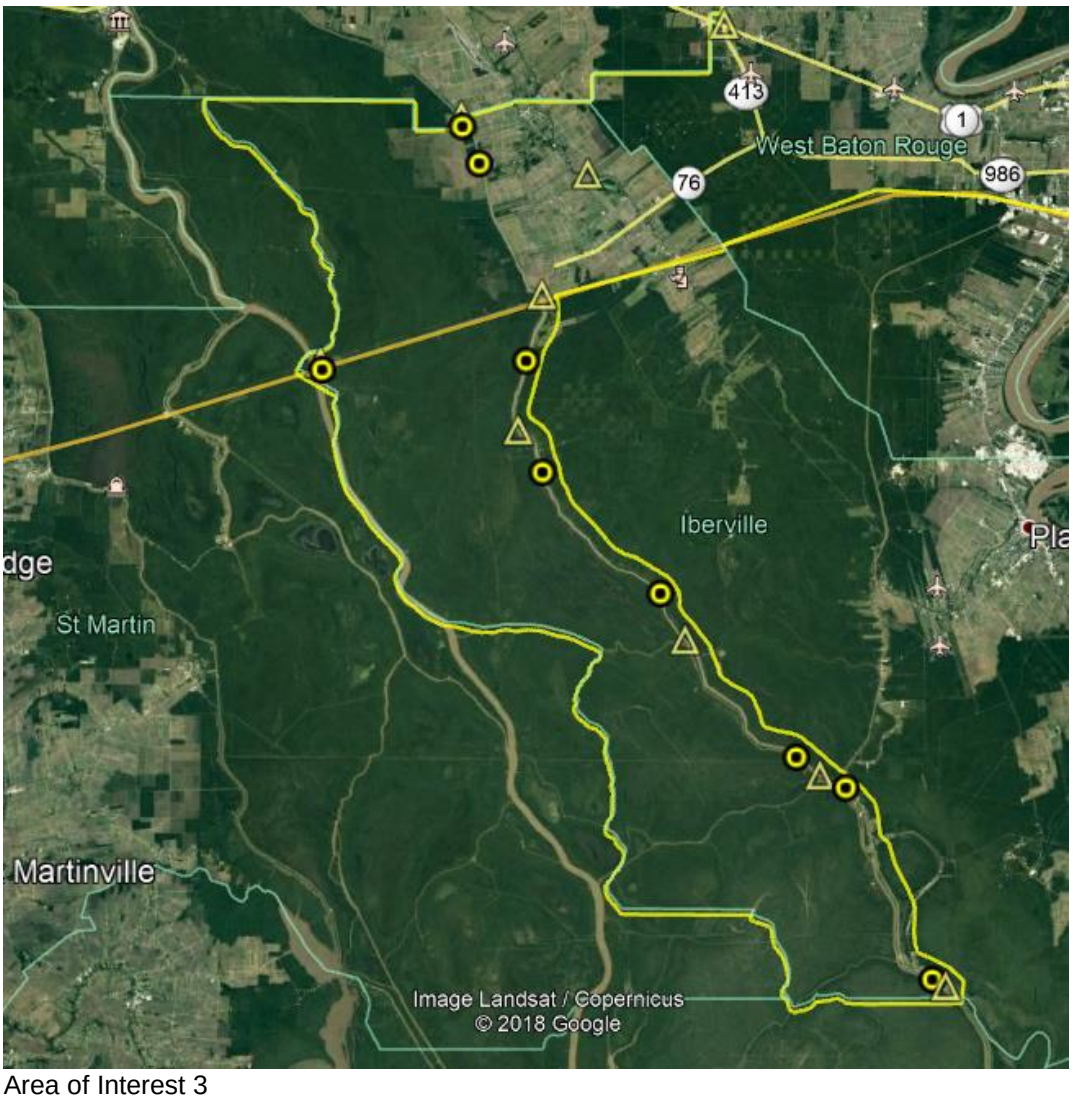
2 PROJECT OVERVIEW

2.1 Project Purpose

Fugro USA Land, Inc. of Lafayette, LA was tasked by Fugro USA Land, Inc. of Fredrick, MD to perform a ground control and checkpoint survey in support of LiDAR data collection of the for the CPRA LiDAR 2019 project. All data and information were conducted under the supervision of a Louisiana RPLS.

A total of 8 ground control points and 9 checkpoints were collected over the course of 2 days.

