



TRANSFORMING MADRASATI SCHOOLS TO GREEN BUILDING

MADRASATI INITIATIVE

FINAL REPORT

May 2011

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USAID JORDAN ECONOMIC DEVELOPMENT PROGRAM

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BACKGROUND

A green school is a healthy, high performance school that monitors its ecological footprint. A high performance school is one that provides a healthy learning and working environment for its students, making it a model of sustainability and provides a blueprint for the community, parents, teachers and small businesses in the area as to how to collaborate to implement this vision.

While the Madrasati initiative focuses on restoring school buildings that are in state of disrepair, it also seeks to improve the learning environment by integrating specialized services and programs by actively engaging the community and CBOs (Community Based Organizations) in activities to promote their participation in the learning process.

Therefore, the Madrasati initiative sought to pilot a green schools project in one area in order to develop a model for future eco-friendly initiatives. To achieve this, we sought simple, cost effective green solutions that were tailored for the specific needs of each school and that cater to the culture of the community.

GOALS AND OBJECTIVES

The Madrasati Initiative contracted with Terra Vertis to conduct a needs assessment for the green school project as well as to implement the solutions according to the following guidelines:

1. Sustainable use of resources: make schools energy, material and water efficient by tailoring the school's consumption of resources around its needs.
2. Assess and introduce renewable energy sources, and increase their use.
3. Make schools thermally, visually, and acoustically comfortable.
4. Strive to make schools environmentally responsive, safe and secure.
5. Create a healthy green space: a comfortable environmentally conscious atmosphere for students to learn in.
6. Initiate actions to prevent harm by designing solutions that are easy to maintain and operate.
7. Educate students, teachers and parents alike on the suggested approach, thereby presenting a new philosophy and way of thinking for the students and parents alike in order to make them responsible, and environmentally aware citizens.
8. Provide the community with the right to know about the potential harm they pose to their environment in their daily practices including energy and water consumption patterns.

PROPOSED ACTIVITIES

The following activities were designed based on the tailored solutions suggested by Terra Vertis for the selected three schools in the proposal that was originally submitted:

WATER

- Building a well to act as a reservoir and to harvest rainwater. This system consists of reservoir well that will be used to defer water shortage problems in the school and to collect the rainwater and utilize it for useful purposes..
- Installation of a grey-water utilization system. This system will consist of a collection scheme that takes the tap water, and water used in cleaning the campus grounds to be used in flushing toilets and irrigating plants.
- Fixing any leakages in faucets and bathroom on campus.

ENERGY AND ELECTRICITY

- Suitable renewable energy options will be explored and installed where feasible particularly for hot water and some heating usages.
- Energy efficient light bulbs will replace current light bulbs in the schools.
- Use curtains, blinds and thin film on windows to minimize overheating due to sunlight in the summer, and heat loss during winter.
- Maximize the use of day lighting; this will decrease the schools' dependence on electric lighting.

IMPROVING COMFORT LEVELS

- Installing pergolas in playgrounds to act as a protection from sunlight and rain.
- Implement drought tolerant and low maintenance landscaping that will improve air quality in the school area, improve the schools' visual appearance, and add to the campus' sustainability through programs like grey water utilization, and farm-to-school initiatives¹
- Install fans for ventilation and cooling; this will improve the air quality in the classrooms and keep the rooms at a healthier temperature during the summer time, and will discharge toxic gases from conventional kerosene heaters like Carbon monoxide from the classrooms.

¹ Farm-to-school programs make use of crops growing on campus in their cafeteria, or sell them. These are maintained by the student body and are a great learning experience for them. Olive trees are a considered option in our project.

- Acoustics; this is a simple cost effective system that will greatly enhance acoustics in small classrooms with many students. It consists of long curved strips of gypsum board to be mounted along the edges of the ceiling.
- Plant trees in larger hallways.

BEHAVIORAL SCHEMES AND RECYCLING

- Recycling schemes will be implemented in the schools based on the 4R's principle: Reduction, Reuse, Recycling and Recovery. These will be enforced for different recyclable materials like water, paper, pens, bottles and cans, organic material...etc
- Elect a "Hero of the Environment" from the teachers and the students to enforce such practices

TRAINING AND INSTRUCTION

- Develop training programs according to each school's needs; these will be benchmarked according to best practices criteria set forth by international programs.
- Training will be delivered to the different entities in the schools:
 - Principals and administrative staff
 - Teachers; and
 - Students.
- Training will focus on the following principles:
 - Recycling
 - Conservation of resources and materials
 - Green practices (energy, water...).

TECHNICAL ASSESSMENT AND SOLUTIONS

Madrasati Initiative sub-contracted Terra Vertis to conduct the technical assessment in each selected school, design the solutions, and implement the possible and most feasible alternatives. Terra Vertis conducted a walk through, detailed audits, staff interviews, and presentations for school/community stakeholders' to develop a thorough understanding of the project scope and expected roles and challenges.

The following are the proposed solutions for each school:

MA'EN ELEMENTARY SCHOOL/MADABA

Lighting system	Space conditioning	Saving water & harvesting	Waste management	Environment
Replacement of 75 florescent lamps with LED lamps that yield an equivalent lux output.	Installation of Hybrid solar thermal & earth tube heat exchanger system	<p>Installation of water saving toilet fixtures.</p> <p>Utilization of recycled grey water.</p> <p>Replacement of all faucets (sinks & drinking stations).</p> <p>Installation of spring-loaded push mechanisms for automatic shutoff & aerator units to throttle flow rate.</p> <p>Water/irrigation water harvesting mechanisms.</p> <p>Installation of reverse osmosis filtration system at the drinking station.</p>	5-way receptacle (metal/glass, paper, organic & others).	<p>Shaded area</p> <p>Zone cultivation area with water retention barriers.</p> <p>Drip irrigation system.</p> <p>A composting pit.</p>

Khadeajah Bint Khuwailed Secondary Girls/Amman

Lighting system	Saving water & harvesting	Waste management
Replacement of florescent lamps with LED lamps that yield an equivalent lux output.	<p>Installation of water saving toilet fixtures.</p> <p>Usage of recycled grey water.</p> <p>Replacement of all faucets (sinks & drinking stations) with spring-loaded push mechanisms for automatic shutoff & aerator units to throttle flow rate.</p> <p>Installation of localized grey water/irrigation and water harvesting mechanisms.</p> <p>Installation of reverse osmosis filtration system at the drinking station.</p>	5-way receptacle (metal/glass, paper, organic & others).

KHAWLAH BINT AL-AZWAR ELEMENTARY MIXED/AJLOUN

Lighting system	Saving water & harvesting	Waste management	Environment
Replacement of 109 florescent lamps with LED lamps that yield an equivalent lux output.	<p>Installation of water saving toilet fixtures.</p> <p>Replacement of all faucets (sinks & drinking stations).</p> <p>Installation of grey with spring-loaded push mechanisms for automatic shutoff & aerator units to throttle flow rate.</p> <p>Installing of rain water harvesting & grey water utilization system..</p>	5-way receptacle (metal/glass, paper, organic & others).	<p>Shaded area 60 m2</p> <p>Green Carpet</p>

ACCOMPLISHMENTS

The table below shows the accomplishments at Ajloun/Khawlah Bent Al-Azwar Primary Girls School. The Program and MADRASATI initiative have agreed to work only in this school.

Activity as per the approved Agreement	Description of Activity	Place of Activity	Achievements/Results
Diagnosing the school needs	The team determined the procedures, issues and locations to be diagnosed in conjunction with a dedicated project management team from the school.	Ajloun	This activity included a comprehensive study of existing green school programs around the world, and incorporated best practices as relevant to Jordan.
	The team has gathered data covering the various procedures and issues via interviews, historical document review, monitoring activities and on-site visits.	Ajloun	All stakeholders (district/school administrators, teaching staff, maintenance staff, and students) were involved in the compilation of initial diagnostic data.
Implementation	Identifying suppliers for the components defined in the design and development phases	Ajloun	All suppliers for the proposed solutions have been identified.
Water saving faucets	Replacement of all faucets (sinks and drinking station) with spring-loaded push mechanisms for automatic shutoff, and aerator units to throttle flow rate.	Ajloun	The expected result is to curb overall domestic water consumption by up to 30%
Installation of specialized 3-way waste receptacles (Plastic, Glass/Metal, Paper)	It's an educational display designed to encourage students and staff to practice waste segregation and learn of the ecological impact of waste generation itself	Ajloun	
Solar Thermal for hot water	Small scale solar hot water system installed on the roof, providing renewable recourse for hot water even during winter.	Ajloun	
Rain and grey Water Harvesting System	17 cubic meter to collect rain water and grey water come from the drinking taps	Ajloun	The collected water will be used for irrigation and cleaning
Pergola	Installation of 60 square meters pergola	Ajloun	This pergola provide an outdoor shaded learning space where teachers can effectively conduct lessons throughout the school year
Green Zone	7 square meters of planters	Ajloun	

Activity as per the approved Agreement	Description of Activity	Place of Activity	Achievements/Results
LED Lighting	Replacement for the existing lighting as it offers significant reduction in energy consumption, and lower lifetime operational costs.	Ajloun	The number of lamps replaced is 109 lamps. (70% reduction in energy consumption is expected)
School Committees	Forming of students committee at the school level, guided by the science or health teacher to carry out awareness services and guidance to students. Each committee defined the main components that should be addressed in the awareness plan	Ajloun	The committee conducted group of activities at the community level to reduce water consumption and energy consumption, garden the schools, and recycle certain wastes.
Solar Water Heating System	Installation of SWH	Ajloun	SWH system installed in the school. It provides hot water for different applications including washing, and bathrooms.

APPENDICES

APPENDIX A: TECHNICAL REPORT



MADRASATI ECO SCHOOL PROGRAM

PROJECT TECHNICAL REPORT

CLIENT: MADRASATI
SUBMITTED BY: TERRA VERTIS

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PROJECT BRIEF

An EcoSchool is defined as a school building or facility that creates a healthy environment and is conducive to learning while saving resources, energy and money.

Terra Vertis, in conjunction with the Madrasati Initiative and funding support from SABEQ/USAID, is leading the ground-up development of an EcoSchool program that is designed for effective implementation in the Jordanian public school system.

The broader objective of the Madrasati Initiative, as established by Queen Rania, is to identify, evaluate and renovate those school facilities that are in a state of disrepair. Terra Vertis' EcoSchool program is designed to add value to this initiative by developing a system to efficiently assess schools based on their built environment, management and administrative practices, and school curricula, with particular reference to sustainability.

Terra Vertis' general approach is to utilize the pilot project as an opportunity to showcase the immense potential for impactful social change towards sustainability, by strategically focusing on the nation's schooling system.

The rationale underpinning the EcoSchool concept is founded in the following principles:

- Lowering operating expenses, especially with the expectation of increasing energy and resource costs – allowing for re-allocation of available funding towards educational activities.
- Mitigating environmental impact by reduction in energy consumption, implementation of water harvesting/conservation mechanisms, and deployment of waste reduction/management systems.
- Improved learning outcome by improving student and staff well-being and comfort.
- The ability to use physical facilities as learning tools for effective environmental education.
- Transferring student learning into the wider community: necessary for a sustainable future.
- It is improbable that any other building category will offer leverage for higher social impact.

Each of the three schools in the pilot project represents a diverse combination of topographical, technical, and social challenges. The scope of the EcoSchools program includes:

- Energy conservation & renewable energy systems
 - Solar thermal system
 - Solar PV system
 - Geo-Thermal/Geo-Exchange System
- Water conservation and harvesting system

- Domestic water flow regulators (faucets, showers, toilets)
- Gray water harvesting system (for use in toilets and/or irrigation systems)
- Rain water harvesting reservoirs
- Learning space enhancements
 - Thermal comfort (energy efficient heating/cooling systems)
 - Optimized lighting levels (leveraging day lighting potential where available)
 - Acoustic enhancements
 - Outdoor shaded spaces
- Integration of learning concepts
 - Innovative display boards
 - Outdoor 'green space' such as a greenhouse or pond for interactive, hands-on experience
 - Building waste management systems
 - Energy and/or water usage meters that are visible and offer direct usage feedback
- Curriculum Programming and Awareness Campaigns
 - Designed based on student and staff surveys, and implemented to target the following groups:
 - Administrative/Maintenance stakeholders
 - Student grade levels
 - Primary (Grades 1-4)
 - Intermediate (Grades 5-8)
 - Secondary (Grades 9-12)
 - Community workshops
 - Use of active (participatory) and passive (displays etc.) techniques to impart knowledge required for a sustainable future.
 - Developed on an open source platform to maximize participatory development from all stakeholders.

