



# **Point Thomson Gas Cycling Project**

## **Well Pad Siting**

March 10, 2003

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### Executive Summary:

The draft project description "Rev B" calls for a three pad development which is comprised of a central pad using the existing PTU 3 site and two new sites for the east and west pads (figure 1). The project team was asked to examine the technical, commercial and environmental constraints associated with moving the existing well pad locations. Proposed alternative locations were developed to address the concerns raised during the scoping exercise conducted in November 2002.

The main issues identified were:

- A. The impact of coastal erosion to the pad sites,
- B. Wetlands and vegetation impact due to the construction of new drill pads and
- C. Access to traditional hunting grounds.

Taking these issues into consideration, the team examined the possible movement of the drill pads inland, as well as movement to existing exploration drill sites.

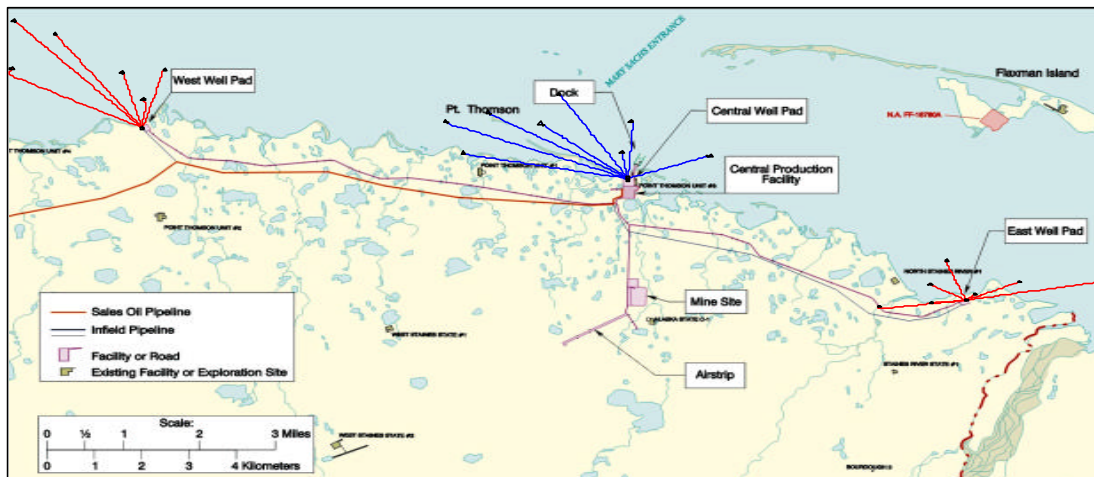


Figure 1. Drill Pad locations

In evaluating the possible movement of pad locations, the team considered the following issues.

1. Effective drainage of the Thomson Sand reservoir
2. Impact on drilling capability
3. Project costs
4. Development infrastructure
5. Position relative to the coastline
6. Environmental impact.

The Thomson Sand reservoir is over-pressured relative to the other North Slope fields and will require high mud weights to safely drill through the reservoir. The current position of the pads south of the Thomson Sand reservoir requires long reach drilling to effectively drain this gas condensate resource. Both these factors combine to make the drilling of the Thomson Sand reservoir a very complex and challenging project.

Movement of as little as 3000' south places three of the western pad drill wells into a category of extreme drilling complexity relative to today's technology and moves several of the central and eastern pad wells into a category of high drilling complexity. For the western pad, this would make several areas of the reservoir inaccessible and would have a detrimental effect on the drainage of the Thomson Sand reservoir. Drilling costs would increase by \$13.8M for the west pad, \$18.4 M for the central pad and \$17.5M for the eastern pad.

The placement of the development wells on existing exploration pads was also examined.

### **East Pad**

The North Staines 1 well pad was examined as a possible alternative location for the eastern pad. The average reach increased by 650' and the associated drilling complexity was deemed acceptable. The incremental drilling cost was calculated at \$7.7 M.

Moving west to the North Staines 1 location would result in a cost saving of \$6.3M in gravel infield roads and gathering lines. The cumulative cost impact is thus \$1.4 M. As regards the issue of coastal erosion, the North Staines location is slightly closer to the shoreline than the proposed pad. A comprehensive study on coastal erosion is currently being conducted. No additional impact on the wetlands would be envisaged if the exploration pad was deemed to be appropriate. Movement of the east pad to the North Staines location appears to be a viable alternative based on the current resource definition and understanding of coastal erosion.

### **Western Pad**

Movement of the western pad to the PTU 4 location would result in an overall increase in drilling complexity, with an average reach increase of 2132'. The

incremental drilling cost was calculated at \$10.8 M. Increased length in gravel infield roads and gathering lines would add approximately \$12 M to the project. In addition to the \$23 M, this move would result in areas of the reservoir being inaccessible. The PTU 4 pad is slightly further from the coastline than the proposed location, which may help in offsetting the effects of coastal erosion. The impact on the wetlands would be negligible.

The PTU 2 location can not be considered as an alternative due to the unacceptable increase in technical complexity associated with drilling from that location.

### **Central Pad**

The current location of the central pad already reuses the original PTU 3 location.

In terms of access to hunting grounds, movement to existing exploration pads does not alleviate these concerns. Movement south from the proposed locations would help but this has a large impact on drilling and infrastructure costs and makes several areas of the reservoir inaccessible and thus has a major effect on reservoir drainage. The impact of this type of move would be impractical.

