Oil & Natural Gas Technology

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Quarterly Research Performance Progress Report

(Period ending 09/30/2015)

Advanced Hydrate Reservoir Modeling Using Rock Physics Techniques

10/1/2012 – 3/31/2016

Submitted by:
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Executive Summary

This research effort focuses on developing and refining techniques that integrate rock physics modeling, amplitude analysis, and spectral decomposition to characterize complex gas hydrate reservoirs. The expected outcome of the research efforts will be an enhanced ability to quantitatively evaluate and prioritize potential gas hydrate accumulations that may be selected as exploration drilling targets based on 3-D seismic data.

On March 19th, Fugro Multi-Client Services agreed to in principle to provide a research license for these 3D seismic data in the Lund and The Elbow protraction areas, offshore Florida, for this research project. The dataset cover a large area of the United States' Lund and The Elbow protraction areas in the Eastern Gulf of Mexico. The data were received and loaded for interpretation on April 22nd. On June 1, Fugro Multi-Client Services sold the seismic data to Spectrum ASA. On June 29th, we were informed that Spectrum ASA would honor an effective research license of the seismic data for this project. Interpretation and screening for potential gas hydrate deposits and setting the budget and tasks to finish this project were the principal efforts in this quarter.

Accomplishments to date

- Reviewed related scientific/industry research efforts.
- Identified relevant research concepts.
- Investigated well logs data in WR 313 and GC955
- Selection of initial rock physics model.
- Progress on selection of possible statistical classification techniques.
- Contact with communities of interest after the award announcement. USGS, Colombian Petroleum Institute, KIGAM, Guanzhou Marine Geological Survey, Shell, BP, Chevron, Petronas, National University of Singapore, and Texas A&M University
- Continued professional development for Dr. Zhang, building on recent past work.
- Received in-kind contribution Jason Workbench Suite of petrophysical and inversion software to develop analytical routines.
- Purchased Hampson Russell AVO and inversion software that can be used in this project
- Modeling mixtures of methane and thermogenic gas hydrate signatures against flux and geothermal gradients and depositional architecture.
- Presentation of Poster showing research progress at Gordon Research Conference in March, 2014.
- Researched attenuation concepts
- Preparation of oral talk for International Conference on Gas Hydrates.
- Negotiated donation of seismic lines in WR 313 and GC955 by CGG for use in this project.
- Presented oral talk at International Conference on Gas Hydrates in Beijing
- Agreement in principle for the use of approximately 12900 sq km of 3D seismic data in the Lund and The Elbow protraction areas, offshore Florida.(Exhibit 1).
- Agreement reached for the use of 3D seismic data in the Lund and The Elbow protraction areas.
- Screening of 3D data for potential gas hydrate targets.
- Use of the data for this project was secured from Spectrum ASA after they became the new owners of the data.
- Approached Lumina Geophysical about making a software use contribution to the project, in specific, a contribution of their high resolution spectral decomposition software.

Progress, Results, and Discussion Summary of technical progress

The project was postponed for the period January 1, 2013 to September 30, 2013. Task Groups 1 (Project Management and Planning) and 2 (Project Initiation) were completed prior to this reporting period. Work was also done on Task Group 3 (Development of Project Research Concepts) prior to the work hiatus. The project restarted with continuation of work within Task Group 3 and Task Group 4. Because of difficulties getting permission to use 3D seismic data in the area of interest, a second no-cost extension was granted that extends the research project until March 31, 2016.

Approximately 12,900 sq km of 3D seismic data in the United States' Lund and The Elbow protraction areas in the Eastern Gulf of Mexico was secured for this project. The large seismic dataset was screened for potential gas hydrate deposits. Several potential targets were identified. One of the principal potential gas hydrate targets is shown on Figures 1 and 2. The potential gas hydrate deposit is an anomalously fast sand about 30 sq km in area and approximately 24 m thick, about 830 m below sea floor, at a water depth of 3120 m. Mississippi Fan channels extend across the survey area. Modern seafloor channels are seen on the present day seabed and shown on Figure 1. Thick sequences of buried channels extend through the inferred gas hydrate stability zone. The base of gas hydrate stability can often be approximated by the depth below seafloor of topmost free gas. One of the challenges for interpreting a gas hydrate petroleum system in this area is that the sediments are mostly flat lying with little indications of gas. The potential gas hydrate deposit is along a singular deep-seated fault. Variations of amplitude strength appear to be effects of pore-fill rather than lithologic amplitude. That said, there is no clear free gas leg. The amplitudes deeper than 3950 m, say at 4063 also not have a clear signature of free gas pore fill, raising conjecture that they could represent at Structure H hydrocarbon fill. If the main potential gas hydrate target is near the base of methane hydrate stability, it suggests that the geothermal gradient is approximately 23° C/km (Figure 3).

