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LEED Gold Certification Cost Analysis

Summary Report prepared for Alberta Infrastructure

July 30, 2008

Audit . Tax . Consulting . Financial Advisory.

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Forward

On May 9, 2008, Deloitte & Touche LLP ("Deloitte" or "we") was engaged by Alberta Infrastructure to undertake a "LEED Gold Certification Cost Analysis". The Deloitte Team encompassed a range of experts in capital projects analysis, including quantity surveyors from the BTY Group and an engineer specializing in LEED certification requirements from Eco-Integration.

The purpose of our analysis was to identify the specific costs and benefits associated with moving a project from a current baseline level of funding to LEED Silver and LEED Gold certification levels, primarily by reviewing three social infrastructure projects in Alberta, identified by Alberta Infrastructure as the following:

1. Chestermere Lake Elementary;
2. Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station; and
3. Mount Royal College Centre for Continuous Learning.

We undertook a three-phased approach to our analysis. Phase 1, which involved an independent review of each case study project (drawings, final construction costs and LEED scorecard) to develop an initial view on the capital costs of the project had it been constructed without LEED certification, was summarized in a memo to Alberta Infrastructure on May 21, 2008.

In Phase 2, half-day workshops were held with design team members from each of the case study projects, to determine the strategies undertaken for each project, including what points were targeted to achieve either LEED Silver or LEED Gold, and what points would have been targeted to achieve either a higher (LEED Gold) or lower (LEED Silver) certification, depending on each project's actual rating. Those findings, including a summary of the percentage increase in costs moving from baseline design to LEED Silver and LEED Gold, were presented in a memo to Alberta Infrastructure on June 12, 2008.

Finally, in Phase 3, further analysis on the information compiled during Phases 1 and 2 was undertaken to determine the implications of the different LEED ratings on lifecycle costs (including capital, operating, maintenance and periodic replacement costs), water consumption, energy consumption and greenhouse gas emissions. Phase 3 also considered the positive externalities of LEED-certified buildings on building occupants, primarily through discussions with user groups for the two case study projects in operation, supplemented by independent, third-party research. Those findings, including a summary of overall cost savings and consumption reduction, moving from baseline design to LEED Silver and LEED Gold, were presented in a memo to Alberta Infrastructure on July 4, 2008.

The enclosed Summary Report is a compilation of the three aforementioned memos, and includes supplementary analysis and materials in the Appendices section.

Phase 1 Memo

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Memo

Date: May 21, 2008

To: Tom O'Neill
Executive Director
Alberta Infrastructure, Capital Projects Branch

From: Mark Hodgson

Subject: LEED Gold Certification Cost Analysis - Preliminary Findings (Phase 1)

The following memorandum summarizes our preliminary Phase 1 findings regarding analysis of costs and benefits associated with moving Provincially-funded buildings from a LEED Silver to LEED Gold standard.

Background

Deloitte was engaged by Alberta Infrastructure on May 9, 2008 to undertake a "LEED Gold Certification Cost Analysis." The "Deloitte Team" includes a range of experts in capital project analysis including quantity surveyors from the BTY Group and an engineer specializing in LEED certification requirements from Eco-Integration.

The analysis focuses on the following three case study projects identified by Alberta Infrastructure:

- Chestermere Lake Elementary School (the "Elementary School Project") ;
- Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station (the "Visitor Centre Project"); and
- Mount Royal College Centre for Continuous Learning (the "College Project").

The purpose of the analysis is to identify the specific costs and benefits of moving from LEED Silver to LEED Gold on actual projects in Alberta that have achieved either LEED Silver or LEED Gold certification. By analyzing real projects, the results of the analysis can be used as a guide to assess future Provincially-funded projects similar in nature to the case study projects.

Approach

We are taking a two phase approach to the analysis. Phase 1 involved an independent review of each case study project (drawings, final construction costs and LEED scorecard) to develop an initial view on the reduction in capital costs of the project if it had been constructed without LEED certification (base cost).

We also developed an initial view on design strategies or scenarios that could lead to a higher or lower level of LEED rating by analyzing, for each case study project, each category of the LEED scorecard.

In Phase 2, half day workshops are planned with the relevant architects, LEED coordinators and mechanical engineers that were directly involved with each of the case study projects. The workshops will be used to confirm and/or refine the findings from Phase 1 as well as gather information relevant to other areas of analysis such as implications of the different LEED ratings on:

- lifecycle costs;
- greenhouse gas emissions;
- water use; and
- externalities (air quality, productivity, etc).

Phase 2 will conclude with a memorandum that provides our findings on the costs and benefits of moving Provincially-funded buildings from a LEED Silver to LEED Gold standard.

The target completion date for Phase 1 and Phase 2 is May 21, 2008 and mid June 2008 respectively.

Preliminary Findings

Our preliminary findings indicated in the table below are based on the partial completion of Phase 1 (we were unable to complete our analysis for the College Project in time for this memo).

The Phase 2 workshops are not scheduled to begin until the week of May 26, 2008 so our preliminary findings have not yet been tested with the relevant architects, LEED Coordinators and mechanical engineers involved with the case study projects.

Case Study Project	**LEED Rating (1)**	**Base Cost (2)**	**Percentage Increase in Base Cost to Achieve LEED Silver**	**Percentage Increase in Base Cost to Achieve LEED Gold**
Elementary School Project	39 points LEED Gold	**$10,235,842**	*Est. 3 to 5%*	**5 to 7%**
Visitor Centre Project	39 points LEED Gold	**$1,289,458**	*Est. 3 to 4%*	**4 to 6%**
College Project	43 points LEED Gold	TBD	*Est. 3 to 5%*	*Est. 5 to 7%*

1) 33 to 38 points required for LEED Silver, 39 – 51 points required for LEED Gold. We note that at least two of the three projects had targeted LEED Silver but actually achieved LEED Gold.
2) Base Cost was determined by removing costs related to LEED requirements from the final construction cost on a element by element basis.

Numbers that appear in bold in the above table are based on calculations performed by the Deloitte Team. Numbers that appear in italics are estimates ("Est.") based on the experience of the Deloitte Team with consideration to similar analysis performed on building projects in other jurisdictions. All numbers should be considered preliminary and are subject to materially change based on further analysis.

Next Steps

After completing the base cost analysis for the College Project, the next step of the assignment involves conducting the Phase 2 workshops.

We anticipate that the workshops will allow us to generate a much tighter range of results for the percentage increase in base cost to move from base cost to each LEED rating. Phase 2 will also provide the required information on the wider implications of the different LEED ratings.

Limitations

This memorandum was prepared for the exclusive use of Alberta Infrastructure, and is not to be reproduced or used without written permission of Deloitte. No third party is entitled to rely, in any manner or for any purpose, on this memorandum. Deloitte's services may include advice or recommendations, but all decisions in connection with the implementation of such advice and recommendations shall be the responsibility of, and be made by, Alberta Infrastructure.

This memorandum relies on certain information provided by Alberta Infrastructure, and Deloitte has not performed an independent review of this information. It does not constitute an audit conducted in accordance with generally accepted auditing standards, an examination or compilation of, or the performance of agreed upon procedures with respect to prospective financial information, an examination of or any other form of assurance with respect to internal controls, or other attestation or review services in accordance with standards or rules established by the CICA or other regulatory body.

Phase 2 Memo

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Memo

Date: June 12, 2008

To: Tom O'Neill
Executive Director
Alberta Infrastructure, Capital Projects Branch

From: Mark Hodgson

Subject: LEED Gold Certification Cost Analysis – Phase 2 Findings

The following memorandum summarizes our Phase 2 findings in relation to our analysis of costs and benefits associated with moving Provincially-funded buildings from a LEED Silver to LEED Gold standard.

1 Background

Deloitte was engaged by Alberta Infrastructure on May 9, 2008 to undertake a "LEED Gold Certification Cost Analysis." The Deloitte Team encompassed a range of experts in capital projects analysis, including quantity surveyors from the BTY Group and an engineer specializing in LEED certification requirements from Eco-Integration.

The purpose of our analysis was to identify the specific costs and benefits associated with moving a project from its current baseline funding to LEED Silver and LEED Gold certification levels, by reviewing three social infrastructure projects in Alberta. It is our understanding that the findings of this study will be used by Alberta Infrastructure and Alberta Treasury Board as a guide to assess future Provincially-funded projects similar in nature to the case study projects.

Our analysis focused on the following three case study projects identified by Alberta Infrastructure:

Project Name & Location	Use	Status	Owner	LEED Classification
Chestermere Lake Elementary (the "Elementary School Project"), Calgary, AB	School	Greenfield Under construction	Catholic School Board	Targeting LEED Silver (identified 39 points)
Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station (the "Visitor Centre Project")	Visitor Centre	Addition to existing facility Completed	Government of Alberta	Targeted LEED Silver, achieved LEED Gold (39 points)
Mount Royal College Centre for Continuous Learning (the "College Project")	College	Greenfield Completed	College Board	LEED Gold (43 points)

2 Our Approach

We undertook a two-phased approach to the analysis. Phase 1 involved an independent review of each case study project (drawings, final construction costs and LEED scorecard) to develop an initial view on the capital costs of the project if it had been constructed without LEED certification ("baseline funding"). We also developed an initial view on design strategies or scenarios that could have resulted in either a higher or lower LEED rating by analyzing, for each case study project, each category of the LEED scorecard.

In Phase 2, half day workshops were held with the design team members from each of the case study projects, including architects, LEED coordinators and/or mechanical engineers. The workshops were used to confirm and/or refine our Phase 1 findings, as well as gather information relevant to other areas of further analysis (Phase 3), such as implications of the different LEED ratings on lifecycle costs, greenhouse gas emissions, and issues of air quality and productivity.

3 Summary of Phase 1 Findings

Our Phase 1 findings were originally presented in a memo to Alberta Infrastructure on May 21, 2008. These findings were based on a partial completion of Phase 1, as we were unable to complete our analysis for the College Project in time. The table below summarizes our *preliminary* Phase 1 findings.

Project Name	LEED Rating(1)	Baseline Cost(2)	Baseline Cost to LEED Silver *(% increase)*	Baseline Cost to LEED Gold *(% increase)*
Elementary School Project	39 points LEED Gold	**$10,235,842**	*Est. 3 to 5%*	**5 to 7%**
Visitor Centre Project	39 points LEED Gold	**$1,289,458**	*Est. 3 to 4%*	**4 to 6%**
College Project	43 points LEED Gold	TBD	*Est. 3 to 5%*	*Est. 5 to 7%*

1) *33 to 38 points required for LEED Silver, 39 – 51 points required for LEED Gold. We note that at least two of the three projects had targeted LEED Silver but actually achieved LEED Gold.*
2) *Base Cost was determined by removing costs related to LEED requirements from the final construction cost on an element-by-element basis.*

Numbers that appear in bold in the above table were based on calculations performed by the Deloitte Team. Numbers that appear in italics were estimates, and based on the experience of the Deloitte Team with similar analysis performed on building projects in other jurisdictions. As the numbers presented above were prepared without the involvement of the relevant team members from the case study projects, we cautioned that our Phase 1 findings were *preliminary* and *subject to materially change* following our Phase 2 undertaking.

4 Summary of Phase 2 Findings

Our approach to Phase 2 involved half-day workshops with design team members from each of the case study projects to discuss the project team's views to establish the following:

- Baseline design: what the project brief would have been if there was no LEED requirement (but still within Alberta Infrastructure guidelines);
- LEED Silver: what strategies would have been undertaken for the project and what possible 36 points would have been targeted for LEED Silver (in some cases this meant eliminating strategies to bring the project back to LEED Silver); and
- LEED Gold: what strategies would have been undertaken for the project and what possible 42 points would have been targeted for LEED Gold.

Workshop participants were also asked to discuss their views on the implications of different LEED ratings on lifecycle costs, greenhouse gas emissions, and issues of air quality and productivity.

The half-day workshops were held in Calgary on May 27, June 3 and June 4. Following the half-day workshops, the Deloitte Team used the information gathered during workshop sessions to refine the preliminary Phase 1 findings. The results of our analyses are presented below.

4.1 Elementary School Project

The half-day workshop for the Elementary School Project was held on May 27, 2008. Workshop attendees included the following:

Attendees:	Quinn Young Architects	Sheldon Quinn
		Eric Heck
	Foraytek Inc.	James Love
	Hemisphere Engineering	Michael Bauer
	Catholic Separate School District	David Clinckett
		Jean Vachon
	Alberta Infrastructure	Brian Oakley
	BTY Group	Joe Rekab
		Eldon Lau
	Eco-Integration	Diana Klein
	Deloitte	Mark Hodgson
		Rob Abbott
		Ruth Summers

The Elementary School Project is a new elementary school that is owned and operated by the Calgary Catholic Separate School Board ("CSSB"). The project was tendered using a stipulated lump-sum contract. Currently under construction, the costs are $10,859,600, or $241/square foot.

CSSB has a philosophy of designing robust, durable buildings with good envelope performance and "kid-proof" materials. Some of this strategy dovetails into LEED philosophy; however, other possible site strategies, such as stormwater, pervious surfaces, shading, use of trees and landscaping) run counter to CSSB's philosophy, making it a challenge to achieve certain credits.

CSSB's philosophy of building 50-year buildings means lifecycle costing is relevant and of interest to them. There was no specific focus on indoor air quality or productivity improvements (such as materials with low VOC's, green space, views, good ventilation, etc). Reduction of greenhouse gas emissions was not identified as a goal for the project.

The items and costs associated with achieving LEED Silver and LEED Gold ratings for this project have been identified as follows:

LEED Requirement	LEED Silver[1] $	LEED Gold[1] $
Hard Costs		
Storm Management	$-	$180,000
Water Management	$37,000	$44,000
Optimize Energy Performance	$162,000	$397,000
Daylight and Views	$25,000	$65,000
Contractor Administration	$41,000	$45,000
Hard Costs sub-total	***$265,000***	***$731,000***
Soft Costs		
LEED Registration, additional consultants	$137,000	$137,000
Commissioning Fundamental	$53,000	$53,000
Commissioning Best Practices	$-	$-
Soft Costs sub-total	***$190,000***	***$190,000***
Total	**$455,000**	**$921,000**

(1) Capital cost to meet LEED certification is based on going from a non-LEED rated baseline.

4.2 College Project

The half-day workshop for the College Project was held on June 3, 2008. Workshop attendees included the following:

Attendees:	Stantec	Pamela Butvin James Furlong Cathy Crawford
	Alberta Infrastructure	Brian Oakley
	BTY Group	Joe Rekab
	Eco-Integration	Diana Klein
	Deloitte	Guy Lembach David Kimber Ruth Summers

The College Project is a new education facility that is owned and operated by the Mount Royal College Board. The project was tendered in May 2005 using a construction management form of contract at a cost of $14,764,964 or $270.27/square foot.

The overall design philosophy was to reduce energy demand on the building by using passive strategies such as a heavier structure providing a heat sink, use of overhangs and other shading strategies, and high performance windows and walls. Similar to the Elementary School Project, lifecycle costing was important for Mount Royal College given its ongoing long-term requirements for the building. While productivity was not measured, it was considered when choosing systems and building form (such as demand control ventilation, use of daylighting, etc). Furthermore, the overall philosophy for the College Project drove the reduction in the use of fossil fuels (primary and secondary).

The items and costs associated with achieving LEED Silver and LEED Gold ratings for this project have been identified as follows:

LEED Requirement	LEED Silver(1) $	LEED Gold(1) $
Hard Costs		
Storm Management	$-	$68,000
Landscape and Exterior Design	$-	$49,000
Water Management	$33,000	$39,000
Optimize Energy Performance	$301.000	$523,000
Controllability of Systems	$16,000	$16,000
Contractor Administration	$50,000	$55,000
Hard Costs sub-total	***$400,000***	***$750,000***
Soft Costs		
LEED Registration, additional consultants	$167,000	$167,000
Commissioning Fundamentals	$65,000	$65,000
Commissioning Best Practices	$-	$-
Soft Costs sub-total	***$232,000***	***$232,000***
Total	**$632,000**	**$982,000**

(1) Capital cost to meet LEED certification is based on going from a non-LEED rated baseline.

4.3 Visitor Centre Project

The half-day workshop for the Visitor Centre Project was held on June 4, 2008. Workshop attendees included the following:

Attendees:	Designworks Architecture	Joanne Perdue
	Stantec	Douglas Bryan
	Alberta Infrastructure	Brian Oakley
	Eco-Integration	Diana Klein
	Deloitte	David Kimber

The Visitor Centre Project is a new addition to the existing Tyrrell Field Station in Dinosaur Provincial Park, and is owned and operated by the Government of Alberta. The project was tendered in October 2004 using a stipulated lump sum form of contract with a tendered cost of $1,346,200 or $250/square foot.

The Visitor Centre Project is situated in an ecologically sensitive area where protection of the environment was paramount; subsequently, many of the LEED requirements were baseline requirements. In addition, the area is a naturally eroding area and arid; therefore, minimizing the building footprint and water usage were important considerations. As a result, baseline ecological and sustainability costs are quite high.

Lifecycle costs were important considerations since the building is provincially owned and designed and built to be operational for many years. Calculations for the payback of selected systems were undertaken as part of the design modelling exercise, and factored into the decision-making process.

Materials and systems (natural ventilation, natural light, controls, etc) were selected to create a healthy and comfortable indoor environment; however, they were not identified in such a way as to measure success. In addition, the Visitor Centre Project has few staff; combined with many transient visitors, it will be difficult to assess the long-term effects of being in the building. While greenhouse gas emissions were not identified as a specific strategy, the design sought to maximize passive and natural systems (natural ventilation, daylighting, etc) which, in turn, reduced the use of fossil fuels (primary and secondary).

The items and costs associated with achieving LEED Silver and LEED Gold ratings for this project have been identified as follows:

LEED Requirement	**LEED Silver(1) $**	**LEED Gold(1) $**
Hard Costs		
Water Management	$6,000	$41,000
Minimum Energy Performance	$41,000	$54,000
Measurement and Verification	$-	$-
Indoor Chemical and Pollutant Source Control	$-	$4,000
Construction Administration	$18,000	$20,000
Hard Costs sub-total	**$65,000**	**$119,000**
Soft Costs		
Additional Project and Professional Design Coordinates	$111,000	$111,000
Commissioning Fundamentals	$40,000	$40,000
Commissioning Best Practices	$-	$-
Soft Costs sub-total	**$151,000**	**$151,000**
Total	**$216,000**	**$270,000**

(1) Capital cost to meet LEED certification is based on going from a non-LEED rated baseline.

5 Conclusion

Based on the results of our undertakings in Phase 2, the following tables provide a summary of the percentage increase in hard and soft costs, moving from baseline to LEED Silver to LEED Gold. We note the baseline costs do not account for soft project costs, which is why the hard and soft costs associated with the target LEED rating have been delineated in the following analyses.

Project Name	**LEED Rating**	**Baseline Cost(1)**	**Baseline to LEED Silver (Hard Costs)** *($/% increase)*	**Baseline to LEED Gold (Hard Costs)** *($/% increase)*
Elementary School Project	39 points LEED Gold	$10,594,600	$265,000/ 2.5% of baseline	$731,000/ 6.9% of baseline
Visitor Centre Project	39 points LEED Gold	$1,227,200	$65,000/ 5.3% of baseline	$119,000/ 9.7% of baseline
College Project	43 points LEED Gold	$14,014,964	$400,000/ 2.9% of baseline	$750,000/ 5.4% of baseline

1) *Baseline costs were refined from the Phase 1 analysis, as a result of information provided during the half-day workshops.*

Project Name	**LEED Rating**	**Baseline Cost(1)**	**Baseline to LEED Silver (Soft Costs)** *($/% increase)*	**Baseline to LEED Gold (Soft Costs)** *($/% increase)*
Elementary School Project	39 points LEED Gold	$10,594,600	$190,000/ 1.8% of baseline	$190,000/ 1.8% of baseline
Visitor Centre Project	39 points LEED Gold	$1,227,200	$151,000/ 12.3% of baseline	$151,000/ 12.3% of baseline
College Project	43 points LEED Gold	$14,014,964	$232,000/ 1.7% of baseline	$232,000/ 1.7% of baseline

1) *Baseline costs were refined from the Phase 1 analysis, as a result of information provided during the half-day workshops.*

6 Limitations

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Phase 3 Memo

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Memo

Date: July 4, 2008

To: Tom O'Neill
Executive Director
Alberta Infrastructure, Capital Projects Branch

From: Mark Hodgson

Subject: LEED Gold Certification Cost Analysis – Phase 3 Findings

The following memorandum summarizes our Phase 3 findings in relation to our analysis of costs and benefits associated with moving Provincially-funded buildings from a LEED Silver to LEED Gold standard.

1 Background

Deloitte was engaged by Alberta Infrastructure on May 9, 2008 to undertake a "LEED Gold Certification Cost Analysis". The Deloitte Team encompassed a range of experts in capital projects analysis, including quantity surveyors from the BTY Group and an engineer specializing in LEED certification requirements from Eco-Integration.

The purpose of our analysis was to identify the specific costs and benefits associated with moving a project from its current baseline funding to LEED Silver and LEED Gold certification levels, by reviewing three social infrastructure projects in Alberta. It is our understanding that the findings of this study will be used by Alberta Infrastructure and Alberta Treasury Board as a guide to assess future Provincially-funded projects similar in nature to the case study projects.

Our analysis focused on the following three case study projects identified by Alberta Infrastructure:

Project Name & Location	Use	Status	Owner	LEED Classification
Chestermere Lake Elementary (the "Elementary School Project"), Calgary, AB	School	Greenfield Under construction	Catholic School Board	Targeting LEED Silver (identified 39 points)
Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station (the "Visitor Centre Project")	Visitor Centre	Addition to existing facility Completed	Government of Alberta	Targeted LEED Silver, achieved LEED Gold (39 points)
Mount Royal College Centre for Continuous Learning (the "College Project")	College	Greenfield Completed	College Board	LEED Gold (43 points)

2 Our Approach

The following approach was undertaken to conduct our analysis. Phase 1 involved an independent review of each case study project (drawings, final construction costs and LEED scorecard) to develop an initial view on the capital costs of the project if it had been constructed without LEED certification (the "Baseline" design). In Phase 2, half day workshops were held with the design team members from each of the case study projects, to determine:

- Strategies undertaken for the project and what possible 36 points would have been targeted for LEED Silver (in some of the project cases this meant eliminating strategies to bring the projects back to LEED Silver); and
- Strategies were undertaken for the project and what possible 42 points would have been targeted for LEED Gold.

The workshops allowed us to confirm and/or refine our Phase 1 findings, as well as gather information relevant to other areas of further analysis (Phase 3).

Phase 3 involved analyzing the information compiled during Phases 1 and 2 to determine the implications of the different LEED ratings on lifecycle costs (including capital, operating, maintenance and periodic replacement costs), water consumption, energy consumption and greenhouse gas emissions. In some cases, follow-up correspondence with workshop participants was required to obtain additional information. Phase 3 also considered the positive externalities of LEED-certified buildings on building occupants, primarily through discussions with user groups for two of the three case study projects (note that the Elementary School Project was still being constructed at the time of this report). Third-party independent research was also reviewed to complement and validate our findings.

3 Summary of Phase 1 Findings

Our Phase 1 findings were originally presented in a memo to Alberta Infrastructure on May 21, 2008. These findings were based on a partial completion of Phase 1, as we were unable to complete our analysis for the College Project in time. The table below summarizes our *preliminary* Phase 1 findings.

Project Name	LEED Rating(1)	Baseline Cost(2)(3)	Baseline Cost to LEED Silver(3) *(% increase)*	Baseline Cost to LEED Gold(3) *(% increase)*
Elementary School Project	39 points LEED Gold	**$10,235,842**	*Est. 3 to 5%*	**5 to 7%**
Visitor Centre Project	39 points LEED Gold	**$1,289,458**	*Est. 3 to 4%*	**4 to 6%**
College Project	43 points LEED Gold	TBD	*Est. 3 to 5%*	*Est. 5 to 7%*

1) *33 to 38 points required for LEED Silver, 39 – 51 points required for LEED Gold. We note that at least two of the three projects had targeted LEED Silver but actually achieved LEED Gold.*
2) *Base Cost was determined by removing costs related to LEED requirements from the final construction cost on an element-by-element basis.*
3) *Bolded numbers were based on calculations performed by the Deloitte Team; italicised numbers were estimates based on experience with similar projects in other jurisdictions.*

As the numbers presented above were prepared without the involvement of the relevant team members from the case study projects, we cautioned at the time that our Phase 1 findings were *preliminary* and *subject to materially change* following our Phase 2 undertaking.

4 Summary of Phase 2 Findings

Our Phase 2 findings were first presented in a memo to Alberta Infrastructure on June 12, 2008. The tables below summarize the percentage increase in costs, moving from baseline to LEED Silver to LEED Gold, and segregated between hard costs and LEED related soft costs noting that the Baseline costs did not account for any soft project costs.

Summary of Hard Costs

Project Name	LEED Rating	Baseline Cost(1)	Baseline to LEED Silver (Hard Costs) *($/% increase)*	Baseline to LEED Gold (Hard Costs) *($/% increase)*
Elementary School Project	39 points LEED Gold	$10,594,600	$265,000/ 2.5% of baseline	$731,000/ 6.9% of baseline
Visitor Centre Project	39 points LEED Gold	$1,227,200	$65,000/ 5.3% of baseline	$119,000/ 9.7% of baseline
College Project	43 points LEED Gold	$14,014,964	$400,000/ 2.9% of baseline	$750,000/ 5.4% of baseline

1) Baseline costs were refined from the Phase 1 analysis, as a result of information provided during the half-day workshops.