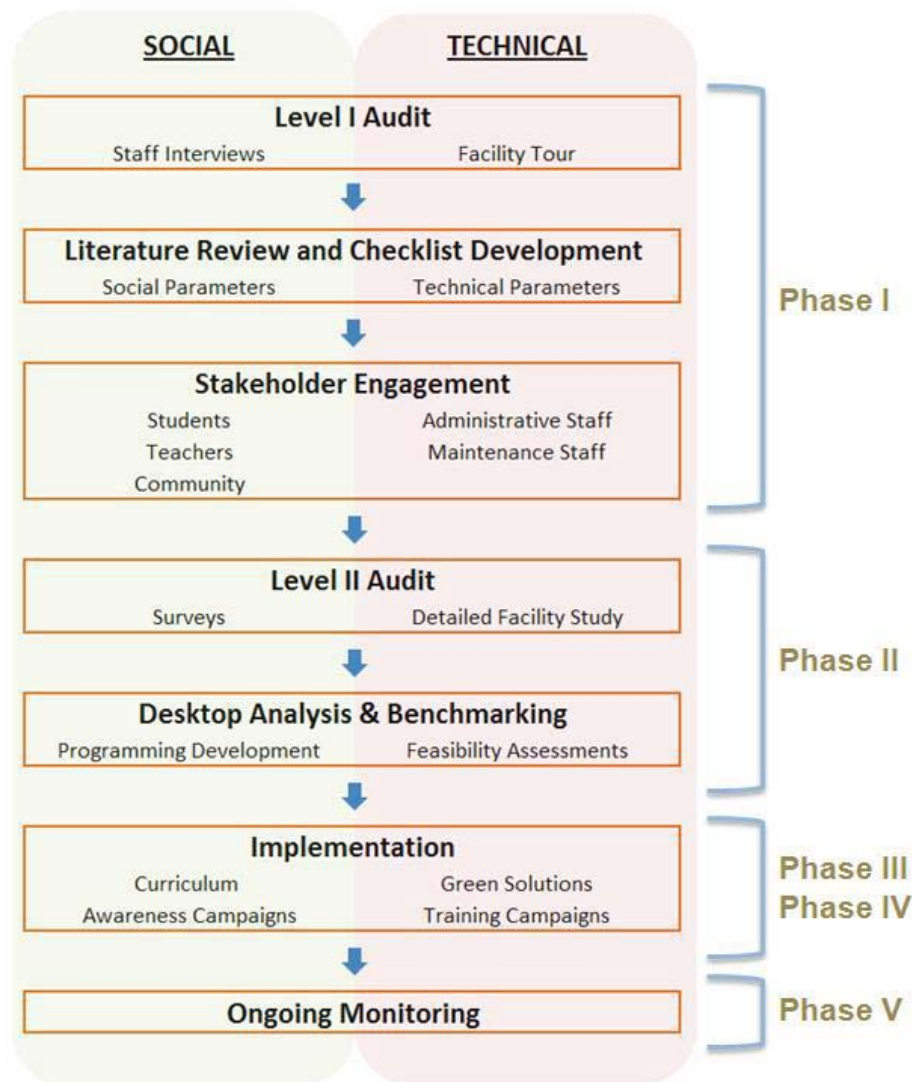
Terra Vertis' EcoSchool program remains a program under constant development and improvement based on interaction with international experts and research of similar endeavours around the world. Our end objective is to develop a world-class schooling system that is capable of enhancing students' experiences and preparing them for a challenging future.

This report outlines the pilot implementation plan at the three participating public schools in Madaba, Sahaab and Ajloun.

APPROACH & METHODOLOGY

The approach to developing a EcoSchool program is fundamentally different than that for a Green Building system. While action towards reducing the building's ecological footprint through implementation of technologies that improve water/energy usage efficiency and systems to harvest renewable potential is critical, the true focus remains on leveraging the school as an instrument for long-term social change towards sustainable behaviour. Accordingly, Terra Vertis has employed a balanced socio-technical approach, as portrayed below.

The Phase designations, on the right, correspond to the original project schedule.



Since allocation of the pilot schools for the program development, Terra Vertis' team has conducted facility walkthroughs, detailed audits, staff interviews, and school/community stakeholder presentations to develop a thorough understanding of the project scope and challenges. Accordingly, this section outlines the current status and proposed solutions for each of three school facilities below:

- [Madaba] Ma'en Elementary School for Boys
- [Sahaab] Khadegeh Bent Khwaileed Secondary School for Girls
- [Ajloun] Khawlah Bent Al-Azwar Elementary School for Boys & Girls

MA'EN ELEMENTARY SCHOOL FOR BOYS [MADABA]

The Ma'en Elementary School for Boys is situated in a rural setting in Madaba, and accommodates approximately 200 students and 15 staff members. A total of 9 classrooms cater to grades 3 through 7. The relatively new school building is in good repair and is well maintained.

ENERGY

LIGHTING

Existing System

Presently, the Ma'en School features a total of 75 working lamps in its classrooms, offices, hallways, and other common areas. Based on the audit team's assessment of the systemic and behavioural characteristics, it is estimated that 74% of the total electric consumption can be attributed to the lighting load.

The facility employs 36W florescent lamps, with 15 operational units in the original building, and 60 units in the new building.

The total annual energy consumed¹ by the lighting system is approximately 4,432 kWh².

Lighting levels are measured using specialized test equipment, with the objective of quantifying the absolute intensity of the ambient light in a given environment. The recommended intensity for a given environment varies based on the usage of the space. Hallways and corridors, for example, can function adequately under low-lighting conditions, but classrooms require adequate lighting intensity to minimize strain on the students' eyes.

Light levels that are too low (or too high) can lead to discomfort and loss of attention in the classroom. The acceptable range for lighting in classrooms (as measured at desk level) is between 300-500 lux. Based on measurement of lighting conditions in each classroom, the audit team

¹ Assuming 197 working day, 6 hour/day and the lamp turned on all time.

² For context, 1 kWh of energy is approximately the amount of energy consumed by a hair dryer or toaster, if left running for 1 hour.

concluded that the lighting levels fall within the recommended range, and that no action is necessary to alter the intensity of the system.

Proposed System

The availability of newer lighting technologies has made it possible to save energy while providing the same level of light output. Furthermore, such technologies offer superior operational longevity that leads to reduced maintenance costs and waste generation.

LED (Light Emitting Diode), as shown below, lighting technology is recommended as a replacement for the existing system at Ma'en School, as it offers significant reduction in energy consumption, and lower lifetime operational costs.



Terra Vertis recommends the replacement of all 75 Florescent (36W) Lamps with LED Lamps that yield an equivalent lux output. In this case, the recommended replacements are 18W LED T8 Lamps. It is expected that this upgrade would lead to an annual energy saving of 2,886 kWh (**65% reduction in energy consumption**).

Financial Analysis

With a unit cost of 34 JD per LED lamp, the total upgrade investment is valued at 2,550 JD (assumed 75 units). An operational cycle cost analyses is presented below to compare the current and proposed systems.

		Units	Current	Proposed
Assumed Life Cycle		[h]	30,000	
Units		[#]	75	75
Energy Cost	Unit Power Rating (including transformer)	[W]	50	18
	System Life Cycle Energy Consumption	[kWh]	112,500	40,500
	Electricity Tariff	[JD/kWh]	0.11	
	Electric Consumption Cost	[JD]	12,375	4,455
Replacement Cost	Product Life	[h]	10,000	30,000
	Number of Replacements during Life Cycle	[#]	3	1
	Unit Cost per Replacement (incl installation)	[JD]	2.5	35
	Total System Life Cycle Replacement Costs	[JD]	563	2,625
Total Life Cycle Operational Cost		[JD]	12,938	7,080

Given an assumed cycle period of 30,000 hours, the cost of the proposed system is 45% lower than that of the existing system. Furthermore, considering that the actual product life of the existing fluorescent lamps (and transformers) is degraded by frequent switching on/off, as is to be expected in a school setting, the lifetime cost savings of the proposed system (not affected by this factor) is expected to be significantly higher.

Implementation Plan / Status

Given the limited budget allocation for technical upgrades, the Terra Vertis team has been actively seeking sponsors for as many of the proposed implementations as possible. Such an approach would provide recognition for the sponsor in exchange for their in-kind contribution towards the upgrade of a school.

For the lighting system, Terra Vertis is currently in the midst of negotiating a sponsorship agreement with Light works. We anticipate a final agreement to be signed by mid-September, featuring complete support (all materials, equipment, and installation costs) for the lighting systems at the three pilot schools. The estimated value of the sponsorship for lighting at Ma'en School, alone, is estimated at approximately 2,550 JD.

The installation of the replacement system is expected to take less than 1 day, and can be completed on a weekend day, with minimal disruption to the school operations.

SPACE CONDITIONING

Existing System

A typical classroom, as shown below, has access to at least one window for basic ventilation, but lacks adequate cross-ventilation or air circulation when the only door to the room is closed – as is common practice for noise reduction while the classes are in session.

During the winters, most classrooms are equipped with a single portable kerosene heater, as shown in the bottom right corner of the image below. Such a heater, particularly with minimal air circulation and insulation, is both inefficient in its consumption of fuel, and ineffective in heating the entire classroom.



Proposed System

A hybrid solar thermal and Earth Tube Heat Exchanger (ETHE) system is proposed as central heating, cooling and ventilation for the primary building in the facility. This system will not only eliminate the need for portable kerosene heaters during winter months but also provide year-long ventilation with fresh air in-flow, and cooling during the warmer summer months. As per the preliminary design, 150m of non-corrugated drainage tubing is to be installed several meters³

³ Specialist geothermal companies have been engaged to provide local expertise on soil conductivity levels. The installation depth is expected to be between 3 and 5 meters.

below the surface in the area adjacent to the main building. A 5kW solar thermal collector array is to be installed on the roof of this building and three 1.5kW blower units will move air through the earth tubes. During winter months, the proposed system is expected to provide up to 18kW of heating, and up to 15kW of cooling during summer months.

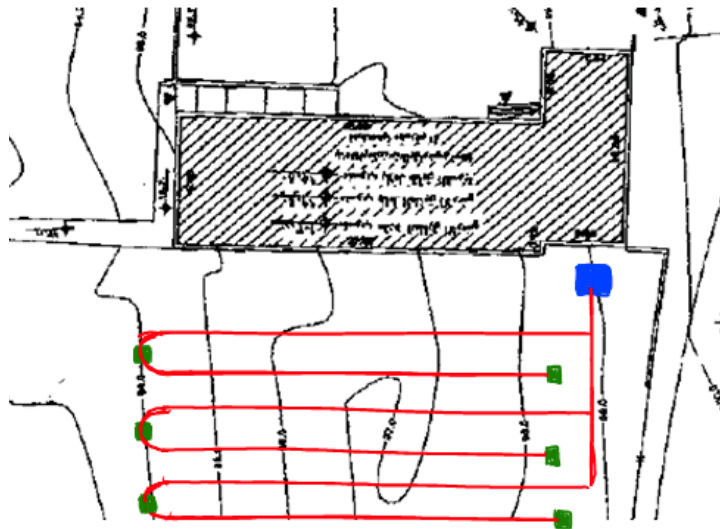


FIGURE 1 PRELIMINARY EARTH TUBE LAYOUT

Implementation Plan / Status

The project team has completed thermal load modeling for the facility, but requires a further survey of the facility since detailed site plans have been unavailable. The team is seeking specialist geothermal sub-contractors for soil thermal conductivity testing and verification of this innovative design concept. Furthermore, the experienced sub-contractor is sought to prepare a detailed financial breakdown of the implementation, and accurate performance projections.

At present, the team is in communication with MENA Geothermal and Geo-CC – two regional experts in the geothermal field. Based on their assessment of the project, we expect to finalize design and enter an implementation agreement in September.

WATER

CONSUMPTION

Existing System

Ma'en School's existing water system comprises of two primary consumption zones – a detached toilet building and a drinking water station.

The toilet building houses a total of 8 toilets and 4 sinks, all of which are in a state of general disrepair with leaking fixtures and clogged drains (image below).



The second feature is a drinking water station with a total of 12 drinking taps. Observations of the unit suggested a lack of sufficient pressure in the water output, leaking faucets, and basins that

were clogged with soil (images below). None of these conditions were suitable from an efficiency or hygienic perspective.



Proposed System

The audit team recommends an overall renovation of the toilet and drinking water facilities with the following specific upgrades:

- Installation of water saving toilet fixtures (low liters per flush).
 - Usage of recycled Gray water, as discussed in a subsequent section.
- Replacement of all faucets (sinks and drinking station) with spring-loaded push mechanisms for automatic shutoff, and aerator units to throttle flow rate.
 - Installation of Gray water/irrigation water harvesting mechanisms, as discussed in a subsequent section.
- Installation of a reverse osmosis filtration system at the drinking water station.