### **Summary Chart**

<b>Movement of Western Pad</b>	<b>Gross Cost</b>	<b>Drilling Complexity</b>	<b>Environmental Impact</b>
<b>3000' South</b>	<b>\$13.8 M</b>	<b>High to Extreme</b>	<b>Medium</b>
<b>To PTU 4</b>	<b>\$23 M</b>	<b>Extreme</b>	<b>Low</b>
<b>To PTU 2</b>	<b>N/A</b>	<b>Unacceptable</b>	<b>N/A</b>

<b>Movement of Central Pad</b>	<b>Gross Cost</b>	<b>Drilling Complexity</b>	<b>Environmental Impact</b>
<b>3000' South</b>	<b>\$18.4 M</b>	<b>High</b>	<b>Medium</b>
<b>To PTU 3</b>	<b>N/A</b>	<b>N/A</b>	<b>Already sited on PTU3</b>

<b>Movement of Eastern Pad</b>	<b>Gross Cost</b>	<b>Drilling Complexity</b>	<b>Environmental Impact</b>
<b>3000' South</b>	<b>\$17.5 M</b>	<b>High</b>	<b>High</b>
<b>To North Staines 1</b>	<b>\$1.4 M</b>	<b>Low</b>	<b>Low</b>

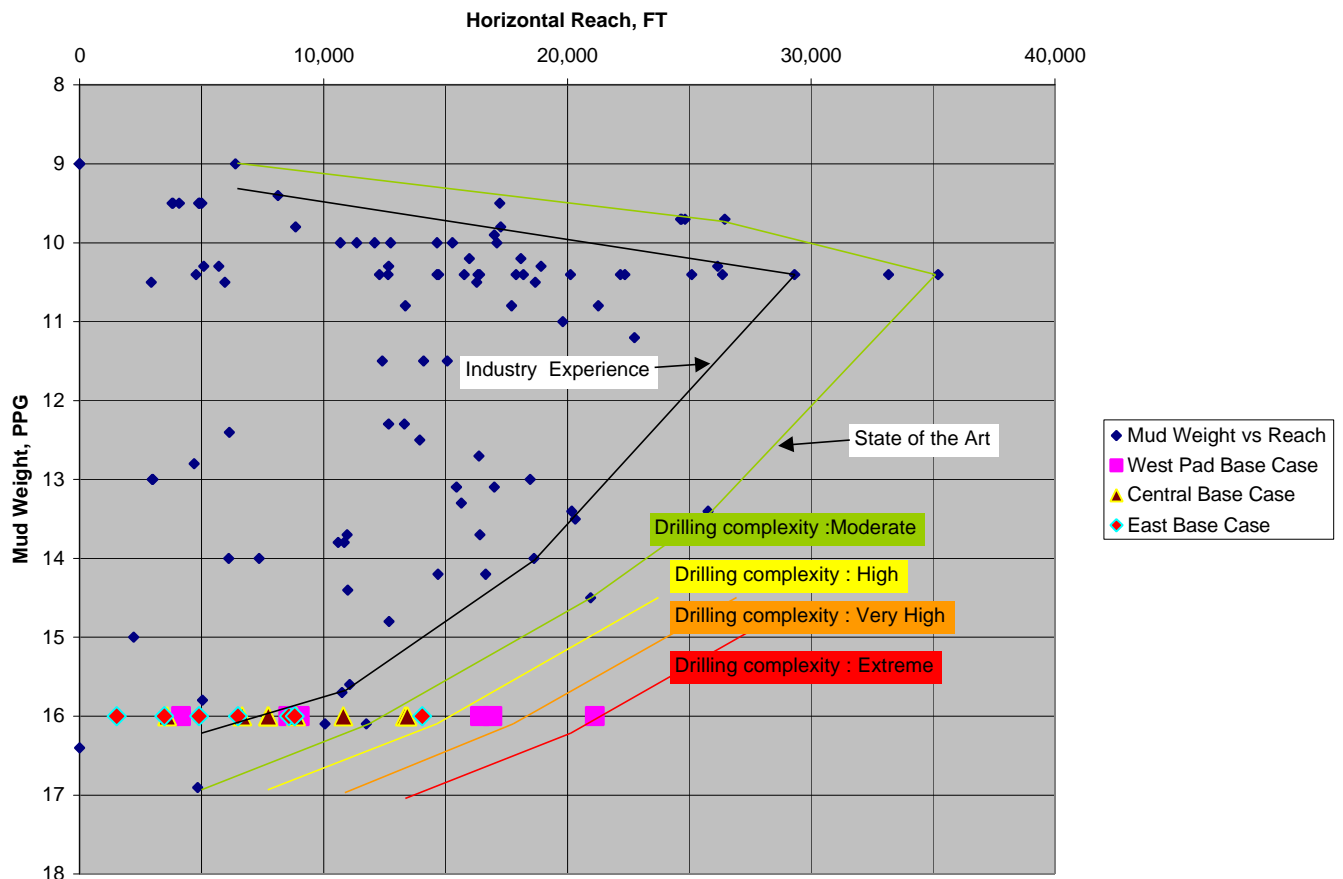
## **Introduction:**

When considering the original location of the three drill pads as part of the Project Development Plan, several areas were considered. Placing the pads directly over the Thomson Sand reservoir would have resulted in less technically challenging wells and would have required gravel islands to be constructed within the lagoon. Based on the environmental impact of these locations, the pads were moved south and onshore which increased drilling costs. The original plan had looked at potentially 4 onshore pads but this was reduced to three to minimize the impact on the shoreline. Moving onshore and reducing the number of pads pushed the reach of some of the wells beyond current industry experience. This increase in drilling complexity was deemed acceptable in light of the environmental advantages and recognition that drilling the shorter reach wells first will establish a learning curve to help push the drilling envelope beyond present day experience.

