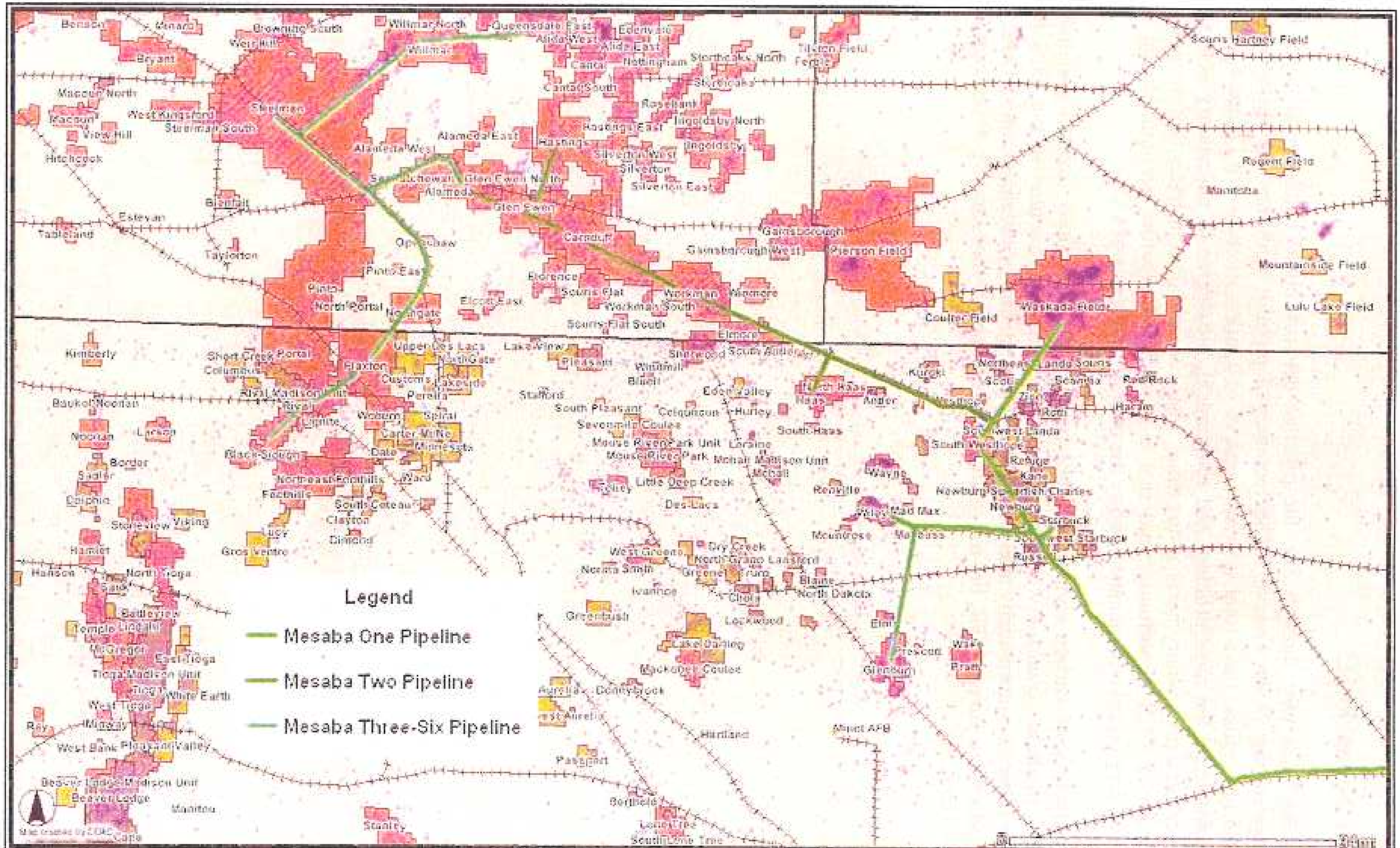
D. Scenario 1C

For Mesaba Units One through Six, the pipeline network could reach much larger fields in Saskatchewan and North Dakota. The incremental pipeline additions for these units would include 85 new miles, for a total system length of 610 miles, as shown in Figure 4. While this scenario would be the most efficient and economical, the degree of uncertainty is too great to model even on a preliminary basis at this time. This scenario demonstrates that the potential for EOR present a CCS opportunity, and that a cost-shared pipeline accommodating multiple sources is a very promising means to defray the overall final costs of CCS.

