Dekker/Perich/Sabatini
architecture interiors landscape planning engineering




This independent study is the first apples-to-apples construction cost analysis that demonstrates that green schools are well worth the investment. Dekker/Perich/Sabatini adapted a previously built prototype school design for Rio Rancho Public Schools to pursue LEED Silver certification.

FEATURES OF THE NEW GREEN-ADAPTED SCHOOLS:

- Increased insulation (R-24 walls, R-38 roof)
- Efficient low-e glazing
- High-efficiency mechanical units
- Waterless urinals, dual-flush toilets, faucet restrictors
- Low-emitting, recycled, and regional materials
- Projecting 30% energy savings and 50% indoor water savings

THE STUDY'S CONCLUSION: 1.3% ADDED COST, 2 YEAR ESTIMATED PAYBACK.


Original Prototype


Green Adapted

David Bend

The Payback Period for High Performance Green Features in K-12 Schools:

A Rio Rancho, New Mexico Case Study

July 21, 2008

Education is the largest commercial construction sector in the United States, projected to be worth $53 billion in 2007.[1] As such, it represents a significant opportunity to incorporate high performance or "green" features. Green schools have been estimated to yield a 33% savings in energy and a 32% reduction in water consumption each year.[2] Yet, school districts around the country question whether these savings are enough to off-set the added cost of incorporating high performance features, the so called "green premium."

Several studies have attempted to quantify this green premium. The results of these studies indicate that incorporating high performance features is relatively inexpensive, approximately 2% of building costs.[3] However, these studies have compared schools with different designs from various regions of the country. As a result, the validity of these comparisons has been called into question because it is difficult to differentiate actual savings from design and climate factors. Thus, what is needed to make a compelling determination about the true costs of high performance schools is an "apples-to-apples" comparison. That is, a comparison between high performance and traditional schools with similar designs in a common location.

An opportunity to make this comparison exists in the southwestern corner of the country. Twelve miles outside of Albuquerque, two schools are being built that will closely resemble two other recently constructed schools in the same area. Unlike the first two schools, the two schools currently under construction will have several additional high performance features intended to reduce their energy and water use while enhancing students' learning environment.

This report will analyze whether the new schools' high performance features result in operational cost savings from reduced energy and water consumption. If so, the payback period (the amount of time it takes to recoup an investment) will be calculated for these features. The report will also explore the potential of high performance schools to increase student performance and attendance, teacher retention, and the health of all school occupants—administrators, teachers and students. While a full assessment of these

[1] McGraw Hill Construction. (2007) Green Building Smart Market Report: Education. pg. 8. Available at www.construction.com.
[2] Katz, Gregory. (2006). Greening America's Schools: Costs and Benefits. Capital E. pgs. 4-7.
[3] Katz. pg. 4.

factors is beyond the scope of this study, the report will provide suggestions to Rio Rancho Public Schools about how they can track these outcomes over time.

Background

Rio Rancho

Rio Rancho, New Mexico is located twelve miles north of Albuquerque (see Attachment 1: Map of Rio Rancho, New Mexico).[4] First incorporated in 1981,[5] Rio Rancho has grown rapidly as a result of a mild climate, relatively inexpensive home prices (median price of $140,900 in 2006),[6] low unemployment (4%),[7] and reasonable wages (median household family income of $55,404).[8] Indeed, the city's population grew from 32,505 in 1990 to over 71,607 today[9]—making it New Mexico's fourth largest city.[10] Rio Rancho is expected to continue growing at a rapid pace—its population is projected to reach 125,000 residents by 2010.[11] Despite this rapid growth rate, Rio Rancho has been able to maintain a high quality of life for its residents. In 2006, Money magazine ranked Rio Rancho as the 56th best place to live in America.[12]

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[4] Rio Rancho Economic Development Corporation. Community Overview: Rio Rancho, New Mexico. January 2007. Retrieved from: http://www.rredc.org/documents/RR_Overview_January07.pdf.

[5] Ibid.

[6] U.S. Census Bureau. 2005 American Community Survey. Data Profile Highlights. Rio Rancho, New Mexico. Retrieved from: http://factfinder.census.gov/servlet/ACSSAFFFacts?_event=&geo_id=16000US3563460&_geoContext=01000US%7C04000US35%7C16000US3563460&_street=&_county=Rio+Rancho%2C+NM&_cityTown=Rio+Rancho%2C+NM&_state=&_zip=&_lang=en&_sse=on&ActiveGeoDiv=&_useEV=&pctxt=fph&pgsl=160&_submenuId=factsheet_1&ds_name=null&_ci_nbr=null&qr_name=null&reg=null%3Anull&_keyword=&_industry=.

[7] U.S. Department of Labor. Bureau of Labor Statistics. 2006 Unemployment Rates for Albuquerque Metropolitan Area. Retrieved from: http://data.bls.gov/cgi-bin/surveymost.

[8] U.S. Census Bureau. 2005 American Community Survey. Data Profile Highlights. Rio Rancho, New Mexico.

[9] U.S. Census Bureau. Population Finder: Rio Rancho, New Mexico. Retrieved from: http://factfinder.census.gov/servlet/SAFFPopulation?_event=Search&_name=Rio+Rancho%2C+NM&_state=&_county=Rio+Rancho%2C+NM&_cityTown=Rio+Rancho%2C+NM&_zip=&_sse=on&_lang=en&pctxt=fph.

[10] U.S. Census Bureau. 2005 American Community Survey. Retrieved from: http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=04000US35&-_box_head_nbr=GCT-T1-R&-ds_name=PEP_2006_EST&-_lang=en&-format=ST-9S&-_sse=on.

[11] Ibid.

[12] Money Magazine. (2006). Best Places to Live in America. Retrieved from: http://money.cnn.com/magazines/moneymag/bplive/2006/snapshots/PL3563460.html.