These measures are expected to curb overall domestic water consumption by up to 30%, making the availability of water more reliable during the dry months.

Furthermore, the team recommends the installation of a reverse osmosis filtration system at the drinking water station, to ensure that students have access to clean drinking water. The supply to the individual taps is to be routed through the filter system.

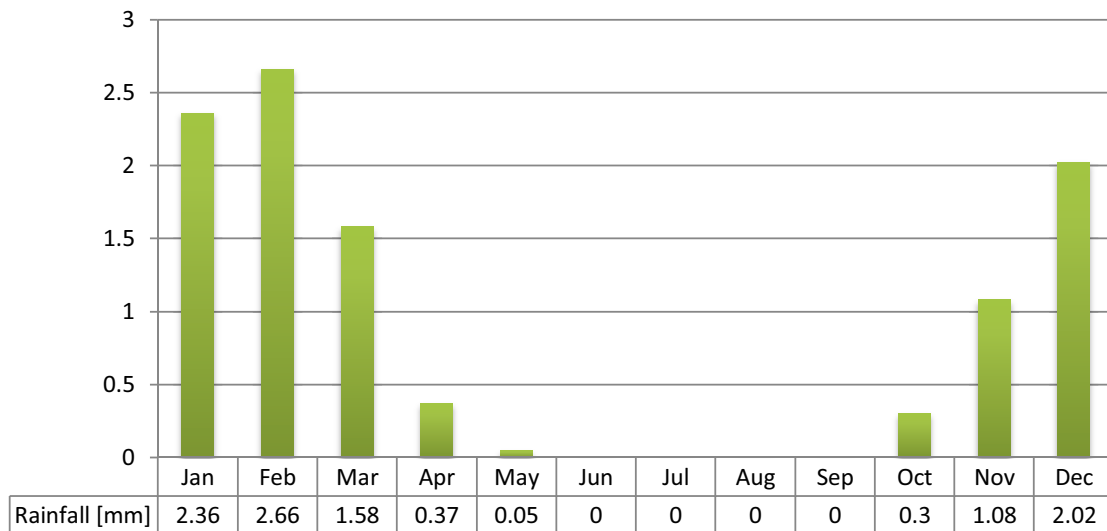
Implementation Plan / Status

Presently, the team has entered an agreement with a general contractor who is acquiring quotations for the necessary materials and is expected to initiate implementation in 2 weeks'

time. The disruption caused by the implementation of the water efficiency and filtration upgrades is expected to be minimal.

RAIN WATER HARVESTING

Local Precipitation Data



Existing System

Ma'en School does not, presently, feature a rainwater harvesting system.

Proposed System

The audit team recommends the installation of purpose built rain water harvesting system that would allow offsetting of on-site irrigation demand to dryer months. The storage capacity is to be optimized such that it is sufficient to allow year-round irrigation of a designated 'green zone', with little or no input from the domestic water supply.

Implementation Plan / Status

A preliminary survey of the facility has led the team to a tentative decision on the location of the in-ground tank. However, detailed analysis of the terrain gradients is needed before the size of the

tank can be determined. Furthermore, the team is awaiting confirmation on the location of new classrooms that are being built, as there is possibility of interference with the proposed harvesting system.

The site plans provided for the facility do not feature any sort of accurate scale, rendering them unusable for the design team's purposes. Terra Vertis is therefore required to complete a detailed survey of the facility. As this activity had not been budgeted for, we do not have the option of outsourcing or sub-contracting the work.

Having now completed the survey work for Ajloun School, the team is redirecting its focus to the Ma'en facility.

GRAY WATER HARVESTING

Existing System

The staff at Ma'en School have demonstrated their existing innovative commitment to the environment by their installation of an ad-hoc gray water harvesting system between the drinking station drainage and the irrigation needs of trees in the area. The images below showcases their work:



Proposed System

Terra Vertis' audit team agrees with the schools gray water-irrigation initiative and proposes the installation of an upgraded system that utilizes water from both the drinking water station and distributes it to the trees in the area.

Furthermore, the team proposes the installation of an independent gray water system that harvests drainage from the sinks in the toilet, and stores it in a tank for usage in the flushing of the toilets.

Implementation Plan / Status

A general contractor has been engaged for both activities, and is in the process of acquiring the necessary quotations before embarking on the implementation.

WASTE MANAGEMENT

Existing System

Ma'en School presently lacks a functional waste management system, as is evident by their current practice of dumping waste material (including non-biodegradable plastics) in the far corner of the school grounds (image below).



Other than very basic waste receptacles within the school building, there is no evidence of students or staff practicing waste segregation and/or management. The problem appears to be both systemic and a result of insufficient awareness.

Proposed System

To address this issue, Terra Vertis is in the process of designing a unique 5-way receptacle (Plastic, Glass/Metal, Paper, Organic, Other) that features an educational display that would encourage students and staff to practice waste segregation and learn of the ecological impact of waste generation itself. The design criteria for this unit include: minimal manufacturing cost, minimal operational maintenance, environmental robust for both indoor and outdoor implementation, re-use of generic 'grocery store' bags as waste containers (waste in itself), and maximum educational impact.

A rendering of the product is presented below. The team is currently acquiring quotations from custom manufacturers, with the intent of mass production and widespread implementation once the units have been tested as part of the pilot project. Presented, as well, is a sample display to be installed above the receptacle bins, with the intent of labeling each bin and providing information on the waste type.



بلاستيك Plastic	زجاج Glass	ورق Paper	نفايات أخرى Other Trash
العبوة البلاستيكية الواحدة تحتاج إلى ٤٥٠ عام حتى تتحلل في الأرض	الزجاج الملقى في الحاويات لا يتحلل أبداً	نحن نقطع ١٧ شجرة لإنتاج طن من الورق	حافظ على البيئة من خلال التقليل من نفاياتك

It is recommended that these units be installed both indoors and outdoors, in high traffic public areas (particularly where high quantities of waste matter are generated – eating areas, for example). The decision on the final number of installed units, and the distribution, is pending a final valuation of the unit cost.

Unfortunately, the municipality currently does not offer a recycling program that would support the management of the segregated waste – and the implementation of such an infrastructure change is beyond the scope of the present undertaking. Nevertheless, the inherent objective of the EcoSchool program is to serve as a catalyst for change towards environmentally sustainable practices and policies in the wider community. We expect that by the schools serving as a starting point for awareness of waste management practices, and becoming the first ‘customers’ to demand proper management of their waste, the necessary changes to the municipality’s waste management system will soon follow.

As a starting point, the municipality would be requested to supply 4 independent dumpsters (Plastic, Glass/Metal, Paper and Other). This would allow the school to do its part and deliver segregated waste to the municipal waste management system.

To deal with the last type of waste (organic), the Terra Vertis team has included a Composting program within the social component of the project, allowing the school to deal with organic waste on site, and utilize it for fertilization of its own ‘Green Zone’. A composting program, such as this, offers students the hands-on ability to learn about organic waste management, and to replicate such efforts in their homes.

Implementation Plan

Terra Vertis has completed design of the product (full 3D rendering of the desired unit), and is in the process of acquiring quotations from manufacturers capable of assembling the product itself.

We expect to have final quotations, including production timeline before the end of September. Once manufactured, the installation of the units into the school is expected to cause negligible disruption, with the possibility of installing all units in under one weekend day.

ENVIRONMENT

Existing Systems

An environmental system, as relevant to the objectives of an EcoSchool, is any space that is purposefully designed for students to engage interactively with their immediate ecosystem. In the case of Ma'en School, the students are fortunate to have access to a particularly 'green' campus, with a significant number of trees and, with adequate irrigation, potential for further utilization of the available soil.



Proposed System

With its rainwater and gray water harvesting potential, Ma'en School offers significant scope for the development of a sustainable 'green zone' that students can access for the practical implementation of sustainable farming/permaculture learning objectives.

Support material for such programming has been included in Terra Vertis' social programming for this project. The image below presents a suitable zone for such an implementation, immediately beside the school's science laboratories.



Pending completion of the site survey (particularly soil assessment and sizing of the recommended green zone), the team can complete irrigation load assessments and finalize a plan to implement in this area:

- a shaded areas;
- zoned cultivation areas with water retention barriers;
- drip irrigation system; and
- a composting pit.

Implementation Plan

As with the rainwater harvesting system, further design development is hindered by the unavailability of site plans, and is pending completion of a detailed site survey (scheduled for mid-September).

A general contractor has already been procured, and is ready to commence implementation as soon as the final criteria are established. Being an outdoor space, the intervention is expected to cause minimal disruption to the school's operations.

KHADEGEH BENT KHWAILED SECONDARY SCHOOL FOR GIRLS [SAHAAB]

ENERGY

LIGHTING

Existing System

Presently, the Khadejeh Bent Khwailed School features a total of 236 working lamps in its classrooms, offices, hallways, and other common areas. Based on the audit team's assessment of the systemic and behavioural characteristics, it is estimated that 92% of the total electric consumption can be attributed to the lighting load.

The total annual energy consumed⁴ by the lighting system is approximately 13,948 kWh⁵.



⁴ Assuming 197 working day, 6hour/day and the lamp turned on all time.

⁵ For context, 1 kWh of energy is approximately the amount of energy consumed by a hair dryer or toaster, if left running for 1 hour.

Lighting levels are measured using specialized test equipment, with the objective of quantifying the absolute intensity of the ambient light in a given environment. The recommended intensity for a given environment varies based on the usage of the space. Hallways and corridors, for example, can function adequately under low-lighting conditions, but classrooms require adequate lighting intensity to minimize strain on the students' eyes.

Light levels that are too low (or too high) can lead to discomfort and loss of attention in the classroom. The acceptable range for lighting in classrooms (as measured at desk level) is between 300-500 lux. Based on measurement of lighting conditions in each classroom, the audit team concluded that the lighting levels fall within the recommended range, and that no action is necessary to alter the intensity of the system.

Proposed System

The availability of newer lighting technologies has made it possible to save energy while providing the same level of light output. Furthermore, such technologies offer superior operational longevity that leads to reduced maintenance costs and waste generation.

LED (Light Emitting Diode), as shown below, lighting technology is recommended as a replacement for the existing system at Khadejeh Bent Khwailed School, as it offers significant reduction in energy consumption, and lower lifetime operational costs.



Terra Vertis recommends the replacement of all 236 Florescent (36W) Lamps with LED Lamps that yield an equivalent lux output. In this case, the recommended replacements are 18W LED T8

Lamps. It is expected that this upgrade would lead to an annual energy saving of 8,927 kWh (**64% reduction in energy consumption**).

Financial Analysis

With a unit cost of 34 JD per LED lamp, the total upgrade investment is valued at 8,024 JD (assumed 236 units). An operational cycle cost analyses is presented below to compare the current and proposed systems.

		Units	Current	Proposed
Assumed Life Cycle		[h]	30,000	
Units		[#]	236	236
Energy Cost	Unit Power Rating (including transformer)	[W]	50	18
	System Life Cycle Energy Consumption	[kWh]	354000	127440
	Electricity Tariff	[JD/kWh]	0.11	
	Electric Consumption Cost	[JD]	38940	14018
Replacement Cost	Product Life	[h]	10,000	30,000
	Number of Replacements during Life Cycle	[#]	3	1
	Unit Cost per Replacement (incl installation)	[JD]	2.5	35
	Total System Life Cycle Replacement Costs	[JD]	1770	8260
Total Life Cycle Operational Cost		[JD]	40710	22278

Given an assumed cycle period of 30,000 hours, the cost of the proposed system is 45% lower than that of the existing system. Furthermore, considering that the actual product life of the existing fluorescent lamps (and transformers) is degraded by frequent switching on/off, as is to be expected in a school setting, the lifetime cost savings of the proposed system (not affected by this factor) is expected to be significantly higher.

Implementation Plan / Status

Given the limited budget allocation for technical upgrades, the Terra Vertis team has been actively seeking sponsors for as many of the proposed implementations as possible. Such an approach would provide recognition for the sponsor in exchange for their in-kind contribution towards the upgrade of a school.

For the lighting system, Terra Vertis is currently in the midst of negotiating a sponsorship agreement with LightWorks. We anticipate a final agreement to be signed by mid-September, featuring complete support (all materials, equipment, and installation costs) for the lighting

systems at the three pilot schools. The estimated value of the sponsorship for lighting at Khadejeh Bent Khwailed School, alone, is estimated at approximately 8,024 JD.

The installation of the replacement system is expected to take less than 1 day, and can be completed on a weekend day, with minimal disruption to the school operations.

WATER

CONSUMPTION

Existing System

Khadejeh Bent Khwailed School's existing water system comprises multiple indoor toilets (on different floors), and an outdoor drinking water station.