Summary of Soft Costs

Project Name	LEED Rating	Baseline Cost(1)	Baseline to LEED Silver (Soft Costs) *($/% increase)*	Baseline to LEED Gold (Soft Costs) *($/% increase)*
Elementary School Project	39 points LEED Gold	$10,594,600	$190,000/ 1.8% of baseline	$190,000/ 1.8% of baseline
Visitor Centre Project	39 points LEED Gold	$1,227,200	$151,000/ 12.3% of baseline	$151,000/ 12.3% of baseline
College Project	43 points LEED Gold	$14,014,964	$232,000/ 1.7% of baseline	$232,000/ 1.7% of baseline

1) Baseline costs were refined from the Phase 1 analysis, as a result of information provided during the half-day workshops.

5 Our Approach to Phase 3 and Overall Findings

As discussed earlier, Phase 3 comprised two distinct components:

- Analyzing the impact of the different LEED ratings on lifecycle costs, water consumption, energy consumption, and greenhouse gas emissions; and
- Considering the positive externalities of LEED-certified buildings on building occupants.

The former primarily involved analyzing the information gathered during Phases 1 and 2, supplemented by follow-up correspondence to certain workshop participants for further information and clarification, whereas the latter was conducted by contacting certain users of the Visitor Centre and College Project to obtain their views on positive building externalities. We also reviewed third party independent research on "green" buildings and related productivity. The results of our undertakings are presented below.

5.1 Lifecycle Costs

For the purpose of analysing lifecycle costs, we considered capital costs, periodic replacement costs, maintenance costs and energy costs over a 30-year period, as follows:

- Capital costs (hard and soft) were based on our Phase 2 findings, as first outlined in our June 12, 2008 memo;
- Periodic replacement costs were estimated based on the Deloitte Team's preliminary views of building system descriptions for the three different design scenarios (Baseline, LEED Silver, and LEED Gold),
- Annual maintenance costs were estimated based on historical cost data for buildings of similar size and nature; and
- Annual operating costs (gas and electricity) were estimated based on energy models prepared by the mechanical engineers in the early stages of the case study projects.

Over the 30-year period, an annual escalation factor of 5% was assumed, and those costs were then discounted at a rate of 6% to determine the present value of all future costs. A payback period has been calculated to provide an indication as to how long it takes for the annual lifecycle cost savings to equate to the additional capital expenditure (hard and soft cost) to achieve the LEED Silver and LEED Gold levels.

For the Visitor Centre Project, an allowance for water supply of $5/m^3 was included, based on local site conditions. However, to verify this allowance, we recommend a detailed cost estimate be carried out.

Elementary School Project Lifecycle Costs

	Baseline		LEED Silver		LEED Gold	
	Estimated Cost	**Present Value**	**Estimated Cost**	**Present Value**	**Estimated Cost**	**Present Value**
Initial Costs						
Construction Costs	$10,594,600	$10,594,600	$10,594,600	$10,594,600	$10,594,600	$10,594,600
Premium for LEED (Hard costs)			$265,000	$265,000	$731,000	$731,000
Premium for LEED (Soft costs)			$190,000	$190,000	$190,000	$190,000
Total Initial Costs (A)		**$10,594,600**		**$11,049,600**		**$11,515,600**
Replacement Costs						
Replacement costs over 30 years		$615,400		$403,800		$464,000
Total Replacement Cost (B)		**$615,400**		**$403,800**		**$464,000**
Annual Costs						
Maintenance costs	$92,100	$2,338,400	$73,700	$1,871,200	$78,300	$1,988,000
Operating costs	$102,740	$2,608,500	$52,305	$1,328,000	$41,844	$1,062,400
Total Annual Costs (C)		**$4,946,900**		**$3,199,200**		**$3,050,400**
Total Lifecycle Costs (A+B+C)		**$16,156,900**		**$14,652,600**		**$15,030,000**
Variance ($)		BASE		($1,504,300)		($1,126,900)
Variance (%)				9.3%		7.0%
Payback (years)				7 years		13 years

Based on the analysis undertaken, moving the Elementary School Project from the Baseline design to LEED Silver results in a 7 year payback; moving the project to LEED Gold from the Baseline design results in a 13 year payback.

Visitor Centre Project Lifecycle Costs

	Baseline		LEED Silver		LEED Gold	
	Estimated Cost	Present Value	Estimated Cost	Present Value	Estimated Cost	Present Value
Initial Costs						
Construction Costs	$1,227,200	$1,227,200	$1,227,200	$1,227,200	$1,227,200	$1,227,200
Premium for LEED (Hard costs)			$65,000	$65,000	$119,000	$119,000
Premium for LEED (Soft costs)			$151,000	$151,000	$151,000	$151,000
Total Initial Costs (A)		**$1,227,200**		**$1,443,200**		**$1,497,200**
Replacement Costs						
Replacement costs over 30 years		$129,400		$72,9700		$83,400
Total Replacement Cost (B)		**$129,400**		**$72,900**		**$83,400**
Annual Costs						
Maintenance costs	$11,000	$279,300	$8,800	$223,400	$8,800	$223,400
Operating costs	$10,452		$6,925		$6,295	
Yearly water costs	$5,223	$398,000	$2,415	$237,100	$2,415	$221,100
Total Annual Costs (C)		**$677,300**		**$460,500**		**$444,500**
Total Lifecycle Costs (A+B+C)		**$2,033,900**		**$1,976,600**		**$2,025,100**
Variance ($)		BASE		($57,300)		($8,800)
Variance (%)				2.8%		0.4%
Payback (years)				27 years		28 years

Based on the analysis undertaken, moving the Visitor Centre Project from the Baseline design to LEED Silver results in a 27 year payback; moving the project to LEED Gold from the Baseline Design results in a 28 year payback.

College Project Lifecycle Costs

	Baseline		LEED Silver		LEED Gold	
	Estimated Cost	Present Value	Estimated Cost	Present Value	Estimated Cost	Present Value
Initial Costs						
Construction Costs	$14,014,964	$14,014,964	$14,014,964	$14,014,964	$14,014,964	$14,014,964
Premium for LEED (Hard costs)			$400,000	$400,000	$750,000	$750,000
Premium for LEED (Soft costs)			$232,000	$232,000	$232,000	$232,000
Total Initial Costs (A)		**$14,014,964**		**$14,646,964**		**$14,996,964**
Replacement Costs						
Replacement costs over 30 years		$737,800		$464,100		$636,300
Total Replacement Cost (B)		**$737,800**		**$464,100**		**$636,300**
Annual Costs						
Maintenance costs	$111,700	$2,836,000	$89,400	$2,269,800	$94,900	$2,409,500
Operating costs	$141,155	$3,583,900	$81,476	$2,068,700	$70,849	$1,798,800
Total Annual Costs (C)		**$6,419,900**		**$4,338,500**		**$4,208,300**
Total Lifecycle Costs						

(A+B+C) Variance ($) Variance (%) Payback (years)	**$21,172,664** BASE	**$19,449,564** ($1,723,100) 8.1% 8 years	**$19,841,564** ($1,331,100) 6.3% 12 years

Based on the analysis undertaken, moving the College Project from the Baseline design to LEED Silver results in a 8 year payback; moving the project to LEED Gold from the Baseline design results in a 12 year payback.

5.2 Water Consumption

Actual water consumption data was unavailable for the two constructed buildings so our approach to estimating water consumption was based on the LEED Calculation Template for the LEED Water Efficiency Credit 3 provided by each of the building teams, and estimating water consumption under the water efficiency related strategies we identified for the Baseline and LEED Gold or LEED Silver.

Alberta Infrastructure may want to consider requirements for full post occupancy measurement and verification of water consumption on future LEED Gold projects to validate water efficiency estimates.

Elementary School Project Estimated Water Consumption

	Baseline	LEED Silver	LEED Gold
Water Consumption (Irrigation)			
Total water use	Catholic Separate School Board policy is no water provided for irrigation	0	0
Water Consumption (Building); Occupants = 370			
Description	• medium flow fixtures for showers and faucets • low flow (6 litre) toilets for kids • conventional urinals with sensor flush • dual flush toilets for staff	In addition to baseline: • sensors on kids low flow toilets • low flow urinals with sensor flush • sensors + aerator to further reduce flow on faucets	In addition to baseline: • low flow showers • ultra low flow kids toilets (or dual flush)
Total Annual Volume	1,269,270	1,136,270	856,590
Grand Total (Irrigation + Building Use)	**1,269,270**	**1,136,270**	**856,590**
Variance (litres)	**0**	**133,000**	**412,680**
Variance (%)		**10.5%**	**32.5%**

Note: All volumes in litres.

Based on the analysis undertaken, total water consumption for the Elementary School Project decreases by 10.5% under LEED Silver, and 32.5% under LEED Gold, compared to the Baseline design.

College Project Estimated Water Consumption

	Baseline	LEED Silver	LEED Gold
Water Consumption (Irrigation)			
Description	Landscaping options that would require more irrigation	Would likely achieve 50% reduction in water for irrigation with the choice of planting even if a cistern	Native and adaptive, drought tolerant planting used, minimum irrigation provided by cistern

		had not been provided	collection of rainwater
Total water use	262,500	210,000	Zero potable water used for irrigation (cistern collects rainwater for irrigation)
Water Consumption (Building); Occupants = 210			
Description	• standard flow fixtures for showers, faucets and urinals • low flow toilets, not dual flush	• would probably still achieve if dual flush toilets and low flow fixtures • delete cistern	• dual flush toilets • waterless urinals • low flow fixtures • rainwater stored in cistern to flush toilets
Total Annual Volume	914,934	697,921	215,678
Grand Total (Irrigation + Building Use)	**1,177,434**	**907,921**	**215,678**
Variance (litres)	**0**	**269,513**	**961,756**
Variance (%)		**22.9%**	**81.7%**

Note: All volumes in litres.

Based on the analysis undertaken, total water consumption of the College Project decreases by 22.9% under LEED Silver, and 81.7% under LEED Gold, compared to the Baseline design.

Visitor Centre Project Estimated Water Consumption

	Baseline	LEED Silver	LEED Gold
Water Consumption (Irrigation)			
Total water use	Water conservation was critical for this arid, dry site so baseline was set at no water (potable or stored) for irrigation	0	0
Water Consumption (Building); Occupants = 116 (based on visitor count)			
Description	• dual flush for existing retrofit • no waterless urinals • no flow restrictors for existing	• same as baseline	In addition to baseline: • add aerators to restrict flow to 1.9gpm on existing fixtures • retrofit waterless urinals in existing
Total Annual Volume	749,109	749,109	483,005
Grand Total (Irrigation + Building Use)	**749,109**	**749,109**	**483,005**
Variance (litres)			**266,104**
Variance (%)			**35.5%**

Note: All volumes in litres.

Based on the analysis undertaken, water consumption decreases by 35.5% under LEED Gold compared to the Baseline design. There is no change under LEED Silver as the water consumption strategy is assumed to be the same as the Baseline.

5.3 Energy Consumption and Greenhouse Gas Emissions

Actual energy consumption data was unavailable for the two constructed buildings so our approach to estimating energy consumption and related Greenhouse Gas Emissions was based on the energy modeling reports provided by each of the building design teams and estimating energy consumption under the energy efficiency related strategies we identified for the Baseline and LEED Gold or LEED Silver. No energy modeling was performed although this could be conducted in the future to verify the estimates for the three case study projects.

Alberta Infrastructure may want to consider requirements for full post occupancy measurement and verification of energy consumption on future LEED Gold project to validate energy modeling results. Furthermore, Alberta Infrastructure may want to consider specifying that future LEED Gold projects target a certain number of energy points to ensure payback periods are reduced to the lowest level.

Elementary School Project Estimated Energy Consumption

	Baseline	LEED Silver	LEED Gold
Energy Consumption			
Electricity (MJ)	1,193,400	967,980	835,000
Natural Gas (MJ)	4,165,091	2,689,200	2,010,000
Total	5,358,491	3,657,180	2,845,000
Energy Savings (Electricity MJ)	0	225,420	358,400
GHG Savings (Electricity tonnes of CO_2)	0	62	99
Energy Savings (Natural Gas MJ)	0	1,475,891	2,155,091
GHG Savings (Natural Gas tonnes of CO_2)	0	73	106
Total GHG Savings (tonnes of CO_2)	0	135	206
Tonnes of CO_2/sqm Savings		0.032	0.049

College Project Estimated Energy Consumption

	Baseline	LEED Silver	LEED Gold
Energy Consumption			
Electricity (MJ)	3,146,057	2,416,982	1,987,763
Natural Gas (MJ)	6,264,734	3,980,181	2,807,334
Total	9,410,791	6,397,163	4,795,097
Energy Savings (Electricity MJ)	0	729,075	1,158,294
GHG Savings (Electricity tonnes of CO_2)	0	202	321
Energy Savings (Natural Gas MJ)	0	2,284,553	3,457,400
GHG Savings (Natural Gas tonnes of CO_2)	0	113	171
Total GHG Savings (tonnes of CO_2)	0	315	492
Tonnes of CO2/sqm Savings		0.062	0.097

Visitor Centre Project Estimated Energy Consumption

	Baseline	LEED Silver	LEED Gold
Energy Consumption			
Electricity (MJ)	203,895	204,786	206,765
Natural Gas (MJ)	478,443	291,828	180,605
Total	682,338	496,614	387,370
Energy Savings (Electricity MJ)	0	-891	-2,870
GHG Savings (Electricity tonnes of CO_2)	0	-0.25	-0.80
Energy Savings (Natural Gas MJ)	0	186,615	297,839
GHG Savings (Natural Gas tonnes of CO_2)	0	9	15
Total GHG Savings (tonnes of CO_2)	0	9	14
Tonnes of CO2/sqm Savings		0.007	0.010

5.4 Positive Externalities of LEED-Certified Buildings

Research has shown that energy-efficient, "green" building designs, in addition to providing reduced energy and water consumption, offer the possibility of improved worker productivity and comfort levels. According to a research paper published by the Rocky Mountain Institute[1], which reviewed eight case study projects of building retrofits and new facilities in the U.S., efficient lighting, heating and cooling systems had measurably increased worker productivity, decreased absenteeism, and/or improved the quality of the work performed. In the case of Lockheed Building 157, noted as one of the most successful examples of daylighting in a large commercial office building, a new 600,000 square foot office building for 2,700 engineers and support people was constructed in Sunnyvale, California. Although the energy-efficient improvements added roughly $2 million to the $50 million cost of the building, energy savings alone were worth $500,000 per year. Moreover, the improved daylighting resulted in productivity gains of 15% and absenteeism declines of 15%.

With regard to sustainable schools and their impact on user groups, it has been noted that buildings with features such as improved air quality, daylighting strategies, and occupant-controlled heat, light and air systems can result in better learning environments, increased productivity levels and reduced operating expenses[2]. In the U.S. Environmental Agency Protection's ("EPA") guide "Indoor Air Quality Tools for

[1] "Greening the Building and the Bottom Line – Increased Productivity Through Energy-Efficient Design", Published by the Rocky Mountain Institute (1998), Authors: Joseph J. Romm (U.S. Department of Energy) and William D. Browning (Rocky Mountain Institute).

[2] Source: http://www.seattle.gov/light, "Sustainability – High Performance Buildings Deliver Better Learning Environments".

Schools"[3], it states that "Good indoor air quality contributes to a favourable learning environment for students, productivity for teachers and staff, and a sense of comfort, health and well-being. These elements combine to assist a school in its core mission – educating children".

For the purpose of our analysis, our approach to assessing positive externalities entailed seeking feedback from select occupants/users of the Visitor Centre and College projects on various features, including indoor air quality, lighting and productivity. In some cases, the view expressed is that of the individual contacted; in other cases, the view is one that the individual has heard from other users of the facility. As the Elementary School Project was still under construction during the time of our report, our comments for that case study project are based on feedback received during the half-day workshop. The results of our findings are presented below.

Project Name	Individual Contacted	Indoor Air Quality	Lighting	Heating / Cooling	Other
Elementary School Project	Findings per workshop participants	Not discussed in this context	Not discussed in this context	Not discussed in this context	• Staff/students benefit from recycling program
Visitor Centre Project	Donna Martin, *Visitor Centre Coordinator*	• No difference noted	• Use of daylighting easier on the eye; however, sometimes the office and working areas are too dark to see files, etc.	• Cooling tower in Visitor Centre works very well in public area, but back offices can get too hot in middle of summer	• Employees love that the building is energy efficient; try and promote it whenever they can to the public
College Project	Corrine Burke, *Mgr. Satellite Campuses*	• "Air feels different", seems fresher and cleaner	• Lighting is visually pleasing, easier on the eye • Ample daylighting reduces need for light fixtures in office space • Classroom users enjoy natural light (some challenges early on with sunlight impeding A/V, but resolved with window shades)	• Aside from really hot or cold days, heating/cooling systems work fine • Classroom-controlled thermostats have increased comfort levels and generally reduced number of calls to maintenance staff	• Generally, space is nicer; use of materials and natural lighting have contributed to a calmer and more relaxed feel • From an ethical perspective, people "feel good" knowing the building is environmentally friendly • Great "selling feature" - used in marketing materials

The positive externalities from the Visitor Centre and College projects do not appear to be material and are somewhat offset by negative impacts such as low lighting and heating / cooling system under-performance under certain conditions. We note that productivity gains and absenteeism were not specifically identified by any of the case study participants and such measures may not be particularly relevant given the nature of these facilities - these measures would be more relevant to facilities with a high proportion of office space.

[3] Source: http://www.epa.gov/iaq/schools/toolkit

To obtain more data on positive externalities for future projects, Alberta Infrastructure may want to consider conducting user group surveys before and after occupation of a LEED-certified building. Benchmarking absenteeism before and after may also be a useful measure. In both cases, interpretation of the data gathered must be carefully considered to determine whether the positive externalities are related to solely moving from an old to new building or indeed whether the specific LEED features are contributing factors.

6 Summary Results

Project	Cost Savings			
	LEED Silver		LEED Gold	
	$	Payback (years)	$	Payback (years)
Elementary School	1,504,300	7	1,126,900	13
Visitor Centre Project	57,300	27	8,800	28
College Project	1,723,100	8	1,331,100	12

Project	Consumption Reduction			
	LEED Silver		LEED Gold	
	% water (Litres)	% Energy (MJ)	% Water (Litres)	% Energy (MJ)
Elementary School	10.5	31.7	32.5	46.9
Visitor Centre Project	0.0	27.2	35.5	43.2
College Project	22.9	32.0	81.7	49.0

7 Limitations

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Appendix 1 –
Phase 2 Supporting Analysis

6.0 CASE STUDY ANALYSIS

Project Background

Chestermere Lake Elementary School
Workshop Date: May 27, 2008

These notes to be read in conjunction with attached LEED scorecard in Section 7.0 indicating the strategies for Baseline, LEED Silver and LEED Gold and the LEED checklist for LEED Silver and LEED Gold and the Actual Project Checklist (not yet certified but at 39 points).

Chestermere Lake is a new elementary school that is owned and operated by the Calgary Catholic School board. The project was tendered using a Stipulated Lump Sum form of contract. Currently under construction, the school costs are **$10,859,600 or $2,593.03/m^2 ($241.02/sq. ft).**

The Calgary Catholic School Board has a philosophy for designing robust, durable buildings with good envelope performance and child resistant of materials. Some of this dovetails into the LEED philosophy but some of the possible site strategies (such as stormwater management, pervious surfaces, shading, use of trees and landscaping) does not, making it challenging to achieve these credits.

The Catholic School Board has also believes in constructing buildings with a 50 year lifespan and therefore lifecycle costing is relevant and of interest to them. They were not aware however of a connection between indoor air quality and productivity (materials with low VOC's, green space, views, good ventilation). Reduction of greenhouse gas emissions were not identified as a goal for the project.

6.0 CASE STUDY ANALYSIS (continued)

The items and costs associated with achieving a LEED rating for this building have been identified as follows:

Chestermere Lake Elementary School

LEED Requirement	Design Solutions	Non-LEED $	LEED Silver $	LEED Gold $
Hard Cost				
Storm Management	Water retaining system including detention pond, membrane and underground piping.	-	-	$180,000
Water Management	Sensors and aerators to plumbing fixtures, low flow fixtures	-	37,000	$44,000
Optimize Energy Performance	Air handling unit changed from constant air volume to variable frequency drive, VAV system on demand heat recovery unit. Additional Doc controls and metering. High-performance envelope and glazing system.	-	162,000	$397,000
Daylight and Views	Additional glazed areas.	-	25,000	$65,000
Contractor Administration	Additional Co-ordination	-	41,000	$45,000
Hard Costs Total			**$265,000**	**$731,000**
Soft Costs				
LEED Administration Documentation	LEED Registration; Additional Professional Design co-coordinators, LEED Consultant; Energy Modeler.	-	$137,000	137,000
	Commissioning Fundamental	-	$53,000	53,000
	Commissioning Best Practice	-	-	-
Soft Cost Total			**$190,000**	**$190,000**
TOTAL			**$455,000**	**$921,000**

6.0 CASE STUDY ANALYSIS (continued)

Project Background

Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station
Workshop Date: June 4, 2008

These notes to be read in conjunction with attached LEED scorecard indicating the strategies for Baseline, LEED Silver and LEED Gold and LEED checklists for LEED Silver and LEED Gold and the Actual Project Checklist (certified Gold at 39 points).

The Visitor Centre Project is a new addition to the existing Tyrrell Field Station. Owned and operated by the Government of Alberta, the project was tendered in October 2004 using a Stipulated Lump Sum form of contract with a tendered cost of **\$1,346,200 or \$2,692.40/m^2 (\$250.13/sq/ft**.).

The Tyrrell Field Station project is situated in an ecologically sensitive area where protection of the environment was paramount; subsequently many of the LEED requirements were baseline requirements. The area is a naturally eroding area and arid; therefore minimizing the building footprint and water usage were very important. The baseline ecological and sustainability costs for this project are therefore higher than many other projects.

Lifecycle costs were important considerations since the building is provincially owned and designed and built to be operational for many years. Calculations for the payback of the selected systems were undertaken as part of the design modeling exercise and to assist informed decision making.

Materials and systems (natural ventilation, natural light, controls) were selected to create a healthy and comfortable indoor environment; however they were not identified in a way to measure how it was successful. The Visitor Centre has few staff and many transient visitor; thus long term effects of being within the building are hard to assess. Whilst greenhouse gas emissions were not identified as a specific strategy the design sought to maximize passive and natural system (natural ventilation, daylighting) which in turn reduced the use of fossil fuels (primary and secondary).

6.0 CASE STUDY ANALYSIS (continued)

The items and costs associated with achieving a LEED rating for this building have been identified as follows:

Tyrell Field Station

LEED Requirement	Design Solutions	Non-LEED $	LEED Silver $	LEED Gold $
Hard Cost				
Water Management	Add waterless urinals and dual flush toilets. Provide Cistern. Add sensors & aerators to facets.	-	6,000	41,000
Minimum Energy Performance	Provide structural insulation panels to walls & roof. Provide high performance operable windows for cooling. Provide air to air heat recovery and natural ventilation. Replace existing boiler with new condensing boilers. More advanced design for windows and heat recovery & ventilation.	-	41,000	54,000
Measurement and Verification	Provide complete building control system.	-	-	-
Indoor Chemical and Pollutant Source Control	Provide entrance mat and fans to copy and janitor room.	-	-	4,000
Construction Administration	Additional Co-originator.	-	18,000	20,000
Hard Costs Total		**$0**	**$65,000**	**$119,000**
Soft Costs				
LEED Administration Documentation	Additional Project & Professional Design co-ordinates.	-	111,000	111,000
	Commissioning Fundamental	-	40,000	40,000
	Commissioning Best Practice	-	-	-
Soft Cost Total			**$151,000**	**$151,000**
TOTAL			**$216,000**	**$270,000**

(1) *The premium cost for revamping and upgrade the building controls system for achieving LEED Gold is excluding. Estimated cost is $70,000.*

6.0 CASE STUDY ANALYSIS (continued)

Project Background

Mount Royal College Centre for Continuous Learning
Workshop Date: June 3, 2008

These notes to be read in conjunction with attached LEED scorecard indicating the strategies for Baseline, LEED Silver and LEED Gold and LEED checklists for LEED Silver and LEED Gold and the Actual Project Checklist (certified Gold at 43 points).

Mount Royal College Centre for Continuous Learning is a new learning facility that is owned and operated by the Mount Royal College Board. The project was tendered in May 2005 using a Construction Management form of contract at a cost of **$14,764,964 or $2,907.63/m^2 ($270.27/sq.ft**.).

The overall design philosophy for this project was to reduce energy demand on the building by the use of passive strategies such as heavier structure providing a heat sink, use of overhangs and other shading strategies, high performance windows and walls. Again, lifecycle costing was important since the project program considers that the college will operate the buildings over a long period of time.. Whilst productivity was not measured it was considered in the choice of the systems and building form (such as demand control ventilation, use of daylighting etc.). The overall philosophy for the project drove the reduction in the use of fossil fuels (primary and secondary).