The introduction of carbon credits or other benefits for reductions under mandated carbon constraints to these scenarios would improve the economics presented in the CCS Plan and would not otherwise intrinsically alter the ideal implementation of pipeline routes. Other sources may be induced to pursue EOR, but the relative cost competitiveness among those sources would not likely change.

Figure 4. Extension of Western Terminus of Pipeline to Accommodate Mesaba One Through Mesaba Six



Source: EERC

E. Scenario 2

Scenario 2 considers CCS based solely on carbon credit revenues or other benefits of CCS under carbon constraints, with the Mesaba Energy Project as the only source. In this case, CO_2 would only need to be piped approximately 265 miles from the West Range site to the Lower Cretaceous saline formation in eastern North Dakota. Once again, existing right-of-way is shown for purposes of illustration. The EERC projects that the capacity of this saline formation dwarfs that of the oil fields considered in Scenario 1, so it is expected that the same pipeline route could serve all units at 30% or 90% capture.[9] The route in Scenario 2 is shown in Figure 5.

[9] EERC, Presentation, Potential Sequestration Options in the Plains CO2 Reduction (PCOR) Partnership Region & Estimated Capacities, Aug. 9, 2006 (on file with Excelsior Energy).

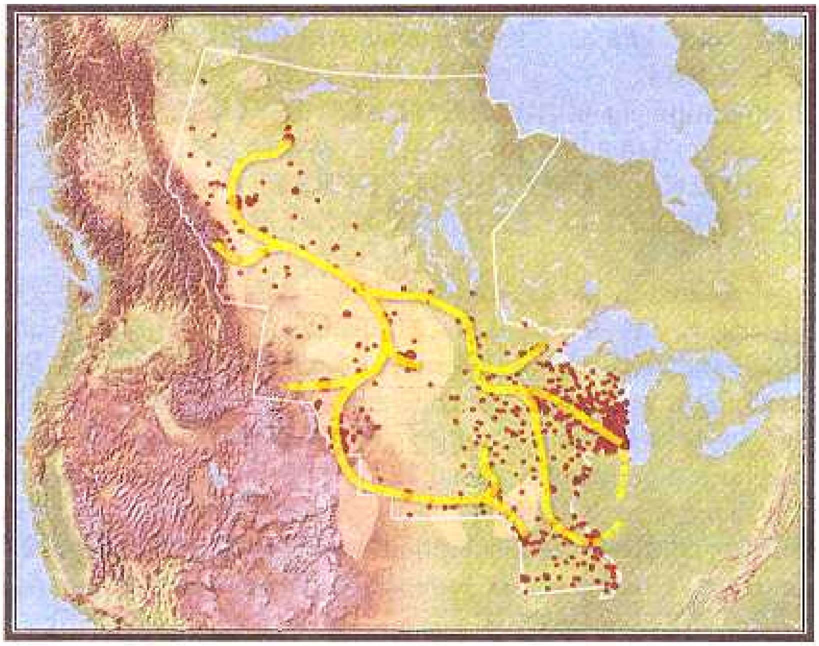
Figure 5. CO_2 Pipeline to Saline Formations for Carbon Credits (No EOR)

Source: EERC

E. Scenario 3

As Scenario 1C begins to demonstrate, the economies of scale for CO_2 transport could be significant. In a fully implemented GHG regulatory scheme, it would be conceivable that the majority of large industrial facilities (epitomized by large electric generation facilities) would be capturing CO_2. The EERC's vision for a major pipeline system serving the PCOR region is laid out in Figure 6. As the map shows, the concentration of industry on the Iron Range makes it a likely route for a major artery of the CO_2 network.