Without well logs the porosity and density ranges for the rock physics models will be estimated by channel architecture, compaction, and seismic-derived values order to calibrate the rock physics model. Spectral decomposition is expected to resolve and isolate fluid-fill amplitude from lithologic amplitude in the hydrate bearing facies

Future work in next reporting period

- Characterize a gas hydrate petroleum system for the study area
- Further delineate gas hydrate targets
- Continue gas hydrate reservoir modeling research with the data
- Spectral decomposition of channel deposits for input to rock physics model and to seismic model.
- Produce gas hydrate distribution and volumes.

Changes or Problems

Because of delays in securing a suitable data set for the research, a second no-cost extension was granted until March 31 2016.

Although there are interpretation questions outstanding, we believe that we have identified potential gas hydrate deposits in the Eastern Gulf of Mexico seismic data set. As long as interpretation suggests the absence of potential gas hydrate deposits data set, there should be no problems to complete the research as envisioned. It would have, however, been far preferable to have received permission to use the 3D data that had been licensed to the Gulf of Mexico Gas Hydrate JIP Leg II project.

Software and work commitments from CGG are still outstanding issues. CGG has indicated that it is likely to not support the project with Jason Workbench software and technical advice.

Participants and Other Collaborating Organizations

	Zijian Zhang, Geophysicist, Fugro Employee	Dan McConnell, Principal Investigator, Fugro Employee	Greg Nash, Consultant Geoscientist, Fugro Employee
Nearest month worked this reporting period	0	1	0
Collaboration outside USA	Not this reporting period	Not this reporting period	None this reporting period
Travel outside USA to communities of interest	Guanzhou, China May and June 2015	None this reporting period	None this reporting period

Special Reporting Requirements
None this quarter.

Budgetary Information
$130,030 has been spent from a budget allocation of $130,030 to date. The federal share of the costs to date is $104,024 and the cost sharing is $26,006. The federal share of the costs per this reporting period is $10,374 and the cost sharing is $2,594.

1. Survey Name: Florida 3D, 516 blocks; as shown on the map.
Consisting of
1. PSTM and PSDM full stack data
2. Acquisition report
3. Processing report for PSTM and PSDM