6.0 CASE STUDY ANALYSIS (continued)

The items and costs associated with achieving a LEED rating for this building have been identified as follows:

Mount Royal College Centre for Continuous Learning

LEED Requirement	Design Solutions	Non-LEED $	LEED Silver $	LEED Gold $
Hard Cost				
Storm Management	Water retaining system including detention pond, memrane and underground piping.	-	-	68,000
Landscape and Exterior Design	Reduction of heat islands by use of white roof membrane.	-	-	49,000
Water Management	Use of local plants using less irrigation and of low flow fixtures and waterless urinals.	-	33,000	39,000
Optimize Energy Performance	Use of Argon-filled windows, additional glazed areas, light shelves high performance walls, displacement ventilation condensing boilers, high efficiency chiller, cooling tower and heat recovery unit. Gold Certification required demand control ventilation (CO_2 sensors) natural ventilation and solar chimneys; high efficiency lighting, occupancy sensors and daylight sensors.	-	301,000	523,000
Controllability of Systems	One operable window and one lighting control for 18.5m within 5m of perimeter wall.	-	16,000	16,000
Contractor Administration	Additional Co-ordination	-	50,000	55,000
Hard Costs Total			**$400,000**	**$750,000**
Soft Costs				
LEED Administration Documentation	LEED Registration; Additional Professional Design co-ordinators, LEED Consultant; Energy Modeler.	-	167,000	167,000
	Commissioning Fundemental	-	65,000	65,000
	Commissioning Best Practice	-	-	-
Soft Cost Total			**$232,000**	**$232,000**
TOTAL			**$632,000**	**$982,000**

7.0 LEED CHECKLIST

-Chestermere Lake
Elementary School

LEED Canada-NC 1.0 Project Checklist

Proposed LEED Silver

Chestermere Lake Elementary School
Chestermere, Alberta

Yes	?	No			
5	1	7	**Sustainable Sites**		14 Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density**	1
		1	Credit 3	**Redevelopment of Contaminated Site**	1
		1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		1	Credit 6.2	**Stormwater Management**, Treatment	1
	1		Credit 7.1	**Heat Island Effect**, Non-Roof	1
		1	Credit 7.2	**Heat Island Effect**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
4		1	**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
6	1	7	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
4		3	Credit 1	**Optimize Energy Performance**	1 to 10
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Best Practice Commissioning**	1
1			Credit 4	**Ozone Protection**	1
		1	Credit 5	**Measurement & Verification**	1
	1		Credit 6	**Green Power**	1

LEED Canada-NC 1.0 Project Checklist
Proposed LEED Gold
Chestermere Lake Elementary School
Chestermere, Alberta

Yes	?	No			
6	1	7	**Sustainable Sites**		14 Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density**	1
		1	Credit 3	**Redevelopment of Contaminated Site**	1
		1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		1	Credit 6.2	**Stormwater Management**, Treatment	1
	1		Credit 7.1	**Heat Island Effect**, Non-Roof	1
		1	Credit 7.2	**Heat Island Effect**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
4		1	**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
10		6	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
6		3	Credit 1	**Optimize Energy Performance**	1 to 10
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Best Practice Commissioning**	1
1			Credit 4	**Ozone Protection**	1
1			Credit 5	**Measurement & Verification**	1
1			Credit 6	**Green Power**	1

Yes	?	No			
8	1	6	**Materials & Resources**		14 Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse:** Maintain 75% of Existing Walls, Floors, and Roof	1
		1	Credit 1.2	**Building Reuse:** Maintain 95% of Existing Walls, Floors, and Roof	1
		1	Credit 1.3	**Building Reuse:** Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management:** Divert 50% from Landfill	1
1			Credit 2.2	**Construction Waste Management:** Divert 75% from Landfill	1
		1	Credit 3.1	**Resource Reuse:** 5%	1
		1	Credit 3.2	**Resource Reuse:** 10%	1
1			Credit 4.1	**Recycled Content:** 7.5% (post-consumer + ½ post-industrial)	1
1	1		Credit 4.2	**Recycled Content:** 15% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Regional Materials:** 10% Extracted and Manufactured Regionally	1
1			Credit 5.2	**Regional Materials:** 20% Extracted and Manufactured Regionally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
1			Credit 7	**Certified Wood**	1
1			Credit 8	**Durable Building**	1

Yes	?	No			
11		4	**Indoor Environmental Quality**		15 Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
		1	Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
1			Credit 2	**Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan:** During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan:** Testing Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
		1	Credit 4.2	**Low-Emitting Materials:** Paints and Coating	1
1			Credit 4.3	**Low-Emitting Materials:** Carpet	1
1			Credit 4.4	**Low-Emitting Materials:** Composite Wood and Laminate Adhesives	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
		1	Credit 6.1	**Controllability of Systems:** Perimeter Spaces	1
		1	Credit 6.2	**Controllability of Systems:** Non-Perimeter Spaces	1
1			Credit 7.1	**Thermal Comfort:** Compliance	1
1			Credit 7.2	**Thermal Comfort:** Monitoring	1
1			Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
1			Credit 8.2	**Daylight & Views:** Views 90% of Spaces	1

Yes	?	No			
3	2		**Innovation & Design Process**		5 Points
1			Credit 1.1	**Innovation in Design:** Green Building Education	1
1			Credit 1.2	**Innovation in Design:** Exemplary performance WEc3 water use reduction 40%	1
	1		Credit 1.3	**Innovation in Design**	1
	1		Credit 1.4	**Innovation in Design**	1
1			Credit 2	**LEED® Accredited Professional**	1

Yes	?	No		
42	4	24	**Project Totals (pre-certification estimates)**	70 Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

Yes	?	No			
7	1	6	**Materials & Resources**		**14 Points**
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse:** Maintain 75% of Existing Walls, Floors, and Roof	1
		1	Credit 1.2	**Building Reuse:** Maintain 95% of Existing Walls, Floors, and Roof	1
		1	Credit 1.3	**Building Reuse:** Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management:** Divert 50% from Landfill	1
1			Credit 2.2	**Construction Waste Management:** Divert 75% from Landfill	1
		1	Credit 3.1	**Resource Reuse:** 5%	1
		1	Credit 3.2	**Resource Reuse:** 10%	1
1			Credit 4.1	**Recycled Content:** 7.5% (post-consumer + ½ post-industrial)	1
	1		Credit 4.2	**Recycled Content:** 15% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Regional Materials:** 10% Extracted and Manufactured Regionally	1
1			Credit 5.2	**Regional Materials:** 20% Extracted and Manufactured Regionally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
1			Credit 7	**Certified Wood**	1
1			Credit 8	**Durable Building**	1

Yes	?	No			
11		4	**Indoor Environmental Quality**		**15 Points**
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
		1	Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
1			Credit 2	**Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan:** During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan:** Testing Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
		1	Credit 4.2	**Low-Emitting Materials:** Paints and Coating	1
1			Credit 4.3	**Low-Emitting Materials:** Carpet	1
1			Credit 4.4	**Low-Emitting Materials:** Composite Wood and Laminate Adhesives	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
		1	Credit 6.1	**Controllability of Systems:** Perimeter Spaces	1
		1	Credit 6.2	**Controllability of Systems:** Non-Perimeter Spaces	1
1			Credit 7.1	**Thermal Comfort:** Compliance	1
1			Credit 7.2	**Thermal Comfort:** Monitoring	1
1			Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
1			Credit 8.2	**Daylight & Views:** Views 90% of Spaces	1

Yes	?	No			
2	3		**Innovation & Design Process**		**5 Points**
1			Credit 1.1	**Innovation in Design:** Green Building Education	1
	1		Credit 1.2	**Innovation in Design**	1
	1		Credit 1.3	**Innovation in Design**	1
	1		Credit 1.4	**Innovation in Design**	1
1			Credit 2	**LEED® Accredited Professional**	1

Yes	?	No		
35	6	25	**Project Totals (pre-certification estimates)**	**70 Points**

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

Actual LEED Canada-NC 1.0 Project Checklist

(this project has not yet been certified - these are the points the design team are targeting for LEED Silver certification)

Chestermere Lake Elementary School
Chestermere, Alberta

Yes	?	No			
6	1	7	**Sustainable Sites**		14 Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density**	1
		1	Credit 3	**Redevelopment of Contaminated Site**	1
		1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		1	Credit 6.2	**Stormwater Management**, Treatment	1
	1		Credit 7.1	**Heat Island Effect**, Non-Roof	1
		1	Credit 7.2	**Heat Island Effect**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
4		1	**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
9	1	7	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
7		3	Credit 1	**Optimize Energy Performance**	1 to 10
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Best Practice Commissioning**	1
1			Credit 4	**Ozone Protection**	1
		1	Credit 5	**Measurement & Verification**	1
	1		Credit 6	**Green Power**	1

Yes	?	No			
7	1	6	**Materials & Resources**		14 Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse:** Maintain 75% of Existing Walls, Floors, and Roof	1
		1	Credit 1.2	**Building Reuse:** Maintain 95% of Existing Walls, Floors, and Roof	1
		1	Credit 1.3	**Building Reuse:** Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management:** Divert 50% from Landfill	1
1			Credit 2.2	**Construction Waste Management:** Divert 75% from Landfill	1
		1	Credit 3.1	**Resource Reuse:** 5%	1
		1	Credit 3.2	**Resource Reuse:** 10%	1
1			Credit 4.1	**Recycled Content:** 7.5% (post-consumer + ½ post-industrial)	1
	1		Credit 4.2	**Recycled Content:** 15% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Regional Materials:** 10% Extracted and Manufactured Regionally	1
1			Credit 5.2	**Regional Materials:** 20% Extracted and Manufactured Regionally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
1			Credit 7	**Certified Wood**	1
1			Credit 8	**Durable Building**	1

Yes	?	No			
11		4	**Indoor Environmental Quality**		15 Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
		1	Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
1			Credit 2	**Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan:** During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan:** Testing Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
		1	Credit 4.2	**Low-Emitting Materials:** Paints and Coating	1
1			Credit 4.3	**Low-Emitting Materials:** Carpet	1
1			Credit 4.4	**Low-Emitting Materials:** Composite Wood and Laminate Adhesives	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
		1	Credit 6.1	**Controllability of Systems:** Perimeter Spaces	1
		1	Credit 6.2	**Controllability of Systems:** Non-Perimeter Spaces	1
1			Credit 7.1	**Thermal Comfort:** Compliance	1
1			Credit 7.2	**Thermal Comfort:** Monitoring	1
1			Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
1			Credit 8.2	**Daylight & Views:** Views 90% of Spaces	1

Yes	?	No			
2	2	1	**Innovation & Design Process**		5 Points
1			Credit 1.1	**Innovation in Design**	1
		1	Credit 1.2	**Innovation in Design**	1
	1		Credit 1.3	**Innovation in Design**	1
	1		Credit 1.4	**Innovation in Design**	1
1			Credit 2	**LEED® Accredited Professional**	1

Yes	?	No		
39	5	26	**Project Totals (pre-certification estimates)**	70 Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

Chestermere Lake Elementary School
LEED Canada Scorecard Cost Analysis

Targeted LEED Silver

39 Points Identified

Prepared: May 2008
Updated from meeting

YES	Y?	N?	NO				Additional cost req'd to achieve LEED none minor moderate high	BASELINE	(4 points identified to delete to take the project back to LEED silver) LEED SILVER	(3points added to put project to solid LEED gold position) LEED GOLD
6	5		3	Sustainable Sites		14 Points				
Y				Prereq 1	Erosion & Sedimentation Control	Req'd	Minor to none	standard requirement		
1				Credit 1	Site Selection	1	None	not a project choice (either receive credit or not depending on site conditions)		
			1	Credit 2	Urban Redevelopment	1	none	not a project choice (either receive credit or not depending on site conditions)		
			1	Credit 3	Redevelopment of Contaminated Sites	1	None	not a project choice (either receive credit or not depending on site conditions)		
			1	Credit 4.1	Alternative Transportation, Public Transportation Access	1	None	not a project choice (either receive credit or not depending on site conditions)		

1				Credit 4.2	**Alternative Transportation,** Bicycle Storage & Changing Rooms	1	Minor	baseline	yes	bike storage and showers provided
	1			Credit 4.3	**Alternative Transportation,** Alternative Fuel Vehicles	1	Minor	not baseline	no	not targeted - do not have a car /van for school that could be hybrid
1				Credit 4.4	**Alternative Transportation,** Parking Capacity and Carpooling	1	none	not baseline	yes	provided less parking than required
	1			Credit 5.1	**Reduced Site Disturbance,** Protect or Restore Open Space	1	none to moderate	not baseline	no	high percentage of ashphalt for play area and parking on site
1				Credit 5.2	**Reduced Site Disturbance,** Development Footprint	1	none to moderate	not baseline	yes	calcluated based on design of site - nothing change due to LEED
1				Credit 6.1	**Stormwater Management,** Rate and Quantity	1	none to moderate	not baseline - no special considerations for stormwater - just collect from hard surfaces and send into municipal system	may not achieve this as no special strategies undertaken (such as roof detension, bioswales, pervious surfaces, green roofs, cisterns for toilet flushing) Minus 1 point	need to achieve this for LEED Gold - possible bioswales to allow water to return to ground not into stormwater system

YES	?	?	NO	Credit	Title	Points	Impact			
	1			Credit 6.2	**Stormwater Management,** Treatment	1	moderate	not baseline	no	Possible bioswales could treat water but difficult to demonstrate. Assume no
	1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands,** Non-Roof	1	moderate	not baseline	no	can achieve by using the outlined requirements (shade, light albedo, non roof impervious surfaces or opengrid pavement for parking - no strategies were deemed appropriate for this school environment
	1			Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands,** Roof	1	moderate	not baseline	no	could achieve using white membrane roof (or green roof) but neither strategy was deemed appropriate for this school environment
1				Credit 8	**Light Pollution Reduction**	1	Minor	baseline	yes	yes
YES	?	?	NO							
4	1				**Water Efficiency**	5 Points				**Available Strategies**
1				Credit 1.1	**Water Efficient Landscaping,** Reduce by 50%	1	Minor	baseline - no water use for irrigation		
1				Credit 1.2	**Water Efficient Landscaping,** No Potable Use or No Irrigation	1	moderate	baseline - no water use for irrigation		
	1			Credit 2	**Innovative Wastewater Technologies**	1	moderate	low flow (6 litre) toilets for kids urinals with sensor flush dual flush toilets for staff	In addition to base line: sensors on kids low flow toilets better low flow urinals with sensor flush not sufficient to achieve credit	would likely need cistern for water storage of rainwater for toilet flushing

YES	Y?	N?	NO	Credit	Title	Points	Cost	Baseline	Option	Strategies
1				Credit 3.1	**Water Use Reduction**, 20% Reduction	1	None to Minor	low flow fixtures for showers and faucets low flow (6 litre) toilets for kids urinals with sensor flush dual flush toilets for staff	in addition to base line: sensors on kids low flow toilets better low flow urinals with sensor flush sensors + aerator to further reduce flow on faucets yes	In addition to base line: low flow showers ultra low flow kids toilets (or dual flush) yes
1				Credit 3.2	**Water Use Reduction**, 30% Reduction	1	Minor	see above	see above	see above 40% is achieveable (1 innovation point) if all strategies applied
9	3		5		**Energy & Atmosphere**	17 Points				**Strategies**
Y				Prereq 1	**Fundamental Building Systems Commissioning**	Req'd	None	not baseline	have to meet as LEED prerequisite	have to meet as LEED prerequisite
Y				Prereq 2	**Minimum Energy Performance**	Req'd	minor	see attached mechanical specification	see attached mechanical specification	see attached mechanical specification
Y				Prereq 3	**CFC Reduction in HVAC&R Equipment**	Req'd	None	CFC's banned in Canada		
7			3	Credit 1	**Optimize Energy Performance**	1 to 10	moderate to high (first costs)	see attached mechanical specification	see attached mechanical specification minus 3 credit	see attached mechanical specification minus 1 credit

YES	Y?	N?	NO	Credit	Title	Points	Cost			
	1			Credit 2.1	**Renewable Energy, 5%**	1	High (first costs)	not baseline	no	not deemed cost effective
			1	Credit 2.2	**Renewable Energy, 10%**	1		see above	see above	see above
			1	Credit 2.3	**Renewable Energy, 20%**	1		see above	see above	see above
1				Credit 3	**Best Practice Commissioning**	1	none to minor	not baseline	yes	yes
1				Credit 4	**Ozone Depletion**	1	none to minor	not baseline	yes	specification of equipment wthout HCFC's
	1			Credit 5	**Measurement & Verification**	1	moderate	not baseline	no	need to target for LEED Gold - add controls and monitoring system - should result in operational savings Plus 1 point
	1			Credit 6	**Green Power**	1	Minor	not baseline	no	buy green power Plus 1 point

YES	Y?	N?	NO							
7	1		6	**Materials & Resources**		13 Points				**Strategies**
Y				Prereq 1	**Storage & Collection of Recyclables**	Req'd	none to minor	not baseline	need to meet as prerequisite	need to meet as prerequisite

			1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors, & Roof	1		n/a		
			1	Credit 1.2	**Building Reuse**, Maintain 95% of Existing Walls, Floors, & Roof	1		n/a		
			1	Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-structural Elements	1		n/a		
1				Credit 2.1	**Construction Waste Management**, Divert 50%	1	none	not baseline	specified by team and executed by contractor can be a cost effective for the contractor with rising prices of landfill	yes
1				Credit 2.2	**Construction Waste Management**, Divert 75%	1	none	see above	see above	see above
			1	Credit 3.1	**Resource Reuse**, Specify 5%	1	minor	not baseline	no	very difficult to achieve: requires commitment and design intensity to achieve
			1	Credit 3.2	**Resource Reuse**, Specify 10%	1	minor	see above	see above	see above
1				Credit 4.1	**Recycled Content**, Specify 7.5% (post-consumer + ½ post-industrial)	1	none	not baseline	yes	Specifications and sourcing materials can be labour intensive but usually cost neutral
	1			Credit 4.2	**Recycled Content**, Specify 15% (post-consumer + ½ post-industrial)	1	none	not baseline	no	As above Identify and price materials that contain recycled material that have not been itemized in project Plus 1 point
1				Credit 5.1	**Regional Materials**, 10% Extracted & Manufactured Regionally	1	none	not baseline	yes	Specifications and sourcing materials can be labour intensive but usually cost neutral
1				Credit 5.2	**Regional Materials**, 20% Extracted & Manufactured Regionally	1	none		yes	As above
			1	Credit 6	**Rapidly Renewable Materials**	1		not baseline	no	no

YES	Y?	N?	NO			Points				
1				Credit 7	**Certified Wood**	1	none to high	not baseline	Specifying 50% certified wood but leaving contractor to source so minimum upcharge (they can select wood with little or no premium) small quantity of wood in building: gym floor misc. cabinets and finishing	yes
1				Credit 8	**Durable Building**	1	minor	concept baseline not the documentation	Cost of Building Envelope consultant to complete documentation of this credit Good Practice, value added to owner	yes
11	4				**Indoor Environmental Quality**	15 Points				**Strategies**
Y				Prereq 1	**Minimum IAQ Performance**	Req'd	none	Mandatory compliance with ASHRAE 62-1999 standard.		
Y				Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Req'd	none	Automatic no smoking in public buildings		
	1			Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1	minor	not baseline	no	no
1				Credit 2	**Ventilation Effectiveness**	1	minor	not baseline	see mech spec	see mech spec

1				Credit 3.1	**Construction IAQ Management** Plan, During Construction	1	minor	not baseline	yes - may have construction upcharge however mech contractor etc should be following SMACNA guidelines	yes
1				Credit 3.2	**Construction IAQ Management** Plan, Flushout / Testing	1	minor	not baseline	flush out with phased occupancy is possible with no cost premium	yes
1				Credit 4.1	**Low-Emitting Materials,** Adhesives & Sealants	1	none	not baseline	specified cost neutral	yes
	1			Credit 4.2	**Low-Emitting Materials,** Paints	1	none	not baseline	school board policy not to specify low VOC paints	no
1				Credit 4.3	**Low-Emitting Materials,** Carpet	1	none	not baseline	specified cost neutral	no
1				Credit 4.4	**Low-Emitting Materials,** Composite Wood & Agrifiber	1	none	not baseline	specified cost neutral	yes
1				Credit 5	**Indoor Chemical & Pollutant Source Control**	1	Minor	not baseline	specify entrance mats and separate rooms for chemicals/ toxic cleaning supplies and copy machines with fans	yes

YES	Y?	N?	NO	Credit	Description	Points	Impact	Cost	Comments	Strategies
	1			Credit 6.1	**Controllability of Systems,** Perimeter	1	minor	not baseline	need operable window and lighting control for perimeter pressume design cannot meet these requirements	no
	1			Credit 6.2	**Controllability of Systems**, Non-Perimeter	1	minor	not baseline	similar to above for non-perimeter	no
1				Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55	1	minor to moderate	not baseline	see mech spec	see mech spec
1				Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1	minor	not baseline	see mech spec	see mech spec
1				Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1	none	not baseline	design not changed to achieve this	yes
1				Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1	none	not baseline	design not changed to achieve this	yes

YES	Y?	N?	NO							
2	6			**Innovation & Design Process**	5 Points					**Strategies**
1				Credit 1.1	**Innovation in Design:** Sustainability Education	1	minor	not baseline	providing signage, information and tours on what has been done in building	yes

YES	Y?	N?	NO	Credit	Description	Points				
	1			Credit 1.2	**Innovation in Design:** ?	1				
	1			Credit 1.3	**Innovation in Design:** energy star appliance	1				
	1			Credit 1.4	**Innovation in Design** green power 4 year contract	1				
	1				**Innovation in Design** Exemplary Performance WEc2 40% water use reduction	1				See WEc3 - plus 1 point
	1				**Innovation in Design**	1				
	1				**Innovation in Design**	1				
1				Credit 2	**LEED™ Accredited Professional**	1	none			

YES	Y?	N?	NO	
39	20		14	**Project Totals (pre-certification estimates)**

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

7.0 LEED CHECKLIST

-Dinosaur Provincial Park
Visitor Centre and
Tyrrell Field Station

BTY GROUP

Deloitte.