Figure 6. EERC's Vision of CCS in a Carbon Managed Economy



Source: EERC

VII. Preliminary Economic Analysis

Excelsior used the Mesaba Energy Project's proprietary financial model to identify the breakeven value of CO_2 (in 2006$ per ton) captured in the 30% approach for each scenario identified in Section VI. This modeling is preliminary in nature and is intended to i) illustrate economic dependencies around important CCS Plan variables rather than absolute costs and ii) determine whether a more thorough investigation is justified. All cases assumed that capital outlays associated with CCS occur in 2011, and that CO_2 capture commences in the third quarter of 2014 and continues for 22 years (through the duration of the financial model).

The financing structure and economic assumptions used in the modeling of these carbon capture scenarios are consistent with Excelsior's assumptions in its current financial model used to evaluate the Mesaba Energy Project. The cases are modeled to recover the costs associated with the CCS program and maintain the required return to the projects equity investors. The effects of the sensitivities shown below are displayed as changes in NPV from a base case and are calculated using an 8% discount rate. Estimates for the cost of 90% removal are not available, so only 30% capture was modeled.

Fluor developed an estimate for the cost of the 30% capture configuration,[10] and Excelsior integrated that estimate into the Mesaba Energy Project's financial model. There are two main economic impacts associated with carbon capture: equipment capital cost and reduced plant capacity, which also causes an increase in plant heat rate. The equipment includes the amine stripper and the CO_2 drier and compressor. Plant capacity is reduced and heat rate is increased because these processes are steam driven, and because the CO_2 would need to be replaced by steam as a diluent for NO_x control. In an attempt to determine if CCS can be accomplished without additional costs to utility ratepayers, the cost of fuel increase on a megawatt-hour (MWh) basis corresponding to the heat rate increase was attributed and charged to the CCS project in the model assumptions. Total capital cost additions are currently estimated to be **[BEGIN TRADE SECRET: END TRADE SECRET]** and the anticipated increased O&M costs for that equipment is **[BEGIN TRADE SECRET: END TRADE SECRET]**. The capacity reduction for the IGCC Power Station is currently estimated to be **[BEGIN TRADE SECRET: END TRADE SECRET]**, with the increased heat rate expected to be **[BEGIN TRADE SECRET: END TRADE SECRET]**.

As for pipeline cost estimates, the Dakota Gasification Project's ("DGP") CO_2 pipeline to the Weyburn oil field was used as the basis for estimating costs. The DGP pipeline was built for $120 million in 1997, and consisted of 204 miles of nominal 12" and 14" Schedule 40 pipeline. Conservatively assuming it was all 12" pipeline and escalated to 2005 dollars, the total cost for a CO_2 pipeline in the Northern Plains is assumed to be $60,920 per inch-mile. Based on the design capacity of the Weyburn pipeline, a nominal 12" Schedule 40 pipeline is sufficient to transport CO_2 produced by 30% capture at Mesaba One, with the Mesaba One and Two units requiring a 14" pipeline. A further conservative assumption utilized in the analysis is that the total pipeline network is built up front. Costs could be reduced by deferring network expansions to additional oil fields

Excelsior Energy modeled Scenarios 1A, 1B, and 2, and the results are presented in Table 2. For Scenarios 1A and 1B, revenues could be earned from both EOR and carbon credits sales (or through other carbon reduction benefits to ratepayers when constraints are imposed). This data illustrates that the economies of scale are important for CCS – the required price per ton drops significantly with larger volumes of CCS, despite the fact that 80 additional miles and an increased diameter for the pipeline would be necessary. Scenario 2 demonstrates that the Mesaba Energy Project could capture and sequester carbon at an even lower overall cost, although such capture could not reap EOR revenues. As explained above, these cost estimates are illustrative rather than predictive, and conclusions should be limited accordingly. The accuracy of these estimates must be refined by additional study before the economic viability of the project can be judged.