Rio Rancho Public Schools

The first public school in Rio Rancho, Rio Rancho Elementary, was built by Albuquerque Public Schools in 1974. In 1993, the New Mexico Department of Education approved the creation of Rio Rancho Public Schools (RRPS). Mirroring the rapid growth of Rio Rancho, RRPS' enrollment has doubled in the last decade, reaching 11,810 students in 2004. RRPS currently serves nearly 15,000 students in eight elementary schools, three middle schools, a mid-high school (grades 8-9), and a comprehensive high school—making it the state's sixth largest school district. Since its inception, Rio Rancho Public Schools has amassed a number of impressive academic awards and accolades as well as several architectural awards for its schools' designs. Continuing this tradition of architectural excellence, RRPS opened Ernest Stapleton and Maggie M. Cordova Elementary Schools in 2005.

Maggie M. Cordova and Ernest Stapleton Elementary Schools

Maggie M. Cordova (Cordova) and Ernest Stapleton (Stapleton) Elementary Schools are RRPS' newest buildings—both schools opened at the beginning of the 2005/2006 school year. Cordova and Stapleton have identical designs and layouts (see Attachment 2: Images of Stapleton Elementary School), but they have different color schemes and entry canopies to provide each school with a unique character.[13] Cordova and Stapleton have several notable green features. For instance, each school was designed to provide ample day-lighting and simple circulation. The buildings have a central core with angled classroom wings which shelter their outdoor recreation areas from the wind and sun.[14] Further, stormwater run-off is directed towards xeriscape plantings to reduce the amount of irrigation required.[15]

Cielo Azul and Sandia Vista Elementary Schools

Although RRPS recently built Cordova and Stapleton Elementary Schools, which have capacity for over 1,600 students, the school district's explosive growth requires that

[13] Dekker/Perich/Sabatini. Project information for Cordova and Stapleton Elementary Schools. Retrieved from: http://www.dpsdesign.org/education_k-12_p5.htm#.
[14] Ibid.
[15] Ibid.

additional elementary schools be constructed. To serve Rio Rancho's current and projected population growth, RRPS has started construction on Cielo Azul and Sandia Vista Elementary Schools which are scheduled to open in the fall of 2008. These schools will use Cordova and Stapleton Elementary Schools' basic design,[16] while incorporating several additional high-performance features intended to further reduce their environmental impact, including: high-efficiency heating and cooling systems, waterless urinals, dual-flush toilets, and an energy-efficient lighting system. RRPS plans to pursue a Leadership in Energy and Environmental Design (LEED) Silver rating for Cielo Azul and Sandia Vista, the third-highest rating available from the United States Green Building Council.[17]

Research Opportunity

It is often difficult to compare the environmental performance of different schools because of variations in design and climate. Thus, the similar designs and locations shared by Cordova, Stapleton, Cielo Azul and Sandia Vista Elementary Schools presents an opportunity to test whether: 1) high performance features result in significant energy and water savings; and, if so 2) how long it takes for these savings to pay back the school's initial investment. Further, if Cielo Azul and Sandia Vista's energy and water usage is significantly less than Cordova and Stapleton's, it will be particularly powerful because Stapleton and Cordova also have many high-performance features.

Methodology

This study's research design consists of several steps. First, Cielo Azul and Sandia Vista's construction costs will be compared to those of Stapleton and Cordova on a per square foot basis to account for the new schools' larger size. This comparison will be used to calculate Cielo Azul and Sandia Vista's green premium (if applicable). Next, the amount of water and energy used at each school will be computed per square foot. Stapleton and Cordova's energy and water usage data will be obtained from RRPS Facilities staff. The water and energy use of Cielo Azul and Sandia Vista will be

[16] Dekker/Perich/Sabatini. Northeast Elementary School. Schematic Design. April 2007. (Copy available upon request).
[17] Ibid.

determined based on projections provided by the schools' architects and engineers. The amount of water and energy saved per square foot at Cielo Azul and Sandia Vista (if applicable) will then be monetized. This amount will be used to determine the length of time necessary for Rio Rancho Public Schools to payback Cielo Azul and Sandia Vista's green premium.

Calculations

School Costs

A variety of figures can be used when assessing construction costs. For this study, the schedule of values was used for all four schools to ensure consistency across calculations. The schedule of values for Cordova, Stapleton, Sandia Vista, and Cielo Azul are: $10,176,690; $9,342,282; $14,183,506; $14,753,395, respectively (See Figure 1: School Construction Costs). Cielo Azul and Sandia Vista's construction costs are clearly more expensive than Cordova and Stapleton's. However, there are several additional factors that need to be considered before a representative comparison can be made. First, material and labor costs have increased dramatically over the past several years.[18] Second, Cielo Azul and Sandia Vista are larger than Cordova and Stapleton, so it is necessary to compare their construction costs per square foot. Third, the costs to prepare each school's location for construction are not equal—Cielo Azul and Sandia Vista's site utility work was significantly more expensive than Cordova and Stapleton. This is true even when the older school's site utility work is adjusted for inflation, and is a result of each school's location rather than differences in design or construction features (See Figure 1: School Construction Costs).

Finally, there are costs associated with LEED™ standards and certification review which RRPS pursued for Sandia Vista and Cielo Azul, but not Stapleton and Cordova. These costs— energy modeling, commissioning, LEED™ administrative fees, and USGBC certification fees—are considered 'soft costs' They are not reflected in the schedule of values and are not routinely considered in "green premium" comparisons, but they are included as adjustments in the cost comparison in this study to provide the full costs of Sandia Vista and Cielo Azul.

[18] RS Means. Square Foot Costs. (2007).