Eco-Integration
sustainable design consulting

LEED Canada-NC 1.0 Project Checklist
Actual LEED Gold Achieved

Expansion of the Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station

Yes	?	No			
6		8	**Sustainable Sites**		14 Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density**	1
		1	Credit 3	**Redevelopment of Contaminated Site**	1
		1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
1			Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		1	Credit 6.2	**Stormwater Management**, Treatment	1
		1	Credit 7.1	**Heat Island Effect**, Non-Roof	1
		1	Credit 7.2	**Heat Island Effect**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
4		1	**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
5		9	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
4		3	Credit 1	**Optimize Energy Performance**	1 to 10
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
		1	Credit 3	**Best Practice Commissioning**	1
		1	Credit 4	**Ozone Protection**	1
		1	Credit 5	**Measurement & Verification**	1
1			Credit 6	**Green Power**	1

Yes	?	No			
8	1	6	**Materials & Resources**		14 Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
1			Credit 1.1	**Building Reuse:** Maintain 75% of Existing Walls, Floors, and Roof	1
1			Credit 1.2	**Building Reuse:** Maintain 95% of Existing Walls, Floors, and Roof	1
1			Credit 1.3	**Building Reuse:** Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management:** Divert 50% from Landfill	1
1			Credit 2.2	**Construction Waste Management:** Divert 75% from Landfill	1
		1	Credit 3.1	**Resource Reuse:** 5%	1
		1	Credit 3.2	**Resource Reuse:** 10%	1
1			Credit 4.1	**Recycled Content:** 7.5% (post-consumer + ½ post-industrial)	1
	1		Credit 4.2	**Recycled Content:** 15% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Regional Materials:** 10% Extracted and Manufactured Regionally	1
1			Credit 5.2	**Regional Materials:** 20% Extracted and Manufactured Regionally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1
		1	Credit 8	**Durable Building**	1

Yes	?	No			
11		4	**Indoor Environmental Quality**		15 Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
		1	Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
		1	Credit 2	**Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan:** During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan:** Testing Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials:** Paints and Coating	1
1			Credit 4.3	**Low-Emitting Materials:** Carpet	1
1			Credit 4.4	**Low-Emitting Materials:** Composite Wood and Laminate Adhesives	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems:** Perimeter Spaces	1
1			Credit 6.2	**Controllability of Systems:** Non-Perimeter Spaces	1
		1	Credit 7.1	**Thermal Comfort:** Compliance	1
		1	Credit 7.2	**Thermal Comfort:** Monitoring	1
1			Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
1			Credit 8.2	**Daylight & Views:** Views 90% of Spaces	1

Yes	?	No			
5			**Innovation & Design Process**		5 Points
1			Credit 1.1	**Innovation in Design**	1
1			Credit 1.2	**Innovation in Design**	1
1			Credit 1.3	**Innovation in Design**	1
1			Credit 1.4	**Innovation in Design**	1
1			Credit 2	**LEED® Accredited Professional**	1

Yes	?	No		
39	1	28	**Project Totals (pre-certification estimates)**	70 Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

LEED Canada-NC 1.0 Project Checklist
Proposed LEED Silver
(this checklist identifies 36 points and at a silver level of certification)

Expansion of the Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station

Yes	?	No			
5		9		**Sustainable Sites**	14 Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density**	1
		1	Credit 3	**Redevelopment of Contaminated Site**	1
		1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
1			Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		1	Credit 6.2	**Stormwater Management**, Treatment	1
		1	Credit 7.1	**Heat Island Effect**, Non-Roof	1
		1	Credit 7.2	**Heat Island Effect**, Roof	1
		1	Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
4		1		**Water Efficiency**	5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
5		9		**Energy & Atmosphere**	17 Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
4		3	Credit 1	**Optimize Energy Performance**	1 to 10
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
		1	Credit 3	**Best Practice Commissioning**	1
		1	Credit 4	**Ozone Protection**	1
		1	Credit 5	**Measurement & Verification**	1
1			Credit 6	**Green Power**	1

Yes	?	No			
8	1	6	**Materials & Resources**		14 Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
1			Credit 1.1	**Building Reuse:** Maintain 75% of Existing Walls, Floors, and Roof	1
1			Credit 1.2	**Building Reuse:** Maintain 95% of Existing Walls, Floors, and Roof	1
1			Credit 1.3	**Building Reuse:** Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management:** Divert 50% from Landfill	1
1			Credit 2.2	**Construction Waste Management:** Divert 75% from Landfill	1
		1	Credit 3.1	**Resource Reuse:** 5%	1
		1	Credit 3.2	**Resource Reuse:** 10%	1
1			Credit 4.1	**Recycled Content:** 7.5% (post-consumer + ½ post-industrial)	1
	1		Credit 4.2	**Recycled Content:** 15% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Regional Materials:** 10% Extracted and Manufactured Regionally	1
1			Credit 5.2	**Regional Materials:** 20% Extracted and Manufactured Regionally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1
		1	Credit 8	**Durable Building**	1

Yes	?	No			
10		5	**Indoor Environmental Quality**		15 Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
		1	Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
		1	Credit 2	**Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan:** During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan:** Testing Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials:** Paints and Coating	1
1			Credit 4.3	**Low-Emitting Materials:** Carpet	1
1			Credit 4.4	**Low-Emitting Materials:** Composite Wood and Laminate Adhesives	1
		1	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems:** Perimeter Spaces	1
1			Credit 6.2	**Controllability of Systems:** Non-Perimeter Spaces	1
		1	Credit 7.1	**Thermal Comfort:** Compliance	1
		1	Credit 7.2	**Thermal Comfort:** Monitoring	1
1			Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
1			Credit 8.2	**Daylight & Views:** Views 90% of Spaces	1

Yes	?	No			
4		1	**Innovation & Design Process**		5 Points
1			Credit 1.1	**Innovation in Design - Green Housekeeping**	1
1			Credit 1.2	**Innovation in Design - Green Education**	1
1			Credit 1.3	**Innovation in Design - Exemplary Performance MRc5.2 (60% regional materials)**	1
		1	Credit 1.4	**Innovation in Design - Exemplary Performance WEc3 (50% reduction in water use)**	1
1			Credit 2	**LEED® Accredited Professional**	1
Yes	**?**	**No**			
36	1	31	**Project Totals (pre-certification estimates)**		**70 Points**

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

LEED Canada-NC 1.0 Project Checklist
Proposed LEED Gold

(although LEED Gold was achieved for this project, this scorecard reflects a more solid number of points to submit for certification)

Expansion of the Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station

Yes	?	No			
6		8	**Sustainable Sites**		14 Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density**	1
		1	Credit 3	**Redevelopment of Contaminated Site**	1
		1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
1			Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		1	Credit 6.2	**Stormwater Management**, Treatment	1
		1	Credit 7.1	**Heat Island Effect**, Non-Roof	1
		1	Credit 7.2	**Heat Island Effect**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
4		1	**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
8		9	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
6		4	Credit 1	**Optimize Energy Performance**	1 to 10
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Best Practice Commissioning**	1
		1	Credit 4	**Ozone Protection**	1
		1	Credit 5	**Measurement & Verification**	1
1			Credit 6	**Green Power**	1

Yes	?	No			
8	1	6	**Materials & Resources**		14 Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
1			Credit 1.1	**Building Reuse:** Maintain 75% of Existing Walls, Floors, and Roof	1
1			Credit 1.2	**Building Reuse:** Maintain 95% of Existing Walls, Floors, and Roof	1
1			Credit 1.3	**Building Reuse:** Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management:** Divert 50% from Landfill	1
1			Credit 2.2	**Construction Waste Management:** Divert 75% from Landfill	1
		1	Credit 3.1	**Resource Reuse:** 5%	1
		1	Credit 3.2	**Resource Reuse:** 10%	1
1			Credit 4.1	**Recycled Content:** 7.5% (post-consumer + ½ post-industrial)	1
	1		Credit 4.2	**Recycled Content:** 15% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Regional Materials:** 10% Extracted and Manufactured Regionally	1
1			Credit 5.2	**Regional Materials:** 20% Extracted and Manufactured Regionally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1
		1	Credit 8	**Durable Building**	1

Yes	?	No			
11		4	**Indoor Environmental Quality**		15 Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
		1	Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
		1	Credit 2	**Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan:** During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan:** Testing Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials:** Paints and Coating	1
1			Credit 4.3	**Low-Emitting Materials:** Carpet	1
1			Credit 4.4	**Low-Emitting Materials:** Composite Wood and Laminate Adhesives	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems:** Perimeter Spaces	1
1			Credit 6.2	**Controllability of Systems:** Non-Perimeter Spaces	1
		1	Credit 7.1	**Thermal Comfort:** Compliance	1
		1	Credit 7.2	**Thermal Comfort:** Monitoring	1
1			Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
1			Credit 8.2	**Daylight & Views:** Views 90% of Spaces	1

Yes	?	No			
5			**Innovation & Design Process**		5 Points
1			Credit 1.1	**Innovation in Design - Green Housekeeping**	1
1			Credit 1.2	**Innovation in Design - Green Education**	1
1			Credit 1.3	**Innovation in Design - Exemplary Performance MRc5.2 (60% regional materials)**	1
1			Credit 1.4	**Innovation in Design - Exemplary Performance WEc3 (50% reduction in water use)**	1
1			Credit 2	**LEED® Accredited Professional**	1

Yes	?	No		
42	1	28	**Project Totals** (pre-certification estimates)	70 Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

Expansion of the Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station
LEED Canada Scorecard Cost Analysis

39 Points Achieved

Prepared: May 2008
Updated from meeting June 4 2008

YES	Y?	N?	NO	Sustainable Sites			14 Points	Requirements: LEED	Additional cost req'd to achieve LEED none minor moderate high	BASELINE	LEED SILVER (3 points identified to delete to take project back to LEED Silver - these are points that are not baseline identified)	LEED GOLD (3 more points would put project to a more solid gold position - there are however a possible 9 points have been identified for this project) Any could be costed but recommend (based on information from design teams regarding most important issues (not neccessarily the cheapest 1st cost options): EA c1 EA c3
6	5		3									
				Prereq 1	Erosion & Sedimentation Control		Req'd	Design site specific sediment and erosion control plan conforming to the more stringent of US EPA. 832/R-92-005 (09/04) Storm Water management for Const. Activities, or local standards and codes.	Minor to none	standard requirement - on this site the mandate was not to have construction impact on erosion		
1				Credit 1	Site Selection		1	Do not develop on Prov. Agricultural or Forest land Reserve ; less than 1.5M above 100yr or 0.9M above 200-yr flood; ecologically sensitive land; endangered species habitat; within 30.5M of wetland; public parkland without trade of same or better.	None	no cost - project achieved this due to site conditions		
			1	Credit 2	Urban Redevelopment		1	Utilize sites within existing urban areas developed at 13,800SM/hectare (60,000 SF/acre) (2-storey downtown development) min.	none	project in remote area - could not achieve this		
			1	Credit 3	Redevelopment of Contaminated Sites		1	Develop on a contaminated site, provide remediation required by provincial Contaminated Sites Program.	None	not relevant to this project		
			1	Credit 4.1	Alternative Transportation, Public Transportation Access		1	Locate within 800M of transit, 400M of two bus lines.	None	project in remote area - could not achieve this		
	1			Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms		1	Provide secure bicycle storage, shower facilities (within 183M) for more stringent of 5% (commercial) OR requirements of local authority.	Minor	not baseline		bicycles are used on the site by visitors and showers are associated with the camping but it was not felt relevant to this project to provide for staff as very unlikely to commute to work as remote site

YES	?	?	NO	Credit	Title	Points	LEED Requirements	Cost			Available Strategies
	1			Credit 4.3	**Alternative Transportation,** Alternative Fuel Vehicles	1	Provide H/AF vehicles for 3% of building occupants with preferred parking OR alternative fuel refueling stations within 500M for 3% of vehicles (Liq. Or gaseous facilities sep. ventilated or outdoors.)	Minor	not baseline		This would be a potential strategy to provide alternate vehicle (hybrid car/truck) for use by staff at the site Plus 1 point for more solid gold
1				Credit 4.4	**Alternative Transportation,** Parking Capacity and Carpooling	1	Provide min. required parking only, AND preferred parking for carpools to 10% of building occupants OR no new AND preferred parking for 10% in rehab. projects.	none	Parking area at site was reduced from existing condition but this was baseline decision		
1				Credit 5.1	**Reduced Site Disturbance,** Protect or Restore Open Space	1	On previously developed sites, restore a minimum of 50% of the site area (excluding the building footprint) by replacing impervious surfaces with native or adaptive vegetation OR	none to moderate	Site was 'restored' to provide open space/natural environment but baseline decision		
1				Credit 5.2	**Reduced Site Disturbance,** Development Footprint	1	Reduce the development footprint (including building, access roads and parking) to exceed the local zoning's open space requirements for the site by 25% OR where no zoning req.s, designate open space = to building footprint. Open space must be protected from development for life of bldg.	none to moderate	see above		
1				Credit 6.1	**Stormwater Management, Rate and Quantity**	1	If existing imperviousness is greater than 50%: Implement stormwater management plan for 25% decrease in rate and quantity of stormwater runoff.	none to moderate	Baseline - stormwater is not removed from site - swales and splash pads provided		
	1			Credit 6.2	**Stormwater Management,** Treatment	1	Treatment systems designed to remove 80% of annual post development total suspended solids (TSS), and 40% of the average annual post development total phosphorous (TP) based on all storms< 2-yr/24 hr storm, by implementing more stringent Best Management Practices (BMPs) outlined in the EPA-840-B-92-002) Guidance Specifying Management Measures for sources of Nonpoint Pollution in Coastal Waters or local gov. BMPs.	moderate	not baseline		since the native type of plant species that survive in this climate would not filter the suspended solids and phosphorous it makes no sense to pursue this strategy
	1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands, Non-Roof**	1	Provide shade (within 5 years) AND/OR use light-colored/high albedo material (reflectance of at least 0.3)on min. 30% of non-roof impervious surface on site, including parking lots, walkways, plazas, etc. OR place min. 50% of parking underground or covered by structured parking Or use open -grid pavement systems for min. 50% of parking area.	moderate	not baseline		the types of trees that could provide shade do not survive in this landscape so makes no sense to provide. Strategy could be met by underground parking but would not make sense given that the parking provided was minimal and the costs to providing it would be high
	1			Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands, Roof**	1	Use ENERGY STAR highly reflective AND high emissivity (0.9) roofing for min.75% of roof; OR 'green' roof for min. 50%; OR combination for 75%.	moderate	not baseline		credit could have been met by providing white membrane but the existing roof did not need to be replaced so would not be valuable to apply a white membrane or have white membrane over a small portion. For the location of the project heat island effect is not an issue. similar comments for green roof - is not requried for stormwater retention so not well spent money just to reduce heat island
1				Credit 8	**Light Pollution Reduction**	1	Meet or provide lower light levels and uniformity ratios than recommended by IESNA Recommended Practice Manual (RP-33-99): Lighting for Exterior Environments, AND design interior and exterior lighting to meet various shielding and cut-off requirements. Shield all luminaries within 2.5 mounting height from boundary line to prevent light crossing boundary. see also LEED Addenda for additional requirements	Minor	not baseline	could remove any special requirements to achieve this credit ie one site light with cut off (an ordinary fixture could be chosen) minus 1 point for LEED Silver	very minimal site lighting (one fixture that would require cut offs) so likely no additional cost to achieve
4	1				Water Efficiency	5 Points	Requirements LEED				Available Strategies

YES	Y?	N?	NO								
1				Credit 1.1	**Water Efficient Landscaping, Reduce by 50%**	1	Use high efficiency irrigation technology or use captured rain or recycled water to reduce potable water consumption for irrigation by 50% over conventional means.	Minor	Baseline: planting all native and drought tolerant no irrigation provided		
1				Credit 1.2	**Water Efficient Landscaping, No Potable Use or No Irrigation**	1	Use only captured rain or recycled site water to eliminate all potable water use for irrigation, or do not install permanent landscape irrigation systems.	moderate	Baseline: planting all native and drought tolerant no irrigation provided		
	1			Credit 2	**Innovative Wastewater Technologies**	1	Reduce the use of municipally provided potable water demand for building sewage conveyance by a minimum of 50%. OR Treat 100% of waste water on site to tertiary standards	moderate	would have installed dual flush for new addition and existing retrofit not likely waterless urinals	Waterless urinals and dual flush toilets for new addition. Retrofited dual flush toilets and waterless urinals in existing	Waterless urinals and dual flush toilets for new addition. Retrofited dual flush toilets and waterless urinals in existing -however not enough water reduction for this project to achieve this credit. 2 options to meet this credit if going for solid gold: 1. Cistern Originally there was a cistern in to collect stormwater for toilet flushing however it was cost cut 2. Other option was to tie into the bio-treatment plant close by and use the water from there to flush toilets (this would involve connecting to the treatment plant to pump the water back to the site) Plus 1 point for gold
1				Credit 3.1	**Water Use Reduction, 20% Reduction**	1	Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation) after meeting all baseline water fixture performance requirements	None to Minor	Water conservation was important for this site as arid, dry area would have - installed dual flush for new addition and existing retrofit -not likely waterless urinals -installed low flow fixtures in new addition -not likely added flow restrictors for existing	For LEED Silver (revised scorecard) keep strategies as baseline installed dual flush for new addition and existing retrofit -no waterless urinals -installed low flow fixtures in new addition -but no added flow restrictors for existing still achieved 20%	Water conservation was important for this site as arid, dry area low flow fixtures installed in new addition - aerators added to restrict flow to 1.5gpm on existing fixtures Waterless urinals and dual flush toilets for new addition. Retrofited dual flush toilets and waterless urinals in existing 50% water reduction was achieved with these strategies
1				Credit 3.2	**Water Use Reduction, 30% Reduction**	1	Exceed the potable water use reduction by an additional 10% (30% total efficiency increase) after meeting fixture requirements.	Minor	see above	see above still achieved 30% but not innovation credit	see above

YES	Y?	N?	NO								
5	4		6	**Energy & Atmosphere**		**17 Points**	**Requirements** **LEED**				**Strategies**
Y				Prereq 1	**Fundamental Building Systems Commissioning**	Req'd	Implement all of the following fundamental best practice commissioning procedures: 1. Engage commissioning authority 2. Develop design intent and basis documentation 3. Include commissioning requirements in construction documents 4. Develop and utilize commissioning plan 5. Verify installation, functional performance, training and operation and maintenance documentation 6. Complete commissioning report.	None	Information from meeting with design team on dinosaur park Baseline for Alberta Infrastructure is between fundamental and best practice commissioning		

				Prereq 2	Minimum Energy Performance	Req'd	New buildings: design to reduce energy consumption by 25% over MNECB reference case OR reduce design energy cost by 18% relative to the reference building designed to ASHRAE/ISNEA 90.1-1999	minor	Standard insulated walls and roof (studs and insulation) +/- R9.6 walls and roof Operable windows may have been used but not as part of ventilation average performing windows base systems strategy would likely have been to expand on existing systems no heat recovery	Structural insulated panels (SIPS) for walls and roof (NRCan downrated the insulation value which should not have happened - more points should have been achieved high performance double glazed kawneer operable windows (open top and bottom) system designed with passive evaporative cooling through a cooling tower combined with operable windows (including on the clerestory windows) utilized air to air heat recovery and natural ventilation new condensing boilers installed in existing bldg (not much heat in winter required - mostly summer cooling) existing system boiler chilled	In addition to strategies identified in LEED silver column: more design assisted modeling to assess location (etc) of windows to be most optimum replacement of existing chiller and boiler system more heat recovery for when the building was unable to use natural ventilation; perhaps trickle ventilation for wintertime Conservatively Plus 2 credits
				Prereq 3	CFC Reduction in HVAC&R Equipment	Req'd	Zero use of CFC-based refrigerants in new base building HVAC&R systems and zero use of halons in fire suppression equipment.	None	Baseline - required for Canada		
4			4	Credit 1	Optimize Energy Performance	1 to 10	Reduce design energy cost compared to the energy cost of MNECB or ASHRAE/IESNA Standard 90.1-1999 reference building for regulated systems , as demonstrated by a whole building simulation using the same compliance path as for EAp2 excluding 'non-regulated' loads. New Building: Reduction % required MNECB/ASHRAE: 1(24/15); 2(29/20); 3(33/25); 4(38/30); 5(42/35); 6(47/40); 7(51/45); 8(55/50); 9(60/55); 10(64/60)	moderate to high (first costs)	See EAp3	See EAp3	See EAp3
	1			Credit 2.1	Renewable Energy, 5%	1	Supply at least 5% of the building's total energy use (expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems.	High (first costs)	not baseline		not cost effective
			1	Credit 2.2	Renewable Energy, 10%	1	Supply at least 10%.				
			1	Credit 2.3	Renewable Energy, 20%	1	Supply at least 20%.				
	1			Credit 3	Best Practice Commissioning	1	Implement additional commissioning tasks: 1. Focused review of design prior to construction documents phase 2. Review construction documents when close to completion 3. Selective review of contractor submittals of commissioned equipment; all by independent authority) 4. Provide system and energy management manual 5. Have a contract in place to review ops. with O&M staff including: report & process plan for IAQ concerns; plan for issues resolution within one year of construction completion.	none to minor	Information from meeting with design team on dinosaur park Baseline for Alberta Infrastructure is between fundamental and best practice commissioning		($70,000 up to go to Best Practice commissioning - would not be a big step however to go further to get this point) Plus 1 point to go for solid gold
	1			Credit 4	Ozone Depletion	1	Install base building level HVAC and refrigeration equipment not containing HCFC's. Large refrideration systems used for process loads for grocery stores (warehouses) are NOT exempt from this credit	none to minor	not baseline requirement		not achieved due to existing chiller with HCFC's there is a plan in place when chiller needs to be replaced to replace with HCFC free higher efficiency chiller

YES	Y?	N?	NO	Credit	Title	Points	Requirements – LEED				Strategies
	1			Credit 5	Measurement & Verification	1	Develop and implement Measurement and Verification (M&V) Plan consistent with Option D: Calibrated Simulation (Savings Estimation Method 2), or Option B: Energy Conservation Measure Isolation, as specified in the International Performance Measurement and Verification Protocol (IMPMV) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April, 2003. The energy M&V program shall be supplemented by a water M&V program consistent with the principles of IPMVP Volumes I (2002) and III, utilizing Baseline and projected water use as defines by Water Efficiency Credits 1, 2 and 3. The M&V period shall cover a period of no less than one year of post-construction occupancy	moderate	not baseline requirement however: Alberta Infrastructure does have in place on many of their buildings controls to measure energy use etc. and feedback information it would be useful information for AI		Not pursued due to cost (Johnson Controls +/- $70,000) Possible plus point
1				Credit 6	Green Power	1	Provide at least 50% of the building's electricity from renewable sources by engaging in a two year renewable energy contract. Renewable sources to meet Environment Canada Environmental Choice EcoLogo req.s for green power supplies.	Minor	AI baseline to buy 90% green power for their buildings		
YES	**Y?**	**N?**	**NO**								
8	3		3		**Materials & Resources**	**13 Points**	**Requirements** **LEED**				**Strategies**
Y				Prereq 1	Storage & Collection of Recyclables	Req'd	Provide an easily accessible area serving entire building dedicated to separation, collection and storage of materials for recycling including (at a minimum) paper, corrugated cardboard, glass, plastics, and metals.	none to minor	AI baseline		
1				Credit 1.1	Building Reuse, Maintain 75% of Existing Walls, Floors, & Roof	1	Reuse large portions of existing structure during renovation or redevelopment projects. Maintain at least 75% of existing building structure and shell (exterior skin and framing excluding window assemblies and non-structural roofing material).		AI decision to preserve existing building and add new addition rather than demolish and construct all new		
1				Credit 1.2	Building Reuse, Maintain 95% of Existing Walls, Floors, & Roof	1	Maintain an additional 20% (95% total) of existing building structure and shell (Same as Above)		see above		
1				Credit 1.3	Building Reuse, Maintain 50% of Interior Non-structural Elements	1	Maintain 50% non-shell (interior walls, floor coverings, and ceiling systems).		see above		
1				Credit 2.1	Construction Waste Management, Divert 50%	1	Develop and implement a waste management plan, quantifying material diversion goals. Recycle and/or salvage at least 50% of construction, demolition, and land clearing waste. Calculations consistent throughout by either weight or volume.	none	not baseline - would probably not have happened if not requried (could however be a cost savings to the project due to cost of landfill fees)	potentially difficult in remote areas however Brooks has sorting area at landfill so it was practical	potentially difficult in remote areas however Brooks has sorting area at landfill so it was practical
1				Credit 2.2	Construction Waste Management, Divert 75%	1	Recycle and/or salvage an additional 25% (75% total by weight) of the construction, demolition, and land clearing waste.	none	see above	see above	see above
			1	Credit 3.1	Resource Reuse, Specify 5%	1	Specify salvaged, refurbished or reused materials products and furnishings for 5% of building materials.	minor			
			1	Credit 3.2	Resource Reuse, Specify 10%	1	Specify salvaged, refurbished or reused materials products and furnishings for 10% of building materials.	minor			

YES	Y?	N?	NO	Credit	Name	Points	Requirements				Strategies
1				Credit 4.1	**Recycled Content, Specify 7.5% (post-consumer + ½ post-industrial)**	1	Use materials with recycled content as per Federal trade Commission Guides for Use of Environmental Marketing Claims 16 CFR 260.7(e) with post-consumer recycled content + 1/2 post-industrial recycled content equal to 7.5% of total value of materials on the project. Determine value by proportion of weight. Do not include mechanical or electrical components.	none	not baseline	no cost premium	high cost items were targeted and tracked (no cost premium) metals /steels concrete rebar drywall Insulation aluminum window frames glazing millwork acoustic panel fabric
	1			Credit 4.2	**Recycled Content, Specify 15% (post-consumer + ½ post-industrial)**	1	As above with 15% total.	none	see above		as above
1				Credit 5.1	**Regional Materials, 10% Extracted & Manufactured Regionally**	1	Specify a minimum of 10% of building materials with 80% of mass extracted, processes and manufactured within 800Km of project site OR 2400km if shipped by rail or water OR that reflect a combination of the above shipment modes.	none	not baseline	no cost premium	high cost items were targeted and tracked (no cost premium) concrete rebar structural insulated panels (SIPS) insulation brick dooes and frames stucco
1				Credit 5.2	**Regional Materials, 20% Extracted & Manufactured Regionally**	1	20% as per above.	none	see above	see above	as above
			1	Credit 6	**Rapidly Renewable Materials**	1	Specify rapidly renewable building materials and products (max.10-yr cycle) for 5% by value of total building materials.		not baseline		not actively pursued - very challenging to source materials to meet credit
	1			Credit 7	**Certified Wood**	1	Use of minimum of 50% of wood-based materials and products certified in accordance with the Forest Stewardship Council Principles and Criteria for wood building components including but not limited to structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes. Only include materials permanently installed in the project. Temporary construction applications such as bracing, concrete formwork and pedestrian barriers are excluded from the calculation. Furniture and other Division 12 items may be included, providing those items are included consistently in MR Credits 3-7	none to high	not baseline		availability and cost challenge
	1			Credit 8	**Durable Building**	1	Implement Building Durability Plan as per CSA S478-95 (R2001) - Guideline on Durability in Buildings for components within guideline scope as follows: (see guideline for detailed requirements) Prevent premature deterioration using shading screens, overhangs, durable materials etc.	minor	not baseline		did not pursue as new credit at the time of design and issues with insurance would target for leed gold Plus 1 point

YES	Y?	N?	NO								
11	4				**Indoor Environmental Quality 15 Points**		Requirements LEED				**Strategies**
Y				Prereq 1	**Minimum IAQ Performance**	Req'd	Meet the minimum requirements of voluntary consensus standard ASHRAE 62-1999, Ventilation for Acceptable Indoor Air Quality and approved Addenda, using Ventilation Rate Procedure.	none	baseline		
Y				Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Req'd	Prohibit smoking in the building Locate any exterior designated smoking areas at least 7.5 meters away from entries, outdoor air intakes and operable windows	none	no smoking so not relevant		