## Technical Constraints Analysis:

The drilling of long reach wells as part of development projects is very common in many areas around the world, e.g. ExxonMobil, Sacate Development, offshore California. In many of these areas, wells have now reached horizontal displacements in excess of 25,000' (see figure 2). What differentiates these types of wells from the long reach wells at the proposed Point Thomson development is that the mud weight required to balance the Thomson overpressured reservoir is higher than any other long reach wells drilled to date i.e. 16 ppg for Point Thomson vs. 10-11 ppg for other long reach developments (see figure 2).

The drilling complexity for long reach wells is derived from several factors. The following are some of the major issues. The ability to effectively clean and circulate the well, the risk of stuck pipe, the ability to successfully reach the desired bottom hole location and complete/evaluate the well.

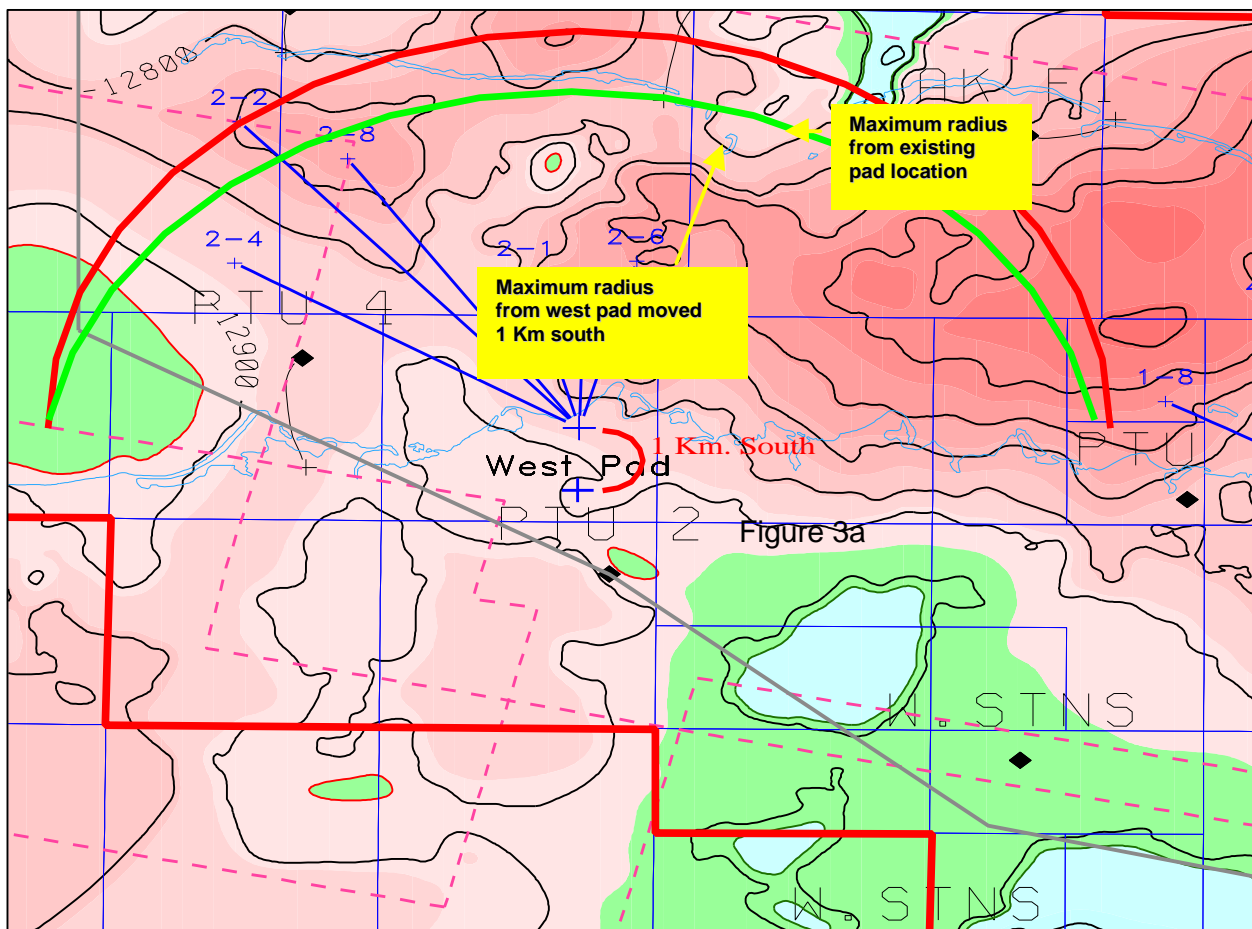


Note: Complexity index based on today's technology and experience.

Figure 2.

Any movement of the pads south will require longer lateral throws and substantially increase the drilling complexity of these wells. By increasing the complexity one also increases the potential for a drilling related environmental incident.

Figure 3 and 4 show how the movement of the west pad 1 Km south moves several of the long reach wells (2-4 & 2-8) into a higher drilling complexity category and places one well (2-2), into an extreme complexity category.