2.2 Project Location



Area of Interest 3

3 SURVEY METHODOLOGY

3.1 Global Positioning System

Global Positioning System (GPS) was used in Static Differential mode and 20+minute fast static sessions were collected for the required ground control and checkpoints. Post Processing Kinematics (PPK) was used to process the precise positions of the required control and checkpoints by adjusting to the nearest Continuously Operating Reference Stations (CORS) using a single baseline adjustment. OPUS was used as an independent verification to ensure that that the transformation from WGS84 to NAD83(2011) is correct.

3.2 Trimble Business Center

Trimble Business Center (TBC) was used to process the baseline adjustment from the collected points to the CORS.

TBC's provided results are reported at 95% confidence horizontally and vertically.

3.3 Survey Control Coordinate Systems

Horizontal Datum	Vertical Datum	Geoid Model	Projection	Units
Geographic NAD83(2011)	Ellipsoidal	N/A	N/A	DD.DDDD
NAD83(2011)	NAVD88	Geiod12b	Universal Transverse Mercator (Zone 15 North)	Meters

3.4 Results - Adjusted Lidar Ground Control Points coordinates

3.4.1 Nad83(2011) Geographic Coordinates (DD.dddd)

Point ID	Latitude	Longitude	Ellipsoid Height (Meter)	Feature Code
1044	30.46110155	-91.48444231	-20.526	AOI-3-GCP1
1040	30.4019222	-91.50993913	-22.303	AOI-3-GCP2
1037	30.36848282	-91.63505779	-18.106	AOI-3-GCP3
1043	30.48869043	-91.55635528	-22.093	AOI-3-GCP4
1027	30.06508573	-91.28044067	-24.436	AOI-3-GCP5
1030	30.16797508	-91.35171332	-24.42	AOI-3-GCP6
1032	30.23392344	-91.42831786	-23.313	AOI-3-GCP7
1035	30.33584645	-91.52315314	-23.153	AOI-3-GCP8

3.4.2 NAD83(2011) Universal Transverse Mercator (Zone 15 North) (Meters)

Point ID	Northing	Easting	Elevation (NAVD88)	Description
1044	3370856.631	645499.861	6.773	AOI-3-GCP1
1040	3364265.000	643138.206	4.993	AOI-3-GCP2
1037	3360407.322	631162.557	9.217	AOI-3-GCP3
1043	3373823.986	638556.101	5.244	AOI-3-GCP4
1027	3327243.730	665751.672	2.204	AOI-3-GCP5
1030	3338546.067	658715.94	2.507	AOI-3-GCP6
1032	3345751.069	651237.748	3.788	AOI-3-GCP7
1035	3356925.025	641964.158	4.108	AOI-3-GCP8

3.5 Results - Adjusted Lidar Check Points coordinates

3.5.1 NAD83(2011) Geographic Coordinates (DD.dddd)

Point ID	Latitude	Longitude	Ellipsoid Height (Meters)	Feature Code
1042	30.48470473	-91.55476975	-21.773	AOI-3-NVA-1
1036	30.37048458	-91.51801924	-21.464	AOI-3-NVA-2
1033	30.25736395	-91.44175914	-21.671	AOI-3-NVA-3
1031	30.1775263	-91.36444919	-24.843	AOI-3-NVA-4
1028	30.06902041	-91.28722407	-24.146	AOI-3-NVA-5
1038	30.36551048	-91.63329008	-20.248	AOI-3-VVA-FOR-6
1041	30.46612552	-91.54565048	-22.738	AOI-3-VVA-NONFOR-7
1034	30.31617254	-91.50834325	-23.512	AOI-3-VVA-NONFOR-8
1029	30.162841	-91.33642927	-24.961	AOI-3-VVA-NONFOR-9

3.5.2 NAD83(2011) Universal Transverse Mercator (Zone 15 North) (Meters)

Point ID	Northing	Easting	Elevation	Feature Code
1042	3373384.183	638713.944	5.563	AOI-3-NVA-1
1036	3360770.487	642407.526	5.818	AOI-3-NVA-2
1033	3348331.246	649908.58	5.471	AOI-3-NVA-3
1031	3339586.995	657474.225	2.114	AOI-3-NVA-4
1028	3327670.011	665091.176	2.508	AOI-3-NVA-5
1038	3360079.946	631336.412	7.073	AOI-3-VVA-FOR-6
1041	3371336.222	639615.823	4.594	AOI-3-VVA-NONFOR-7