Energy modeling is used during the design-stage to evaluate the impact of different design decisions on projected building energy consumption (e.g. building orientation, form, windows, shading, materials, insulation, etc.). Commissioning is the process of calibrating and testing the mechanical systems of a building to assure that they are performing at optimum efficiency under a range of conditions. LEED™ administrative fees are hours billed by architects for the extra steps required in designing and delivering a building that strictly adheres to rigorous energy and environmental standards. These steps include managing the project team to stay on target to achieve LEED™ points and prerequisites, collecting and quality assuring documentation and calculations from contractors, and working with the USGBC throughout the certification process. The USGBC fees (roughly $3,500 for each school) cover the review and analysis of documentation to certify compliance with LEED™ standards. These costs are detailed in Figure 1: School Construction Costs.

With these adjustments, the average price/square foot for Cordova and Stapleton was $160.22, and the average price/square foot for Cielo Azul and Sandia Vista was $162.31 (See Figure 1: School Construction Costs). This $2.13/sq.ft. difference represents a 1.30 percent green premium for the newly constructed schools (See Figure 1: School Construction Costs). This amount is approximately 35 percent less than the 2 percent green premium commonly cited.[19] The next step in this analysis is to compute the energy and water savings (if any) that are projected to result from Cielo Azul and Sandia Vista's additional high-performance features.

Energy and Water Savings

Stapleton and Cordova were constructed with several "environmentally friendly" features designed to reduce the schools' energy and water use including: day-lighting, simple circulation, and an innovative storm-water management system. Thus, Cordova and Stapleton's energy and water use is likely less than other traditionally-designed elementary schools in this climatic region. Yet, RRPS still spends a significant amount of money on energy and water at Stapleton and Cordova. RRPS' electricity costs for the 2006/2007 school year at Stapleton and Cordova were $67,393 and $64,221, respectively,

[19] Katz, Gregory. Greening America's Schools: Costs and Benefits (2006).

or $.92/square foot and $.84/square foot (see Figure 3: Electricity Costs). In contrast, the projected electricity costs for Sandia Vista and Cielo Azul are $29,253 and $28,084, respectively, or $.34/square foot and $.33/square foot (see Figure 3: Electricity Costs). Thus, the average cost of Stapleton and Cordova's electricity is $.88/square foot/year compared to $.34/square foot/year for Cielo Azul and Sandia Vista (see Figure 3: Electricity Costs). This represents a savings of $.54/square foot/year for Cielo Vista and Sandia Vista (See Figure 3: Electricity Costs).

RRPS also spends a significant amount of money on natural gas for Stapleton and Cordova. During the 2006/2007 school year the district spent $27,787 and $18,999 for natural gas at Stapleton and Cordova, respectively, or $.38/square foot and $.31/square foot (see Figure 4: Natural Gas Costs). In contrast, Cielo Azul and Sandia Vista are projected to use $1,205 and $1,174 of natural gas each year, respectively, or $.01/square foot. Since Stapleton and Cordova's average natural gas costs are $.31/square foot/year, Cielo Azul and Sandia Vista are each projected to save $.30/square foot/year on natural gas costs.

Cielo Azul and Sandia Vista's high performance features are projected to use significantly less water than Stapleton and Cordova. In the 2006/2007 school year, Stapleton and Cordova each used an average 646,041 gallons of water, or 8.6 gallons/square foot/year. Cielo Azul and Sandia Vista are projected to each use 511,020 gallons of water each year, or 6.0 gallons/square foot/year. This will result in a savings of approximately $.03/square foot/year.

Cielo Azul and Sandia Vista's additional high performance features are projected to save RRPS a total of $.87/square foot/year (see Figure 6: Green Premium Savings). When this amount is multiplied by the school's total area, it yields a savings of over $73,500[20] a year.[21] This amount is more than the salary of either school's principal.[22] With this stream of direct savings in utility costs, RRPS will recoup the construction premium for the two green schools in slightly over two years.

[20] In 2007 dollars.
[21] This figure was derived by multiplying $.86 by Cielo Azul and Sandia Vista's total square footage.
[22] Elementary school principals in RRPS get paid between $65-68K. This information was retrieved from: http://www.observer-online.com/articles/2006/08/02/news/story4.txt.

Discussion

There are several additional factors which should be considered when interpreting this analysis. First, RRPS did not pay all of Cielo Azul and Sandia Vista's construction costs. The bonds used for these schools' construction leveraged a great deal of funding from the State of New Mexico. For example, the city of Rio Rancho spent $3.1 million for Cielo Azul Elementary School, but the State of New Mexico's Public School Capital Outlay Council provided $7.15 million.[23] Thus, the city of Rio Rancho only paid approximately 30 percent of the school's construction costs. Yet, although New Mexico's Public School Capital Outlay Council provides funds for new school construction, there are not any state funds available to support schools' operation costs. As a result, the community of Rio Rancho is able to enjoy the financial benefits of Cielo Azul and Sandia Vista's reduced operation expenditures, but they only had to pay for a third of these features' costs.

In addition, Cielo Azul and Sandia Vista incurred two other costs, which were unrelated to performance but could not be controlled for in this comparison. The first is that they are being constructed on an expedited schedule whereas Cordova and Stapleton were not. Increasing the speed of construction raises costs, however, Cielo Azul and Sandia Vista's contractors were not able to provide a specific figure for the amount this added to the schools' total costs in the schedule of values. Secondly, just prior to soliciting bids for Sandia Vista and Cielo Azul, RRPS switched from the Uniform Building Code to the International Building Code. This switch resulted in these two schools being slightly larger and having significantly more plumbing fixtures than their predecessors. This factor also impacted construction costs, but did not result from the use of the LEED™ standard. Due to lack of accurate cost data, these two additional costs were omitted from this comparison. However, the architect for these schools estimates that these additional expenditures could have added as least $500,000 to the cost of each school. As a result, Cielo Azul and Sandia Vista's green premium is no doubt less than $2.13/sq.ft as is stated in this report.

[23] Rio Rancho Public Schools. 2006 Bond Issue Questions and Answers. Retrieved from: http://www.rrps.net/News/BondElection/qna.htm.