	1			Credit 1	Carbon Dioxide (CO_2) Monitoring	1	Commercial bldgs: Install a permanent carbon dioxide (CO2) monitoring system that provides feedback on space ventilation performance to ensure that ventilation systems maintain design minimum ventilation requirements and in a form that affords operational adjustments. configure all monitoring equipment to generate an alarm if under ventilation is detected, via either a building automation system alarm to the building operator or via an alarm that alerts building occupants. Refer to the CO2 differential for all types of occupancy in accordance with ASHRAE 62.1-2004	minor	not baseline		not value added due to systems with natural ventilation - difficult to verify
	1			Credit 2	Ventilation Effectiveness	1	For mechanically ventilated buildings, design ventilation systems that result in an air change effectiveness (Eac) greater than or equal to 0.9 as determined by ASHRAE Standard 129-1997. For naturally ventilated spaces demonstrate a distribution and laminar flow pattern that involves not less than 90% of the room or zone area in the direction of air flow for at least 95% of hours of occupancy	minor	not baseline		hard to demonstrate / verify
1				Credit 3.1	Construction IAQ Management Plan, During Construction	1	Develop an Indoor Air Quality (IAQ) Management Plan for construction and pre-occupancy phases of the building: see LEED Addendum for details	minor	not baseline		requirements specified and implemented on site (guidelines that should be part of contractors business)
1				Credit 3.2	Construction IAQ Management Plan, Flushout / Testing	1	Develop IAQ Management Plan for the pre-occupancy Phase following one of the following options Option 1 Building Flush prior to Occupancy Option 2 Building Flush overlapping wit Occupancy Option 3 IAQ Testing Prior to Occupancy	minor	not baseline		flush out carried out - this is staggered with occupancy (not testing)
1				Credit 4.1	Low-Emitting Materials, Adhesives & Sealants	1	Adhesives must meet or exceed the VOC limits of South Coast Air Quality Management District (SCAQMD) Rule #1168 June 2006	none	not baseline	no cost premium	specified cost neutral option
1				Credit 4.2	Low-Emitting Materials, Paints	1	Paints and coatings used on the interior of the building (defined as inside o the weatherproofing system and applied on site) shall comply with the standards outlined in the LEED Addendum	none	not baseline	no cost premium	specified cost neutral option
1				Credit 4.3	Low-Emitting Materials, Carpet	1	Use carpet that meet or exceed req.s of Carpet and Rug Institute's Green label IAQ Test Program	none	not baseline	no cost premium	specified cost neutral option
1				Credit 4.4	Low-Emitting Materials, Composite Wood & Agrifiber	1	Use composite wood and agri-fiber products with no added urea-formaldehyde resins and adhesives used to fabricate laminated assemblies containing these products with no added urea-formaldehyde.	none	not baseline	no cost premium	specified cost neutral option (this credit more challenging to achieve due to availability of materials that meet the requirement but still cost neutral on this project)

1				Credit 5	Indoor Chemical & Pollutant Source Control	1	Design to minimize pollutant cross contamination of regularly occupied areas: Employ permanent entryway systems (grills, gates, etc.) to capture dirt, particulates, etc. from entering the building at all high volume entryways Provide garages, housekeeping/laundry and copy/print room areas with structural deck to deck partitions with separate outside exhaust at 9.2CM/hr/SM, no re-circ. and neg.pressure of 5 Pa, min 1PA with doors to room closed. Provide containment drains for appropriate disposal of hazardous wastes for maint. or lab purposes. Replace all filtration media prior to occupancy with new at MERV 13.	Minor	not baseline except for entrance mats	Could delete ventilation and fans in copy room minus 1 point	Entrance mats fans in copy room and janitor room
1				Credit 6.1	Controllability of Systems, Perimeter	1	Provide a minimum of one operable window and one lighting control zone per 18.5 SM for all regularly occupied areas within 5M of the perimeter wall.	minor	Baseline - windows on perimeter would be operable and small building so lighting control would be there (theatre exempt)		no cost (see baseline)
1				Credit 6.2	Controllability of Systems, Non-Perimeter	1	Provide one controls for airflow, and lighting for each regularly occupied, non perimeter area. if no regularly occupied perimeter areas then credit is met.	minor	Baseline - due to size of building		no cost (see baseline)
	1			Credit 7.1	Thermal Comfort, Comply with ASHRAE 55	1	Comply with ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy.	minor to moderate	not baseline		difficult to demonstrate would target if going for gold (the design would not change - the design would have to demonstrate compliance) plus 1 point
	1			Credit 7.2	Thermal Comfort, Permanent Monitoring System	1	Provide a permanent monitoring system to ensure building performance to the desired comfort criteria as determined by EQ Credit 7.1, Thermal Comfort - Compliance..	minor	not baseline		difficult to demonstrate would target if going for gold (the design would not change - the design would have to demonstrate compliance) plus 1 point
1				Credit 8.1	Daylight & Views, Daylight 75% of Spaces	1	Achieve a minimum Daylight Factor of 2% (excluding all direct sunlight penetration) or achieve at least 250 Lux (25 foot candles) using a computer simulation model in 75% of all regularly occupied areas, excluding areas where tasks hidered by daylight (considered on their merits).	none	Baseline for this building type Theatre exempt easy to achieve due to size and type of building		
1				Credit 8.2	Daylight & Views, Views for 90% of Spaces	1	Achieve direct line of sight to vision glazing for 90% of building occupants in regularly occupied areas. Areas adjacent windows to have glazing-to-floor area ratio of 0.07 min. Non window-adjacent areas to have 10 degree horizontal view angle at 1.27M for 50% of floor area for entire room area to qualify. Exceptions considered on their merit.	none	Baseline for this building type Theatre exempt easy to achieve due to size and type of building		

YES	Y?	N?	NO	Innovation & Design Process 5 Points			Requirements LEED				Strategies
5											
1				Credit 1.1	Innovation in Design: Green Housekeeping	1		minor	not baseline however there was during the process of this project a maintenance contract being developed by AI and Parks to use green cleaning products. For this site it was even more important as they are treating the sewage so do not want 'toxic' cleaning materials used		
1				Credit 1.2	Innovation in Design: Low Green Education Program	1		none to minor	not baseline		document was developed for use by parks and at the site describing the strategies done signage around the site was put in place (14 display signs) to describe t he strategies undertaken for the project on sustainability
1				Credit 1.3	Innovation in Design: Exemplary Performance - Water use reduction at 50%	1		none	SEE WE c3.1 and 3.2	With LEED silver strategies only achieve 30% Minus 1 point	
1				Credit 1.4	Innovation in Design Exemplary Performance - Regional Materials at 60%	1		none	SEE MR c5.1 and c5.2		
1				Credit 2	LEED™ Accredited Professional	1	At least one principal participant of the project team that has successfully completed the LEED Accredited Professional exam.	none	not baseline		cost should be identified in design fees for LEED

YES	Y?	N?	NO	
39	17		12	**Project Totals** (pre-certification estimates)

Certified 26-32 points Silver 33-38 points Gold 39-51 points Platinum 52-69 points

7.0 LEED CHECKLIST

-Mount Royal College for
Continuous Learning

BTY GROUP

Deloitte.

Eco-Integration

LEED Canada-NC 1.0 Project Checklist
Proposed LEED Silver

(this checklists identifies 36 points - 7 points removed from the original LEED Gold certified project)

Mount Royal College Centre for Continuous Learning

Yes	?	No			
5		9	**Sustainable Sites**		14 Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density**	1
		1	Credit 3	**Redevelopment of Contaminated Site**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
		1	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
		1	Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		1	Credit 6.2	**Stormwater Management**, Treatment	1
1			Credit 7.1	**Heat Island Effect**, Non-Roof	1
		1	Credit 7.2	**Heat Island Effect**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
3		2	**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
		1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
9		8	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
8		2	Credit 1	**Optimize Energy Performance**	1 to 10
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
		1	Credit 3	**Best Practice Commissioning**	1
1			Credit 4	**Ozone Protection**	1
		1	Credit 5	**Measurement & Verification**	1
		1	Credit 6	**Green Power**	1

Yes	?	No			
5		6	**Materials & Resources**		14 Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse:** Maintain 75% of Existing Walls, Floors, and Roof	1
		1	Credit 1.2	**Building Reuse:** Maintain 95% of Existing Walls, Floors, and Roof	1
		1	Credit 1.3	**Building Reuse:** Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management:** Divert 50% from Landfill	1
1			Credit 2.2	**Construction Waste Management:** Divert 75% from Landfill	1
		1	Credit 3.1	**Resource Reuse:** 5%	1
		1	Credit 3.2	**Resource Reuse:** 10%	1
1			Credit 4.1	**Recycled Content:** 7.5% (post-consumer + ½ post-industrial)	1
1			Credit 4.2	**Recycled Content:** 15% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Regional Materials:** 10% Extracted and Manufactured Regionally	1
		1	Credit 5.2	**Regional Materials:** 20% Extracted and Manufactured Regionally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1
		1	Credit 8	**Durable Building**	1

Yes	?	No			
11		4	**Indoor Environmental Quality**		15 Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
1			Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
1			Credit 2	**Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan:** During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan:** Testing Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
		1	Credit 4.2	**Low-Emitting Materials:** Paints and Coating	1
1			Credit 4.3	**Low-Emitting Materials:** Carpet	1
1			Credit 4.4	**Low-Emitting Materials:** Composite Wood and Laminate Adhesives	1
		1	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems:** Perimeter Spaces	1
		1	Credit 6.2	**Controllability of Systems:** Non-Perimeter Spaces	1
1			Credit 7.1	**Thermal Comfort:** Compliance	1
1			Credit 7.2	**Thermal Comfort:** Monitoring	1
1			Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views:** Views 90% of Spaces	1

Yes	?	No			
3		2	**Innovation & Design Process**		5 Points
		1	Credit 1.1	**Innovation in Design: Exemplary performance WEc3 80% reduction**	1
1			Credit 1.2	**Innovation in Design: Green Housekeeping Program**	1
1			Credit 1.3	**Innovation in Design: Green Building Education**	1
		1	Credit 1.4	**Innovation in Design**	1
1			Credit 2	**LEED® Accredited Professional**	1

Yes	?	No		
36		31	**Project Totals** (pre-certification estimates)	70 Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

LEED Canada-NC 1.0 Project Checklist
Actual LEED Gold

Mount Royal College Centre for Continuous Learning

Yes	?	No			
8		6	**Sustainable Sites**		14 Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density**	1
		1	Credit 3	**Redevelopment of Contaminated Site**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
		1	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
1			Credit 6.2	**Stormwater Management**, Treatment	1
1			Credit 7.1	**Heat Island Effect**, Non-Roof	1
1			Credit 7.2	**Heat Island Effect**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
5			**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
1			Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
10		7	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
8		2	Credit 1	**Optimize Energy Performance**	1 to 10
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Best Practice Commissioning**	1
1			Credit 4	**Ozone Protection**	1
		1	Credit 5	**Measurement & Verification**	1
		1	Credit 6	**Green Power**	1

Yes	?	No			
5		6	**Materials & Resources**		**14 Points**
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse:** Maintain 75% of Existing Walls, Floors, and Roof	1
		1	Credit 1.2	**Building Reuse:** Maintain 95% of Existing Walls, Floors, and Roof	1
		1	Credit 1.3	**Building Reuse:** Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management:** Divert 50% from Landfill	1
1			Credit 2.2	**Construction Waste Management:** Divert 75% from Landfill	1
		1	Credit 3.1	**Resource Reuse:** 5%	1
		1	Credit 3.2	**Resource Reuse:** 10%	1
1			Credit 4.1	**Recycled Content:** 7.5% (post-consumer + ½ post-industrial)	1
1			Credit 4.2	**Recycled Content:** 15% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Regional Materials:** 10% Extracted and Manufactured Regionally	1
		1	Credit 5.2	**Regional Materials:** 20% Extracted and Manufactured Regionally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1
		1	Credit 8	**Durable Building**	1

Yes	?	No			
11		4	**Indoor Environmental Quality**		**15 Points**
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
1			Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
1			Credit 2	**Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan:** During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan:** Testing Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
		1	Credit 4.2	**Low-Emitting Materials:** Paints and Coating	1
1			Credit 4.3	**Low-Emitting Materials:** Carpet	1
1			Credit 4.4	**Low-Emitting Materials:** Composite Wood and Laminate Adhesives	1
		1	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems:** Perimeter Spaces	1
		1	Credit 6.2	**Controllability of Systems:** Non-Perimeter Spaces	1
1			Credit 7.1	**Thermal Comfort:** Compliance	1
1			Credit 7.2	**Thermal Comfort:** Monitoring	1
1			Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views:** Views 90% of Spaces	1

Yes	?	No			
4		1	**Innovation & Design Process**		**5 Points**
1			Credit 1.1	**Innovation in Design: Exemplary performance WEc3 80% reduction**	1
1			Credit 1.2	**Innovation in Design: Green Housekeeping Program**	1
1			Credit 1.3	**Innovation in Design: Green Building Education**	1
		1	Credit 1.4	**Innovation in Design**	1
1			Credit 2	**LEED® Accredited Professional**	1

Yes	?	No		
43		24	**Project Totals** (pre-certification estimates)	**70 Points**

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

Mount Royal College Centre for Continuous Learning
LEED Canada Scorecard Cost Analysis

Prepared: May 2008
Updated from meeting June3 2008

43 Points Achieved

YES	Y?	N?	NO	Sustainable Sites		14 Points	Additional cost req'd to achieve LEED none minor moderate high	BASELINE	LEED SILVER (7 points identified to delete to take project back to LEED Silver - these are points that are not baseline identified)	LEED GOLD
8	2		4							
Y				Prereq 1	Erosion & Sedimentation Control	Req'd	Minor to none	standard requirement		
1				Credit 1	Site Selection	1	None	no cost - project achieved this due to site conditions		
			1	Credit 2	Urban Redevelopment	1	none	not a project choice (either receive credit or not depending on site consitions)		
			1	Credit 3	Redevelopment of Contaminated Sites	1	None	not relevant to this project		

1				Credit 4.1	**Alternative Transportation,** Public Transportation Access	1	None	not a project choice (either receive credit or not depending on site consitions)		
	1			Credit 4.2	**Alternative Transportation,** Bicycle Storage & Changing Rooms	1	Minor	city requirement to provide bike storage but not showers	easy to achieve but showers were not in program	was not targeted
	1			Credit 4.3	**Alternative Transportation,** Alternative Fuel Vehicles	1	Minor	not baseline	only would target if clent perceives a need (ie owns and operates either a leet of hybrids or e-vehicles	comments as silver
1				Credit 4.4	**Alternative Transportation,** Parking Capacity and Carpooling	1	none	not baseline to reduce parking capacity	yes would target	met this credtit - could be perceived as cost saving to have less parking (though may be a revenue stream for campus)
			1	Credit 5.1	**Reduced Site Disturbance,** Protect or Restore Open Space	1	none to moderate	not a baseline requirement	since the site is a campus the LEED boundaries were set close to the building so not possible to capture this credit	since the site is a campus the LEED boundaries were set close to the building so not possible to capture this credit
			1	Credit 5.2	**Reduced Site Disturbance,** Development Footprint	1	none to moderate	see above	see above SSc5.1	see above SSc5.1
1				Credit 6.1	**Stormwater Management,** Rate and Quantity	1	none to moderate	no special considerations for baseline stormwater - just collect from hard surfaces and sent it into the municipal / city system	cistern may not be in LEED silver - if no cistern then: minus 1 point	Cistern designed to collect stormwater and use for toilet flushing - it was located in a 'unused dead space' in parkade
1				Credit 6.2	**Stormwater Management,** Treatment	1	moderate	not baseline	unlikely if no cistern minus 1 point	treatment of the stormwater was make easier due to the cistern: Solids are settled out in tank phosporous eliminated from landscape fertilizers etc. so not introduced to the water

YES	?	?	NO	Credit		Points				
1				Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands, Non-Roof**	1	moderate	Parking for this project is underground: Question for client (design team did not know): Did the decision to go LEED drive the parking underground?	credit automatic if parkade is undergound so would not eliminate	50% underground parkade meets this credit
1				Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands, Roof**	1	moderate	baseline is standard roofing	Probably stay with standard roofing minus 1 point	credit met by providing white membrane
1				Credit 8	**Light Pollution Reduction**	1	Minor	no special considerations for exteriro lighting: standard fixtures - no cut offs	minimal or no cost: likely keep this credit	met this credit - small bollard typ lighting with cut offs. Attention to no spillage of light from building and site
YES	**?**	**?**	**NO**							
5				**Water Efficiency**		**5 Points**				**Available Strategies**
1				Credit 1.1	**Water Efficient Landscaping,** Reduce by 50%	1	Minor	more likely grass and 'cheaper' landscaping options that would require more irrigation	would likely get this credit with the choice of planting even if a cistern has not been provided	native and adaptive, dought tolerant planting used, minimum irrigation provided by cistern collection of rainwater
1				Credit 1.2	**Water Efficient Landscaping, No** Potable Use or No Irrigation	1	moderate	as above	would not get this credit if cistern removed as some irrigation would be needed for the planting minus 1 point	as above

YES	Y?	N?	NO								
1				Credit 2	Innovative Wastewater Technologies	1	moderate	no dual flush toilets only low flush standard urinals (not waterless) no cistern for flushing toilets	if cistern and waterless urinals and dual flush toilets deleted would not get this credit minus 1 point	stormwateter is collected in cistern and used for flushing toilets dual flush toilets and waterless urinals provided
1				Credit 3.1	Water Use Reduction, 20% Reduction	1	None to Minor	standard flow fixtures for showers, faucets and urinals low flow toilets not dual flush	would probably still achieve if dual flush toilets and low flow fixtures - delete cistern	Dula flush toilets waterless urinals low flow fixtures rainwater stored in cistern to flush toilets
1				Credit 3.2	Water Use Reduction, 30% Reduction	1	Minor	see above	see above still achieved 30% but not innovation credit	see above
10	1		6	Energy & Atmosphere		17 Points				Strategies
Y				Prereq 1	Fundamental Building Systems Commissioning	Req'd	None	not standard	have to meet as is LEED prerequisite	have to meet as is LEED prerequisite

				Prereq 2	**Minimum Energy Performance**	Req'd	minor	Windows: low e, double glazed, not argon, not operable, window to wall ration similar to LEED end result No shading devices sealed building Walls - likely to be lighter weight type construction- not so much heavy mas concrete, block etc and lower insulation values> Probably a steel frame building VAV System mid efficiency boilers standard chiller technology water source cooling towers Water source cooling tower with air side economizer, no solar chimneys, no natural ventilation standard efficiency lighting no lighting sensors (in parkade or calssrooms)		would have to meet as LEED prerequisite- the following was the strategies that contributed to achieveing the 8 energy points: Windows: low e, double glazed, argon, area of glazing to balance building requirements for energy efficiency (minimizing area) and daylight and views (maximizing area) walls heavy mass (inside), exterior insulation, excellance performance light shelves and shading devices for windows Natural Ventilation - solar chimneys (form part of architectural atriums) - assist with natural venticaltion strategy as provides stack effect Condensing boiler technology, low temp radiation baseboards at perimeter heat exchanger to extract coolth from city water displacement ventilation heating or cooling air to spaces mid efficiency boiler for domestic HW hight efficiency lighting sensors in classrooms for occupance and daylighting (not in parkade) a small chiller was added after certification and occupancy as city water temperature was too high in peak summer to be effective for cooling
				Prereq 3	**CFC Reduction in HVAC&R Equipment**	Req'd	None	Baseline - required for Canada		
8			2	Credit 1	**Optimize Energy Performance**	1 to 10	moderate to high (first costs)	See EAp3	See EAp3	See EAp3

YES	Y?	N?	NO	Credit	Title	Points	Cost	Baseline	Notes	Strategies
			1	Credit 2.1	**Renewable Energy, 5%**	1	High (first costs)	not baseline	no renewables considered (PV / solar hw / wind etc.) as paybacks too long	no renewables considered (PV / solar hw / wind etc.) as paybacks too long
			1	Credit 2.2	**Renewable Energy, 10%**	1				
			1	Credit 2.3	**Renewable Energy, 20%**	1				
1				Credit 3	**Best Practice Commissioning**	1	none to minor	not standard baseline	do not target minus 1 point	cost of commissioning $1.60 /sqft for fundamental (EAp1) + 30% for best practice (EAc3 this credit) should result in operational cost savings for the client if this is done
1				Credit 4	**Ozone Depletion**	1	none to minor	not standard	if energy strategies remain then this credit is achieved	since no refridgerants in te design this credit is achived (chiller added after met the requirements for this credit)
	1			Credit 5	**Measurement & Verification**	1	moderate	not baseline	not targeted	not targeted - opinion of team that this is an expensive credit for commercial builidngs $80,000-$150,000 for all the controls etc to meet this point (can however result in no loss per year in efficiency if systems are monitored) otherwise can get 2-3% loss per year in efficiency
			1	Credit 6	**Green Power**	1	Minor	not standard	not targeted	not targeted - not achieved on this project as not required

YES	Y?	N?	NO							
5	1		8	**Materials & Resources**		13 Points				**Strategies**
Y				Prereq 1	**Storage & Collection of Recyclables**	Req'd	none to minor	not standard	would need to meet as prerequisite	space was allocated in parkade for strorage of recyclables for builidng

			1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors, & Roof	1		n/a		
			1	Credit 1.2	**Building Reuse**, Maintain 95% of Existing Walls, Floors, & Roof	1		n/a		
			1	Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-structural Elements	1		n/a		
1				Credit 2.1	**Construction Waste Management**, Divert 50%	1	none	not standard baseline	would be targeted	specified by design team tracked by contractor reported 93% constuction waste diversion and $80,000 in savings
1				Credit 2.2	**Construction Waste Management**, Divert 75%	1	none	see above	see above	see above
			1	Credit 3.1	**Resource Reuse**, Specify 5%	1	moderate to high	not baseline	not targeted	not targeted
			1	Credit 3.2	**Resource Reuse**, Specify 10%	1	moderate to high	not baseline	see above	see above
1				Credit 4.1	**Recycled Content**, Specify 7.5% (post-consumer + ½ post-industrial)	1	none	not baseline	no cost premium	high cost items were targeted and tracked (no cost premium) concrete (with fly ash) rebar drywall Insulation carpet tecknion ceiling tiles
1				Credit 4.2	**Recycled Content**, Specify 15% (post-consumer + ½ post-industrial)	1	none	see above	as above	as above
1				Credit 5.1	**Regional Materials**, 10% Extracted & Manufactured Regionally	1	none	not baseline	no cost premium	high cost items were targeted and tracked (no cost premium) concrete rebar structural insulated panels (SIPS) insulation brick dooes and frames stucco

YES	Y?	N?	NO								
	1			Credit 5.2	Regional Materials, 20% Extracted & Manufactured Regionally	1	none	see above	see above	as above
			1	Credit 6	Rapidly Renewable Materials	1		not baseline	no	not achieved though many materials specified were renewable at no additional cost - could not however meet the 5% threshold
			1	Credit 7	Certified Wood	1	none to high	not baseline	no	additional premium cost (at that time - now not so high a premuium depending on the wood) so not targeted
			1	Credit 8	Durable Building	1	minor	not baseline	not targeted	not targeted - at that tiem liability was not clear - now it would be likely targed through design team felt it would not be value to the client since they expect the Building Envelope consultant to design durable envelope systems
11	1		2		Indoor Environmental Quality 15 Points					Strategies
Y				Prereq 1	Minimum IAQ Performance	Req'd	none	not standard		see energy strategies (EA p2)
Y				Prereq 2	Environmental Tobacco Smoke (ETS) Control	Req'd	none	no smoking so not relevant		

1				Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1	minor	not baseline	yes	demand CO2 sensors provided as part of energy strategies
1				Credit 2	**Ventilation Effectiveness**	1	minor	not baseline	yes	see energy strategies (EA p2)
1				Credit 3.1	**Construction IAQ Management** Plan, During Construction	1	minor	not baseline	yes	credit achieved (may have construction upcharge but not identified and technically the mech contractor etc. should be following SMACNA guidelines anyway)
1				Credit 3.2	**Construction IAQ Management** Plan, Flushout / Testing	1	minor	not baseline	yes	achieved
1				Credit 4.1	**Low-Emitting Materials,** Adhesives & Sealants	1	none	not baseline	no cost premium	specified cost neutral option
	1			Credit 4.2	**Low-Emitting Materials,** Paints	1	none	not baseline	no cost premium	targeted but some paint arrived on site not meeting the LEED requirements
1				Credit 4.3	**Low-Emitting Materials,** Carpet	1	none	not baseline	no cost premium	specified cost neutral option

1				Credit 4.4	**Low-Emitting Materials,** Composite Wood & Agrifiber	1	none	not baseline	no cost premium	specified cost neutral option
			1	Credit 5	**Indoor Chemical & Pollutant Source Control**	1	Minor	not baseline	not targeted	not targeted
1				Credit 6.1	**Controllability of Systems,** Perimeter	1	minor	not baseline	yes	yes achieved provided one operable window and one lighting control per 18.5m within 5 m of perimeter wall
			1	Credit 6.2	**Controllability of Systems,** Non-Perimeter	1	minor	not baseline	no	not targeted
1				Credit 7.1	**Thermal Comfort,** Comply with ASHRAE 55	1	minor to moderate	not baseline	yes	yes achieved energy strategies tie into this credit
1				Credit 7.2	**Thermal Comfort,** Permanent Monitoring System	1	minor	not baseline	yes	yes achieved energy strategies tie into this credit

YES	Y?	N?	NO	Credit	Title	Points	Cost	Baseline	Achieved	Strategies
1				Credit 8.1	**Daylight & Views, Daylight 75% of Spaces**	1	none	not baseline	yes	yes achieved - no additional cost identified - window placement and size tie into this credit
				Credit 8.2	**Daylight & Views, Views for 90% of Spaces**	1	none	not baseline	no	not achieved
YES	**Y?**	**N?**	**NO**							
4			1		**Innovation & Design Process**	5 Points				**Strategies**
1				Credit 1.1	**Innovation in Design: Exemplary Performance - Water use reduction at 80%**	1	moderate	not baseline	no if cistern not provided minus 1 point	cistern ad waster strategies contributed to achieving the 80% water reduction (see WE c3)
1				Credit 1.2	**Innovation in Design: Green Housekeeping Program**	1	none to minor	not baseline	yes	green housekeeping strategies defined (cleaning materials for the building)
1				Credit 1.3	**Innovation in Design: Green Education Program**	1	none to minor	not standard	yes	green builidng education provided
			1	Credit 1.4	**Innovation in Design**	1	none			
1				Credit 2	**LEED™ Accredited Professional**	1	none	not baseline		cost should be identified in design fees for LEED

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

YES	Y?	N?	NO	
43	5		21	**Project Totals** (pre-certification estimates)

Prepared by:
Eco-Integration

Appendix 2 –
Phase 3 Supporting Analysis

Appendix 2A –
Life Cycle Costing Analysis

BTY GROUP

ALBERTA INFRASTRUCTURE

Facilities LEED Study

July 4, 2008

Life Cycle Costing

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1.0 INTRODUCTION

In late June 2008, Deloitte, BTY Group and Eco-Integration were retained by Alberta Infrastructure to undertake a Life Cycle Costing for three (3) social infrastructure projects as an extension of the "LEED Certification Cost Analysis" prepared in early June 2008. The projects selected by Alberta Infrastructure were:

- Chestermere Lake Elementary School (the "Elementary School Project");
- Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station (the "Visitor Centre Project");
- Mount Royal College – Centre for Continuous Learning (the "College Project").