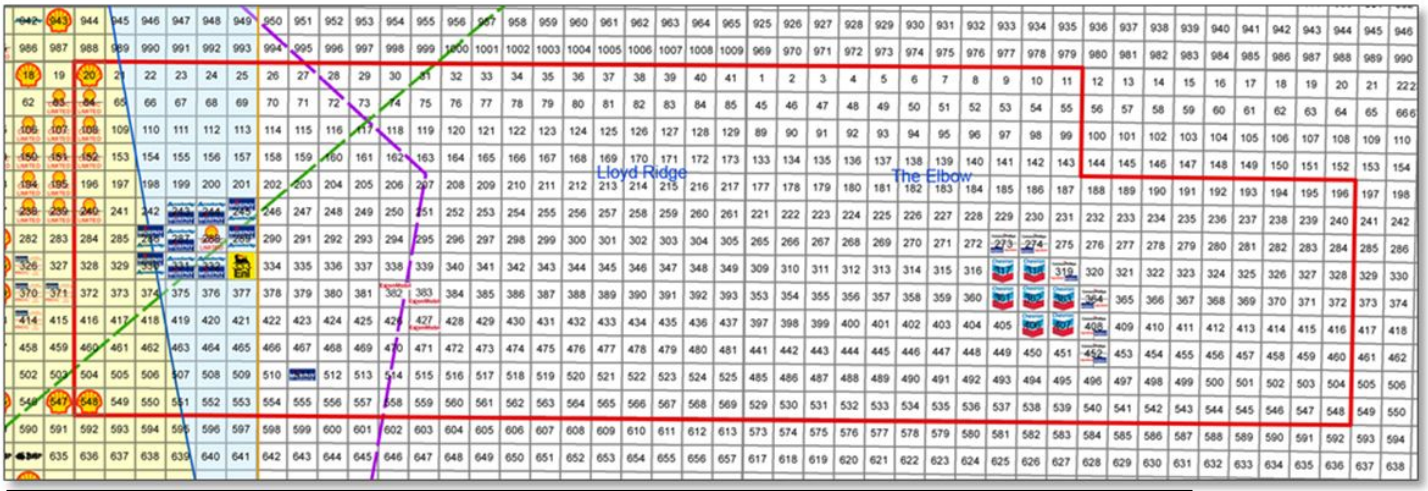
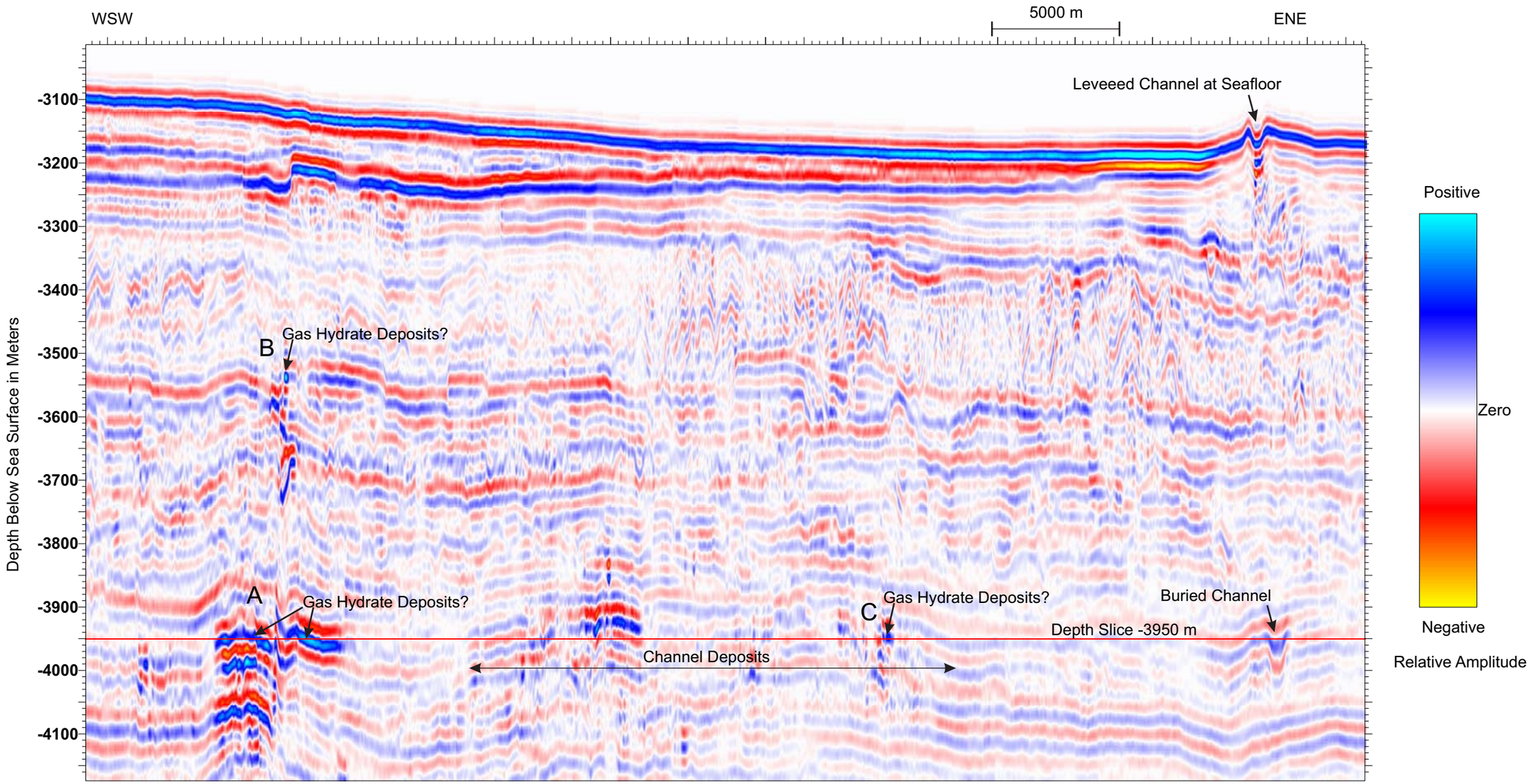