**Figure 3. West pad bottom hole locations**

### West pad + 1 Km South

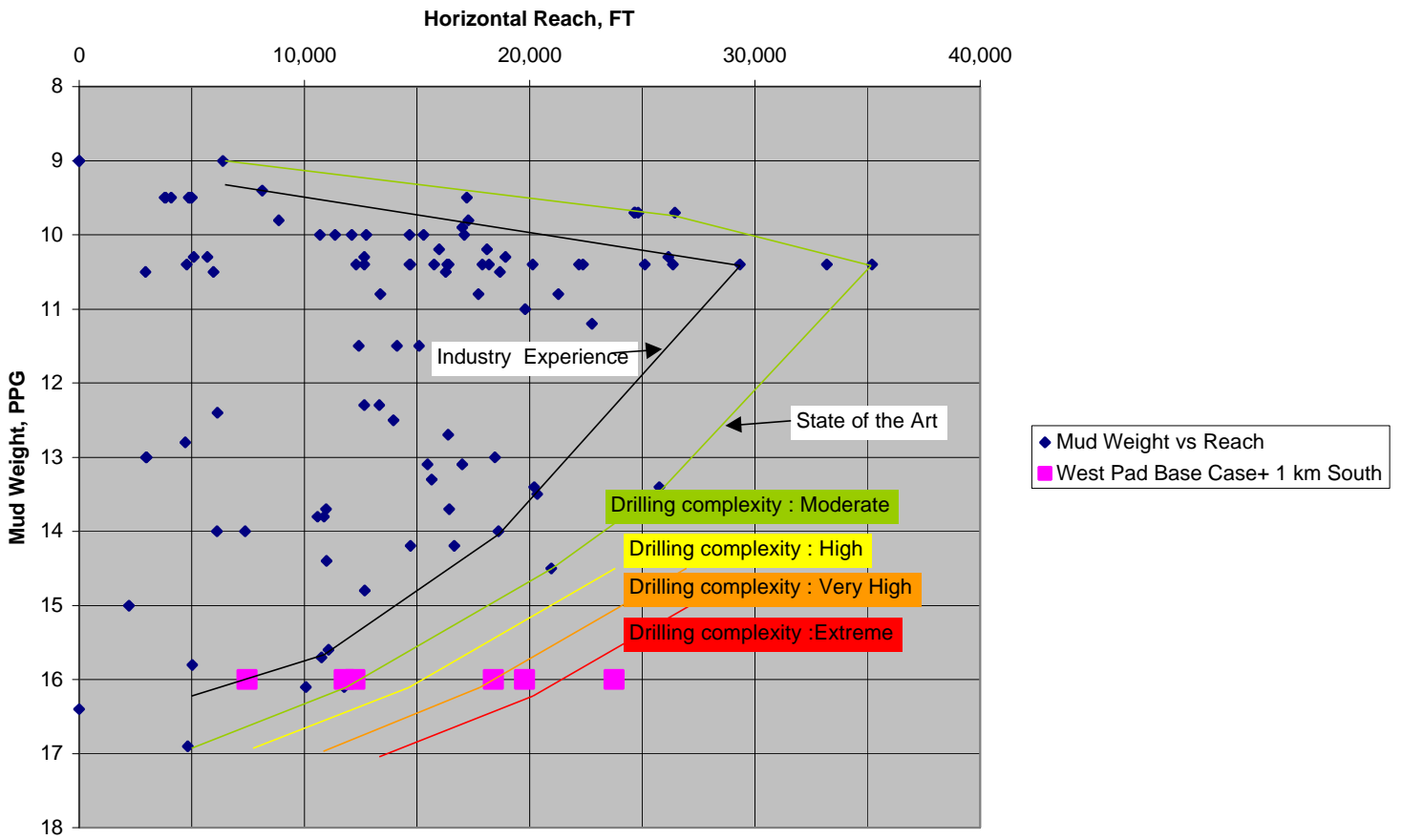
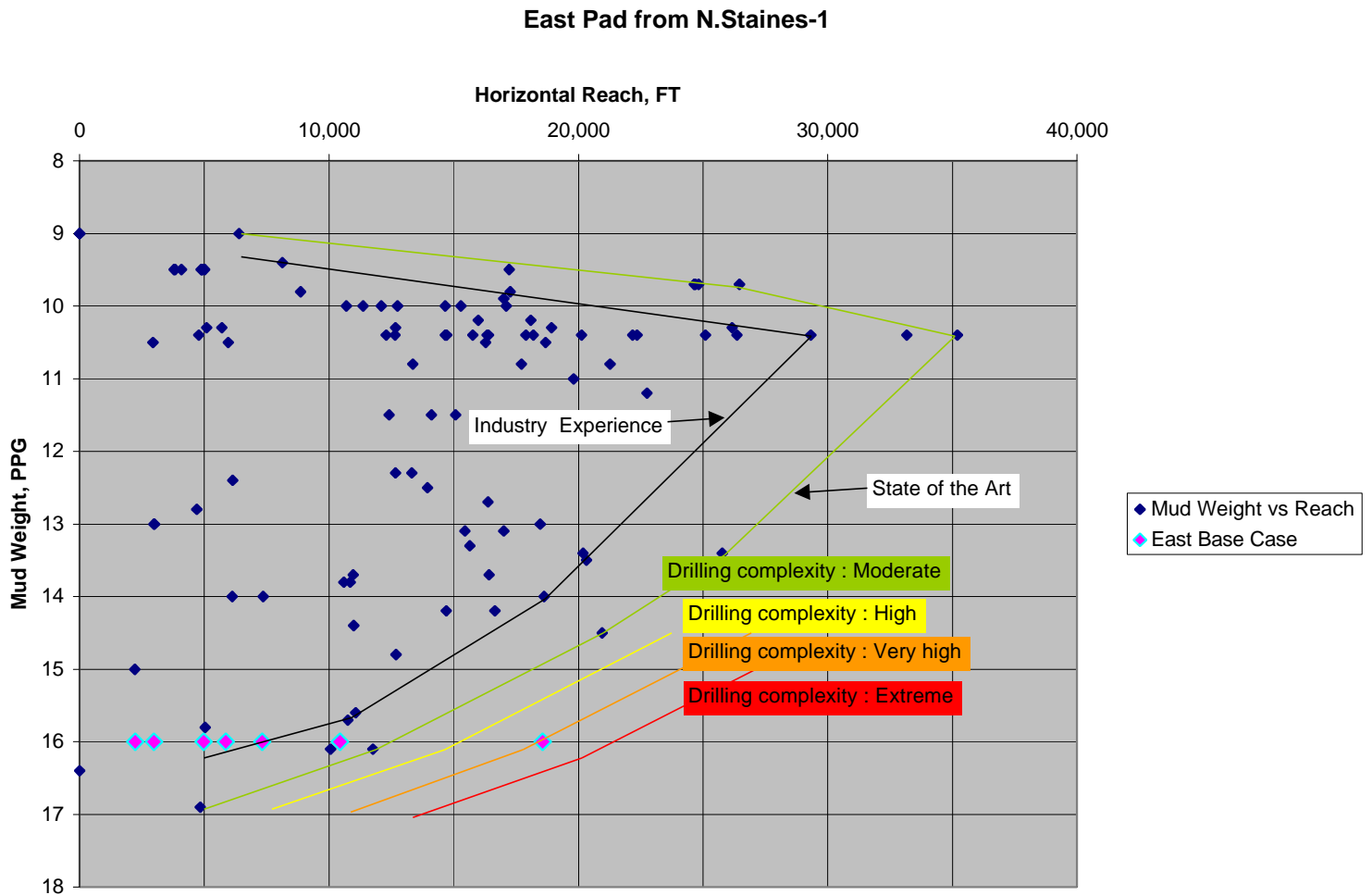