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[10] Fluor Enterprises, Inc., *Mesaba Energy Project Partial Carbon Dioxide Capture Case*, October 2006, attached as Exhibit DC __ (DC-7) to the Oct. 10, 2006 testimony of Douglas H. Cortez, OAH Docket No. 12-2500-17260-2, MPUC Docket No. E-6472-/M-05-1993.

Table 2. Cost of Captured CO_2

	EOR	Pipeline length	Total CCS Cost ($/ton)
Scenario 1A	Yes	445 miles	$40
Scenario 1B	Yes	525 miles	$35
Scenario 2	No	265 miles	$32

Due to the high degree of uncertainty in many of the important assumptions, Excelsior conducted a sensitivity analysis. Scenario 1A was used as the base case for this analysis, and the results are shown in Table 3. Pipeline costs represent the greatest source of uncertainty, both in terms of the uncertainty of the cost assumed and impact that assumption has on total project cost. It is crucial that the range of this cost be narrowed, and the engineering studies proposed in Section 1 would address these and other issues. While the effect of capacity loss is nearly as material to the analysis, there is greater modeling certainty in the assumed values.

Table 3. Sensitivity Analysis of CCS Costs

Factor	Case	Input Value Assumed	Required CO2 Value/Total CCS Cost
Pipeline Cost	Low	\$30,145/in-mi	\$30/ton CO_2
	Base	\$60,290/in-mi	\$40/ton CO_2
	High	\$90,435/in-mi	\$50/ton CO_2
Plant Capital	Low	[BEGIN TRADE SECRET:	END TRADE SECRET]
	Base	[BEGIN TRADE SECRET:	END TRADE SECRET]
	High	[BEGIN TRADE SECRET:	END TRADE SECRET]
Capacity/ Heat Rate	Low	[BEGIN TRADE SECRET:	END TRADE SECRET]
	Base	[BEGIN TRADE SECRET:	END TRADE SECRET]
	High	[BEGIN TRADE SECRET:	END TRADE SECRET]
Plant O&M	Low	[BEGIN TRADE SECRET:	END TRADE SECRET]
	Base	[BEGIN TRADE SECRET:	END TRADE SECRET]
	High	[BEGIN TRADE SECRET:	END TRADE SECRET]
Pipeline O&M	Low	\$890/mi-yr	\$40/ton CO_2
	Base	\$1,780/mi-yr	\$40/ton CO_2
	High	\$2,760/mi-yr	\$41/ton CO_2

It is important to note that the greatest uncertainty surrounding the economics of a CCS project is revenue, as EOR depends upon volatile oil prices and carbon credit prices (or other economic benefits from reductions under carbon constraints) depend upon future regulation. However, such uncertainties are not specific to the Mesaba Energy Project and must be overcome by any major undertaking of CCS. The figures presented in the remainder of this section elaborate upon the modeled impact of CO_2 prices on the net present value of different scenarios in the CCS Plan.

Figure 7 shows the impact that the value of CO_2 has on project economics. This value for CO_2 is derived from either EOR or a combination of EOR and carbon credits or other CCS regulatory benefits, and corresponds to Scenario 1A with the baseline assumptions described above. Similarly, Figure 8 examines this impact if revenues are from carbon credits exclusively (that is, no EOR). CO_2 would be sequestered in saline formations, corresponding to Scenario 2. Thus, for Figure 8 the impact to the NPV is based on Scenario 2's \$32/ton case as the \$0 NPV reference.