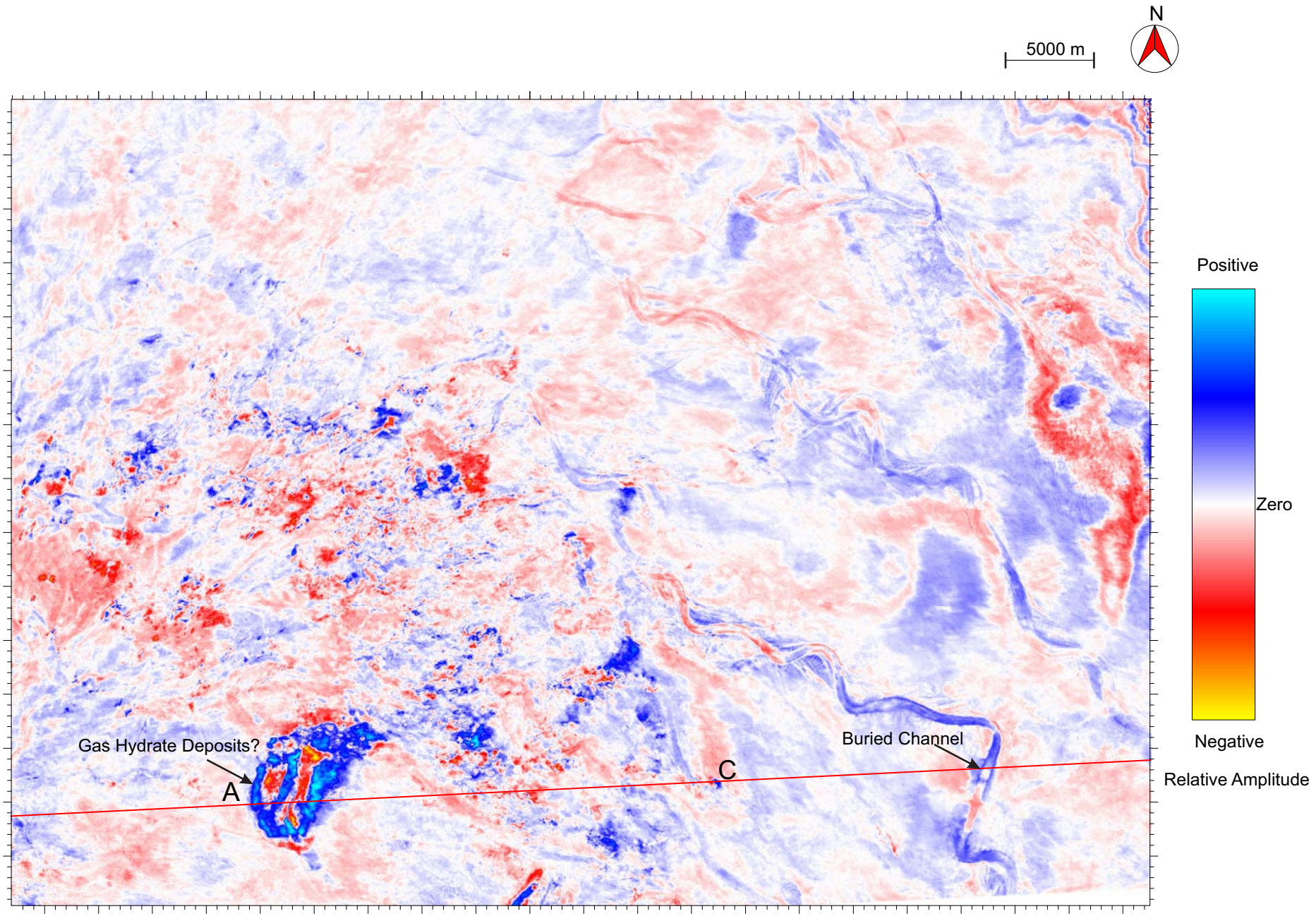