Proposed System

The audit team recommends an overall renovation of the toilet and drinking water facilities with the following specific upgrades:

- Installation of water saving toilet fixtures (low liters per flush).
 - Usage of recycled Gray water, as discussed in a subsequent section.
- Replacement of all faucets (sinks and drinking station) with spring-loaded push mechanisms for automatic shutoff, and aerator units to throttle flow rate.

- Installation of localized gray water harvesting mechanisms, as discussed in a subsequent section.
- Installation of a reverse osmosis filtration system at the drinking water stations.



These measures are expected to curb overall domestic water consumption by up to 30%, making the availability of water more reliable during the dry months.

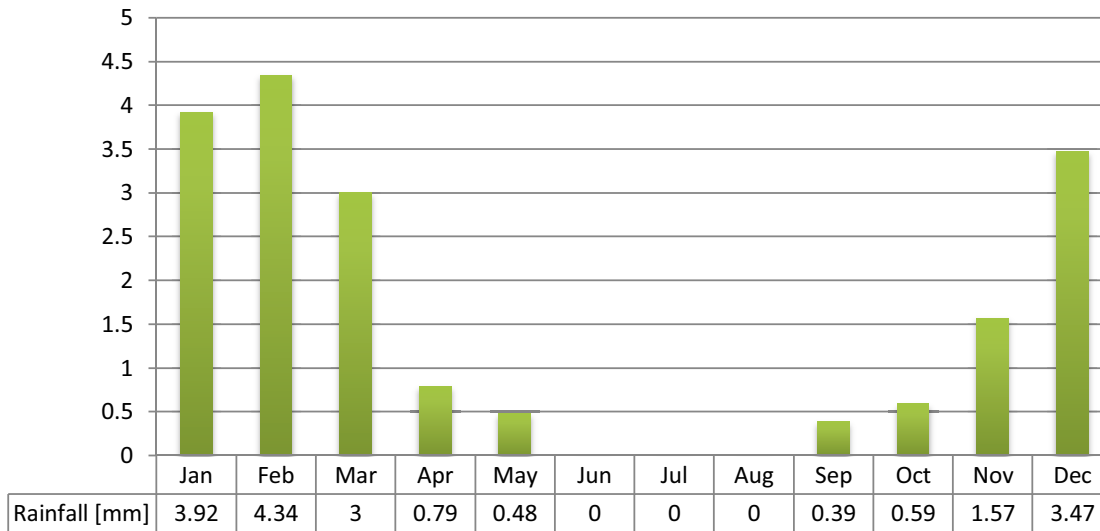
Furthermore, the team recommends the installation of a reverse osmosis filtration system at the drinking water station, to ensure that students have access to clean drinking water. The supply to the individual taps is to be routed through the filter system.

Implementation Plan / Status

Presently, the team has entered an agreement with a general contractor who is acquiring quotations for the necessary materials and is expected to initiate implementation towards the end of September. The disruption caused by the implementation of the water efficiency and filtration upgrades is expected to be minimal.

RAIN WATER HARVESTING

Local Precipitation Data



Existing System

Khadejeh Bent Khwailed School does not, presently, feature a rainwater harvesting system.



Proposed System

Given the significant rooftop space at the facility, and the shape of the building itself, Terra Vertis' audit team assessed the potential of a decentralized rainwater harvesting system – specifically the installation of smaller, above-ground, tanks at each rainwater downspout from the building. Holding the water in multiple such locations opens up the possibility of installing a wider spread green space (potentially along the perimeter of the courtyard, as shown in the image above), with its irrigation demands met exclusively with harvested rainwater.

Implementation Plan / Status

Further development of the proposed rainwater harvesting system is pending completion of a detailed site survey, and generation of a site plan.

GRAY WATER HARVESTING

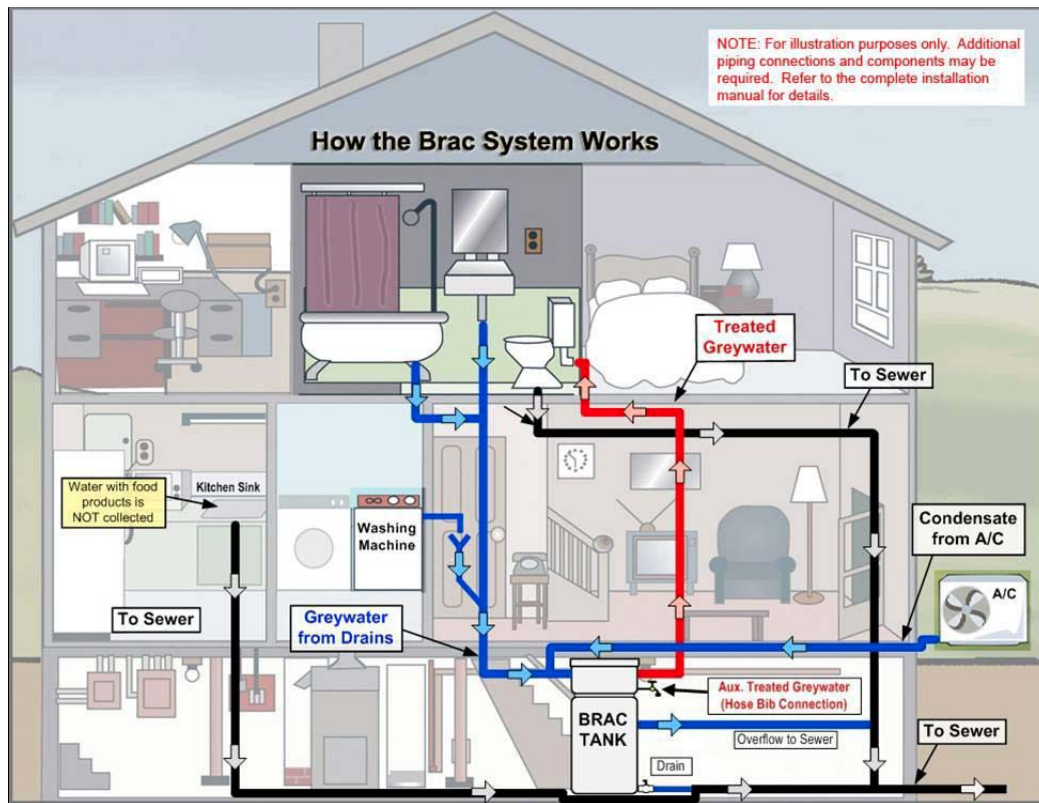
Existing System

Khadejeh Bent Khwailed School does not, presently, feature a gray water harvesting system.

Proposed System

Given the locations of the toilets in the building and the potential for gray water generation, Terra Vertis proposes the installation of a centralized gray water harvesting system, whereby all drainage water is harvested and treated for reuse as part of the irrigation system, for flushing of toilets, or for cleaning purposes.

Terra Vertis is engaged in discussions with Kavar for a suitable Brac System (illustrated below).



Implementation Plan / Status

Once again, progress on the further development of the gray water harvesting system is hindered by the development of a detailed site plan.

WASTE MANAGEMENT

Existing System

Based on the audit team's observations, Khadejeh Bent Khwailed School did not appear to have problems with their conventional waste management practices. There was no stray litter anywhere on the campus grounds. However, there was also no waste segregation or recycling program implemented at the school.

Proposed System

Terra Vertis proposes the installation of specialized 5-way waste receptacles (Plastic, Glass/Metal, Paper, Organic, Other) that feature an educational display designed to encourage students and staff to practice waste segregation and learn of the ecological impact of waste generation itself. The design criteria for this unit include: minimal manufacturing cost, minimal operational maintenance, environmental robust for both indoor and outdoor implementation, re-use of generic 'grocery store' bags as waste containers (waste in itself), and maximum educational impact.

A rendering of the product is presented below. The team is currently acquiring quotations from custom manufacturers, with the intent of mass production and widespread implementation once the units have been tested as part of the pilot project. Presented, as well, is a sample display to be installed above the receptacle bins, with the intent of labeling each bin and providing information on the waste type.



بلاستيك Plastic	زجاج Glass	ورق Paper	نفايات أخرى Other Trash
العبوة البلاستيكية الواحدة تحتاج إلى ٤٥٠ عام حتى تتحلل في الأرض	الزجاج الملقى في الحاويات لا يتحلل أبداً	نحن نقطع ١٧ شجرة لإنتاج طن من الورق	حافظ على البيئة من خلال التقليل من نفاياتك

It is recommended that these units be installed both indoors and outdoors, in high traffic public areas (particularly where high quantities of waste matter are generated – eating areas, for example). The decision on the final number of installed units, and the distribution, is pending a final valuation of the unit cost.

Unfortunately, the municipality currently does not offer a recycling program that would support the management of the segregated waste – and the implementation of such an infrastructure change is beyond the scope of the present undertaking. Nevertheless, the inherent objective of the EcoSchool program is to serve as a catalyst for change towards environmentally sustainable practices and policies in the wider community. We expect that by the schools serving as a starting point for awareness of waste management practices, and becoming the first ‘customers’ to demand proper management of their waste, the necessary changes to the municipality’s waste management system will eventually follow.

As a starting point, the municipality would be requested to supply 4 independent dumpsters (Plastic, Glass/Metal, Paper and Other). This would allow the school to do its part and deliver segregated waste to the municipal waste management system.

To deal with the last type of waste (organic), the Terra Vertis team has included a Composting program within the social component of the project, allowing the school to deal with organic waste on site, and utilize it for fertilization of its own ‘Green Zone’.

Implementation Plan

Terra Vertis has completed design of the product (full 3D rendering of the desired unit), and is in the process of acquiring quotations from manufacturers capable of assembling the product itself.

We expect to have final quotations, including production timeline before the end of September. Once manufactured, the installation of the units into the school is expected to cause negligible disruption, with the possibility of installing all units in under one weekend day.

ENVIRONMENT

Existing Systems

An environmental system, as relevant to the objectives of an EcoSchool, is any space that is purposefully designed for students to engage interactively with their immediate ecosystem. In the case of Khadejeh Bent Khwailed School, however, the campus is virtually devoid of any natural green spaces, even though the orientation and elevation of the building does offer sufficient outdoor shading.



Proposed System

Terra Vertis proposes the installation of a purpose built 'green-zone' within the school yard, with educational and interactive features built in. Given the paved nature of the school campus, however, the ability to use natural landscaping is limited. As an alternative, Terra Vertis recommends the utilization of Green Roofing technology to create a suitable soil base on top of the existing pavement.

Irrigation demands for this space can be met directly by the rainwater harvesting system, as discussed previously.

Implementation Plan / Status

Khadejeh Bent Khwailed School has yet to be surveyed for a detailed site plan. The audit team currently has access to a siteplan version that seems both incomplete and inaccurate in its scale. Therefore, further development of the environmental system design is pending completion of the necessary layout plan.

The team is, however, engaged in discussion with a specialist Green Roofing and Landscaping firm, GREENCarpet, and is hoping to collaboratively design an appropriate space that is both educational and interactive for the students.

KHAWLAH BENT AL-AZWAR ELEMENTARY SCHOOL FOR BOYS & GIRLS [AJLOUN]

Located in Kuranjeh, Ajlun, the school is situated in Kufranjeh village between different roads from three directions and an abandoned land on the northern side.

There are 18 classes and 8 other rooms in the two floor building, housing a total of 616 students divided between 8th grades plus the kindergarten, moreover, it has boys in the kindergarten and 1st grade only, the number of school's staff is 35.

ENERGY

LIGHTING

Existing System

Presently, the Khawlah Bent Al-Azwar School features a total of 74 working lamps in its classrooms, offices, hallways, and other common areas. Based on the audit team's assessment of the systemic and behavioural characteristics, it is estimated that 57% of the total electric consumption can be attributed to the lighting load.

The total annual energy consumed⁶ by the lighting system is approximately 4,373 kWh⁷.

Lighting levels are measured using specialized test equipment, with the objective of quantifying the absolute intensity of the ambient light in a given environment. The recommended intensity for a given environment varies based on the usage of the space. Hallways and corridors, for example, can function adequately under low-lighting conditions, but classrooms require adequate lighting intensity to minimize strain on the students' eyes.