Figure 7. Sensitivity to Changes in Total CO_2 Revenue (\$/ton CO_2) in Scenario 1A

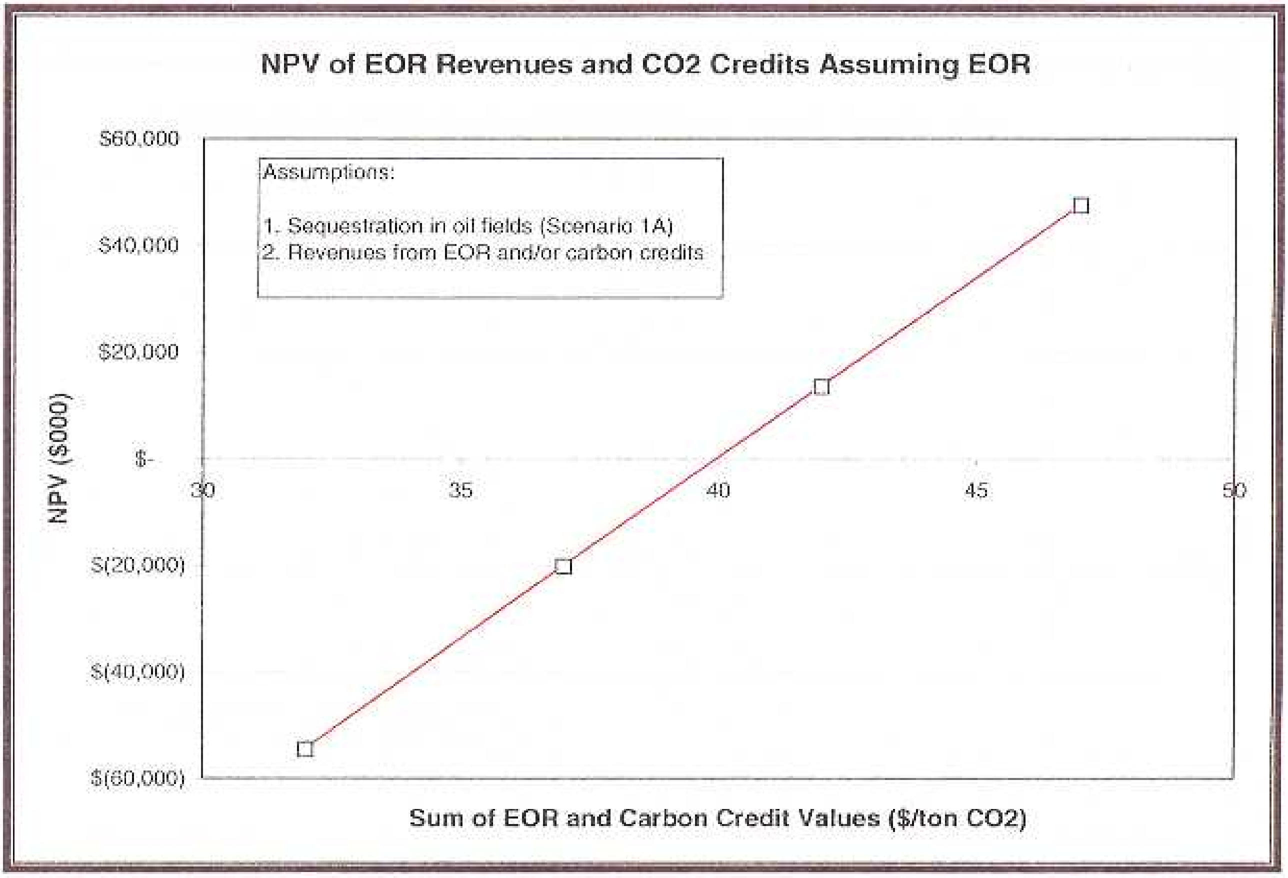