Figure 4

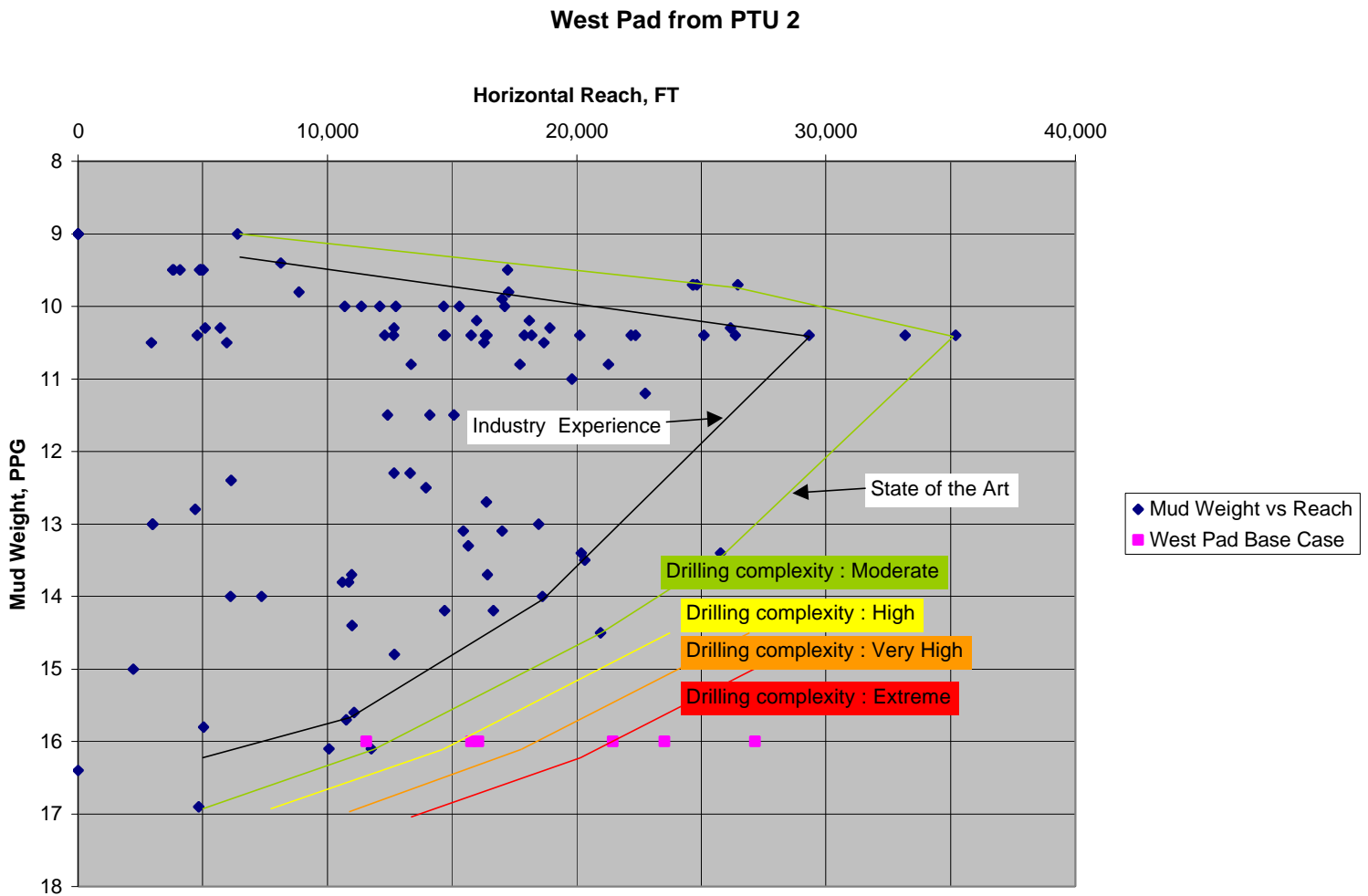


Figure 5 displays the impact of moving the east pad to the old North Staines exploration site. Even though the reach is increased for several wells and one well moves from the moderate to the high drilling complexity category, this degree of movement is deemed to be acceptable.