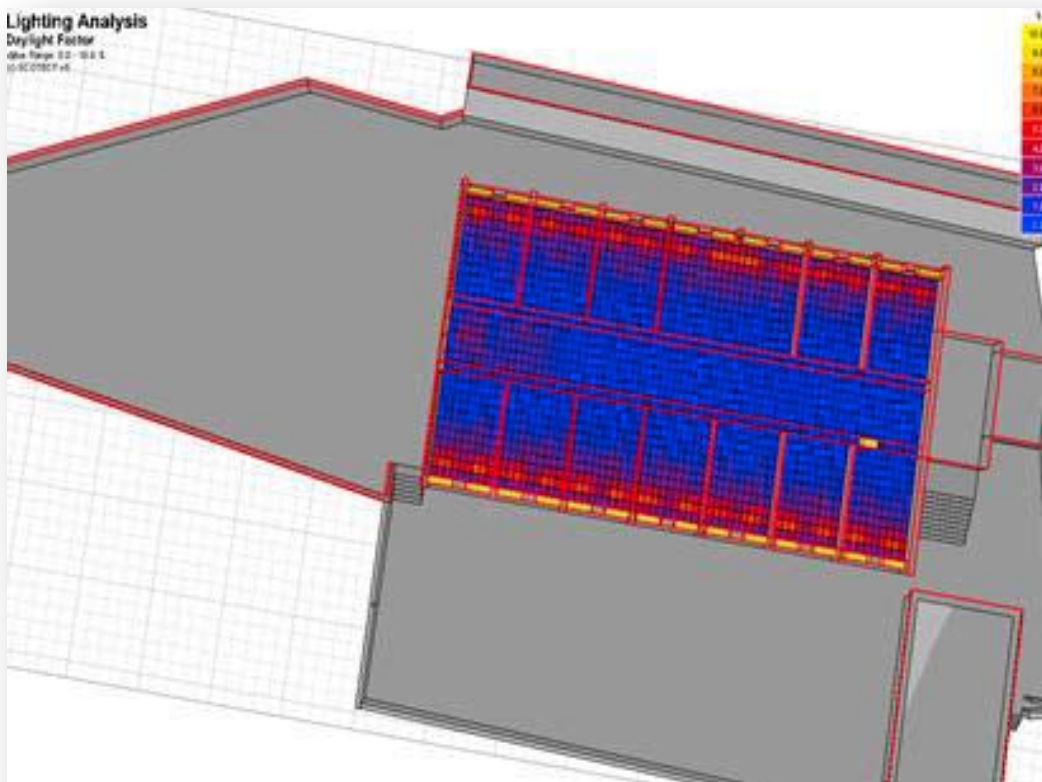
⁶ Assuming 197 working day, 6hour/day and the lamp turned on all time.

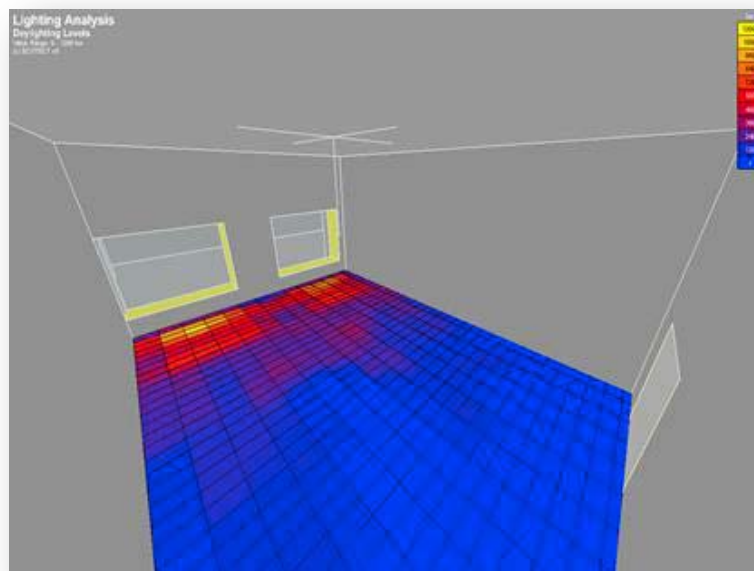
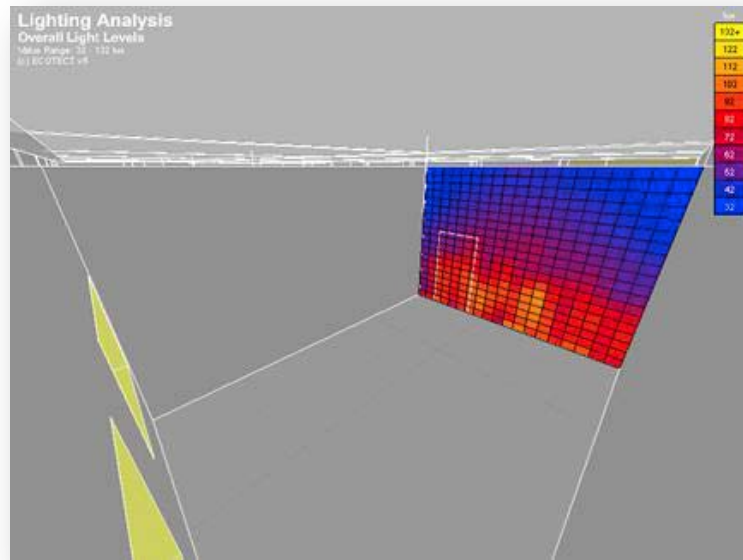
⁷ For context, 1 kWh of energy is approximately the amount of energy consumed by a hair dryer or toaster, if left running for 1 hour.

Light levels that are too low (or too high) can lead to discomfort and loss of attention in the classroom. The acceptable range for lighting in classrooms (as measured at desk level) is between 300-500 lux.

Based on measurement of lighting conditions in each classroom, the audit team concluded that the lighting levels lower than the recommended range, which it found to be in the range of 150-250. Ambient light level enhancements are therefore necessary.

Presented below are interior lighting simulations that quantitatively evaluate the light intensity throughout the building, accounting for all natural (daylighting) and artificial light sources.





As verified through this analysis, the light levels at desk level, and on the blackboard wall are inadequate for classroom conditions. The same analysis does allow the lighting design team to analyze the effects of higher lumen-output fixtures and can, accordingly, estimate optimal requirements for the replacements.



Proposed System

The lighting system at Khawlah Bent Al-Azwar School is faced with the following two challenges:

- Inadequate classroom lighting intensity.
- Replacement of existing lighting system with one that offers lower energy consumption, maintenance expenses, and operation costs.

The availability of newer lighting technologies has made it possible to save energy while providing the same level of light output. Furthermore, such technologies offer superior operational longevity that leads to reduced maintenance costs and waste generation.

LED (Light Emitting Diode), as shown below, lighting technology is recommended as a replacement for the existing system at Khawlah Bent Al-Azwar School, as it offers significant reduction in energy consumption, and lower lifetime operational costs.



In order to increase lighting levels to appropriate levels, our simulations suggest that 26W T8 LED fixtures will bring lux levels within the recommended range. As a result, energy cost savings relative to the present system cannot be compared directly (the lux output capacities of the present and the proposed system are not the same).

Terra Vertis recommends the replacement of all 74 Florescent (36W) Lamps with 26W LED T8 Lamps. It is expected that even with the higher output lamps an annual energy savings of 2,099 kWh (**48% reduction in energy consumption**) is expected.

Financial Analysis

With a unit cost of 44 JD per LED lamp, the total upgrade investment is valued at 2,516 JD (assumed 74 units). An operational cycle cost analyses is presented below to compare the current and proposed systems.

		Units	Current	Proposed
Assumed Life Cycle		[h]	30,000	
Units		[#]	74	74
Energy Cost	Unit Power Rating (including transformer)	[W]	50	26
	System Life Cycle Energy Consumption	[kWh]	111000	57720
	Electricity Tariff	[JD/kWh]	0.11	
	Electric Consumption Cost	[JD]	12210	6349.2
Replacement Cost	Product Life	[h]	10,000	30,000
	Number of Replacements during Life Cycle	[#]	3	1
	Unit Cost per Replacement (incl installation)	[JD]	2.5	35
	Total System Life Cycle Replacement Costs	[JD]	555	2590
Total Life Cycle Operational Cost		[JD]	12765	8939.2

Given an assumed cycle period of 30,000 hours, the cost of the proposed system is 25% lower than that of the existing system. Furthermore, considering that the actual product life of the existing fluorescent lamps (and transformers) is degraded by frequent switching on/off, as is to be expected in a school setting, the lifetime cost savings of the proposed system (not affected by this factor) is expected to be significantly higher.

Implementation Plan / Status

Given the limited budget allocation for technical upgrades, the Terra Vertis team has been actively seeking sponsors for as many of the proposed implementations as possible. Such an approach

would provide recognition for the sponsor in exchange for their in-kind contribution towards the upgrade of a school.

For the lighting system, Terra Vertis is currently in the midst of negotiating a sponsorship agreement with Light works. We anticipate a final agreement to be signed by mid-September, featuring complete support (all materials, equipment, and installation costs) for the lighting systems at the three pilot schools. The estimated value of the sponsorship for lighting at Khawlah Bent Al-Azwar School, alone, is estimated at approximately 3,256 JD

The installation of the replacement system is expected to take less than 1 day, and can be completed on a weekend day, with minimal disruption to the school operations.

WATER

CONSUMPTION

Existing System

Khawlah Bent Al-Azwar School's existing water system comprises of two primary consumption zones – a detached toilet building and a drinking water station.

The available data on water consumption patterns is presented below:

Year	Qtr	Consumption	
		[cubic m]	[JD]
2005	1	90.00	136.30
	2	100.00	151.30
	3	70.00	106.30
	4	80.00	124.95
	Total	340.00	518.85
2006	1	80.00	124.90
	2	70.00	109.90
	3	60.00	94.90
	4	60.00	94.90
	Total	270.00	424.60
2007	1	50.00	79.90
	2	50.00	79.90
	3	79.00	123.40
	4	60.00	94.90
	Total	239.00	378.10



Proposed System

The audit team recommends an overall renovation of the toilet and drinking water facilities with the following specific upgrades:

- Installation of water saving toilet fixtures (low liters per flush).
 - Usage of recycled Gray water, as discussed in a subsequent section.
- Replacement of all faucets (sinks and drinking station) with spring-loaded push mechanisms for automatic shutoff, and aerator units to throttle flow rate.
 - Installation of Gray water/irrigation water harvesting mechanisms, as discussed in a subsequent section.
- Installation of a reverse osmosis filtration system at the drinking water station.



These measures are expected to curb overall domestic water consumption by up to 30%, making the availability of water more reliable during the dry months.

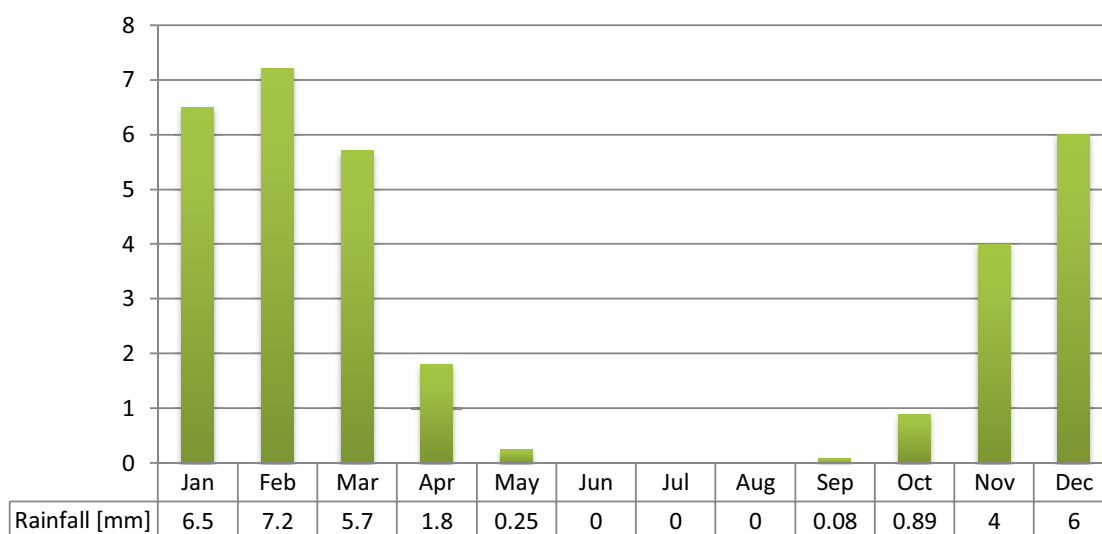
Furthermore, the team recommends the installation of a reverse osmosis filtration system at the drinking water station, to ensure that students have access to clean drinking water. The supply to the individual taps is to be routed through the filter system.

Implementation Plan / Status

Presently, the team has entered an agreement with a general contractor who is acquiring quotations for the necessary materials and is expected to initiate implementation in 2 weeks' time. The disruption caused by the implementation of the water efficiency and filtration upgrades is expected to be minimal.

RAIN WATER HARVESTING

Local Precipitation Data



Khawlah Bent Al-Azwar School's location in Ajloun allows it to benefit from one of the highest average rainfalls in Jordan. As depicted in the chart above, the annual total precipitation amounts to approximately 33mm, or three times the annual average.