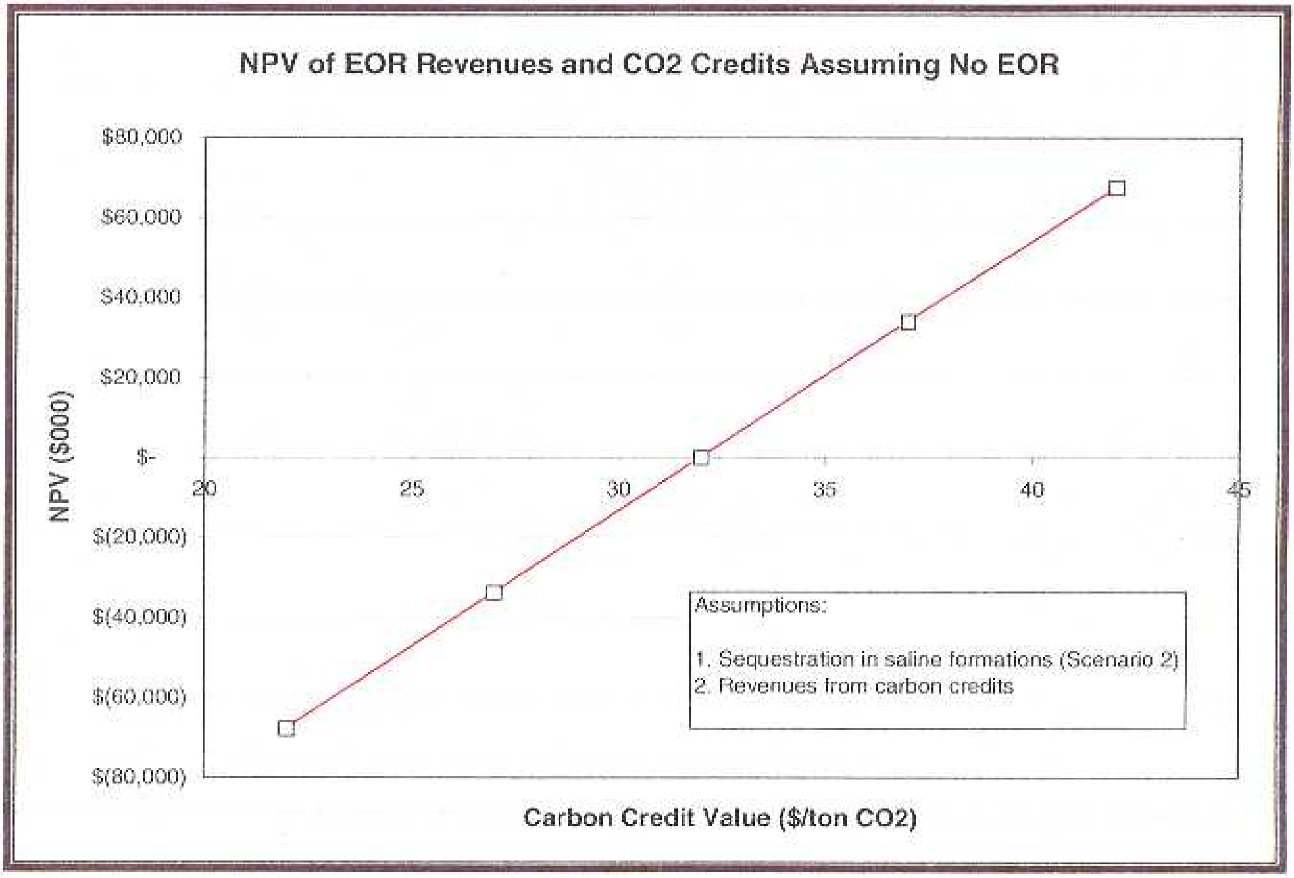
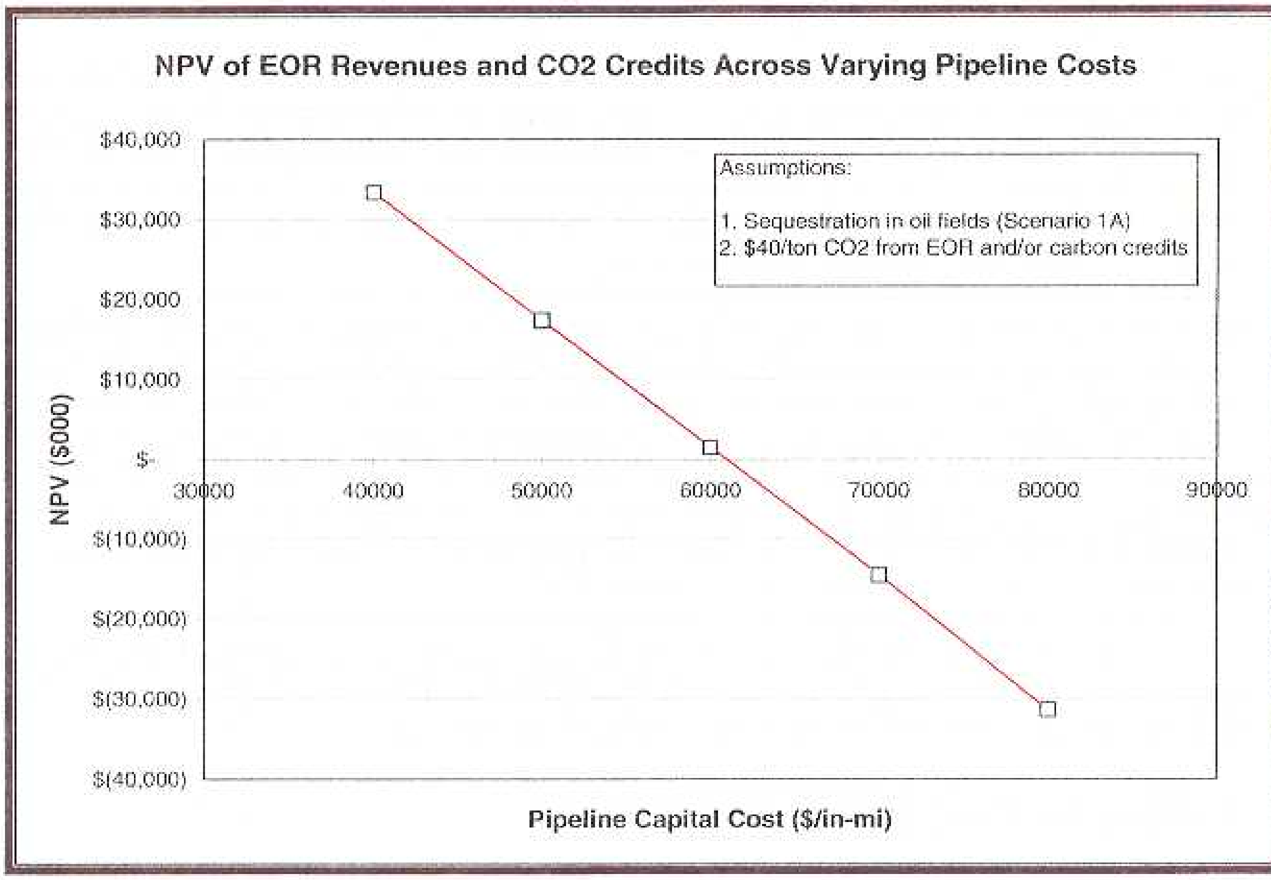