**Figure 5**

Figure 6 was constructed to show the impact of moving the west pad to the old PTU 2 location. As can be seen in the graph, several of the wells move into the extreme drilling complexity category. This type of movement would thus render several of the reservoir areas inaccessible and severely impact the reservoir depletion plan and hence the project economics.



**Figure 6**

## Cost Constraints Analysis:

A cost impact analysis was constructed to estimate the impact of moving the pads to several locations. The cost per foot of reach for the drill wells was calculated from a best-fit line constructed from the calculated costs associated with the original wells (figure 8). The results are tabulated in figure 7.

Any movement of the drill pads has an impact on other infrastructures such as gravel roads and pipelines. As an example, the addition of 1 mile of roads and gathering lines adds \$6 M to the project cost. All of the above mentioned costs have a severe impact on the project economics and need to be examined carefully if any pad movements are to be considered.

### Impact Moving all pads 1 km South

	West pad	Central Pad	East Pad
<b>Increase in Avg Reach, ft</b>	<b>2854</b>	<b>2122</b>	<b>1925</b>
<b>Increase in Well Costs, \$M</b>	<b>13.8</b>	<b>18.4</b>	<b>17.5</b>
<b>Drilling Complexity</b>	<b>High to Extreme</b>	<b>Moderate to High</b>	<b>Moderate to High</b>

### Impact Moving West pad to PTU 4

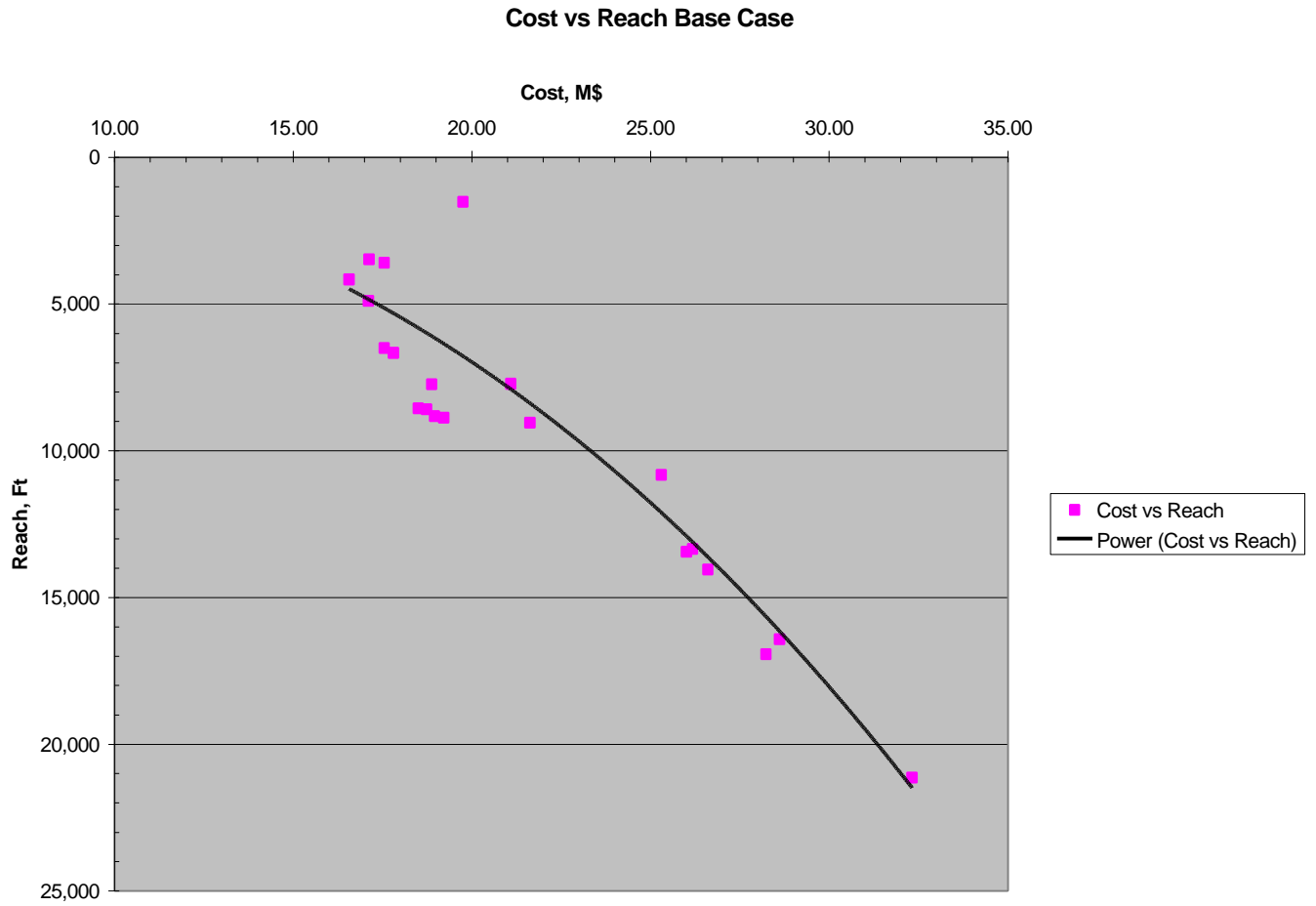
	West pad
<b>Increase in Avg Reach, ft</b>	<b>2132</b>
<b>Increase in Well Costs, \$M</b>	<b>10.8</b>
<b>Drilling Complexity</b>	<b>Extreme</b>

### Impact Moving West pad to PTU 2 is technically unacceptable

### Impact Moving East pad to N. Staines 1

	East pad
<b>Increase in Avg Reach, ft</b>	<b>650</b>
<b>Increase in Well Costs, \$M</b>	<b>7.7</b>
<b>Drilling Complexity</b>	<b>No Change</b>

Figure 7



**Figure 8**

## **Environmental Constraints Analysis:**

Coastal erosion and impact of access to native hunting grounds have been voiced as concerns and this section addresses these issues.