These conditions are ideal for rainwater harvesting, and make Khawlah Bent Al-Azwar School a focal point for Terra Vertis' efforts at developing a suitable system.

Existing System

Khawlah Bent Al-Azwar School does not, presently, feature a rainwater harvesting system.

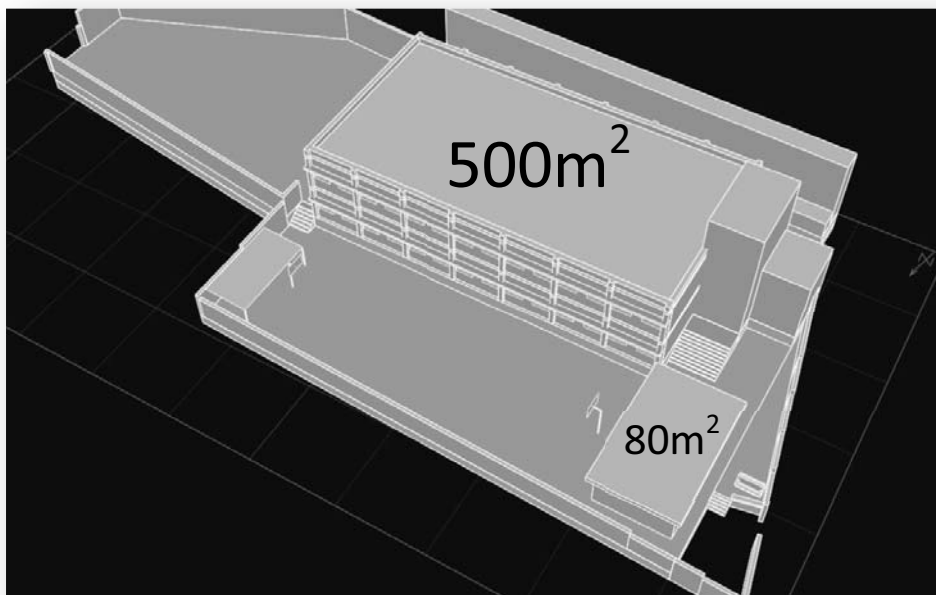
Proposed System

Having completed a detailed site survey of the facility, including mapping of the natural on-site water ways, the audit team has established the ideal location for the installation of a tank as being the far corner of the campus, below the drinking water station (north east corner). Most drainage

pipes from the rooftops of the school and toilet buildings re-direct water flow to this area, as shown below.



As illustrated in the image below, the rooftop collection area totals 580 m^2 . Given the annual rainfall in the area, approximately 19,000 L can be harvested annually. However, considering the flow of water on the remainder of the campus, it is likely that the vast majority of the remaining surface runoff would also lead into the well.



The storage capacity of the well is expected to be sufficient enough to suit year-round irrigation of the school's green zone, and as an alternative source for flushing of toilets (combined with gray water system).

Implementation Plan

Terra Vertis has already engaged a general contractor for the implementation of the necessary well. The final sizing (and costing) of the well is pending assessment of the location by a local civil engineer to ensure that we do not encounter interference with an underground septic tank or municipal piping.

Depending on soil composition (loamy or rocky), the expected cost of implementation is between 2,000 and 3,000 JD. The digging of the well is expected to take one week.

GRAY WATER HARVESTING

Existing System

Khawlah Bent Al-Azwar School does not, presently, feature a gray water harvesting system.

Proposed System

Due to site proximity of the two systems, Terra Vertis proposes combining the gray water system with the infrastructure for the rainwater harvesting system. Particularly, the team recommends that the same tank/well be utilized for containment of drainage water from sink and drinking water taps, and then reused for toilet flushing and irrigation purposes.

Implementation Plan

Accordingly, the implementation of this system is closely associated with that of the rainwater harvesting system. Aside from digging the well, minimal intervention is necessary to install piping from the toilet to the reservoir. The same contractor/engineer for the rainwater harvesting system have been engaged for this purpose.

WASTE MANAGEMENT

Existing System

Based on the audit team's observations, Khawlah Bent Al-Azwar School did not appear to have problems with their conventional waste management practices. There was no stray litter anywhere on the campus grounds. However, there was also no waste segregation or recycling program implemented at the school.

Other than very basic waste receptacles within the school building, there is no evidence of students or staff practicing waste segregation and/or management. The problem appears to be both systemic and a result of insufficient awareness.

Proposed System

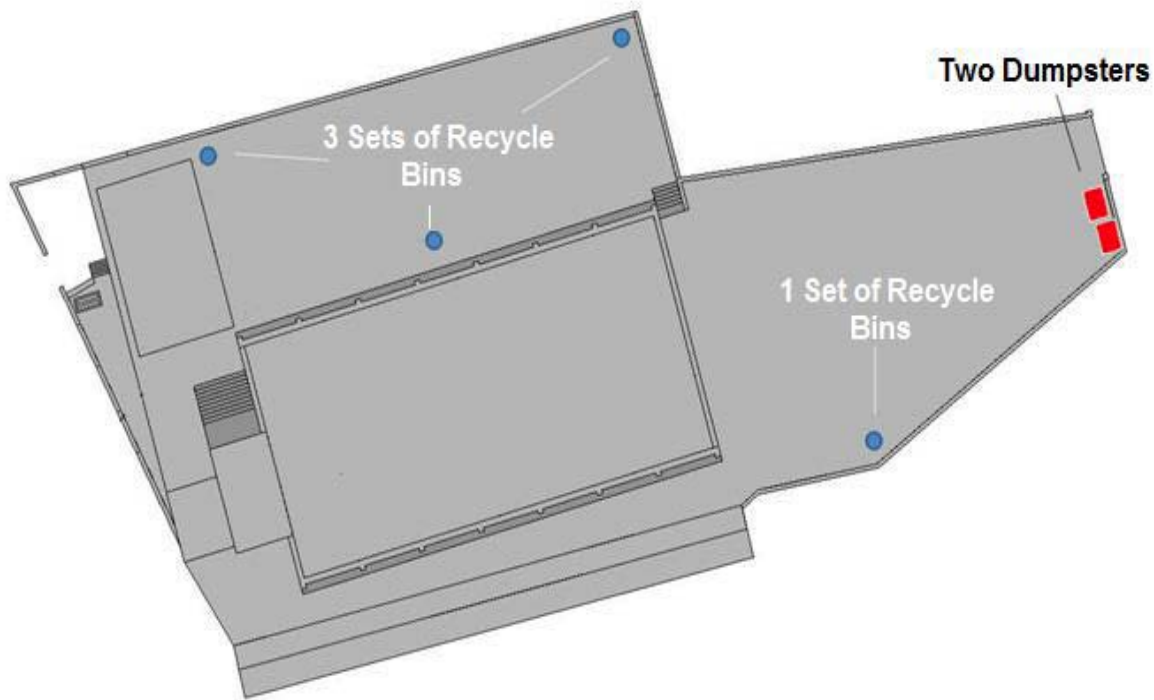
Terra Vertis proposes the installation of specialized 5-way waste receptacles (Plastic, Glass/Metal, Paper, Organic, Other) that feature an educational display designed to encourage students and staff to practice waste segregation and learn of the ecological impact of waste generation itself. The design criteria for this unit include: minimal manufacturing cost, minimal operational maintenance, environmental robust for both indoor and outdoor implementation, re-use of generic 'grocery store' bags as waste containers (waste in itself), and maximum educational impact.

A rendering of the product is presented below. The team is currently acquiring quotations from custom manufacturers, with the intent of mass production and widespread implementation once the units have been tested as part of the pilot project. Presented, as well, is a sample display to be installed above the receptacle bins, with the intent of labeling each bin and providing information on the waste type.



نفايات أخرى Other Trash	ورق Paper	زجاج Glass	بلاستيك Plastic
حافظ على البيئة من خلال التقليل من نفاياتك	نحن نقطع ١٧ شجرة لإنتاج طن من الورق	الزجاج الملقى في الحاويات لا يتحلل أبداً	العبوة البلاستيكية الواحدة تحتاج إلى ٤٥٠ عام حتى تتحلل في الأرض

It is recommended that these units be installed both indoors and outdoors, in high traffic public areas (particularly where high quantities of waste matter are generated – eating areas, for example). The decision on the final number of installed units, and the distribution, is pending a final valuation of the unit cost.



Unfortunately, the municipality currently does not offer a recycling program that would support the management of the segregated waste – and the implementation of such an infrastructure change is beyond the scope of the present undertaking. Nevertheless, the inherent objective of the EcoSchool program is to serve as a catalyst for change towards environmentally sustainable practices and policies in the wider community. We expect that by the schools serving as a starting point for awareness of waste management practices, and becoming the first ‘customers’ to demand proper management of their waste, the necessary changes to the municipality’s waste management system will eventually follow.

As a starting point, the municipality would be requested to supply 4 independent dumpsters (Plastic, Glass/Metal, Paper and Other). This would allow the school to do its part and deliver segregated waste to the municipal waste management system.

To deal with the last type of waste (organic), the Terra Vertis team has included a Composting program within the social component of the project, allowing the school to deal with organic waste on site, and utilize it for fertilization of its own ‘Green Zone’.

Implementation Plan

Terra Vertis has completed design of the product (full 3D rendering of the desired unit), and is in the process of acquiring quotations from manufacturers capable of assembling the product itself.

We expect to have final quotations, including production timeline before the end of September. Once manufactured, the installation of the units into the school is expected to cause negligible disruption, with the possibility of installing all units in under one weekend day.

ENVIRONMENT

Existing Systems

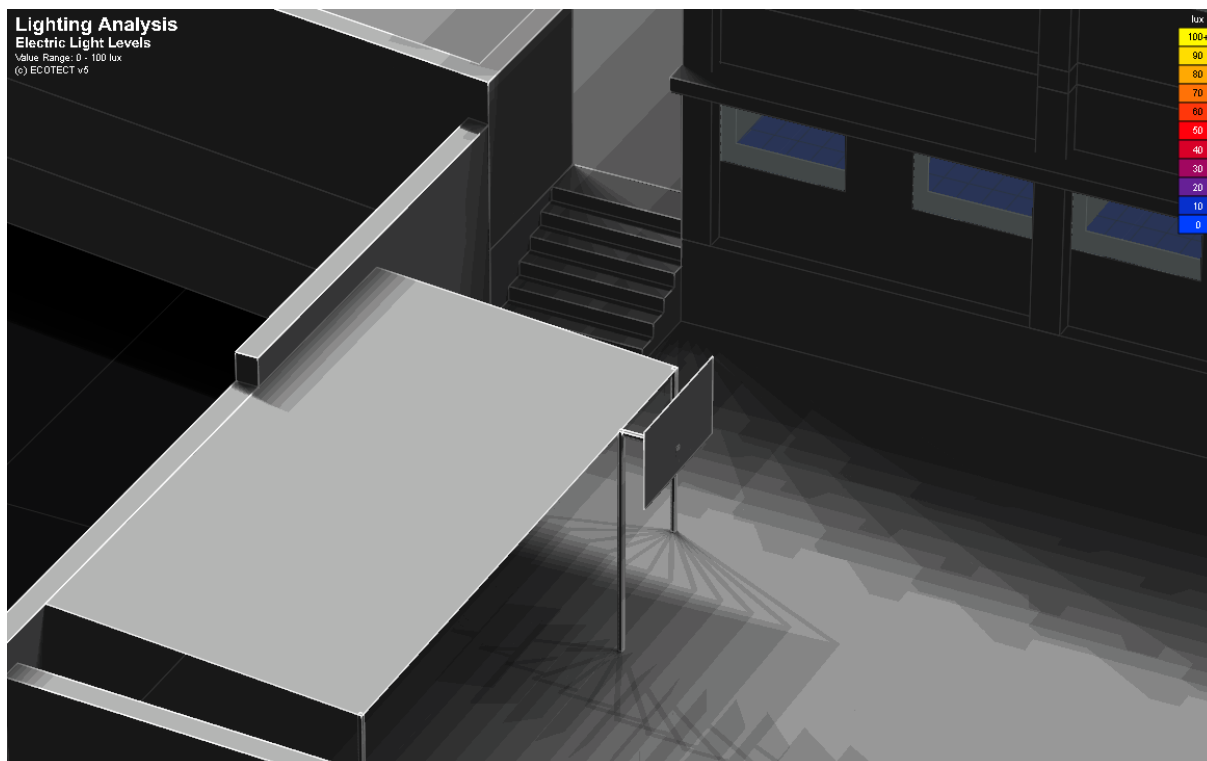
An environmental system, as relevant to the objectives of an EcoSchool, is any space that is purposefully designed for students to engage interactively with their immediate ecosystem. Sited in a flora-rich setting, the students of Khawlah Bent Al-Azwar School already have access to the natural eco-system. Even so, the students and staff at the school have demonstrated a desire to conduct classes in the outdoors. On one occasion, the audit team observed a class being conducted in the shaded corridor between the toilet building and the school boundary. Given the orientation of the school building, there is limited outdoor shaded space during the non-winter months.