Figure 8. Sensitivity to Changes in Carbon Credit Revenue (\$/ton CO_2) in Scenario 2



Changes in the NPV of different scenarios in the CCS Plan due to changes in pipeline costs are shown in Figure 9. This figure assumes that the total value of CO_2 will average \$40/ton.

Figure 9. Sensitivity to Changes in Pipeline Costs ($/in-mi) in Scenario 1A



Carbon credits are currently trading at approximately $17/ton in Europe. The value of CO_2 for EOR is highly variable according to oil prices, specific field geology, and source competition. At oil prices of $15–20/bbl, CO_2 can be worth $10–16/ton for EOR, and more at higher prices of oil.[11] As carbon regulations are introduced and become stricter, and as the price of oil increases, the price of CO_2 can be expected to rise. Although it is premature to conclude whether CCS in any scenario presented here is economical, Excelsior believes that additional study towards that end is warranted.

The alternative sources of CO_2 for EOR in the fields identified in Scenario 1 are limited. The largest of these by far are conventional coal plants in the region, but post-combustion CO_2 capture for such sources has only been demonstrated at pilot scale. The cost per ton is expected to be higher for conventional coal than for the Mesaba Energy Project, even if a much shorter pipeline is assumed for the former. Ethanol plants and natural gas processing facilities are able to produce CO2 at a much lower cost than conventional coal plants, but lack the capacity to saturate the EOR market. Fields along the pipeline built by the Dakota Gasification Project can

[11] Intergovernmental Panel on Climate Change, IPCC Special Report: Carbon Dioxide Capture and Storage, p. 33 (2005), *available at* http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/ccsspm.pdf.

accommodate its supply for decades to come. Therefore, it is reasonable to expect that EOR revenues could be available to the Mesaba Energy Project across the time frames proposed.

Excelsior assumes that it will be positioned to obtain partial DOE cost sharing for construction of the CO2 pipeline. However, irrespective of such funding potential, Excelsior believes it is in the interests of the both the Mesaba Project and the State to better understand the economic drivers for CCS programs and the need to firm up equipment/construction costs at the plant, along the pipeline route, and at the oil fields. Detailed engineering studies conducted under carefully defined scopes of work will help refine such costs.

The EERC, in conjunction with Excelsior, will develop CO_2 management options for the Mesaba Energy Project based on evaluations of sequestration opportunities associated with regional geologic formations/features and nearby terrestrial features. The study will match carbon sinks to the Mesaba Project and rank the sinks according to engineering, economic, and public-acceptance considerations. The schedule calls for the EERC to complete an analysis of the identified CO_2 management options in December 2006. Excelsior will use the results of this analysis to narrow the scope of its Phase III proposal to the DOE for demonstrating the commercial readiness of carbon sequestration via IGCC.

In preparing the Phase III proposal, the EERC and Excelsior will formulate best practices required to accomplish sequestration of CO2 from IGCC facilities and publish the results as part of a manual that can be used by others undertaking IGCC projects.

VIII. Summary and Conclusions

Excelsior has prepared this CCS Plan to offer the Commission and Minnesota ratepayers options to capture and sequester a significant portion of the CO_2 emissions from the Mesaba Energy Project. Based on the scientific and technical considerations, marketplace and operating assumptions, the financial analyses, and future carbon regulations assumed in this CCS Plan, Excelsior anticipates that future technical studies will verify that it will be feasible to capture and sequester CO_2 emissions from the Mesaba Energy Project. As explained in the CCS Plan, the most promising CCS scenario is for Excelsior to transport its CO_2 via high-pressure pipelines to the depleted oil fields associated in the Williston Basin located in North Dakota, southwestern Manitoba, and southeastern Saskatchewan.

This CCS Plan reflects the work undertaken to date by Excelsior and the PCOR initiative. Significant work remains to refine the engineering and economic information it contains. This work will be advanced by the PCOR initiative. Excelsior will continue to update this information as its work with PCOR progresses. Excelsior would be amenable to exploring a commitment with the Commission to apply the final \$2 million of its RDF award to further efforts to refine this plan. If feasible from the Commission's perspective, Excelsior would propose to accelerate the funding of that amount in order to facilitate a more rapid completion of a detailed engineering plan and cost proposal for CCS. Excelsior anticipates that such a detailed plan could be developed within a year from the date such funding is made available. The CCS Plan could also serve as the foundation for a competitive proposal in response to the Department of Energy's ("DOE") planned Phase III solicitation for demonstrating full scale CCS projects. Accelerating development of a very detailed plan would enhance Minnesota and the Mesaba

Project's prospects to obtain federal matching funds under DOE programs.

It is in the long-term interests of the State to proceed expeditiously with the development of feasible CCS options. Excelsior looks forward to working with regulators, stakeholders, and industry participants to provide the important hedge to Minnesota consumers offered by the timely development of carbon capture and sequestration.