Exhibit 1. Extents of 3D Seismic Data Made Available to the Research Project



Seismic Line Showing Possible Gas Hydrate Deposits
Lloyd Ridge Protraction Area, Gulf of Mexico



Depth Slice -3950m Showing Possible Gas Hydrate Deposits
Lloyd Ridge Protraction Area, Gulf of Mexico

Exhibit 2 Milestone Status
Milestone 1, Task 1 was completed November 14, 2012
Milestone 2 is outstanding.

Exhibit 3: Cost Plan

Baseline Reporting Quarter	Budget Period 1													
	Q1 2012		Q2 2013		Q3 2013		Q4 2013		Q1 2013		Q2 2014		Q3 2014	
	Sept- Dec 2012		Jan-Mar 2013		April-June 2013		June-Sept 2013		Sept-Dec 2013		Jan-Mar 2014		April - June 2014	
	Q1	Cumulative Total	Q2	Cumulative Total	Q3	Cumulative Total	Q4	Cumulative Total	Q1	Comulative Total	Q2	Comulative Total	Q3	Comulative Total
Baseline Cost Plan														
Federal Share	7114	7114	16226	23340	0	23340	0	23340	17135	40475	11800	52275	5504	57779
Non-Federal Share	1778	1778	4057	5835	0	5835	0	5835	4284	10119	2950	13069	1376	14445
Total Planned	8892	8892	20283	29175	0	29175	0	29175	21419	50594	14750	65344	6880	72224
Actual Income Cost														
Federal Share	7114	7114	16226	23340	0	23340	0	23340	17135	40475	11800	52275	5504	57779
Non-Federal Share	1778	1778	4057	5835	0	5835	0	5835	4284	10119	2950	13069	1376	14445
Total Incurred Costs	8892	8892	20283	29175	0	29175	0	29175	21419	50594	14750	65344	6880	72224
Variance														
Federal Share	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-Federal Share	0	0	(0)	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Total Variance	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Baseline Reporting Quarter	Budget Period 1		Budget Period 2											
	Q4 2014		Q1 2014		Q2 2015		Q3 2015		Q4 2015		Q1 2016		Q2 2016	
	June-Sept 2014		Sept-Dec 2014		Jan-Mar 2015		April-June 2015		July-Sept 2015		Oct-Dec 2016		Jan-Mar 2015	
	Q4	Comulative Total	Q1	Cumulative Total	Q2	Cumulative Total	Q3	Cumulative Total			Q3	Cumulative Total	Q4	Comulative Total
Baseline Cost Plan														
Federal Share	0	57779	3233	61012	6952	67964	25686	93650	10374	104024	33072	137096	33659	170755
Non-Federal Share	0	14445	808	15253	1738	16991	6421	23412	2594	26006	8268	34274	8415	42689
Total Planned	0	72224	4041	76265	8690	84955	32107	117062	12968	130030	41340	171370	42074	213444
Actual Income Cost														
Federal Share	0	57779	3233	61012	6952	67964	25686	93650	10374	104024		104024		104024
Non-Federal Share	0	14445	808	15253	1738	16991	6421	23412	2594	26006		26006		26006
Total Incurred Costs	0	72224	4041	76265	8690	84955	32107	117062	12968	130030	0	130030	0	130030
Variance														
Federal Share	0	0	0	0	0	0	0	0	0	0	(33072)	(33072)	(33659)	(66731)
Non-Federal Share	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	(8268)	(8268)	(8415)	(16683)
Total Variance	0	0	0	0	0	0	0	0	0	0	(41340)	(41340)	(42074)	(83414)

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