There are also some aspects of this analysis which will need to be revisited in the future. The commissioning process allows greater predictive accuracy, however, RRPS will need to monitor Cielo Azul and Sandia Vista's actual water and energy use over time to see if the projections are accurate. Also, although it will be critical for RRPS to monitor energy and water usage in the upcoming years, there are a variety of other performance measures which should also be tracked to provide a more complete picture of the value of Cielo Azul and Sandia Vista's high performance features. These measures are discussed in the following section.

On-going Performance Measurement Topics

While a variety of studies have demonstrated the positive impact green buildings can have on increasing student performance, reducing water and energy use, and enhancing the health of school occupants, [24] there are also areas where the research is less complete. As a result, RRPS has a significant opportunity to reinforce, as well as contribute to, the body of knowledge about green schools' benefits. The author, in collaboration with RRPS' facilities manager, Martin Montano, identified the following ten performance measures for further study:

1. Water Use
2. Energy Use
3. Teacher Absenteeism
4. Teacher Turnover
5. Student Absenteeism
6. Student Performance
7. Student Health
8. Student Behavior
9. Community Perceptions
10. Operation and Maintenance Cos

[24] Katz. Pgs.4-20.

Water Use

As indicated above, the conclusion reached in this analysis that Cielo Azul and Sandia Vista's efficient features will result in water use reductions compared to Stapleton and Cordova is based on modeling data provided by the schools' architects. Savings may or may not materialize when the schools begin operating in the fall of 2008. RRPS should compare water use per square foot (to normalize for differences in school size) at Cielo Azul and Sandia Vista compared to other RRPS schools. This process should not require too much additional effort on behalf of RRPS' Facilities staff because the district already uses a software program called SchoolDude which generates reports on each schools' resource use (e.g., irrigation, sewer, water, electricity, and natural gas).

Energy Use

Elementary and secondary schools spend $6 billion each year on energy.[25] Moreover, since schools operate primarily in the daytime during the workweek they often pay the highest energy rates.[26] This presents a significant opportunity for school districts across the country to reduce their operational expenditures. In fact, the United States Department of Energy has predicted that schools' energy costs could be reduced by a fourth if high performance features were used.[27] Nationwide these savings could provide funding for 30,000 new teachers or 30 million new textbooks.[28]

Using energy modeling data provided by Cielo Azul and Sandia Vista's architects this analysis predicts significant energy savings compared to their RRPS counterparts. However, like the water use data discussed above, these figures are based on models, so Cielo Azul and Sandia Vista's actual energy use will need to be monitored by RRPS over time to make sure these savings are realized. The SchoolDude software program discussed in the previous "Water Use" section is also used to keep track of RRPS' energy use data. As a result, it should not be difficult for RRPS Facilities staff to compare Cielo Azul and Sandia Vista's energy use with other RRPS elementary schools.

[25] Turner Construction Company. (2005). Market Barometer. 2005 Survey of Green Building in K-12 and Higher Education. Pg. 5.
[26] Ibid.
[27] Ibid.
[28] Ibid.

Teacher Absenteeism

Studies have demonstrated that teachers are the most significant factor in student achievement.[29] In fact, research indicates that if you take students of average ability and place them in the classrooms of teachers in the top fifth of their profession, the pupils perform in the top 10% of their peer group.[30] In contrast, if students of average ability are placed in classrooms of teachers in the bottom fifth of their profession, they end up as the lowest performers.[31] It is reasonable to assume that substitute teachers are, on balance, not as effective as full-time instructors. Thus, teacher absences may seriously impact students' learning. High performance schools should create more healthy working conditions (e.g., better indoor air quality, less off-gassing, etc.) than traditional schools. One proxy for measuring this assertion is to track the number of sick days per teacher each year. Indeed, there is evidence to suggest that Cielo Azul and Sandia Vista will experience a decrease in teacher sick days. For instance, Clearview Elementary School, a LEED gold building in Pennsylvania, witnessed a 12% decrease in teacher sick days when they transferred from a traditional school.[32] Thus, RRPS should track whether Cielo Azul and Sandia Vista also experience improved teacher health outcomes when compared to other RRPS elementary schools.

Teacher and Staff Turnover and Recruitment

Students spend approximately 1,300 hours in school each year.[33] It is reasonable to assume that the 5.9 million K-12 staff members in this country[34] spend even more time in schools given their additional responsibilities. As a result, it has been asserted that green schools can be a recruitment and retention tool for school districts. Indeed, a report by Turner Construction Company indicates that 74 percent of school executives surveyed thought high performance schools made it easier to attract and retain top teachers.[35]

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[29] Kati Haycock. "Good Teaching Matters: How Well-Qualified Teachers Can Close the Achievement Gap. Thinking K-12. Volume 3, Issue 2. pg. 2.
[30] Economist. How to be Top: What works in education: the lessons according to McKinsey. October 18, 2007. Retrieved from: http://economist.com/world/international/displaystory.cfm?story_id=9989914.
[31] Ibid.
[32] Doll, Wesley. "Green Design Experiences: A Case Study." Cited in Katz, pg. 16.
[33] Turner Construction Company. (2005). Market Barometer. 2005 Survey of Green Building in K-12 and Higher Education. Pg. 5.
[34] Ibid.
[35] Turner Construction Company. Page 7.

Given the costs to recruit high quality teachers, RRPS should assess whether Cielo Azul and Sandia Vista Elementary School experience less turnover than other district elementary schools. Since the number of teachers at each school varies, this should be determined based on a ratio of the number of teachers retained per elementary school compared to the total number of teachers at that school. Teacher and staff recruitment could be measured by comparing the number of applications per vacancy at Cielo Azul and Sandia Vista with other RRPS elementary schools. Further, the district could monitor the number of transfers requested per the total teacher population at Cielo Azul and Sandia Vista compared to other schools.