The elementary school is under construction and the other two, the Tyrrell Field Station and the Mount Royal facility, have been completed and are currently occupied.

2.0 EXECUTIVE SUMMARY

BTY Group has estimated the 30-year Life-cycle cost premiums for LEED Silver and LEED Gold levels, compared with a "Non-LEED" baseline, as follows:

	COST SAVINGS			
	SILVER		GOLD	
PROJECT	$	pay back (years)	$	pay back (years)
- Chestermere Lake Elementary School	1,504,300	7	1,126,900	13
- Tyrrell Field Station	57,300	27	8,800	28
- Mount Royal College -	1,723,100	8	1,331,100	12

Notes:

The detailed calculation of these figures is shown in the Appendices of this report.

A 5% annual rate has been included for escalation and a 6% real discount rate has been used to calculate the present value of future cash flows.

3.0 METHODOLOGY

This Life Cycle Cost analysis includes elements of capital costs, periodic replacement costs, maintenance and energy costs.

The capital costs for three design scenarios namely Base Design, LEED Silver, and LEED Gold are extracted from the "LEED Certification Cost Analysis" prepared in early June 2008.

The replacement costs are estimated based on the building system description for the three different designs prepared by the consultants during the early stage of this cost analysis.

The yearly maintenance costs are estimated based on historical cost data of buildings of similar nature and size.

The yearly energy costs are estimated based on the Energy Modeling prepared by the mechanical engineers in the early stage of the building design.

An escalation rate of 5% has been included in the life cycle costing exercise to cover cost escalation over the assumed 30 years of building life.

The Future Costs have been expressed in terms of Equivalent Cost by using a discounted cash flow method to allow Future Costs to be compared to Present Values in constant dollars for cost comparison purposes. In this particular cost analysis, a 6% real discount rate has been used to calculate the present value of future cash flows.

An allowance of water supply charge of $\$5/m^3$ is included in the Life Cycle Cost calculation of the Tyrrell Station project. We recommend a detailed cost estimate be carried out based on local site condition to verify this allowance.

APPENDIX 1

-Chestermere Lake
Elementary School

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LIFE CYCLE COST ANALYSIS	Base Design		LEED Silver		LEED Gold	
Element : **Overall Building** **Gross Floor Area:** 4,188 m² **Discount Rate:** 6% **Escalation Rate:** 5% **Life Cycle Period :** 30 **years**						
	Estimated Cost $	Present Worth $	Estimated Cost $	Present Worth $	Estimated Cost $	Present Worth $
1.0 INITIAL COSTS						
Construction Cost	10,594,600	10,594,600	10,594,600	10,594,600	10,594,600	10,594,600
Premium for LEED (Hard Cost)	0	0	265,000	265,000	731,000	731,000
Premium for LEED (Soft Cost)	0	0	190,000	190,000	190,000	190,000
TOTAL INITIAL COST (A) :		**$10,594,600**		**$11,049,600**		**$11,515,600**
2.0 REPLACEMENT COSTS						
Replacement cost over 30 years:		615,400		403,800		464,000
TOTAL REPLACEMENT COST (B) :		**$615,400**		**$403,800**		**$464,000**
3.0 ANNUAL COSTS						
Maintenance cost :						
- yearly capital expenditure on maintenance	92,100	2,338,400	73,700	1,871,200	78,300	1,988,000
Operating cost :						
- yearly energy cost (Gas & Electricity)	102,740	2,608,500	52,305	1,328,000	41,844	1,062,400
TOTAL ANNUAL COST (C) :		**$4,946,900**		**$3,199,200**		**$3,050,400**
4.0 SUMMARY						
Total Life Cycle Cost (A+B+C) ($)		**$16,156,900**		**$14,652,600**		**$15,030,000**
Variance ($) (LEED - Base)		**base**		**($1,504,300)**		**($1,126,900)**
Pay back (years)				**7**		**13**

APPENDIX 2

-Dinosaur Provincial Park
Visitor Centre and
Tyrrell Field Station

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Deloitte.

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Alberta Infrastructure Projects
Tyrrell Field Station
Order of Magnitude Estimate #1
July 4, 2008

LIFE CYCLE COST ANALYSIS	Base Design		LEED Silver		LEED Gold	
Element : **Overall Building** **Gross Floor Area:** 500 m² **Discount Rate:** 6% **Escalation Rate:** 5% **Life Cycle Period :** 30 years						
	Estimated Cost $	Present Worth $	Estimated Cost $	Present Worth $	Estimated Cost $	Present Worth $
1.0 INITIAL COSTS						
Construction Cost	1,227,200	1,227,200	1,227,200	1,227,200	1,227,200	1,227,200
Premium for LEED (Hard Cost)	0	0	65,000	65,000	119,000	119,000
Premium for LEED (Soft Cost)	0	0	151,000	151,000	151,000	151,000
TOTAL INITIAL COST (A) :		**$1,227,200**		**$1,443,200**		**$1,497,200**
2.0 REPLACEMENT COSTS						
Replacement cost over 30 years:		129,400		72,900		83,400
TOTAL REPLACEMENT COST (B) :		**$129,400**		**$72,900**		**$83,400**
3.0 ANNUAL COSTS						
Maintenance cost :						
- yearly capital expenditure on maintenance	11,000	279,300	8,800	223,400	8,800	223,400
Operating cost :						
- yearly energy cost (Gas & Electricity)	10,452	398,000	6,925	237,100	6,295	221,100
- yearly water cost (based on $5/m³)	5,223		2,415		2,415	
TOTAL ANNUAL COST (C) :		**$677,300**		**$460,500**		**$444,500**
4.0 SUMMARY						
Total Life Cycle Cost (A+B+C) ($)		**$2,033,900**		**$1,976,600**		**$2,025,100**
Variance ($) (LEED - Base)		**base**		**($57,300)**		**($8,800)**
Pay back (years)				**27**		**28**

APPENDIX 3

-Mount Royal College for
Continuous Learning

LIFE CYCLE COST ANALYSIS	Base Design		LEED Silver		LEED Gold	
Element : **Overall Building**						
Gross Floor Area: 5,078 m²						
Discount Rate: 6%						
Escalation Rate: 5%						
Life Cycle Period : 30 **years**						
	Estimated Cost $	Present Worth $	Estimated Cost $	Present Worth $	Estimated Cost $	Present Worth $
1.0 INITIAL COSTS						
Construction Cost	14,014,964	14,014,964	14,014,964	14,014,964	14,014,964	14,014,964
Premium for LEED (Hard Cost)	0	0	400,000	400,000	750,000	750,000
Premium for LEED (Soft Cost)	0	0	232,000	232,000	232,000	232,000
TOTAL INITIAL COST (A) :		**$14,014,964**		**$14,646,964**		**$14,996,964**
2.0 REPLACEMENT COSTS						
Replacement cost over 30 years:		737,800		464,100		636,300
TOTAL REPLACEMENT COST (B) :		**$737,800**		**$464,100**		**$636,300**
3.0 ANNUAL COSTS						
Maintenance cost :						
- yearly capital expenditure on maintenance	111,700	2,836,000	89,400	2,269,800	94,900	2,409,500
Operating cost :						
- yearly energy cost (Gas & Electricity)	141,155	3,583,900	81,476	2,068,700	70,849	1,798,800
TOTAL ANNUAL COST (C) :		**$6,419,900**		**$4,338,500**		**$4,208,300**
4.0 SUMMARY						
Total Life Cycle Cost (A+B+C) ($)		**$21,172,664**		**$19,449,564**		**$19,841,564**
Variance ($) (LEED - Base)		**base**		**($1,723,100)**		**($1,331,100)**
Pay back (years)				**8**		**12**

Appendix 2B –
Water Consumption Analysis

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Building Designs to Enhance Life

Report on Process for Phase 3 **June 30, 2008**
LEED Gold Certification Cost Analysis

For the Phase 3 LEED Gold Certification Cost Analysis the following environmental areas were addressed for each of the 3 case study buildings; Chestermere Lake Elementary School, Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station, and Mount Royal College Centre for Continuous Learning:

1. Water Consumption
2. Energy Consumption and Green House Gas Emissions

In our analysis of each of these areas we compared back to our previously identified project descriptions:

- Baseline: what would the project brief have been if there was no LEED requirement
- Silver LEED: what strategies were undertaken for the project and what possible 36 points would have been targeted for LEED Silver (in some of the project cases this meant eliminating strategies to bring the projects back to LEED silver)
- Gold LEED: what strategies were undertaken for the project and what possible 42 points (or close) would have been targeted for LEED Gold

1. WATER CONSUMPTION

Chestermere Lake Elementary School

Irrigation: The Catholic School Board have a policy not to provide any irrigation on school grounds therefore the potable water use for irrigation is zero.

Building Use: Quinn Young provided us with the LEED Calculation Template for building use (LEED; Water Efficiency Credit 3). Since this project is not yet certified, this information is an estimate of the LEED credits to be obtained to achieve the LEED Silver Certification required. The calculations show that there would be a 35.16% savings in water compared to the ***LEED Baseline.*** This results in achievement of 2 LEED credits; as reflected in the LEED Cost Analysis document forming part of Phase 2 (attached again for your information). For this study however we are not comparing to the LEED Baseline but to the Baseline described above.
Therefore our analysis below includes the estimated water consumption for the building to achieve the targeted LEED certification, estimated water consumption to only meet the defined baseline and to achieve LEED Gold. The following summary indicates no. of occupants, total annual water consumption and savings in water consumption.

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Building Designs to Enhance Life

Chestermere School			
	Water Consumption (irrigation)		
	Baseline	**Silver**	**Gold**
Total water use (litres)	No water used for irrigation	0	0

	Water Consumption (building level)		
Total Occupants = 370	**Baseline**	**Silver (Actual specified)**	**Gold**
Description	medium flow fixtures for showers and faucets low flow (6 litre) toilets for kids conventional urinals with sensor flush dual flush toilets for staff	in addition to base line: sensors on kids low flow toilets low flow urinals with sensor flush sensors + aerator to further reduce flow on faucets	In addition to base line: low flow showers ultra low flow kids toilets (or dual flush)
Total Annual Volume (litres)	1,269,270	1,136,270	856,590

Total water consumption for Irrigation	0	0	0
Total water consumption for Building Use	1,269,270	1,136,270	856,590
Grand Total (Irrigation + Building Use	**1,269,270**	**1,136,270**	**856,590**
Water Savings Compared to Defined Baseline (Annual L)	**0**	**133,000**	**412,680**

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Building Designs to Enhance Life

Mount Royal College Centre for Continuous Learning

Irrigation: The College provide irrigation for landscaping, therefore part of the design strategies for this building was to reduce potable water for irrigation, hence a stormwater storage tank was installed to use for irrigation in the summer months and for toilet flushing year round. For our analysis Stantec provided an estimate of water required for landscaping for the planting chosen.

Building Use: Stantec provided us with the LEED Calculation Template for building use (LEED; Water Efficiency Credit 3). This project is certified Gold, however this information is an estimate showing an 84.09% savings in water compared to the ***LEED Baseline.*** This results in achievement of 2 LEED credits + 1 innovation credit; as reflected in the LEED Cost Analysis document forming part of Phase 2 (attached again for your information). For this study however we are not comparing to the LEED Baseline but to the Baseline described above.
Therefore our analysis below includes the estimated water consumption for the building to achieve the actual LEED Gold certification, estimated water consumption to only meet the defined baseline and to achieve LEED Silver. The summary indicates no. of occupants, total annual water consumption and savings in water consumption.

Mount Royal College			
	Water Consumption (irrigation)		
	Baseline	**Silver**	**Gold**
Description	landscaping options that would require more irrigation	would likely achieve 50% reduction in water for irrigation with the choice of planting even if a cistern has not been provided (Landscape architect advised that water consumption was probably only reduced 25% from baseline with planting choices)	native and adaptive, drought tolerant planting used, minimum irrigation provided by cistern collection of rainwater
Total water use (litres)	262,500	210,000	Zero potable water used for irrigation (cistern collects rainwater for irrigation)

	Water Consumption (building level)		
Total Occupants = 210	**Baseline**	**Silver (Actual specified)**	**Gold**

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Description	standard flow fixtures for showers, faucets and urinals low flow toilets not dual flush	would probably still achieve if dual flush toilets and low flow fixtures - delete cistern	Dual flush toilets waterless urinals low flow fixtures rainwater stored in cistern to flush toilets
Total Annual Volume (litres)	914,934	697,921	215,678

Total water consumption for Irrigation	262,500	210,000	0
Total water consumption for Building Use	914,934	697,921	215,678
Grand Total (Irrigation + Building Use	**1,177,434**	**907,921**	**215,678**
Water Savings Compared to Defined Baseline (Annual Litres)	**0**	**269,513**	**961,756**

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Building Designs to Enhance Life

Dinosaur Provincial Park Visitor Centre and Tyrrell Field Station

Irrigation: Water conservation was critical for this arid, dry site, therefore the baseline was set at no water (potable or stored) for irrigation.

Building Use: Designworks Architecture provided us with the LEED Calculation Template for building use (LEED; Water Efficiency Credit 3). This project is certified Gold, however this information is an estimate showing a 53.77% savings in water compared to the ***LEED Baseline.*** This results in achievement of 2 LEED credits + 1 innovation credit; as reflected in the LEED Cost Analysis document forming part of Phase 2 (attached again for your information). For this study however we are not comparing to the LEED Baseline but to the Baseline described above. Therefore our analysis below includes the estimated water consumption for the building to achieve the actual LEED Gold certification, estimated water consumption to only meet the defined baseline and to achieve LEED Silver. The summary indicates no. of occupants, total annual water consumption and savings in water consumption.

Dinosaur Provincial Park			
	Water Consumption (irrigation)		
	Baseline	**Silver**	**Gold**
Total water use (litres)	No water for irrigation used	0	0

Total Occupants = 116 (based on a visitor count)	**Water Consumption (building level)**		
	Baseline	**Silver (Actual specified)**	**Gold**
Description	Water conservation was important for this site as arid, dry area installed dual flush for existing retrofit -no waterless urinals -did not add flow restrictors for existing	For LEED Silver (revised scorecard) keep strategies as baseline	In Addition to baseline: add aerators to restrict flow to 1.9gpm on existing fixtures Retrofit Waterless. urinals in existing

Total Annual Volume (litres)	749,109	749,109	483,005
Water Savings Compared to Defined Baseline (Annual Litres)	0	0	266,104

Total water consumption for Irrigation	0	0	0
Total water consumption for Building Use	749,109	749,109	483,005
Grand Total (Irrigation + Building Use	**749,109**	**749,109**	**483,005**
Water Savings Compared to Defined Baseline (Annual Litres)	**0**	**0**	**266,104**

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2.0 ENERGY CONSUMPTION and GHG

Energy modeling reports were provided by the design teams for each of the three case studies and these numbers have been used in the following analysis. The modeling results in the energy design reports are for the reference building (as defined by MNECB), and the proposed building (designed and outlined in the LEED Cost Analysis document). Energy modeling has not been done for our defined baseline, and a variety of LEED levels. We have therefore estimated the energy consumption based on number of assumed points for various levels of LEED. From these numbers we have then estimated the GHG emission savings for LEED Gold and LEED Silver compared to our defined baseline levels.

The attached spreadsheet is a summary of these results.

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Appendix 2C –
Energy Consumption Analysis

ENERGY CONSUMPTION

Chestermere School

	Energy Consumption				
Area = 4188sq m	**Baseline**	**Silver (Actual specified)**	**Gold**	**% Consumption Savings (energy modeled bldg compared to LEED Ref bldg)**	LEED Reference bldg
Description	See Cost Analysis LEED Scorecard	See Cost Analysis LEED Scorecard	See Cost Analysis LEED Scorecard		
	Estimated based on 15% better than MNECB ie LEED prerequisite is not achieved*	Estimated based on a merged 40% better than MNECB* ie achieved 4-5 points	Estimated based on 50% better than MNECB*ie achieved 6-7 points **Note these are modeled numbers - 7 points were modeled (55% better than MNECB)**		
Energy Consumption - Electricity (MJ)	1,193,400	967,980	835,000	37%	1,326,000
Energy Consumption - Natural Gas (MJ)	4,165,091	2,689,200	2,010,000	60%	4,980,000
Total	5,358,491	3,657,180	2,845,000	55%	6,306,000
Energy Savings: Electricity MJ (compared to Defined Baseline)	0	225,420	358,400		

GHG Savings : Electricity tonnes of CO2 (compared to Defined baseline)	0	62	99		
Energy Savings; Natural Gas MJ (compared to Defined Baseline)	0	1,475,891	2,155,091		
GHG Savings: Natural Gas tonnes of CO2 (compared to Defined baseline)	0	73	106		
TOTAL GHG Savings tonnes of CO2 (compared to Defined Baseline)	0	135	206		
Tonnes of CO2/sqm savings compared to defined baseline		0.032	0.049		

NOTE * these numbers are estimates only based on % better than the modeled reference building.
Modeling of the actual systems proposed would need to be done to verify these estimated numbers

Mount Royal College

	Energy Consumption				
Area of Building = 5078sqm	**Baseline**	**Silver**	**Gold (Actual Certified)**	**Consumption Savings (compared to LEED Ref bldg)**	LEED Reference bldg
Description	See Cost Analysis LEED Scorecard	See Cost Analysis LEED Scorecard	See Cost Analysis LEED Scorecard		
	Estimated based on a merged 15% better than MNECB ie did not achieve LEED prerequisite*	Estimated based on a merged 40% better than MNECB* ie achieved 4-5 points	Estimated based on a merged 50% better than MNECB* ie achieved 6-7 points **Note these are modeled numbers - 8 points were achieved (57% better than MNECB)**		
Energy Consumption - Electricity (MJ)	3,146,057	2,416,982	1,987,763	44%	3,554,385
Energy Consumption - Natural Gas (MJ)	6,264,734	3,980,181	2,807,334	63%	7,509,776
Total	9,410,791	6,397,163	4,795,097	57%	11,064,161
Energy Savings: Electricity MJ (compared to Defined Baseline)	0	729,075	1,158,294		
GHG Savings : Electricity tonnes of CO2 (compared to Defined baseline)	0	202	321		

Energy Savings; Natural Gas MJ (compared to Defined Baseline)	0	2,284,553	3,457,400		
GHG Savings: Natural Gas tonnes of CO_2 (compared to Defined baseline)	0	113	171		
TOTAL GHG Savings tonnes of CO_2 (compared to Defined Baseline)	0	315	492		
Tonnes of CO_2/sqm savings compared to defined baseline		0.062	0.097		

NOTE * these numbers are estimates only based on % better than the modeled reference building.
Modeling of the actual systems proposed would need to be done to verify these estimated numbers

Dinosaur Provincial Park

	Energy Consumption				
Area of new extension + existing = 500sqm + 850sqm (confirm that modeling was for whole building	**Baseline**	**Silver**	**Gold (Actual Certified)**	**Consumption Savings (compared to LEED Ref bldg)**	LEED Reference bldg
Description	See Cost Analysis LEED Scorecard	See Cost Analysis LEED Scorecard	See Cost Analysis LEED Scorecard		
	Estimated based on a merged 15% better than MNECB* ie did not achieve LEED prerequisite	Estimated based on a merged 40% better than MNECB* ie achieved 4-5 points **Note these are modeled numbers - 4 points were achieved (38% better than MNECB)**	Estimated based on a merged 50% better than MNECB* ie achieved 6-7 points		
Energy Consumption - Electricity (MJ)	203,895	**204,786**	206,765	-0.73%	203,309
Energy Consumption - Natural Gas (MJ)	478,443	**291,828**	180,605	52%	602,015
Total Energy	682,338	496,614	387,370	38%	805,324
Energy Savings: Electricity MJ (compared to Defined Baseline)	0	-891	-2,870		

GHG Savings : Electricity tonnes of CO2 (compared to Defined baseline)	0	-0.25	-0.80		
Energy Savings; Natural Gas MJ (compared to Defined Baseline)	0	186,615	297,839		
GHG Savings: Natural Gas tonnes of CO2 (compared to Defined baseline)	0	9	15		
TOTAL GHG Savings tonnes of CO2 (compared to Defined Baseline)	0	9	14		
Tonnes of CO2/sqm savings compared to defined baseline assume 1350sqm total area of new and existing		**0.007**	**0.010**		

NOTE * these numbers are estimates only based on % better than the modeled reference building.
Modeling of the actual systems proposed would need to be done to verify these estimated numbers

GHG Emissions		
Electricity (coal fired generation)	1000 tons /GWh	277x10-6tonnes/MJ
Natural Gas	0.0494tonnes/GJ	49.4x10-6tonnes/MJ

References for GHG

Environment Canada
(http://www.ec.gc.ca/pdb/ghg/inventory_report/2004_report/ann13_e.cfm#sa13_6_2)

Environment Canada: NATIONAL INVENTORY REPORT, 1990-2005: GREENHOUSE GAS SOURCES AND SINKS IN CANADA
Alberta: 1000tons of CO2/GWH

Appendix 2D – Report

‘Greening the Building and the Bottom Line’

Rocky Mountain Institute (1998)

GREENING THE BUILDING AND THE BOTTOM LINE

Increasing Productivity Through Energy-Efficient Design

By: Joseph J. Romm
U.S. Department of Energy
and
William D. Browning
Rocky Mountain Institute

Executive Summary

Energy-efficient building and office design offers the possibility of significantly increased worker productivity. By improving lighting, heating, and cooling, workers can be made more comfortable and productive. An increase of 1 percent in productivity can provide savings to a company that exceed its entire energy bill. Efficient design practices are cost-effective just from their energy savings; the resulting productivity gains make them indispensable.

This paper documents eight cases in which efficient lighting, heating, and cooling have measurably increased worker productivity, decreased absenteeism, and/or improved the quality of work performed. They also show that efficient lighting can measurably increase work quality by reducing errors and manufacturing defects.

The case studies presented here include retrofits of existing buildings and the design of new facilities, and cover a variety of commercial and industrial settings. They include:

• The main post office of Reno, Nevada, a lighting retrofit with a six-year payback that led to a 6-percent gain in productivity—worth more than the cost of the retrofit.

• Boeing's "Green Lights" effort, which reduced its lighting electricity use by up to 90 percent, with a two-year payback (a 53-percent return on investment) and reduced defects.

• Hyde Tools' implementation of a lighting retrofit with a one-year payback and an increase in product quality estimated to be worth $25,000 annually.

• Pennsylvania Power & Light's upgrade of the lighting system in a drafting facility that produced energy savings of 69 percent and a 13-percent increase in productivity, with a 25-percent decrease in absenteeism.

• Lockheed's engineering development and design facility, which saved nearly $500,000 a year on energy bills and gained 15 percent in productivity with a 15-percent drop in absenteeism.

• West Bend Mutual Insurance's new building, which yielded a 40-percent reduction in energy consumption per square foot and a 16-percent increase in claim-processing productivity.

• Wal-Mart's new prototype Eco-Mart, where enhanced daylighting through the use of skylights in one half of the store led to "significantly higher" sales than in the other half.

• ING Bank's new headquarters, which used one-tenth the energy per square foot of its predecessor, created a positive new image for the bank, and lowered absenteeism by 15 percent.

Each case study identifies the design changes that were most responsible for increased productivity. While such gains may not necessarily be achievable by all companies, the cases profiled in this paper are by no means out of the ordinary. These companies realized significant productivity and energy savings because their former offices and plants were inefficient—but no more so than those of most American companies.

As these eight case studies illustrate, energy-efficient design may be one of the least expensive ways for a business to improve the productivity of its workers and the quality of its product.

INTRODUCTION

This paper describes case studies of companies that undertook to increase the energy efficiency of buildings, and thereby inadvertently increased worker productivity.

Energy-efficiency retrofits for existing buildings, and new buildings designed for energy-efficient performance, have very attractive economic returns. For example, a three-year payback, typical in lighting retrofits, is equal to an internal rate of return in excess of 30 percent. This return is well above the "hurdle rate" of most financial managers. The same retrofit may also cut energy use by 50¢ or more per square foot, which has significant positive effects on the net operating income of a building.