1034	3354763.155	643416.609	3.724	AOI-3-VVA-NONFOR-8
1029	3337998.42	660196.173	1.946	AOI-3-VVA-NONFOR-9

3.6 Ground Control Points Photographs

3.6.1 AOI-3 Ground Control Point 001

AOI-3 GCP 001 Asphalt road

AOI-3 GCP 001 Asphalt road

3.6.2 AOI-3 Ground Control Point 002

AOI-3 GCP 002 Gravel road

AOI-3 GCP 002 Gravel road

3.6.3 AOI-3 Ground Control Point 003

AOI-3 GCP 003 Gravel road

AOI-3 GCP 003 Gravel road

3.6.4 AOI-3 Ground Control Point 004

AOI-3 GCP 004 Asphalt road

AOI-3 GCP 004 Asphalt road

3.6.5 AOI-3 Ground Control Point 005

AOI-3 GCP 005 Gravel road

AOI-3 GCP 005 Gravel road

3.6.6 AOI-3 Ground Control Point 006

AOI-3 GCP 006 Concrete

AOI-3 GCP 006 Concrete

3.6.7 AOI-3 Ground Control Point 007

AOI-3 GCP 007 Gravel road

AOI-3 GCP 007 Gravel road

3.6.8 AOI-3 Ground Control Point 008

AOI-3 GCP 008 Gravel road

AOI-3 GCP 008 Gravel road

3.7 Checkpoints Photographs

3.7.1 AOI-3 NVA 001

AOI-3 NVA 001 Gravel road

AOI-3 NVA 001 Gravel road

3.7.2 AOI-3 NVA 002

AOI-3 NVA 002 Gravel road

AOI-3 NVA 002 Gravel road

3.7.3 AOI-3 NVA 003

AOI-3 NVA 003 Gravel road

AOI-3 NVA 003 Gravel road

3.7.4 AOI-3 NVA 004

AOI-3 NVA 004 Gravel road

AOI-3 NVA 004 Gravel road

3.7.5 AOI-3 NVA 005

AOI-3 NVA 005 Gravel road

AOI-3 NVA 005 Gravel road

3.7.6 AOI-3 VVA-FOR 006

AOI-3 VVA-FOR 006 Tall grass near tree line

AOI-3 VVA-FOR 006 Tall grass near tree line

3.7.7 AOI-3 VVA-NONFOR 007

AOI-3 VVA-NONFOR 007 Tall grass

AOI-3 VVA-NONFOR 007 Tall grass

3.7.8 AOI-3 VVA-NONFOR 008

AOI-3 VVA-NONFOR 008 Grass field

AOI-3 VVA-NONFOR 008 Grass field

3.7.9 AOI-3 VVA-NONFOR 009

AOI-3 VVA-NONFOR 009 Short grass

AOI-3 VVA-NONFOR 009 Short grass

3.8 Baseline Processing Report (CORS data) (meters) (95%)

Observation	From	To	Solution Type	H. Prec.(Meter)	V. Prec.(Meter)	Geodetic Az.	Ellipsoid Dist.(Meter)	ΔHeight(Meter
BSRL --- 1027 (B47)	BSRL	1027	Fixed	0.009	0.016	151°52'45"	8624.87	-2.003
BSRL --- 1028 (B46)	BSRL	1028	Fixed	0.009	0.015	154°33'39"	7940.724	-1.713
BSRL --- 1029 (B45)	BSRL	1029	Fixed	0.011	0.023	337°34'58"	3493.15	-2.528
BSRL --- 1030 (B44)	BSRL	1030	Fixed	0.007	0.013	323°33'51"	4721.56	-1.987
BSRL --- 1031 (B43)	BSRL	1031	Fixed	0.008	0.015	320°19'00"	6312.206	-2.41
BSRL --- 1032 (B42)	BSRL	1032	Fixed	0.01	0.018	317°31'16"	15068.882	-0.88
BSRL --- 1033 (B41)	BSRL	1033	Fixed	0.01	0.015	320°05'50"	17876.3	0.762
BSRL --- 1034 (B40)	BSRL	1034	Fixed	0.008	0.013	318°34'09"	26997.396	-1.079
BSRL --- 1035 (B39)	BSRL	1035	Fixed	0.008	0.015	319°18'18"	29576.87	-0.72
BSRL --- 1036 (B38)	BSRL	1036	Fixed	0.008	0.014	324°25'35"	32290.331	0.969
1LSU --- 1040 (B57)	1LSU	1040	Fixed	0.01	0.025	268°58'53"	31686.079	-17.092
1LSU --- 1041 (B56)	1LSU	1041	Fixed	0.008	0.014	280°35'48"	35698.57	-17.527
1LSU --- 1044 (B53)	1LSU	1044	Fixed	0.013	0.022	281°35'18"	29821.202	-15.315
TONY --- 1037 (B67)	TONY	1037	Fixed	0.007	0.014	67°26'08"	42684.763	-12.549
TONY --- 1038 (B66)	TONY	1038	Fixed	0.052	0.039	67°55'51"	42718.176	-14.691
THHR --- 1042 (B72)	THHR	1042	Fixed	0.021	0.02	95°27'57"	50718.172	-24.501
THHR --- 1043 (B71)	THHR	1043	Fixed	0.008	0.013	94°59'05"	50524.353	-24.821