Student Health

The Government Accountability Office estimates that the air in over 15,000 K-12 schools is unfit to breathe.[36] This statistic has troubling health consequences for all 60 million K-12 school occupants—students, faculty and staff.[37] Poor indoor air quality is particularly alarming for students because children breathe in more air relative to their body size than adults, thereby making them more susceptible to harm from pollutants and toxins.[38] To be sure, one of the largest drivers for green schools is the positive impact they may have on students' health. As a result, RRPS should monitor whether Cielo Azul and Sandia Vista Elementary Schools have fewer nurse visits per pupil than other RRPS elementary schools.

Student Absenteeism

Consistent attendance increases students' learning opportunities. Yet, research demonstrates that poorly maintained and/or ventilated schools can negatively impact children's health. According to a United States General Accountability Office study, 14 million students attend schools below standard and almost two thirds of schools have features (e.g., air conditioners) that need repair or replacement.[39]Poor maintenance and

[36] Government Accountability Office. "School Facilities: America's Schools not Designed or Equipped for the 21st Century. Report #HEHS-95-95. Cited in Katz, pg. 8.
[37] Katz. Pg. 8.
[38] Ibid.
[39] Government Accountability Office. "School Facilities: America's Schools not Designed or Equipped for the 21st Century. Report #HEHS-95-95. Cited in Katz, pg. 8.

ventilation has important health implications for students. For instance, studies have found improved indoor air quality can reduce cold and flu occurrences by 51 percent. This reduction is for the general population; the impact on children may be even more significant because they are more susceptible to illnesses. These illnesses do not only impact student performance, they also have societal economic impacts in the form of increased health care costs and reduced productivity because parents may stay at home from work with their sick child.

The high performance features of green schools (e.g., increased day lighting) create a more healthy and inviting learning environment which should increase student attendance. In fact, a study of Washington State schools found that green features led to a 15 percent reduction in absenteeism.[40] Similarly, children moving to a new green school in Oregon also experienced a 15 percent reduction in student absences.[41] To test these assertions, RRPS should monitor whether Cielo Azul and Sandia Vista have lower absentee rates than Stapleton, Cordova, and other RRPS elementary schools. This measure should not be difficult to monitor since RRPS is already required to report student attendance to the state of New Mexico.

Student Performance

A variety of factors influence students' academic performance. Yet, high performance schools offer the possibility of increasing test scores by creating a healthier, more engaging learning environment. A 2001 study found that the test scores of 21,000 California students in schools with the most natural light scored 26 percent higher on reading tests and 20 percent higher on mathematics tests than students in classrooms with the least amount of daylight.[42] Further, a survey of building executives involved with green schools found that 70 percent believed that high performance features increased

[40] Paladino & Company. "Washington High Performance School Buildings: Report to Legislature." Cited in Katz, pg. 11.
[41] Katz, pg. 11.
[42] Heschong Mahone Grup. (1999). "Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance.

student performance.[43] The data relating school performance and building design suggests that Cielo Azul and Sandia Vista students may experience a 3-5% improvement in test scores.[44] RRPS should monitor whether these gains materialize. Fortunately, testing requirements mandated by the federal No Child Left Behind law will make it relatively easy for these comparisons to be made by RRPS staff.

Student Behavior

Student behavior in green schools is a measure that has not been examined by researchers. Yet, by creating more engaging learning environments, high performance schools may lead to a reduction in behavioral disruptions. As a result, RRPS should monitor the average number of behavior reports per student at Cielo Azul and Sandia Vista compared to other RRPS elementary schools.

Community Perceptions

Schools are not only centers for learning; they are also important community assets. School districts rely on the communities they serve for support—financial and otherwise. As a result, it is important to assess whether Rio Rancho residents favorably view RRPS' green investments at Cielo Azul and Sandia Vista. RRPS administers an annual survey to gauge community perceptions. A question should be included to see whether Cielo Azul and Sandia Vista are rated more favorably by community members than traditionally built schools.

Operations and Maintenance Costs

The durable materials used by green schools should reduce operations and maintenance costs compared to traditionally designed buildings.[45] Yet, studies to date have not quantified the amount of operation and maintenance savings realized by incorporating high performance features. As a result, RRPS has an opportunity to add to the body of knowledge about green schools by closely examining the amount of expenditures per square foot used to maintain Cielo Azul and Sandia Vista compared to

[43] Turner. Pg. 5.
[44] Katz, pg. 12.
[45] Katz, pg. 17.