Figures 9. & 10. are aerial photographs of the North Staines River 1 location and the PTU 4 exploration pads. These alternate locations were examined as possible sites for the east and west pads respectfully.

The North Staines location is slightly closer to the coastline than the eastern pad (figure 9) but is orientated in a N-S direction compared to the E-W orientation of the east pad. With the long shore drift being predominately in a westerly direction the North Staines location may be less susceptible to erosion.

The PTU 4 site is more inland than the proposed western pad and may thus be less affected by coastal erosion (figure 10.).

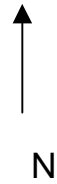
Movement of the pads to either of these locations would not reduce the impact to the area for traditional hunting. This would require several miles of movement and has already been demonstrated to be unfeasible due to the high technical impact on drilling and the inability to effectively drain the reservoir.

Slight movements inland from the proposed drill pads would need to address the impact on the local wetlands. Figures 11 -13 show the current locations and the surrounding wetlands. Areas in purple represent very wet tundra, which is regarded as a high value wetland. Areas in yellow are wet barren/wet sedge tundra complexes (saltmarsh) also a high value wetland, whilst areas in green are areas of wet tundra.

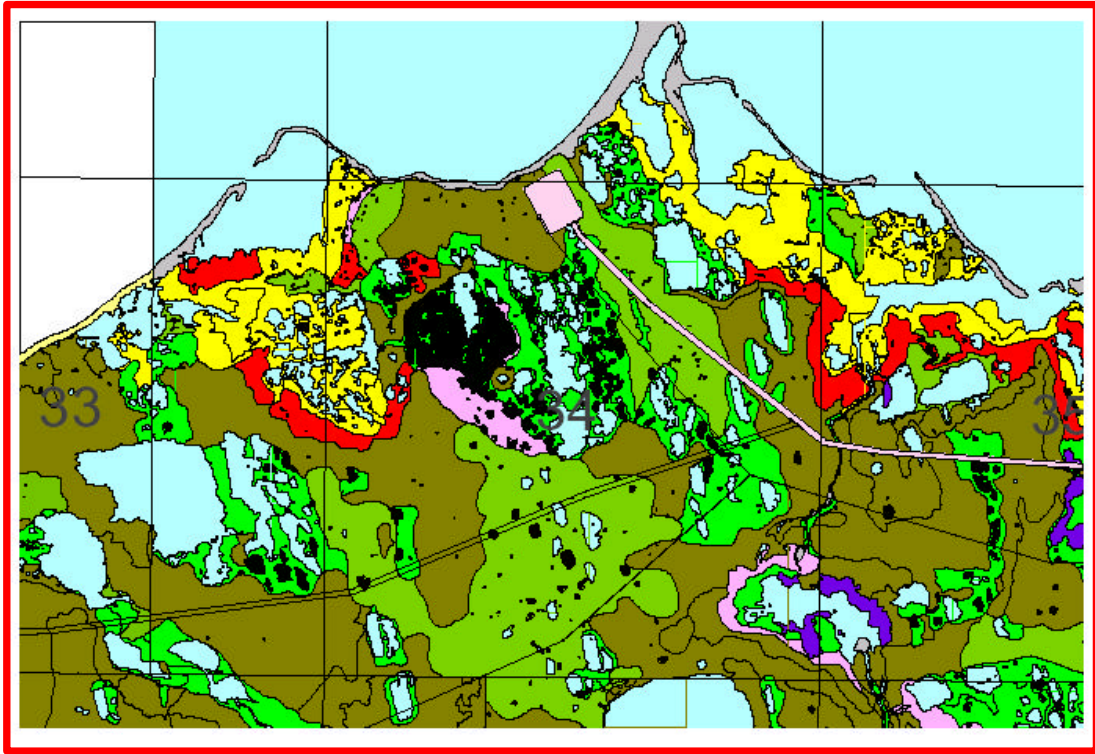
Expansion or movement of the pads would need to address proximity to all of these areas.



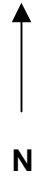
**Figure 9. North Staines 1 Exploration Pad**