Proposed System

It is with this observation in mind that Terra Vertis recommends the installation of an outdoor shaded learning space where teachers can effectively conduct lessons throughout the school year. We recommend the installation of an outdoor blackboard and sufficient bench/table space to accommodate an average sized classroom.

Based on an outdoor shading analysis for the month of April, the most optimal location for such an installation is presented in the image below. A 4m x 8m sun shade, constructed behind the east basketball net, should provide consistent enough shade for outdoor classes. Furthermore, this location would prevent any detrimental impact to day lighting within the school building itself (blocking light from entering through windows).



Implementation Plan

Presently, Terra Vertis is discussing final implementation plans with a general purpose contractor for the construction of the recommended shaded space, and with GREENCarpet, for the possible inclusion of a 'green zone' as part of this feature. It is expected that the plans will be finalized

before mid-September, however the implementation itself will have to be designed to have minimal impact on the school's operations.

EcoSCHOOL SOCIAL PROGRAM DEVELOPMENT

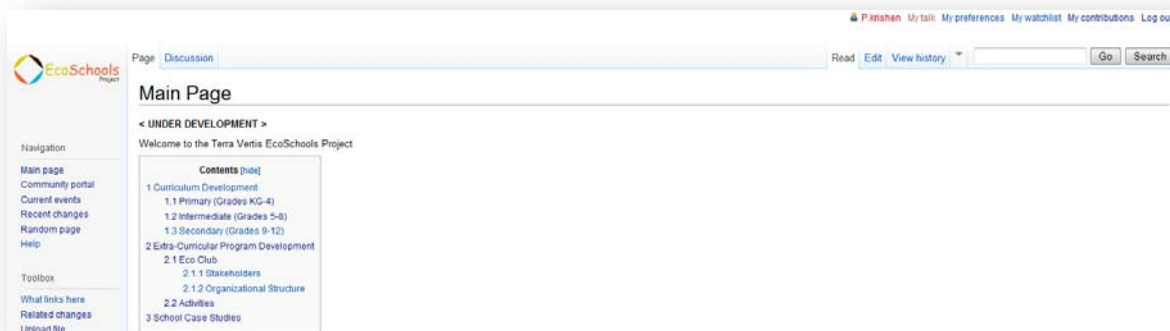
Terra Vertis is of the strong opinion that the maximum impact is possible only through effective social programming. Based on our vision for this undertaking, we have been strategically developing a framework that would allow the EcoSchool program to transition non-linearly from a small scale pilot project to a widespread, self-organizing movement. Unrestrained flow of information and knowledge, we believe, is the answer.

Accordingly, the project's social team has been actively researching and compiling a social program based on similar international initiatives, with the intent of bringing together a custom knowledgebase that is relevant to Jordan. Having completed the development of the curriculum framework and designing several environmental themed social activities the team was faced with the challenge of effective/efficient dissemination of this information.

Our primary objective is to engage stakeholders in the development of this content, while making it accessible to the public at large. To meet these criteria, Terra Vertis has now developed and deployed an *open-source* web platform (available at **ecoschools.terravertis.com**). The system has been designed to give the public unrestricted access to the information, and the ability for them directly add to and modify, the content.

Judging by the staggering success of existing public domain knowledgebases (Wikipedia being a prime example), we are confident in the transformational capabilities of this initiative. We expect that with effective marketing, directed towards the appropriate stakeholders (students, teachers, and other educational/industry professionals), we can foster an information sharing culture on this web platform that would drive innovation and inspire widespread adoption of the EcoSchool concept.

Presented, below, are sample screenshots of the online knowledgebase.



Eco Club

The environmental activities program depends on students' participation and dedication. Therefore, and in order to improve students' participation in the program, an active organized eco-club is needed

Stakeholders

- **Faculty**
Representatives from the different faculties, to supervise student activities and provide direction.
- **Students**
Representatives from each class or grade level to represent student interests.
- **Administration**
Administrative representative, in charge of budget management, financial control etc.
- **Facility**
Maintenance staff representation for input and feedback on the operation of the school and consider developmental ideas from the student body.

Organizational Structure

```
graph TD; Supervisor[Supervisor] --> President[President]; President --> Vice-president[Vice-president]; President --> Treasurer[Treasurer]; President --> GRM[General Relations Manager]; President --> M9_12[Members 9-12]; President --> M5_8[Members 5-8]; President --> M1_4[Members 1-4];
```

Activities

Activities	Grades KG - 4 (Primary School)	Grades 5 - 8 (Intermediate School)	Grades 9 - 11 (Secondary School)
Environmental Based Community Service	✓	✓	✓
Environmental Magazine		✓	✓
The Three R's Awareness Campaign	✓	✓	✓
Paper Recycling	✓	✓	✓
School Garden	✓	✓	✓
"Who is the Greenest?" Competition	✓	✓	✓
The Annual Youth Run Environmental Court			✓

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Primary School Energy Section

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[edit]

What is energy?

Energy is the ability to do work. Taking your dog for a walk, eating, and doing homework are ways you use energy. There are so many different ways we use energy everyday:

- Playing sports
- Eating
- Watching Television^[1]

Energy sources can be categorized to:

- Non-renewable: energy sources are considered nonrenewable if they cannot be replenished (made again) in a short period of time. The four nonrenewable energy sources used most often are:
 - Oil and petroleum products
 - Natural gas
 - Coal
 - Nuclear energy
- Renewable: sources that can be replenished naturally in a short period of time. Some example about these sources are:
 - Solar Energy
 - Wind
 - Water^[2]

[edit]

Activities

The teacher let the students state some examples about activities we use non-renewable energy in, and activities we use renewable energy in.

Electricity

Electricity is considered one of the energy forms; we can get electricity from both renewable and nonrenewable energy sources. It can be made from renewable energy sources like wind and water power. It can also be made by nuclear power, yet another source of energy. And it can be made from non-renewable energy like fuel.^[3]

[edit]

oil pump

The top-level outline of the curriculum and extra-curricular programming is presented below.

Curriculum

Grade 1-4

Water

- Importance of Water
- Uses of Water
- Water Properties
- Forms of Water
- Water sources
- Water Shortage
- Water pollution

Energy

- Definition
- Examples of Energy-Consuming Activities
- Energy Sources
- Electricity
- Solar Energy
- Simple tips to save energy

Environment

Grade 5-8

Water

- Water Importance
- Definition
- Water Cycle
- Water Sources
- Water Shortage
- Water Pollution

Energy

- Energy Sources
- Energy Conserving Tips

Environment

- Jordan Geography and Climate Areas

Grade 9-11

Water

- Water Shortage

Energy

- Nuclear Energy

Environment

- Global Warming
- Desertification

Extra-curricular

Eco-Club

Stakeholders

- Faculty
- Students
- Administration
- Facility

Budget

- Funding Sources
- Management

Organizational Structure

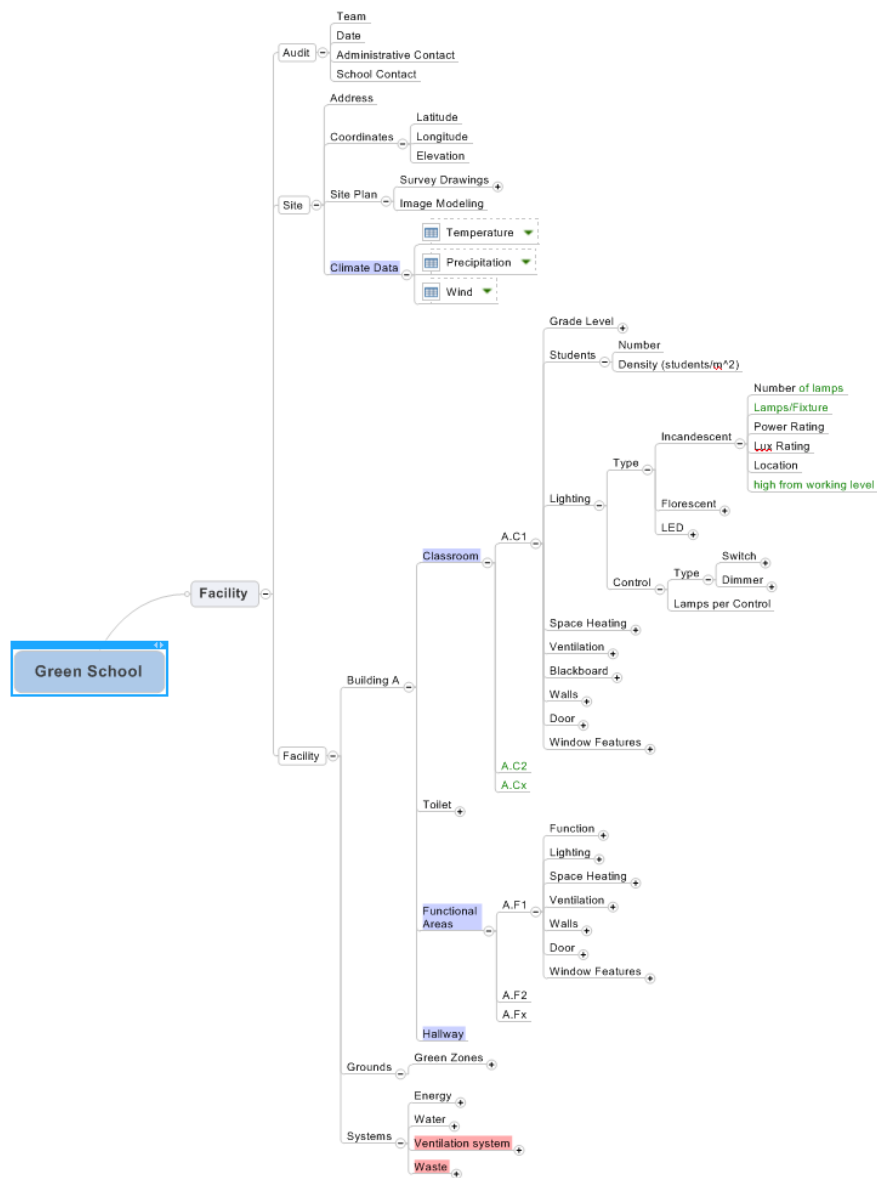
Tasks of the Eco-Club

Activities

- Environmental Community Service
- Environmental Magazine
- The Green Wall
- Who is the Greenest Competition
- The 3R's Awareness Campaign
- Paper Recycling
- The Youth-Run Environmental Court
- School Garden
- Environmental Play

EcoSCHOOL AUDIT TOOL DEVELOPMENT

The final component of Terra Vertis' EcoSchool initiative is the development of a comprehensive, Jordan specific, audit tool that is capable of objectively compiling the environmental conditions of a school into a consistent data set. Experience with the three pilot schools has allowed the team to thoroughly examine the key parameters and create a streamlined framework for the database. Based on several iterations and revisions of the initial 'checklist', the team is now in the final stages of deploying a proprietary EcoSchool Audit software. The general framework of the database is as below.



Presented, below, is a view from the database itself.

Site Plan	Location Code				C.3.C7
	Building				C
	Floor				3
	Room ID				C7
	Floor Area			[m^2]	25
Students	Grade Level			[Grade]	2
	Number (#)			[#]	30
	Density			[students/m^2]	1.2
Lighting	Fixture	Type A	Technology		Flourescent (Compact)
			Manufacturer		
			Number of lamps (#)	[#]	5
		Type B	Power Rating (W)	[W]	37
			Technology		Flourescent (Compact)
			Manufacturer		
	Control		Primary	Number of lamps (#)	[#]
		Power Rating (W)		[W]	37
		Secondary	Technology		Switch
	Lamps		[#]		
	Lux Level	Reading			
		Table Height		[m]	
Space Heating	Type	Primary	Technology		Radiator
			Energy Source		Diesel Boiler
			Capacity		
			Number	[#]	
		Energy Source	Electric	Location	
	Capacity (W)			[W]	
	Kerosene		Number	[#]	
		Capacity	[?]		

The ultimate objective of this tool is to give a school auditor the ability to efficiently complete comprehensive data acquisition of all relevant school parameters and characteristics for thorough desktop analysis. It is expected, that once complete, the tool would allow a team of 4 auditors to thoroughly evaluate a facility within one day, and automatically generate meaning reports relevant to the environmental conditions of the facility.

Such a tool, we believe, is essential for the widespread assessment and implementation of EcoSchools.

APPENDIX B: TRAINING MATERIAL



مشروع المدارس الخضراء



يحمل المستقبل العديد من التحديات للأجيال الصاعدة...
الاحتباس الحراري العالمي، سوء التغذية، والفقر، هي من أبرز تلك التحديات

والمدارس لها دور ريادي في تحضير الأجيال الشابة لمواجهة هذه التحديات...