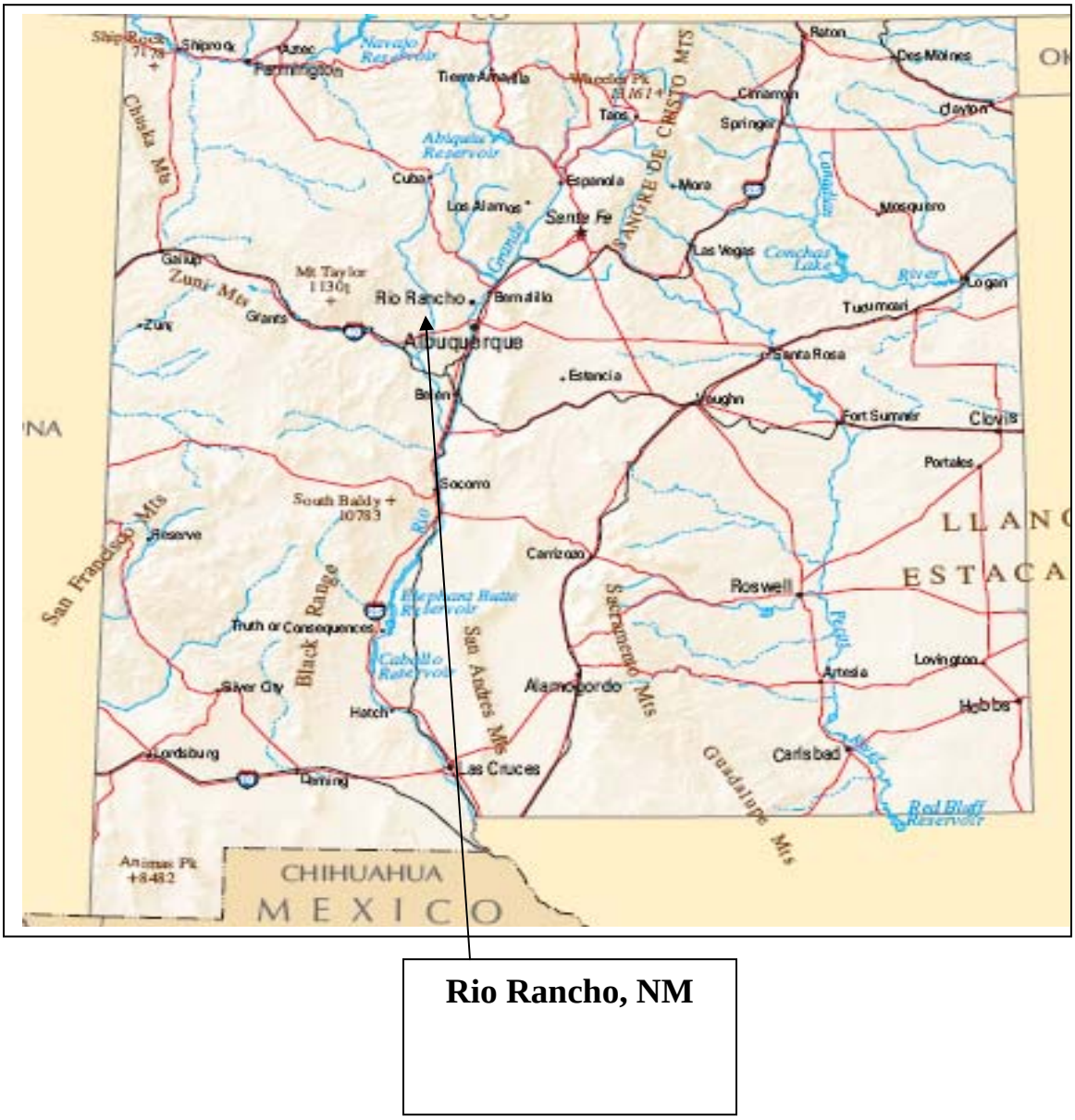
other RRPS elementary schools. This amount should be easily obtained from RRPS' Facilities staff.

Conclusion

The high performance design and features of Cielo Azul and Sandia Vista represent a sound investment on behalf of Rio Rancho Public Schools and the State of New Mexico. Yet, the true value of this investment will not be determined for several years. As a result, it will be important for RRPS to conduct a post-audit of Cielo Azul and Sandia Vista after the schools begin operating. A post-audit should occur after one year and another should be administered after Cielo Azul and Sandia Vista have been operating for five years. This will allow more accurate energy and water data to be computed for the new schools. Further, additional benefits (e.g., improved student health, increased test scores, higher teacher retention) can be determined, thereby offering a more complete and accurate view of the benefits accrued from RRPS' investment.

It should be noted however, that some benefits will be difficult to accurately monetize, such as reduced air pollution. Further, other impacts will be nearly impossible to measure, such as instilling a stewardship ethic in the next generation of Rio Rancho residents—perhaps the most important benefit of all.

Attachment 1: Map of Rio Rancho, New Mexico[46]



Attachment 2:
Images of Stapleton Elementary School[47]

[46] Map retrieved from http://www.nationalatlas.gov/printable/images/pdf/reference/pagegen_nm.pdf.

[47] Images retrieved from: http://www.dpsdesign.org/education_k-12_p5.htm#.

Figure 1: School Construction Costs[48]

[48] All school construction cost amounts in this figure were rounded to the nearest dollar.

	Cordova Elementary School	Stapleton Elementary School	Sandia Vista Elementary School	Cielo Azul Elementary School
Total Cost	**$10,176,690**	**$9,342,282**	**$14,138,506**[49]	**$14,753,395**[50]
Site Utility Work	$108,897	$150,584	$540,000	$1,076,000
Site Utility Work RS Means Adjustment[51]	$27,063	$37,423	N/A	N/A
Subtotal: Without Site Utility Work	**$10,040,730**	**$9,154,275**	**$13,643,506**	**$13,677,395**
RS Means Adjustment[52]	$2,495,329	$2,275,027	N/A	N/A
Subtotal: With RS Means Adjustment	**$12,536,059**	**$11,429,302**	**$13,643,506**	**$13,677,395**
LEED Administrative Fees	N/A	N/A	$49,842	$49,842
USGBC registration & certification fees	N/A	N/A	$3,500	$3,500
Energy Modeling	N/A	N/A	$10,000	$10,000
Commissioning	N/A	N/A	$158,976	$158,976
Total Commissioning and Registration Fees			$222,318	$222,318

[49] Sandia Vista total cost estimate from schedule of values at 80% construction
[50] Cielo Azul total cost estimate from schedule of values at 69% construction
[51] RS Means data for Albuquerque, NM was used to adjust 2004 construction materials and labor costs to 2007 values.[2004 cost * (147.7/118.3)= 2007 cost]
[52] Ibid.

2007 Adjusted Cost	**$12,536,059**	**$11,429,302**	**$13,865,824**	**$13,899,713**
Square Footage	76,226	73,274	85,513	85,513
Cost/Square Foot[53]	$164.46	$155.98	$162.15	$162.55
Average Cost/Square Foot	$160.22		$162.35	
Green Premium	$2.13/square foot			
Green Premium as Percentage of Cost/Square Foot	1.33%[54]			

[53] All cost/square foot amounts in this figure were rounded to the nearest cent.
[54] Rounded to the nearest hundredth of a percent.