3.9 Online positioning user service (OPUS) results

Accuracy

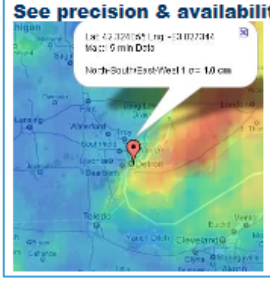
How accurate is it?

Under normal conditions, most positions can be resolved to within a few centimeters. Estimating the accuracy for a specific solution is difficult, however, as formal error propagation is notoriously optimistic for GPS reductions. Systematic errors, such as misidentification of antenna or height, are not detected. Local multipath or adverse atmospheric conditions may also negatively impact your solution.

Static: Static processing provides "peak-to-peak" errors for each coordinate (X, Y, Z, Φ, λ, h, and H). These describe the error range, the disagreement between the 3 baseline solutions, as shown above.

One advantage of peak-to-peak errors is that they include any error from the CORS reference coordinates.

See precision & availability



Rapid static: Absent any warning messages, the best estimates of coordinate accuracy are the standard deviations reported by single baseline analysis. Our experiments indicate that the actual error is less than these estimated accuracies more than 95 percent of the time.

Source: https://www.ngs.noaa.gov/OPUS/about.jsp

3.9.1 Opus results for point number 1038 compared to results provided from single point baseline processing

Details	
Grid azimuth:	98°19'41"
Grid distance:	0.01142 m
Δ Elevation:	0.03489 m
Geodetic azimuth:	99°01'08"
Forward:	99°01'08"
Backward:	279°01'08"
Ellipsoid distance:	0.01142 m
Ground distance	
Geodetic:	0.01142 m
Δ Height:	0.03489 m

1038	3360079.946	631336.4121	7.07288	AOI-3-VVA-FOR-6

FILE: 27721081.19o OP1555941138792

NGS OPUS-RS SOLUTION REPORT
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All computed coordinate accuracies are listed as 1-sigma RMS values.
For additional information: https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy

USER: lcastille@fugro.com DATE: April 22, 2019
RINEX FILE: 2772108m.19o TIME: 13:54:21 UTC

SOFTWARE: rsgps 1.38 RS54.prl 1.99.3 START: 2019/04/18 12:36:59
EPHEMERIS: igr20494.eph [rapid] STOP: 2019/04/18 12:57:43
NAV FILE: brdc1080.19n OBS USED: 1232 / 1456 : 85%
ANT NAME: TRMR8_GNSS3 NONE QUALITY IND. 15.70/ 6.41
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.469

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2019.29461)

X:	-156987.604(m)	0.009(m)	-156988.435(m)	0.009(m)
Y:	-5505630.263(m)	0.029(m)	-5505628.779(m)	0.029(m)
Z:	3205389.016(m)	0.019(m)	3205388.830(m)	0.019(m)
LAT:	30 21 55.83766	0.010(m)	30 21 55.85638	0.010(m)
E LON:	268 22 0.15614	0.010(m)	268 22 0.12346	0.010(m)
W LON:	91 37 59.84386	0.010(m)	91 37 59.87654	0.010(m)
EL HGT:	-20.213(m)	0.033(m)	-21.566(m)	0.033(m)
ORTHO HGT:	7.108(m)	0.035(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES (UTM (Zone 15))	STATE PLANE COORDINATES (SPC (1702 LA S))
Northing (Y) [meters]	3360079.945	206820.270
Easting (X) [meters]	631336.423	971166.541
Convergence [degrees]	0.69099167	-0.14998333
Point Scale	0.99981280	0.99994592
Combined Factor	0.99981597	0.99994909

US NATIONAL GRID DESIGNATOR: 15RXP3133660079(NAD 83)

4 QUALITY ASSURANCE

Fugro has a totally integrated Quality Assurance System that is documented, implemented, and under the control of a Quality Manager. Certification and compliance of this system to the ISO standards listed below verifies our commitment to meet customer needs by providing the proper policies, procedures, and resources. The Quality Assurance System is used to provide job control and promote optimal client communication during all stages of a project – from the initial proposal to final invoicing. Implementation of our Quality Assurance System assures compliance with all applicable regulatory and ecological requirements. For data management, the Fugro Quality System provides checks to validate and confirm that all survey data and processed data are interpreted and stored as required. The effectiveness of these business and operational processes are monitored, measured and analyzed as part of our compulsory quarterly Management Review of the Quality Assurance System which includes surveillance audits and certification renewal audits.