**Figure 10. PTU 4 Exploration Pad**



**Figure 11. Proposed Western Pad location with access roads**





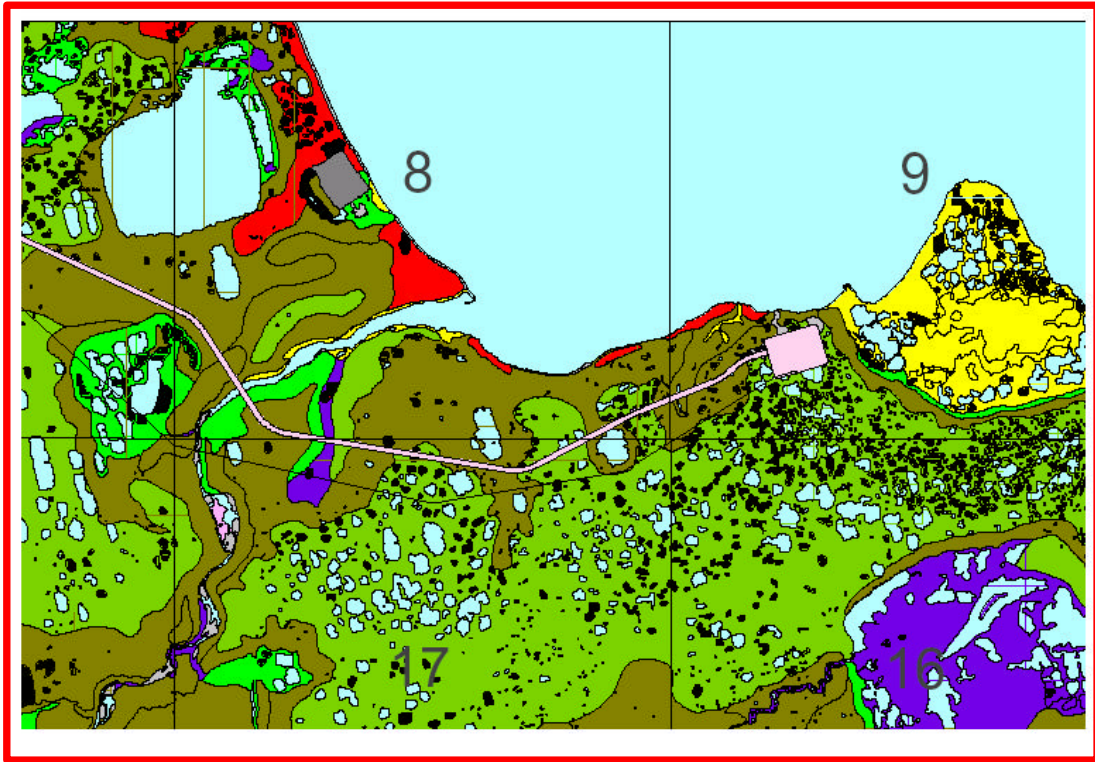
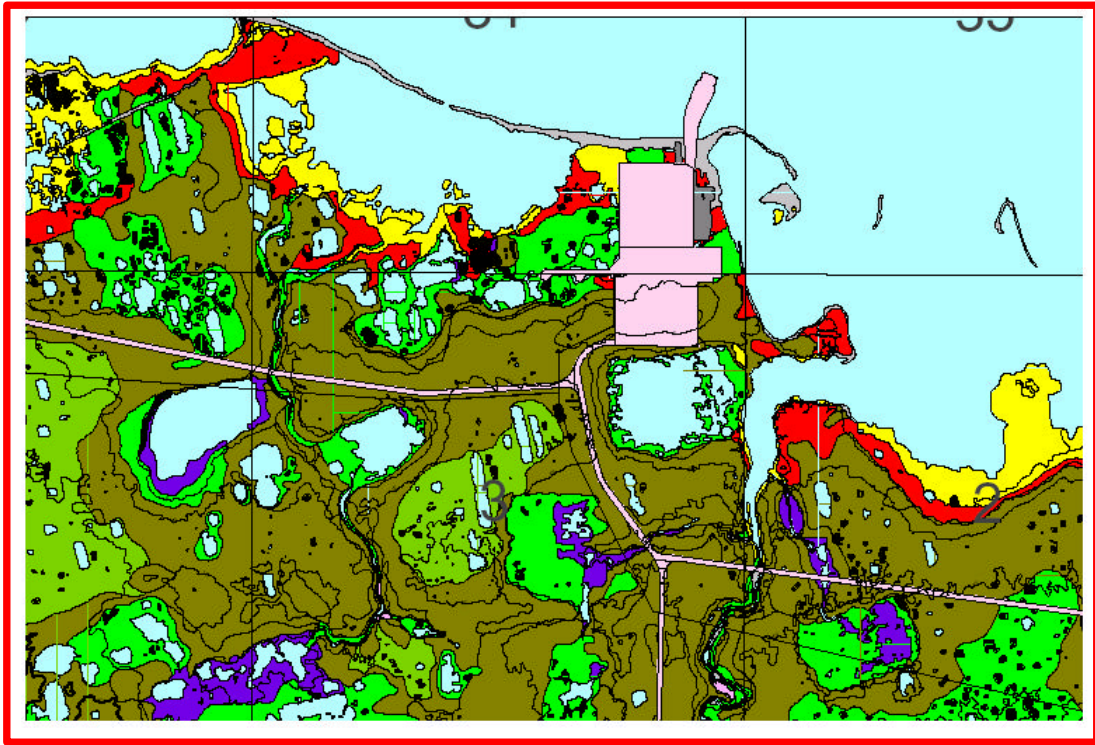
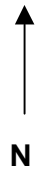


Figure 12. Proposed Eastern Pad Location and access road





**Figure 13. Proposed central pad with drilling, processing facilities and access roads**



## **Summary:**

Having examined numerous options for pad movement it is clear that all changes involve several issues ranging from the ability to effectively drain the reservoir to significant increases in project costs.

The movement of drill pads inland more than a few hundred feet has significant economic impact to the project and is technically prohibitive. Whereas it would address concerns on coastal erosion, movement of this scale does not help with increasing access to the traditional hunting grounds.

Movement of the pads to existing exploration sites has varying impacts. The movement of the eastern pad to the North Staines 1 location has the least technical and project cost impact but may require further study on the effects of coastal erosion. Movement to the North Staines 1 pad would not address the issue of access to traditional hunting grounds.

The PTU 4 location as an alternative for the west pad increases overall technical drilling complexity and adds over \$23 M to the gross cost. Coastal erosion effects are reduced but access to the hunting areas would not be improved.

PTU 2 is technically unacceptable due to drilling complexity concerns.

The central pad is already utilizing the old PTU 3 location.