Figure 3: Electricity Costs[55]

	Electricity (MBtu)	MBtu to KWH conversion	Cost Estimate	Square Footage	Cost per square foot
Sandia Vista Elementary School	1,930	565,651[56]	$29,253[57]	85,513	$29,253/85,513 = $.34/square foot/year[58]
Cielo Azul Elementary School	1,926	564,478	$28,084	85,513	$28,084/85,513 = $.33/square foot/year
Average of Sandia Vista and Cielo Azul's Electricity Costs	$.34/square foot				
Stapleton Elementary School	N/A	758,320	$67,394	73,274	$67,393.66/73,274 = $.92/square foot/year
Cordova Elementary School	N/A	729,720	$64,221	76,226	$56,588.96/76,226 = $.84/square foot
Stapleton/Cordova Totals		1,488,040	$131,615	149,500	$.88/square foot
Average of Stapleton and Cordova's Electricity Costs	$.88/squre foot				
Green Premium Savings	$.54/square foot				

[55] The raw data for Cordova and Stapleton's Electricity costs can be found in Table 1: Ernest Stapleton Electricity Costs and Table 2: Maggie Cordova Electricity Costs.
[56] Rounded to the nearest KWH.
[57] All cost estimates are rounded to the nearest dollar.
[58] All prices/square foot are rounded to the nearest cent.

Figure 4: Natural Gas Costs[59]

	Natural Gas (MBtu)	Cost Estimate	Square Footage	Cost per square foot
Sandia Vista Elementary School	357[60]	$1,174[61]	85,513	$.01/square foot[62]
Cielo Azul Elementary School	392	$1,205	85,513	$.01/squre foot
Sandia Vista/Cielo Azul Average	374.5	$1190	85,513	$.01/square foot
Stapleton	3314	$27,787	73,274	$.38/square foot
Cordova	2255	$18,999	76,226	$.25/square foot
Cordova/Stapleton Average	2788	$23,393	74,750	$.31/square foot
Green Premium Savings	$.30/square foot			

[59] The raw natural gas data for Stapleton and Cordova can be found in Table 3: Ernest Stapleton Natural Gas Costs and Table 4: Maggie Cordova Natural Gas Costs.
[60] All natural gas amounts are rounded to the nearest MBtu.
[61] All cost estimates are rounded to the nearest dollar.
[62] All costs per square foot are roundest to the nearest cent.

Figure 5: Water Costs[63]

School Name	Water Use (Gallons)	Square Footage	Gallons of Water Used /Square Foot	Cost of Water/Square Foot
Sandia Vista Elementary School	511,020	85,513	6.0[64]	$.01[65]
Cielo Azul Elementary School	511,020	85,513	6.0	$.01
Sandia Vista/Cielo Azul Average	511,020	85,513	6.0	$.01
Stapleton	813,458	73,274	11.1	$.01
Cordova	478,623	76,226	6.3	$.01
Cordova/Stapleton Average	646,041	74,750	8.6	$.01
Green Premium Savings	$.03[66]			

[63] The raw water cost data for Stapleton and Cordova can be found in Table 5: Stapleton Water Use and Table 6: Maggie Cordova Water Use.
[64] All water use per square foot figures are rounded to the nearest tenth of a gallon
[65] Assumes a $.01/gallon unit cost
[66] Rounded to the nearest cent.

Figure 6: Green Premium Savings

Resource	Green Premium Savings
Electricity	$.54/square foot
Natural Gas	$.30/square foot
Water Use	$.03/square foot
Total Green Premium Savings	$.86/square foot

Table 1: Ernest Stapleton Electricity Use

Month/Year	Start Date	End Date	Days	KWH	Cost	Average Unit Cost
July/2006	6/19/06	7/19/06	30	59440	$5553.09	.093[67]
August/2006	07/19/06	08/18/06	30	66080	$6476.15	.098
September/2006	8/18/06	9/19/06	32	78720	$7171.85	.091
October/2006	9/19/06	10/18/06	29	65280	$5924.18	.090
November/2006	10/18/06	11/15/06	28	59360	$5067.70	.085
December/2006	11/15/06	12/16/06	31	63040	$5131.00	.081
January/2007	12/16/06	1/17/07	32	54240	$4372.47	.080
February/2007	1/17/07	2/14/07	28	59680	$4938.78	.083
March/2007	2/14/07	3/17/07	31	68640	$5764.07	.083
April/2007	3/17/07	4/17/07	31	60800	$5396.43	.090
May/2007	4/17/07	5/17/07	30	67200	$6208.82	.092
June/2007	5/17/07	6/18/07	32	55840	$5204.48	.093
Total			364	758320	$67,209.02	.005

Adjustment to Add One Day of Electricity Use

$67,209.02/364 = $184.64[68]/day

$67,209.02 + $184.64 = $67,393.66/year

[67] All average unit costs are rounded to the nearest tenth of a cent.
[68] Rounded to the nearest cent

Table 2: Maggie Cordova Electricity Use

Month/Year	Start Date	End Date	Days	KWH	Cost	Average Unit Cost
July/2006	6/16/06	7/18/06	32	57840	$5151.76	.089[69]
August/2006	7/18/06	8/17/06	30	64120	$6093.71	.095
September/2006	8/17/06	9/18/06	32	76000	$7014.61	.092
October/2006[70]						
November/2006	10/17/06	11/14/06	28	55440	$4979.34	.090
December/2006	11/14/06	12/15/06	31	62000	$5035.58	.081
January/2007	12/15/06	1/16/07	32	53520	$4270.34	.079
February/2007	1/16/07	2/13/07	28	60720	$5029.71	.082
March/2007	2/13/07	3/15/07	30	64400	$5435.17	.084
April/2007	3/15/07	4/16/07	32	57440	$5045.16	.088
May/2007	4/16/07	5/16/07	30	64000	$5878.29	.092
June/2007	5/16/07	6/15/07	30	54800	$5238.50	.096
July/2007	06/15/07	07/17/07	32	59440	$5399.14	.090
Total			367	729720	$64,571.31	.088