Fugro has qualified for and applied the following standards to our business and operational activities:

Quality Management System:
ISO 9001:2008
Certificate NO. UQA 4000406/AB
Approved by: Lloyd's Register Quality Assurance
Provision of Advanced Surveying, Mapping, Regulatory and Ecological Services for Land Applications and Airborne LIDAR data Collection and Interpretation

Environmental Management System:
ISO 14001:2004
Certificate NO. UQA 4000406/CB
Approved by: Lloyd's Register Quality Assurance
Provision of Advanced Surveying, Mapping, Regulatory and Ecological Services for Land Applications and Airborne LIDAR data Collection and Interpretation

Occupational Health & Safety Management System:
OHSAS 18001:2007
Certificate NO. UQA 4000406/BB
Approved by: Lloyd's Register Quality Assurance
Provision of Advanced Surveying, Mapping, Regulatory and Ecological Services for Land Applications and Airborne LIDAR data Collection and Interpretation

If desired, Fugro can develop and implement a specific project Quality Assurance/Quality Control (QA/QC) plan for this project. Fugro ensures that all surveys and associated documentation will be accurate and will comply with accepted Industry Standards.

5 SAFETY

Fugro has developed and implemented an Occupational Health & Safety (OH&S) and Environmental Management System (EMS) to satisfy the needs of our customers, employees, shareholders, and community. We continually strive to improve our employee and company performance in the areas of health, safety, and protection of the environment. Fugro assures that ALL required safety equipment and gear including personal protective equipment (PPE) were utilized on this project.

Fugro also strives to prevent wasteful and inefficient operations, avoid damage to property and equipment, show respect for the environment, and, foremost, to protect the safety and well-being of all employees. Fugro employees received all safety training as specified in the contract.

The schedule of safety meetings and drills executed for this project included but were not limited to:

- Pre-job safety meetings;
- Pre-job vessel health, safety, and environmental orientation including man overboard, fire, and abandon ship drills;
- Daily tailgate safety meetings prior to each day's operations;
- When a new procedure or piece of equipment is introduced, including a written Job Safety Analysis; and
- Document a Near Miss accident or Injury.

Fugro ensures compliance with all applicable rules, regulations, orders, standards and interpretations promulgated under the Occupational Safety and Health Act (1997) and all other applicable laws, ordinances, rules, regulations and orders of anybody having jurisdiction over safety and health of persons or property or the protection of same to protect them from injury, illness, damage or loss. The Fugro Survey Project Manager or his designee conducted and documented a daily safety meeting at the beginning of each work day. A copy of the daily safety meeting minutes will be furnished upon request.

Fugro ensures that Personal Protective Equipment (PPE) will be utilized and maintained in accordance with the written PPE program. Training in the proper use, maintenance and inspection of PPE is provided to all Fugro employees prior to beginning work. Fugro will supply all required PPE required at the work site. Unless otherwise specified, the minimum PPE includes:

- Hard hats
- Safety glasses with side shields or side impact protection as necessary
- Safety toe shoes/boots (steel/composite toe or approved toe caps)
- Protective clothing with high visibility vest
- Task appropriate gloves

6 CONTACT INFORMATION

By use of these specific contact points, Fugro ensures quality control and prompt action with respect to all project-related issues.

Morgan Reed: For all corporate, legal, and contractual issues

David Cormier, PLS: For all operational QA/QC issues from mobilization through final product delivery and for final project responsibility

CONTACT INFORMATION			
	Fugro USA Land, Inc. 226 Dulles Drive Lafayette, LA 70506		
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Professional Land Surveyor	David Cormier, RPLS	337.268.3293	d.cormier@fugro.com
Project Manager	Jesse Kibodeaux	337.268.4556	jkibodeaux@fugro.com
Regional QHSEE Manager	Cathy Morris	713.346.4016	cmorris@fugro.com
QHSEE Advisor	Faron Olivier	337.268.3389	folivier@fugro.com

This geodetic survey was conducted under my direct supervision.

David L. Cormier
Professional Land Surveyor
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License VF.0000794