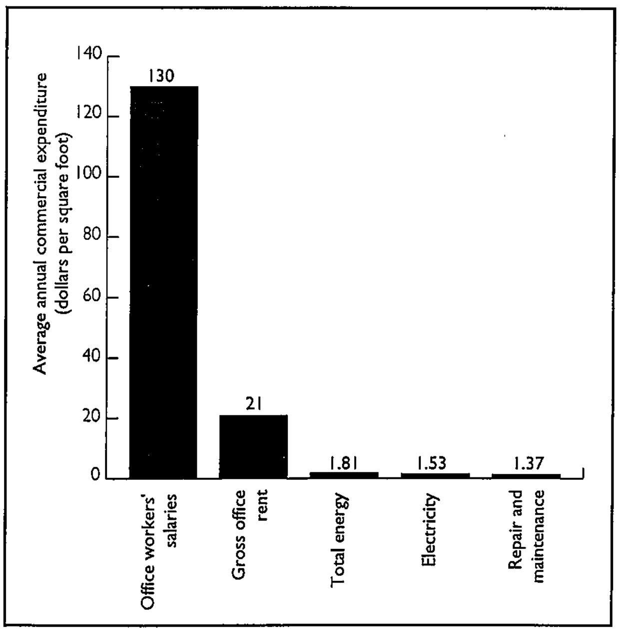
However, these gains are tiny compared to the cost of employees, which is greater than the total energy and operating costs of a building. Based on a 1990 national survey of large office buildings[1], as summarized in the graph below, electricity typically costs $1.53 per square foot and accounts for 85 percent of the total energy bill, while repairs and maintenance typically add another $1.37 per square foot; both contribute to the gross office-space rent of $21 per square foot. In comparison, office workers cost $130 per square foot[2]—72 times as much as the energy costs. Thus an increase of 1 percent in productivity can nearly offset a company's entire annual energy cost.

Productivity is measured here in terms of production rate, quality of production, and changes in absenteeism. This can be improved by fewer distractions from eye strain or poor thermal comfort, and similar factors.

Research done at Western Electric in the 1920s and '30s suggests that contrived experiments to monitor the effect of a workplace change on productivity can be complicated by the special conditions of the experiment, particularly the interaction between the worker and the researcher. Indeed, some have come to see the "Hawthorne effect" as implying that changes in the physical environment have an effect on worker performance only because those changes signal to the worker the interest and concern of management.[3] Subsequent analyses, however, have called into question the experimental methods and results from this work. A major 1984 study of the effect of office design on productivity found direct correlation between specific changes in the physical environment and worker productivity.

It is important to note that increases in worker productivity were not the reason for the measures described in these case studies. The companies based their decisions solely on projected energy and maintenance savings. In all the examples, productivity had always been monitored by the companies. Additionally, none of the cases involved a change in management style. The gains in productivity observed by the companies were for the most part unanticipated. Some of the companies were aware that the measures implemented would improve the quality of spaces.

The measures described were not undertaken for energy *conservation*, but rather to increase energy *efficiency*. Both activities lower energy consumption. However, conservation implies a decrease in service; energy efficiency must meet or exceed the quality of service that it replaces.



Data from Building Owners and Managers Association; Electric Power Research Institute; Statistical Abstract of the United States 1991.

Retrofit case studies

Reno Post Office

In 1986, the mail sorters at the Main Post Office in Reno, Nevada[4] became the most productive of all the sorters in the entire western region of the United States, which stretches from Colorado to Hawaii. At the same time, the operators of one of their two mechanized sorting machines achieved the lowest error rate for sorting in the western region. What happened?

It began a few years earlier when the Reno Post Office was selected by the federal government to receive a renovation that would make it a "minimum energy user." An architectural firm, Leo A. Daly, was hired to do everything necessary to reduce energy use.

The post office was a modern warehouse with high ceilings and coal-black floors. It was quite noisy in the areas where the two sorting machines were run. The sorter is grueling to use. Once a second, it drops a letter in front of the operator, who must punch in the correct zip code before the next letter appears. If the operator keys in a zip code that doesn't exist, or no zip code at all, the letter will immediately be sent back through the machine for repunching. If the wrong zip code is keyed in, the letter will be sent to the wrong bin and it will take even longer to track down the mistake. The job is so stressful that an operator can work a maximum of only 30 minutes on the machine at one time.

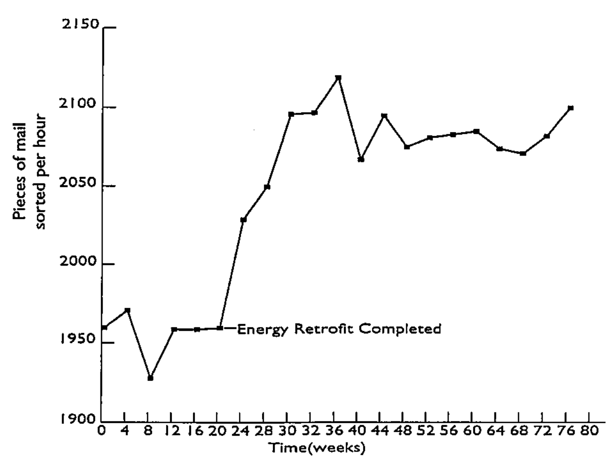
The chief architect, Lee Windheim, proposed a lowered ceiling and improved lighting. The new ceiling would make the room easier to heat and cool, while also creating better acoustics. The ceiling would be sloped to enhance the indirect lighting, and to replace harsh direct downlighting. More efficient, longer-lasting lamps that gave off a more pleasant light quality were installed.

Before starting the complete renovation, estimated to cost about $300,000, Windheim did a small test section of the lighting and new ceiling over one of the two sorting machines. The graph at right shows the number of pieces of mail sorted per hour in the 24 weeks before the change, and for more than a year after the change.

In the next 20 weeks, productivity increased more than 8 percent. The workers in the area with the old ceiling and lighting showed no change in productivity. A year later, productivity had stabilized at an increase of about 6 percent. Under the new lighting design, the rate of sorting errors by machine operators dropped to 0.1 percent—only one mistake in every 1,000 letters—the lowest error rate in the entire western region. Working in a quieter and more comfortably lit work area, postal employees did their jobs better and faster. The manager of mail processing, Robert McLean, says the data were "solid enough to get $300,000 to do the whole building."

The energy savings projected for the whole building came to about $22,400 a year. There would be an additional savings of $30,000 a year because the new ceiling would require less frequent repainting. Combined, the energy and maintenance savings came to about $50,000 a year: a six-year payback. The productivity gains, however, were worth $400,000 to $500,000 a year. In other words, the productivity gains alone would pay for the entire renovation in less than a year. The annual savings in energy use and maintenance were a free bonus.

At the Reno Post Office, no one conducted any special experiment intended to raise productivity, and there was no unusual interaction between workers and supervisors. Productivity had always been measured. McLean, now postmaster for Carson City, denies any personal responsibility for the improvement. "We had the same people, the same supervisor, and I don't believe I was doing any motivational work," he says. Yet he notes that the data on the productivity and quality increase were "irrefutable." The changes to the building were designed solely to reduce energy use. The increases in productivity were unexpected.



Productivity gain after retrofit

BOEING

Boeing[5] participates in the Environmental Protection Agency's voluntary "Green Lights" program to promote energy-efficient lighting. To date, the aircraft manufacturer has retrofitted more than 1 million of the 8 million square feet of assembly space in its hangar-sized assembly plants near Seattle.

Using various efficiency measures, Boeing has reduced lighting electricity use by up to 90 percent in some of its plants, and the company calculates its overall return on investment in the new lighting to be 53 percent—the energy savings pay for the lights in just two years. Lawrence Friedman, then Boeing's conservation manager, notes that if every company adopted the lighting Boeing has installed, "it would reduce air pollution as much as if one-third of the cars on the road today never left the garage."

However, Boeing has discovered even more interesting results from its lighting retrofit.

With the new efficient lighting, employees have more control, the interior looks nicer, and glare has been reduced. Friedman says that after the new lighting was put in, "The things that people tell us are almost mind-boggling." One woman, who puts rivets in 30-foot wing supports, had been relying on touch with one part because she was unable to see inside. Now, for the first time in 12 years, she could actually see inside the part. Another riveter reported that it's much safer. With the old lighting, a rivet head would occasionally break off, fly through the air, hit one of the old fluorescent light tubes, and possibly break the lamp. The new high-efficiency metal-halide lamps have hard plastic covers that don't break when a flying rivet head hits them. Steve Cassens, a lighting engineer for Boeing, says that the first thing machinists with new lighting tell him is that they can read the calipers on their lathes and measurement tools much more easily.

One shop that produced the interior sidewall panel for jets was moved from an area with old fluorescents into an area with high-efficiency metal-halide lamps. One of the tasks performed by machinists in the shop is to attach a panel to a stiffening member using numerous fasteners, which leave very small indentations in the panel. The old lighting had poor contrast and made it difficult to tell if a fastener had been properly attached. With the new lighting, the indentations left by properly attached fasteners are far easier to detect; it improves workers' ability to detect imperfections in the shop by 20 percent.[6]

Friedman says that most of the errors in the aircraft interiors that used to slip through "weren't being picked up until installation in the airplane, where it is much more expensive to fix." Even worse, some imperfections were found during customer walk-throughs, which is embarrassing, and costly. Although it is difficult to calculate the savings from catching errors early, a senior manager estimates that they exceed the energy savings for that building.

Hyde Tools

Hyde Tools[7], a Massachusetts-based manufacturer of cutting blades, has 300 employees. An environmentally proactive company, Hyde decided in the early 1990s that it could save energy and improve its bottom line by upgrading its lighting from old fluorescents to new high-pressure sodium-vapor and metal-halide fixtures.

The cost of the retrofit was $98,000 (including labor), with $48,000 covered by the local utility. Doug DeVries, then the company's purchasing manager, estimated that annual energy savings would also come to $48,000—yielding a payback of about one year—but he still insisted in trying the upgrade in only one area to start. He gave workers the option of restoring the original lighting after a six-month trial period, on the principle that no amount of energy saved would be worth making his operators dissatisfied.

"For the first three weeks, a lot of people complained because the new lights cast an orange hue," says DeVries. "But when we experimented by turning the old fluorescent lights back on after six months, there was a near riot of disapproval." Why? Because the new lights had made it possible to see tiny specks of dirt on the equipment that holds the blades while they're being worked on. That dirt creates tiny indentations on a blade, called "mud holes." The mud holes make the blade defective or difficult to plate, which can cause a customer to reject it.

With the new lighting, DeVries says, "the quality of work improved significantly because we could see things we couldn't see before." DeVries estimates that the improved quality was worth another $25,000 a year to the company. Those bottom-line savings are critical to a small company. DeVries notes that every dollar saved on the shop floor is worth $10 in direct sales. In other words, the improved quality from the efficient lighting was the equivalent of a $250,000 increase in sales.

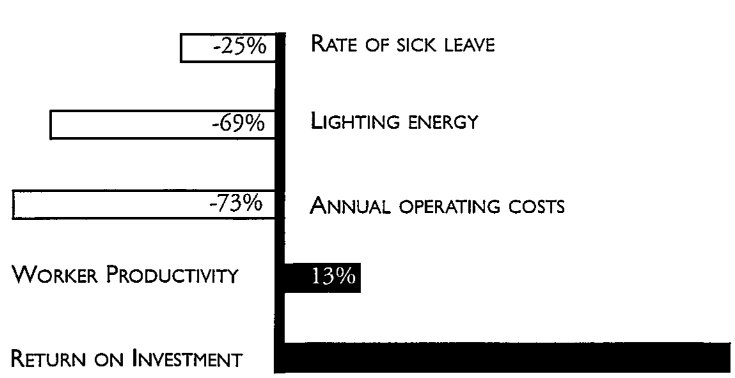
Pennsylvania Power & Light

In the early 1980s, Pennsylvania Power & Light[8] became increasingly concerned about the lighting system in a 12,775-square-foot room that housed its drafting engineers. According to Russell Allen, superintendent of the office complex, "The single most serious problem was veiling reflections, a form of indirect glare that occurs when light from a source bounces off the task surface and into a worker's eyes."

Veiling reflections "wash out the contrast between the foreground and background of a task surface, making it more difficult to see." This increases the time required to perform a task and the number of errors likely to be made. Allen adds: "Low-quality seeing conditions were also causing morale problems among employees. In addition to the veiling reflections, workers were experiencing eye strain and headaches that resulted in sick leave."

After considering many suggestions, the utility decided to upgrade the lighting in a 2,275-square-foot area with high-efficiency lamps and ballasts. Rather than just swapping out lamps in the old fixtures that ran perpendicular to the workstations, the new fixtures were reconfigured and installed parallel to reduce veiling reflections. To improve lighting quality still further, the fixtures were fitted with eight-cell parabolic louvers—metal grids that help reduce glare. Allen notes, "Generally speaking, it can be said that we converted from general lighting to task lighting. As a result, more of the light is directed specifically to work areas and less is applied to circulation areas,

Results of Pennsylvania Power & Light's retrofit



creating more variance in lighting levels which upgrades the appearance of the space."

With veiling reflections reduced, less light was needed to provide better visibility. Allen believes this general principle: "As lighting quality is improved, lighting quantity can often be reduced, resulting in more task visibility and less energy consumption."

Finally, local controls were installed to permit more selective use of lighting during clean-up and occasional overtime hours. Previously, all the lighting was controlled by one switch and every fixture had to be on during clean-up. With multiple circuits, maintenance crews can now turn the lights on and off as they move from one area to the next.

Allen performed a detailed cost analysis, comparing the initial capital and labor costs of purchasing and installing the new lighting with the total annual operating costs, including energy consumption, replacement lamps and ballasts, fixture cleaning and lamp replacement labor.

The total net cost of the changes amounted to $8,362. Lighting energy use dropped by 69 percent, and total annual operating costs fell 73 percent, from $2,800 to $765. This $2,035 annual savings alone would have paid for the improvement in 4.1 years, a 24-percent return on investment. (In addition, the new lighting lowered heat loads, and therefore space cooling costs.)

Under the improved lighting, productivity also jumped by 13.2 percent. In the prior year, it had taken a drafter 6.93 hours on average to complete one drawing, a productivity rate of 0.144 drawings per hour. After the upgrade, "the time required to produce a drawing dropped to an average of 6.15 hours, boosting the productivity rate to 0.163 drawings per hour." This gain was worth $42,240 a year, reducing the simple payback from 4.1 years to 69 *days*. The productivity gain turned a 24-percent return on investment into a 540-percent return!

"Not only is this an amazing benefit," comments Allen, but "it is only one of several." Before the upgrade, drafters in the area had used about 72 hours of sick leave a year. After the upgrade, the rate dropped 25 percent to 54 hours a year. The better appearance of the space, reduced eye fatigue and headaches, and the overall improvement in working conditions all helped boost morale.

Finally, supervisors report that the new lighting has reduced the number of errors. Better lighting means higher-quality work. Allen says of the reduced error rate: "We are unable to gather any meaningful data on the value of these savings because any given error could result in a needless expense of thousands of dollars. Personally, I would have no qualms in indicating that the value of reduced errors is at least $50,000 a year." If this estimate were included in the calculation, the return on investment would exceed 1,000 percent.

540%

New Building Case Studies

Lockheed Building 157

One of the most successful examples of daylighting in a large commercial office building is Lockheed's Building 157 in Sunnyvale, California[9]. In 1979, Lockheed Missiles and Space Company commissioned the architectural firm, Leo A. Daly, to design a new 600,000-square-foot office building for 2,700 engineers and support people.

The architects posed a question to Lockheed: "If we could design a building for you that would use half as much energy as the one you're planning to build, would you be interested?" Lockheed said yes, and Daly's architects responded with a design for energy-conscious daylighting that was completed in 1983.

Daly used 15-foot-high window walls with sloped ceilings to bring daylight deep into the building. "High windows were the secret to deep daylighting success," says the project architect, Lee Windheim. "The sloped ceiling directs additional daylight to the center of each floor and decreases the perception of crowded space in a very densely populated building."

Daylighting is also enhanced by a central atrium, or "litetrium," as the architects call it. The litetrium runs top to bottom and has a glazed roof. Workers consider it the building's most attractive feature. Other light-enhancing features include exterior "light shelves" on the south facade. These operate as sunshades or as reflectors for bouncing light onto the interior ceiling from the high summer sun; in the winter, when the sun's angle is lower, they diffuse reflected light and reduce glare.

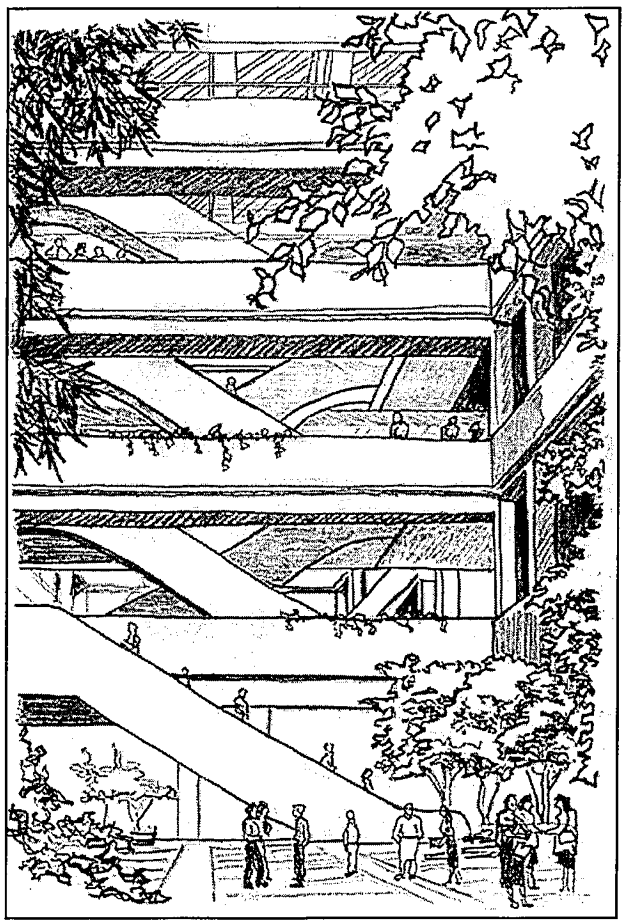
The overall design separates ambient and task lighting, with daylight supplying most of the ambient lighting and task lighting fixtures supplementing each workstation. Continuously dimmable fluorescents with photocell sensors maintain a constant level of light automatically to save even more energy.

The open office layout and a large cafeteria were designed to foster interaction among the engineers. At the same time, workstations were tailored for employee needs. They included acoustic panels and chambers to block out ambient noise. When a worker moves forward into a chamber, the annoying sound of telephones becomes practically inaudible. Ambient noise was further controlled by sound-absorbing ceilings and speakers that introduced background white noise on each floor.

Employees love the building. More than a year after occupancy, a survey of workers at the building included the following representative responses.

"My work space," says engineer Ben Kimura, "is 15 feet from the litetrium and the lighting is great. The office decor, arrangement, and temperature are ideal. There are many people working on this floor, but the feeling is not one of crowding, but of spaciousness. Interface with other departments is greatly facilitated because we're finally all in one building. By nature I'm very cynical, but the conditions in this building are far superior to any I've experienced in 30 years in the aerospace industry."

"I love my work space," says financial controller Joanne Navarini. "I think the building itself is very pret-



Lockheed Building 157

ty; my own workstation is very functional. I am five workstations from the window and the light is fine. I use my task light and could order an additional desk lamp if I felt the need to. I like the daylight." Daylighting has saved Lockheed about 75 percent on its lighting bill. Since daylight generates less heat than office lights, the peak air-conditioning load has also been reduced. Overall, the building runs with about half of the energy costs of a typical building constructed at that time.

Daly's energy-efficient improvements added roughly $2 million to the $50 million cost of the building. The energy savings alone were worth nearly $500,000 a year. The improvements paid for themselves in a little over four years.

Perhaps more important, Russell Robinson, manger of Facility Interior Development, reported that productivity is up because absenteeism has declined. Lockheed itself has never published the figures concerning the improvements in absenteeism and productivity. But according to Don Aitken, then chairman of the Department of Environmental Studies at San Jose State, "Lockheed moved a known population of workers into the building and absenteeism dropped 15 percent." Aitken led numerous tours of Building 157 after it opened and was told by Lockheed officials that the reduced absenteeism paid 100 percent of the extra cost of the building in the first year.

The architect, Lee Windheim, also reports that Lockheed officials told him that productivity rose 15 percent on the first major contract done in the building compared to previous contracts done by those Lockheed engineers. Aitken reported something even more astonishing: Top Lockheed officials told him that they believe they won a very competitive $1.5 billion defense contract on the basis of their improved productivity—and that the profits from that contract paid for the entire building.

West Bend Mutual Insurance

West Bend Mutual Insurance Company's new 150,000-square-foot headquarters in West Bend, Wisconsin[10] is the subject of one of the most carefully documented increases in productivity due to green design. The West Bend Mutual building won the 1992 Intellex Building for Excellence Award, cosponsored by *Consulting-Specifying Engineer* magazine and the Intelligent Buildings Institute.

The building has a number of energy-saving design features, including an energy-efficient lighting system (including task lighting and occupancy sensors), better windows, shell insulation, and a more efficient heating, ventilation, and air-conditioning (HVAC) system. It uses a thermal-storage system that makes ice overnight to help cool the building during the day. These measures allowed West Bend Mutual to get utility rebates that kept the project within its $90-per-square-foot budget.

Enclosed offices all have individual temperature control. But the most hi-tech feature of the building is its "environmentally responsive workstations" (ERWs). Workers in open-office areas are given direct, individual control over temperature and airflow. Radiant heaters and vents are built directly into their furniture and controlled by a panel on their desks. The control panel also provides direct control of task lighting and white-noise levels. A motion sensor in each ERW turns the workstation off when the worker leaves the space and turns it back on when he or she returns.

Giving workers direct control over their environment allows individuals working near each other to have very different temperatures in their spaces. The entire HVAC system no longer needs to be driven by a manager, or by a few vocal employees, who want it hotter or colder than everyone else. The motion sensors save even more energy. It's worth noting that before the move into the new building, West Bend Mutual employees were given the chance to try out and comment on a full-scale demo of the ERWs. The outspoken workers were allowed to test ERWs at their own desks.

The annual electricity costs in the old building were $2.16 per square foot. The annual electricity costs in the new building are $1.32 per square foot. This 40-percent reduction is all the more impressive, given that the old building got its heat from gas-fired boilers while the new building is completely electric.

The Center for Architectural Research and the Center for Services Research and Education at the Rensselaer Polytechnic Institute (RPI) in Troy, New York conducted a detailed study of productivity in the old building in the 26 weeks before the move and in the new building for 24 weeks after the move. The RPI study made use of a productivity assessment system used by West Bend Mutual for many years, which basically tracked the number of insurance files processed by each employee per week. Researchers also conducted a detailed survey of workers' perceived levels of comfort, air quality, noise control, privacy, and lighting, both before and after the move.[11] The conclusion of the RPI study: "The combined effect of the new building and ERWs produced a statistically significant median increase in productivity of approximately 16 percent over productivity in the old building."

In an attempt to determine just how much of the productivity gain was due to the ERWs, the units were turned off randomly during a two-week period for a fraction of the workers. The researchers concluded, "Our best estimate is that ERWs were responsible for an increase in productivity of about 2.8 percent relative to productivity levels in the old building." The company's annual payroll is about $13 million, so even a 2.8-percent gain in productivity is worth about $364,000. The 2.8 percent figure almost certainly underestimates the actually benefit of the ERWs, according to West Bend Mutual senior vice president Ronald W. Lauret. Lauret observes that many workers demanded that their units be turned back on immediately. Some even threatened to go home (they were eliminated from the study). He estimates that if those employees were factored back in, the productivity gain from the ERWs alone would have been 4 percent to 6 percent. The remainder of the productivity gain may be due to the building's other efficiency measures.

Attention to the West Bend Mutual study has focused almost exclusively on the ERWs. The real lesson from West Bend Mutual should be that while the ERWs are interesting and probably worth further experimentation, the most significant gains in productivity may have come from the building design and systems.

WAL-MART

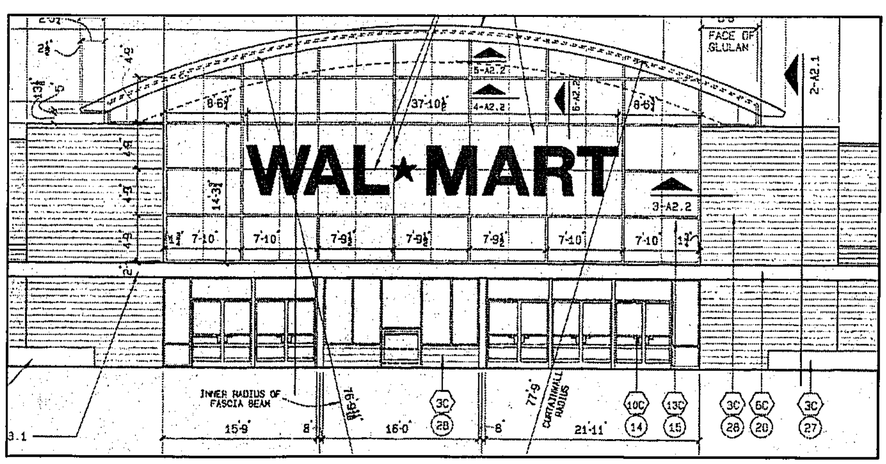
In June 1993, a new prototype Wal-Mart store opened in Lawrence, Kansas.[12] Called the "Eco-Mart," the building is an experimental foray into sustainable design by the nation's largest retailer. The project was led by Wal-Mart's Environment Committee and BSW Architects of Tulsa, Oklahoma. The design consulting team involved a number of firms, including Center for Resource Management, William McDonough Architects, and Rocky Mountain Institute. The team focused on experimenting with a series of environmentally responsive design strategies and technologies.