Adjustment to Subtract Two Days of Electricity Use

$64,571.31/367 = $174.94[71]/day

$174.94 X 2 = $349.88

$64,571.31 - $349.88 = $64,221.43/year

[69] All average unit costs are rounded to the nearest tenth of a cent.
[70] RRPS did not have information for October 2006
[71] Rounded to the nearest cent

Table 3: Ernest Stapleton Natural Gas

Month/Year	Start Date	End Date	Days	MBTU	Cost	Average Unit Cost
July/2006	07/01/06	08/01/06	31	10.040[72]	$79.63	7.931[73]
August/2006	08/01/06	09/01/06	31	15.760	$130.47	8.278
September/2006	09/01/06	10/01/06	30	67.258	$493.89	7.343
October/2006	10/01/06	11/01/06	31	171.681	$829.58	4.832
November/2006	11/01/06	12/01/06	30	381.938	$3317.05	8.685
December/2006	12/01/06	01/01/07	31	699.443	$6298.78	9.005
January/2007	01/01/07	02/01/07	31	787.564	$6587.00	8.364
February/2007	02/01/07	03/01/07	28	556.082	$4836.61	8.700
March/2007	03/01/07	04/01/07	31	307.815	$2804.71	9.111
April/2007	04/01/07	05/01/07	30	234.797	$1723.73	7.341
May/2007	05/01/07	06/01/07	31	68.388	$559.60	8.183
June/2007	06/01/07	07/01/07	30	13.497	$126.08	9.341
Total			365	3314.209	$27,787.13	8.384

[72] All Mbtu amounts are rounded to the nearest thousandth.
[73] All average unit costs are rounded to the nearest tenth of a cent

Table 4: Maggie Cordova Natural Gas

Month/Year	Start Date	End Date	Days	MBTU	Cost	Average Unit Cost
July/2006	07/01/06	08/01/06	31	8.146[74]	67.01	8.226[75]
August/2006	08/01/06	09/01/06	31	15.190	125.63	8.270
September/2006	09/01/06	10/01/06	30	37.344	279.82	7.493
October/2006	10/01/06	11/01/06	31	95.103	463.78	4.877
November/2006	11/01/06	12/01/06	30	255.135	2214.40	8.680
December/2006	12/01/06	01/01/07	31	549.685	4939.82	8.987
January/2007	01/01/07	02/01/07	31	550.325	4593.79	8.347
February/2007	02/01/07	03/01/07	28	342.551	2976.97	8.691
March/2007	03/01/07	04/01/07	31	234.745	2046.21	8.717
April/2007	04/01/07	05/01/07	30	115.502	852.98	7.385
May/2007	05/01/07	06/01/07	31	38.456	320.40	8.332
June/2007	06/01/07	07/01/07	30	12.546	117.74	9.385
Total			365	2254.728	18,998.55	8.426

[74] All MBtu amounts are rounded to the nearest thousandth.
[75] All average unit costs are rounded to the nearest tenth of a cent.

Table 5: Ernest Stapleton Water Use

Month/Year	Start Date	End Date	Days	Gallons	Cost	Average Unit Cost
July/2006	6/24/06	7/27/06	33	13000	$442.13	.034[76]
August/2006	7/27/06	8/24/06	28	33000	$504.18	.015
September/2006	8/24/06	9/25/06	32	88000	$674.44	.007
October/2006	9/25/06	10/23/06	28	77000	$640.37	.008
November/2006	10/23/06	11/22/06	30	82000	$655.86	.008
December/2006	11/22/06	12/22/06	30	51000	$559.84	.010
January/2007	12/22/06	1/23/07	32	77000	$640.37	.008
February/2007	1/23/07	2/22/07	30	89000	$677.54	.007
March/2007	2/22/07	3/28/07	34	90000	$706.41	.008
April/2007	3/28/07	4/25/07	28	80000	$675.43	.008
May/2007	4/25/07	5/24/07	29	92000	$715.60	.008
June/2007	5/24/07	6/22/07	29	37000	$524.24	.014
Total			363	809000	$7,413.31	.009

Adjustment to Add Two Days of Water Use

809,000/363 = 2229[77] gallons/day

2229 X 2 = 4458 gallons for two additional days

809,000 + 4458 = 813,458 gallons of water/year

[76] All average unit costs are rounded to the nearest tenth of a cent.
[77] Rounded to the nearest gallon

Table 6: Maggie Cordova Water Use

Month/Year	Start Date	End Date	Days	Gallons	Cost	Average Unit Cost
July/2006	6/24/06	7/24/06	30	3000	$229.61	.077[78]
August/2006	7/24/06	8/29/06	36	30000	$313.24	.010
September/2006	8/29/06	9/28/06	30	56000	$393.77	.007
October/2006	9/28/06	10/25/06	27	44000	$356.60	.008
November/2006	10/25/06	11/28/06	34	55000	$390.68	.007
December/2006	11/28/06	12/27/06	29	35000	$328.73	.009
January/2007	12/27/06	1/29/07	33	38000	$338.02	.009
February/2007	1/29/07	2/25/07	27	53000	$384.48	.007
March/2007	2/25/07	3/28/07	31	53000	$429.79	.008
April/2007	3/28/07	4/27/07	30	54000	$432.89	.008
May/2007	4/27/07	5/29/07	32	51000	$423.60	.008
June/2007	5/29/07	6/22/07	24	4000	$278.01	.070
Total			363	476,000	$4,299.42	.009

Adjustment for Two Additional Days of Water Use

476,000/363 = 1311[79] gallons/day

1311 X 2 = 2622 gallons for two additional days

476,000 + 2622 = 478,623[80]gallons of water/year

[78] All average unit costs are rounded to the nearest tenth of a cent.
[79] Rounded to the nearest gallon
[80] Ibid.