إن تنمية شباب اليوم وتسليحهم بالقدرة اللازمة لمواجهة الصعوبات المستقبلية ليست مجرد رغبة، بل هي إحدى
متطلبات العملية التعليمية



نود لمدارسنا أن تكون نموذجا
للمواطنة العالمية، تعزز فيها
الرسالة التعليمية بنشاطات تحسن
حياة الطلاب وحياة الناس في
أماكن أخرى من العالم



المدرسة الخضراء: تلك المنشأة أو البناية
المدرسية التي تخلق جواً صحياً يحفز
العملية التعليمية، موفرة في نفس الوقت
مصرف الطاقة، واستهلاك المصادر
المتنوعة و ما يعنيه ذلك من مصروفات
مادية



لماذا نقوم بتخصير مدارسنا؟

منظمة الصحة العالمية تقدر بأن البيئة غير الصحية تساهم بحوالي 80% من الأمراض الأساسية. وهذا يشمل أمراض الأطفال التالية: السرطان، السكري و الالتهابات الرئوية. وبالإضافة إلى ذلك، فإن ثلث أمراض الأطفال ممن هم أقل من 9 سنوات يسببها التعرض إلى بيئة غير صحية

إن الطلاب والمعلمين ممن هم مرضى بالسرطان، مشاكل التنفس، السكري، قصور الانتباه وفرط الحركة، الحساسية بأنواعها، وذوي مناعة الجسم الضعيفة يتأثرون بشكل خاص بالممارسات والبيئة غير الصحية داخل المدرسة

إن المدارس لديها دور أساسي لتلعبه في تحضير الجيل الشاب
لبناء مستقبل أفضل، وكأماكن للتعلم، فإن المدارس قادرة على:

😊 مساعدة الطلاب على فهم تأثيرنا حولنا

😊 أن يجمعوا ويقارنوا هذه الدلالات بأنفسهم

😊 يمكن لها أن توفر للطلاب فرصاً للمساهمة في حياة مستدامة وأن يرشدوا

غيرهم للقيام بذلك



فوائد المدارس الخضراء

😊 جو صحي، وبناء محفز للعملية التعليمية

😊 التقليل من تسرب الطلبة

😊 توفير المال والسيولة

😊 التعلم بالعمل

😊 صديقة للبيئة



عرض موجز للمشروع



سيتم تنفيذ المشروع الأولي في ثلاث من
مدارس من مبادرة "مدرستي"

⊕ مدرسة "زيد بن حارثة" في مائيا
⊕ مدرسة "خولة بنت الأزور" في عجلون
⊕ مدرسة "خديجة بنت خويلد" في تسان



المخرجات المتوقعة

😊 زيادة وعي 1300 طالب و 100 معلم ومدير في المدارس الثلاث المستهدفة و 1300 من عائلات المجتمع المحلي

😊 ستقلل أجهزة توفير الطاقة الجديدة المصروفات التشغيلية، وتحسن الأداء الأكاديمي للطلاب كمثل منع وصول الغازات الضارة (أول أكسيد الكربون) من المدافئ التقليدية اليهم.

😊 سيكون استخدام الملاعب الرياضية أكثر فاعلية لأنها ستكون مجهزة لاستقبال مجموعات الطلبة و المنافسات الرياضية

😊 ستصبح البيئة المدرسية جاذبة أكثر للطلاب، حيث سيتم زراعة الحدائق وجعل المباني صحية

حلول خضراء



نهدف إلى إيجاد حلول مبنية على ظروف كل مدرسة من حيث سعتها و خصائصها والبيئة المدرسية. وهذه الحلول يتم تصنيفها إلى أقسام:

😊 كفاءة استخدام المياه

😊 الطاقة والكهرباء

😊 تحسين ظروف الراحة

😊 برامج إعادة التدوير وبرامج سلوكية

😊 ورش عمل توعوية

يتم اقتراح الحلول بناءً على المعايير التي تعرف المدرسة الخضراء كمدرسة عالية الفعالية والأداء، وسوف نركز على الخطوط العريضة التالية لاجترار الحلول:

- ☺ الاستخدام المستدام للموارد: تحسين كفاءة استخدام الطاقة، المواد المدرسية و الموارد المائية بالمطابقة ما بين استهلاك المدارس و احتياجاتها
- ☺ عمل دراسات تقييمية وتطبيق حلول الطاقة المتجددة وزيادة الاعتماد عليها
- ☺ جعل المدارس ذات بيئة مريحة من ناحية التدفئة والتبريد، ومن النواحي البصرية والسمعية
- ☺ العمل على جعل المدارس آمنة ومستجيبة للتغيرات البيئية
- ☺ ايجاد مساحات خضراء: مكان مريح بيئياً يتمكن فيه الطلاب من الدراسة والتعلم بفاعلية
- ☺ تصميم حلول سهلة الادارة و التشغيل
- ☺ تدريب الطلاب والمعلمين حول المبادئ العامة للمدارس الخضراء بهدف تمكينهم من المعرفة والوعي البيئي و جعلهم مواطنين مسؤولين بيئياً
- ☺ برامج توعية للمجتمع المدرسي والمحلي حول الممارسات الضارة بيئياً وتلك التي تستنزف الطاقة ومحاولة تعديلها وتغييرها
- ☺ تقييم واعتبار التكاليف المستقبلية لأي نشاطات يتم اقتراحها، وابقاءها في أدنى حد ممكن



كفاءة استخدام المياه

😊 حفر بئر يعمل كخزان للمياه ومجمع لمياه الأمطار

😊 نظام تخزين وجمع مياه الأمطار من المباني المدرسية إلى الخزان

😊 تخطيط لنظام حصاد مائي للمياه الرمادية: هذا النظام سيعمل على تجميع مياه الحنفيات من المشارب و نواتج عمليات التنظيف من أجل استخدامها في تنظيف المراحيض و سقي المزروعات

😊 تصليح أماكن التسرب في الحمامات والبناء المدرسي





😊 سيتم تركيب أنظمة متجددة للطاقة حيثما أمكن، وسيتم تشغيل وحدات تدفئة المياه من الطاقة الشمسية

😊 استبدال وحدات الانارة المستهلة للطاقة بأخرى كفوة استهلاك الطاقة

😊 استخدام الستائر وموانع النفاذية الحرارية لتقليل ارتفاع حرارة الغرفة صيفاً بسبب السطوع الشمسي و
فقدان الحرارة شتاءً بسبب النتوءات في النوافذ

😊 زيادة استغلال الانارة الطبيعية نهراً مما يقلل من الاعتمادية على الكهرباء





😊 تركيب مظلات في الساحات وأماكن اللعب للحماية من الشمس والأمطار

😊 زراعة نباتات مقاومة للجفاف تحسن من المنظر الجمالي للمدرسة و البيئة المدرسية

😊 تركيب مراوح للتدفئة والتبريد، مما يعمل على تحسين نوعية الهواء داخل المدرسة وابقاء الصفوف ضمن حرارة معتدلة ومريحة خلال فصل الصيف والتخلص من الغازات السامة مثل أول أكسيد الكربون خلال فصل الشتاء

😊 تحسين النظام السمعي في الصفوف عبر تركيب ألواح الجبس على أطراف السقف

😊 زراعة النباتات والأشجار الكبيرة في الممرات الكبيرة داخل المدرسة

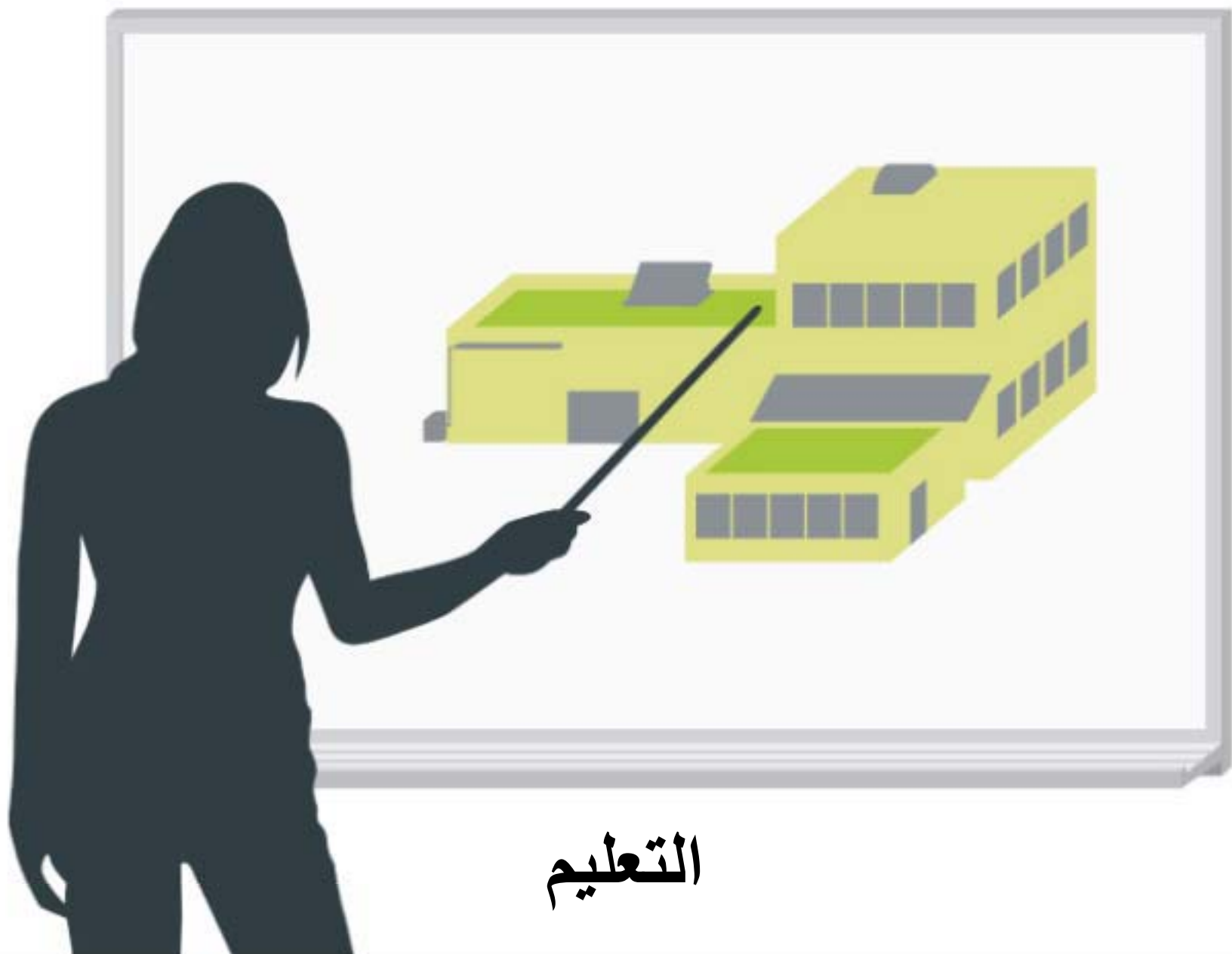




😊 سيتم تطبيق برامج لإعادة التدوير بناءً على المبادئ التالية: تقليل النفايات، إعادة استخدامها، إعادة تدويرها، واستخلاص المفيد منها. ويشتمل التطبيق على كافة المنتجات القابلة للتدوير، مثل: المياه، الورق، الأقلام، العلب، والمواد العضوية... الخ

😊 اختيار " بطل الشهر " المسؤول عن متابعة هذه التغييرات شهرياً





التعليم

😊 القيام بتطوير برامج تدريب مبنية على احتياجات كل مدرسة، هذه البرامج سيقارن أدائها و نتائجها
بتلك المعتمدة على برامج عالمية

😊 سيتم اىصال هذا التدريب إلى مختلف الوحدات في المدرسة

- المدراء والهيئة الادارية
- المعلمون
- الطلاب

😊 سيركز التدريب على النواحي التالية:

- اعادة التدوير
- المحافظة على المصادر والمواد
- التوفير في استخدام المياه
- ممارسات خضراء داخل المدرسة
- ممارسات للحفاظ على الطاقة





ماذا بعد...

- 😊 الحصول على التزام الهيئة المدرسية
- 😊 التخطيط للمشروع بمراحله المتعددة
- 😊 تسجيل الوفر الحالي والمتوقع
- 😊 حل مشاكل التشغيل والادارة الحالية
- 😊 توثيق قصص النجاح
- 😊 البدء بمشاريع صغيرة والتخطيط لمشاريع أكبر بعد ذلك
- 😊 التثقيف حول المشروع



شكراً لكم



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