Elements of the experiment included the use of native species for landscaping; a constructed wetlands for site runoff and as a source for irrigation; a building shell design for adaptive reuse as a multifamily housing complex; a structural roof system constructed from sustainably harvested timber; an environmental education center; and a recycling center. A major goal of the project was to design for energy efficiency. The building has a glass arch at the entrance for daylighting, an efficient lighting system, an HVAC system that utilizes ice-storage, and special light-monitoring skylights developed specifically for the project.

Construction costs for the Eco-Mart were about 20 percent higher than the average for other Wal-Mart stores. (Wal-Mart's normal costs are extremely low, and a building typically pays for its own construction cost in a three to five years.) Several factors accounted for the additional cost of this building: using sustainably harvested timber added 10 percent to the roof cost; the integration of systems was not optimized, resulting in a more expensive cooling system; and the building included elements not found in other stores (a recycling center, a McDonald's, and the light-monitoring skylights). As a cost-cutting measure, Wal-Mart decided to install skylights on only half of the roof, leaving the other half without daylighting.

Even with such focused effort on the design process, the building had some problems. The energy performance of the building could have been better. The controls on the lighting systems were not compatible with the ballasts. The ice-storage system leaked water, and due to the expanded hours of store operation, was not able to fully refreeze.

However, something else has gotten the corporation's attention. Each of Wal-Mart's cash registers is connected in real time back to headquarters in Bentonville, Arkansas, as part of the retailer's "just-in-time" stocking and distribution system. According to Tom Seay, Wal-Mart's vice president for real estate, register activity revealed that "sales pressure (sales per square foot) was significantly higher for those departments located in the daylit half of the store." Sales were also higher than for the same departments in other stores. Additionally, employees in the half without the skylights are arguing that their departments should be moved to the daylit side. Wal-Mart is now considering implementing many of the Eco-Mart measures in both new construction and existing stores.



Wal-Mart blueprints

ING BANK

In 1978, International Netherlands Group (ING) Bank, then known as Nederlandsche Middenstandsbank, needed a new image, and a new headquarters in Amsterdam[13]. According to Dr. Tie Liebe, head of the bank's development subsidiary, ING wanted a building that was "organic, which integrated art, natural materials, sunlight, plants, energy conservation, low noise, and water."

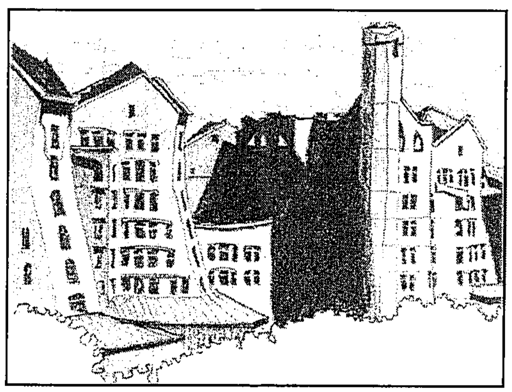
An integrated design team was instructed to work across disciplines—architects, construction engineers, landscape architects, energy experts, artists, and bank employees worked for three years on the design. The architect Anton Alberts describes the building, completed in 1987, as "anthroposophical," based on Rudolph Steiner's design philosophy. Rather than a monolithic tower, the 538,000-square-foot building is broken up into ten slanting towers. The irregular S-curve ground plan has gardens and courtyards interspersed over the top of parking and service areas. Restaurants and meeting rooms for the 2,400 employees line an internal street connecting the towers.

Like most northern European offices, the floor plates are narrow. All desks are located within 23 feet of a window for daylighting. Interior louvers in the top third of windows bounce daylight onto office ceilings. Atriums in the towers provide a significant portion of the lighting. Additional needs are met by task lighting, custom decorative wall sconces, and limited overhead fixtures. The building has double glazing, as it predates high-efficiency "superwindows." Insulation separates the brick skin from the precast-concrete structure, which is used to store heat from simple passive solar measures and internal gains. Additional heat is supplied through hydronic radiators connected to a 26,420-gallon hot-water storage system, heated by a cogeneration facility, and heat recovery from elevator motors and computer rooms. Air-to-air heat exchangers transfer the heat from exhaust air to intake air. The bank has no conventional compression chillers; it relies on the building's thermal storage, mechanical ventilation, natural ventilation through operable windows, and a back-up absorption cooling system powered by the cogeneration system's waste heat.

The integration of building design, daylighting, and energy systems has yielded impressive results. ING's former headquarters consumed 422,801 BTU per square foot per year of primary energy; the new building consumes 35,246 BTU per square foot. In comparison, an adjacent bank, constructed at approximately the same time and cost, consumes five times the energy per square foot.[14] Construction costs of $162 square foot (in 1991 dollars) included land, structure, landscaping, art, furniture, and equipment. Costs attributed to the energy systems were approximately $700,000, while annual energy savings are estimated at $2.6 million—in other words, using early-1980s technology, the energy measures paid for themselves in just three months.[15] According to Dr. Liebe, "construction costs were comparable to or cheaper than other office buildings in Holland," and ING's energy costs are among the lowest in the European office sector.

Sophisticated integration is evident from the artwork, plants, and "flow-form" sculptures. Expansion joints are treated as relief sculpture. Colored metal reflectors high in the atrium towers bathe lower spaces in colored light. Interiors feature a simple palette, textured paint over the precast concrete, wood trim, with wood slat and some drop ceilings. Cisterns capture rainwater for fountains and landscaping. Flow-form sculptures are used extensively, even in handrails, to create a pulsing, gurgling stream of water that adds visual appeal, moisture to the air, and a pleasing level of white noise in the corridors.

Absenteeism among ING employees has dropped, and remains 15 percent lower than in the bank's old building, Dr. Liebe attributes this to the better work environment. The building has done wonders for ING's image, he adds, noting that "ING is now seen as a progressive, creative bank, and the bank's business has grown dramatically."



ING Bank

Conclusion

The results of these case studies are compelling, for two reasons. First, the measurements of productivity in most of the cases came from records that were already kept, not from a new study. Second, the gains in productivity were sustained and not just a temporary effect.

Will just any energy retrofit produce gains in productivity? No, only those designs and actions that improve visual acuity and thermal comfort seem to result in these gains. This speaks directly to the need for good design, a total-quality approach that seeks to improve energy efficiency and improve the quality of workplaces by focusing on the end user—the employee. This is a point that seems to have been forgotten by many designers and building owners.

Clearly, there is a need for further research; however, the results of these few case studies indicate that the economic benefits of energy-efficient design may be significantly greater than just the energy cost savings. That energy efficiency provides numerous benefits has long been known. That it can lead to productivity gains far exceeding the energy savings gives it a new imperative.

Retrofits

Reno Post Office

Cost: $300,000
Measures: LIGHTING RETROFIT, NEW CEILING
Energy Savings/yr: $22,400
Productivity: 6% INCREASE IN PROCESSING RATE
ONE YEAR PAYBACK

Boeing

Cost: N/A
Measures: LIGHTING RETROFIT
Energy Savings/yr: 90% LIGHTING ELECTRICITY
Productivity: 20% IMPROVEMENT IN DEFECT RATE

Hyde Tools

Cost: $98,000
Measures: LIGHTING RETROFIT
Energy Savings/yr: $48,000
Productivity: IMPROVED PRODUCT QUALITY WORTH $25,000/YR.

Pennsylvania Power & Light

Cost: $8,362
Measures: LIGHTING RETROFIT
Energy Savings/yr: $2,035
Productivity: INCREASED DRAFTING RATE BY 13.2%
ABSENTEEISM DOWN 25%

New Buildings

Lockheed Building 157

Cost: $2 MILLION
Measures: DAYLIGHTING, ENERGY EFFICIENCY
Energy Savings/yr: $500,000
Productivity: 15% RISE IN PRODUCTION
ABSENTEEISM DOWN 15%

West Bend Mutual Insurance

Cost: N/A
Measures: LIGHTING, HVAC, INDIVIDUAL CONTROLS
Energy Savings/yr: 40% ELECTRICITY
Productivity: 16% INCREASE IN CLAIMS PROCESSED

Wal-Mart

Cost: N/A
Measures: DAYLIGHTING, HVAC
Energy Savings/yr: N/A
Productivity: INCREASED SALES IN THE DAYLIT PORTION OF THE STORE

ING Bank

Cost: $700,000
Measures: DAYLIGHTING, HVAC, OVERALL BUILDING
Energy Savings/yr: $2.6 MILLION
Productivity: ABSENTEEISM DOWN 15%
NEW IMAGE FOR BANK

Notes

[1] Building Owners and Managers Association, *Experience Exchange Report 1991*, p. 95, showing 1990 national means for downtown private-sector office buildings of 100,000–300,000 square feet. Areas are net rentable space; income ($21) is for the office area only, versus $16.68 for the entire building including retail space, parking, etc. The energy costs, other costs, and income are probably somewhat higher for new offices than for the stock average described here, which is based on a sample of hundreds of buildings totaling more than 70 million square feet. The authors are grateful to BOMA for kindly making these proprietary data available.

[2] *Statistical Abstract of the United States 1991*, Table 678, p. 415, gives 1989 average office salaries whose weighted average was $27,939 per year. We nominally adjust this by 4.12 percent for 1989–90 monetary inflation (implicit GNP real price deflator) and add an estimated 20 percent for taxes and benefits, then divide by the BOMA 1990 national average of 268 square feet per office worker in 100,000–300,000-square-foot office buildings.

[3] For a survey of some of the literature on the flaws in the Hawthorne effect research—and a major study that came to a different conclusion—see Michael Brill et. al., *Using Office Design to Increase Productivity, Volume I* (Buffalo; Workplace Design and Productivity, Inc., 1984), pp. 224-25. See also William J. Dickson and F. J. Roethlisberger, *Counseling an Organization: A Sequel to the Hawthorne Researches* (Boston: Harvard University Press, 1986). This book explains that the traditional view of the Hawthorne Effect—that workplace environment affects productivity only because it signals management's interest in the worker—is very different from what the Hawthorne researchers themselves concluded from their work. They concluded that productivity can be enhanced by a more cooperative relationship between management and labor, a greater identification by workers with the goals of management, and more effort by management to treat workers with respect and to be responsive to their needs and abilities.

[4] The Reno Post Office case was developed from personal communications with Lee Windheim of Leo A. Daly and Robert McLean of the U.S. Postal Service.

[5] The discussion of Boeing is based on personal conversations with Larry Friedman and Steve Cassens, articles in *Boeing News* (May 10, 1991 and January 15, 1993), 1992 EPA data on the Green Lights program, and a site visit. DOE's Pacific Northwest Laboratory is now undertaking a detailed study of energy efficiency and productivity gains at Boeing.

[6] From Boeing's weekly newsletter, *Boeing News*, January 15, 1993, p. 5.

[7] The Hyde Tools study is based on an article in *TPM Newsletter*, January 1993, p. 7, and personal communication with Doug DeVries.

[8] This case study is based on Russell Allen, "Pennsylvania Power and Light: A Lighting Case Study," *Buildings*, March 1982, pp. 49–56; and "Office Lighting Retrofit Will Pay Back in 69 Days," *Facilities Design & Management*, June 1982, p. 13.

[9] This case study is based on Charles C. Benton and Marc C. Fountain, "Successfully Daylighting a Large Commercial Building: A Case Study of Lockheed Building 157," *Progressive Architecture*, Nov. 1990, pp. 119 -121; "Employees respond to Lockheed Building 157," *Professional Energy Manager*, July 1984, p. 5; "Lockheed's No. 157: Ex Post Facto," *Facilities Planning News*, October 1984; and personal communications with Lee Windheim and Don Aitken.

[10] The case study of West Bend Mutual is based on Paul Beck, "Intelligent Design Passes IQ Test," *Consulting-Specifying Engineer*, January 1993, pp. 34–38; and Walter Kroner et. al., *Using Advanced Office Technology to Increase Productivity* (Troy, NY: The Center for Architectural Research, 1992).

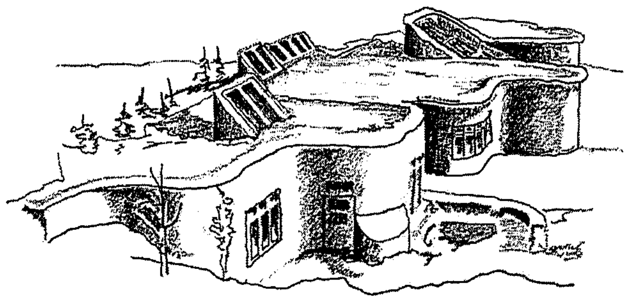
[11] The RPI researchers note: "Subjects were not informed that an analysis of their productivity was being conducted by the research team. . . . Since the company's productivity measurements were ongoing and were not specifically noted by the employees, we believe that worker's behavior was not affected by their participation in the study."

[12] This case study is based on the authors' design consulting for and analysis of the Eco-Mart, and personal communication with Tom Seay.

[13] This case comes from William Browning, "NMB Bank Headquarters: The Impressive Performance of a Green Building," *Urban Land*, June 1992, pp. 23-25; William Browning, "NMB Bank," *Progressive Architecture*, May 1993; and personal communication with Dr. Tie Liebe and Anton Alberts.

[14] Olivier, David, *Energy Efficiency and Renewables: Recent Experience on Mainland Europe* (Energy Advisory Associates, Herefordshire, England, 1992), pp. 27, 28.

[15] Olivier, David, *loc. cit.*, pp. 27, 28; and Vale, Brenda, and Vale, Robert, *Green Architecture: Design for an Energy Conscious Future* (Bulfinch Press, Little Brown and Company, Boston, 1991), pp. 156-168.



Rocky Mountain Institute

Rocky Mountain Institute is a nonprofit research and educational foundation with a vision across boundaries. Seeking ideas that transcend ideology, and harnessing the problem-solving power of free-market economics, our goal is to foster the efficient and sustainable use of resources as a path to global security.

Rocky Mountain Institute's work on environmentally responsive development is coordinated by Green Development Services. This program promotes sustainable development to the building industry through three components: research into the cost, approvals, construction, and market implications of environmentally responsive development; direct consulting services to architects, planners, developers, and corporations on the implications and methods of environmentally responsive development; and information services to such professional organizations as the American Institute of Architects and the U.S. Green Building Council.

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The views presented in this paper and the conclusions drawn from the case studies are not necessarily those of the U.S. Department of Energy.

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Appendix 2E –
Sustainable Building Case Studies

‘Sustainability – High Performance Buildings Deliver Better Learning Environments’

www.seattle.gov/light

Sustainability

High Performance Buildings deliver

Better Learning Environments

They also help teachers and staff perform better.

They can reduce operating expenses.

Look at some interesting case studies to see how!

Indoor Air Quality (IAQ)

According to the U.S. General Accounting Office, 50% of schools suffer from IAQ problems (EPA 1998). Singer et al. (1997) report: "... at least **19 percent** of U.S. school districts reported unsatisfactory or very unsatisfactory IAQ. Surveys have reported that at least **20 to 25 percent of schools** have inadequate heating, ventilating and air conditioning ... a school that fails to take actions consistent with existing IAQ guidelines and standards runs the risk that it will be found liable for negligence. **The risk is significant because, under negligence theory, a school**

board's liability is not limited to the costs of remedying the IAQ problem; the board also faces the threat of actual and punitive damages."

A Scoping Study on the Costs of Indoor Air Quality Illnesses: An Insurance Loss Reduction Perspective, Allan Chen and Edward L. Vine LBNL 41919

Indoor air problems can have consequences such as:

- increasing acute and chronic health problems for students and staff; such as cough, eye irritation, headache, asthma episodes, allergic reactions, and possibly life-threatening conditions such as severe asthma attacks or carbon monoxide poisoning
- spreading airborne infectious disease
- reducing productivity and increasing discomfort, sickness and absenteeism for students and staff
- increasing the likelihood that the school or portion of the school will have to be closed and occupants relocated
- producing negative publicity which could damage the school's reputation and effectiveness presenting potential liability problems

In an era of high education expectations but tight school budgets solving IAQ problems can be challenging.

Here's one solution:

In the EPA' s recently published *IAQ Tools for Schools* guide it is stated that, "Good indoor air quality contributes to a favorable learning environment for students, productivity for teachers and staff, and a sense of comfort, health, and well-being. These elements combine to assist a school in its core mission -- educating children".

IAQ Tools for Schools Action Kit shows schools how to carry out a practical plan of action to improve indoor air quality at little or no cost using common-sense activities and in-house staff. The Kit provides simple-to-follow checklists, background information, sample memos and policies, and a recommended IAQ Management Plan.

http://www.epa.gov/iaq/schools/toolkit.html

What are High Performance Building Strategies?

Case Studies show the following are some of the strategies that can make buildings healthy, comfortable and productive:

- daylighting
- properly commissioned and maintained HVAC systems
- narrow floor plans to optimize natural daylight
- high benefit lighting upgrades
- under floor air distribution and displacement ventilation
- occupant control of heat, light and air
- operable windows and mixed mode HVAC

What Improvements Do They Provide?

Case Studies show the following benefits of High Performance Building strategies:

- office productivity increases up to 16%
- absenteeism reductions to 40%
- increased market value up to 100%
- ROI up to 1000%
- up to 90% decreased energy costs
- up to 73% decreased O&M costs

- reduction in liability insurance and workers comp cases
- up to 40% increased retail sales
- up to 26% increased learning rates

Here is why High Performance Building makes good financial sense.

Looking at annual operating expenses for commercial space, on a dollar per square foot basis, salaries are by far the largest item, followed by rent. Maintenance and energy costs are relatively insignificant. A one percent savings in salaries -- or a one percent productivity improvement -- of $2.00/s.f./year, exceeds either energy or maintenance costs.

Average Annual Commercial Expense in $/s.f./year

Source: *Indoor Quality Update, Oct. 1996, Vol. 9, No. 10*

This can also apply to educational facilities.

Indoor Air Quality Case Studies

Elizabethtown College, Pennsylvania

A 185-acre campus in Lancaster County, Pennsylvania, with 1,524 undergraduate students from 20 states and 17 foreign countries. Eighty-seven percent live on campus and 63% have on-campus jobs.

The primary technical solutions for campus improvements included major retrofits and replacement of mechanical equipment, improvements in comfort control, lighting system upgrades and modifications, a technical support program, and the installation of a building automation system.

Benefits of the performance contract were:

- guaranteed savings of $267,000 per year. Total program savings to top $2.8 million in 10 years.
- improved comfort and satisfaction
- cut temperature-related complaint calls by 75%
- reduced deferred maintenance by 25%
- cut repair budget by 15%

The students and faculty really notice it, said Larry Bekelja, Director of Plant

Operations. *We have all become totally engaged in the educational process to enhance the learning environment. As a result, we have many more students seeking the 'full college experience' here on campus.*

Hastings Public School District, Hastings, Nebraska

The Hastings Public School District serves almost 3,500 students in nine buildings totaling more than 500,000 square feet.

Solutions implemented were a $2.1 million performance contract that included a lighting retrofit, installation of a Facility Management System (FMS) and other equipment improvements.

Benefits of the performance contract were:

- significantly improved classroom comfort levels of temperature and indoor air quality
- implemented project without raising the tax levy, using existing funding options and monies saved from energy efficiencies
- reduced first year utility expenses by $168,399, exceeding projected savings by $80,634; these resources were reinvested in the education process
- achieved a 5 percent decrease in liability insurance
- experienced operational savings of $85,014

http://www.johnsoncontrols.com/cg-cases/cs_Hastings.htm

Beyond Healthy Interior Environments, can the Classroom Itself Improve the Quality of Education? Consider these

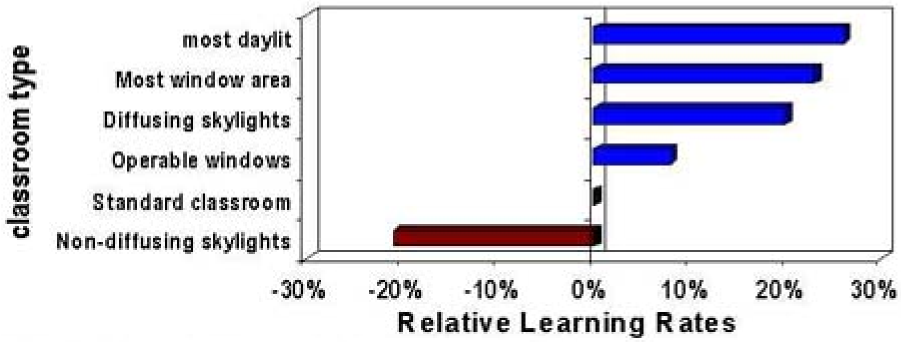
Daylighting Case Studies

A study by the Heschong Mahone Group for Pacific Gas and Electric, published August 20, 1999, analyzed test score results for over 21,000 students in three school districts in California, Washington and Colorado.

Capistrano Unified School District, Orange County, California

- Classrooms with the **most daylight** had a **20%** to **26%** faster learning rate
- Classrooms with the **most window area** had a **15%** to **23%** faster learning rate
- Classrooms with **diffusing skylights** had a **19%** to **20%** faster rate
- Classrooms with **non-diffusing skylights** (causing patches of light and glare) had a **21%** ***decrease*** for reading tests and no significant results for math tests
- Classrooms with **operable windows** had **7%** to **8%** faster improvement compared to classrooms with

fixed windows



Relative Learning Rates for Capistrano Unified School District
Source: *Daylighting in Schools, August 20, 1999*

Seattle Public School District, Seattle, Washington

- Students in classrooms with **largest window area or the most daylight** tested **9%** to **15%** higher than those with the least window area or daylighting
- Students in skylit classrooms tested **6%** to **7%** higher

Poudre School District, Fort Collins, Colorado

- Results showed a **7%** improvement in test scores in classrooms with the **most daylighting**
- Results also showed a **14%** to **18%** improvement for students in classrooms with the **largest window areas**
- There was a **3%** effect for classrooms with **roof top monitors** for math scores but with no significant effect on reading scores

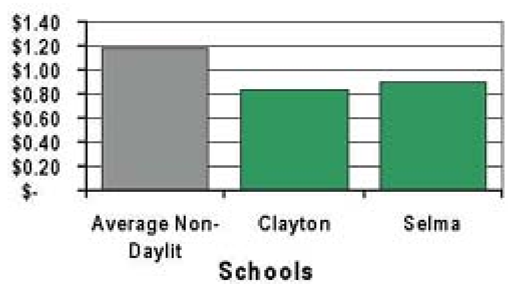
Heshong Mahone Group. *Daylighting In Schools*. August 20, 1999. http://www.h-m-g.com/
http://www.pge.com/003_save_energy/003c_edu_train/pec/daylight/daylight.shtml

Daylit Schools
Johnson County, North Carolina

Michael Nicklas and Gary B. Bailey of Innovative Design in Raleigh, North Carolina, prepared two papers, 'Energy Performance of Daylit Schools in North Carolina' and 'Analysis of the Performance of Students in Daylit Schools.'

The following conclusions are taken from those studies.

All three schools are designed with overhead daylighting in all classroom and assembly spaces. They are more energy efficient than other County schools, as shown by the graph of 'Annual Energy Costs/s.f.' to the right, and as shown below in the table of **Annual Energy Savings**.



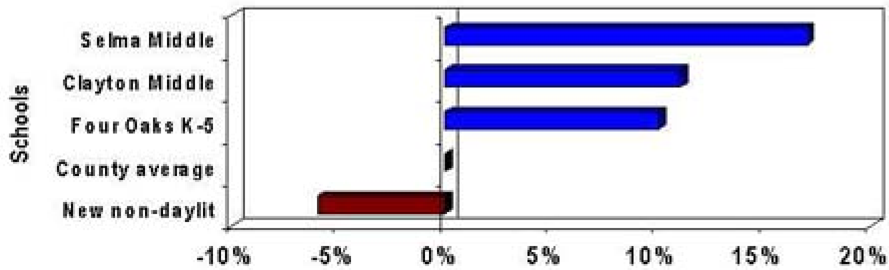
Annual Energy Cost/s.f.

	$/s.f./yr savings	school s.f.	annual savings
Clayton Middle	$0.28	120,000	$ 33,600
Slema Middle	$0.22	98,000	$ 21,560
Four Oaks K-5	$.40	120,000	$ 48,000

Table of Annual Energy Savings

Further, square foot construction costs for the three schools were actually lower than other County schools. The three, built between 1990-1992, had an average cost of $64.06 per square foot. Eleven other County schools, built between 1992-1995, had an average construction cost of $82.88 per square foot.

Studies of improvement in student test scores indicated relative improvement of 10% to 17% for the three schools when compared to the County average improvement in test score, as shown in the chart below.



Relative Test Score Improvements

It is significant to note that another new, non-daylit school, constructed in the same time period, actually exhibited negative test score improvement compared to the County norm.

www.innovativedesign.net/index.htm

With questions, contact Peter Dobrovolny:
peter.dobrovolny@seattle.gov or **206.615.1094**.

www.deloitte.ca