Corporate Environmental Responsibility Policy

DRAFT

2011

1 Preventive Mechanisms

Mapping of all environmental compliance aspects with mechanisms (technologies, management, and operational practices) for identifying and detailing the following:

a) best practice sources (design, and maintenance) for avoidance of unstable system performance

b) monitoring protocol (above minimum requirements for compliance) and designed for early detection of threshold intrusion

c) response mechanisms (technological options, communication plan)

d) feedback and design, operation learnings distillation from system failure

e) perpetual alignment with state of the art through periodic knowledge enhancement

Element	Acts / Rules	Key Compliance Elements	Prevention through Design	Prevention through Management / Maintenance
Water	The Water (Prevention & Control of Pollution) Rules, Environmental (Protection) Rules	1. Meeting Water Quality Criteria for Raw Water Source depending on designated usage type. 2. Failure to observe orders issued to immediately restrain or prohibit discharge of any poisonous ,noxious or polluting matter 3. Failure to observe orders from court on restraining or prohibiting discharge of pollutants. 4. Interfering with working of measuring devices like gauge, meters etc. or prevent it from monitoring. 5. Illegal	1. Designing Industrial Effluents Treatment Plants to incorporate tertiary treatment processes such as chemical precipitation, filtration, chemical and wet air oxidation processes, reverse osmosis, anaerobic treatment, activated carbon adsorption, ion-exchange, and air/stream stripping to meet effluent criteria with respect to removal of: a) Heavy Metals and Inorganics (Zinc, Arsenic, Boron, Cadmium, Chromium, Lead, Mercury, Cyanides), b) Volatile Organic Compounds, Soluble Organic	1. All industrial units within Lavasa that produce and discharge aqueous phase or oil-based pollutants to be either ISO 14001 Certified as a prerequisite to receive consent to operate or require ISO 14001 Certification within 2 years of commencement of operations to receive consent to continue operating. This will allow industrial entities to identify potential

		establishment of any industry, operation or process, or any treatment and disposal system or an extension or addition thereto, which is likely to discharge sewage or trade effluent into a stream or well or sewer or on land , bring into use any new or altered outlets for the discharge of sewage; or begin to make any new discharge of sewage; 6. Preservation of biological diversity of the area which, if deemed by the Central Government needs to be preserved.	and Toxic Organics Chemicals, c) Sulfates, Chlorides, Ammonia in order to maintain A-I Class (Unfiltered Public water supply after approved disinfection) compliant Water Quality in receiving Water Bodies within or outside Lavasa. The appropriate treatment technologies for achieving removal of the above specific classes of compounds should be determined based on site specific industrial effluent characterization studies. 2. Designing all Commercial and Domestic Effluent and Sewage Treatment Plants to incorporate treatment processes to meet effluent criteria with respect to a) Dissolved Oxygen in receiving water body (i.e. BOD and COD), Phosphorous and Nitrogen Removal, b) Iron	sources of detrimental impact of their effluent water quality on downstream treatment systems and/or receiving water bodies. 2. Annual cycle of conducting tracer-study / smoke-testing to identify illegal effluent connections to municipal wastewater collection systems. 3. Establishment of a wastewater flow monitoring network through flowmeters to identify areas of significant infiltration (dilution), cross-connection with the water distribution system, and large-scale illegal industrial/commercial effluent connections with the municipal wastewater

			and Manganese, c) Pathogen Removal (disinfection), d) Alkyl Benzene Sulphates, e) Phenolic Compounds, f) Pathogen removal and Disinfection. 3. Designing industrial wastewater treatment plants to be equipped with off-gas capture and treatment to limit concentration of carcinogenic VOCs (such as benzene) in the wastewater as well as limit release of VOCs and ammonia into the air emanating from aeration basins. 4. Incorporation of local flora into the design of project sites to minimize disturbance to the local ecology. 5. Incorporation of design elements into landscape architecture of sites to continue providing habitat support to ecologically fragile species of native fauna in constructed projects and provisions of landscape design	collection network. 4. Industrial wastewater survey to be conducted periodically to determine waste loadings (quantity) and variations to ensure adequate treatment capacity in the receiving treatment plant 5. Staggered schedules for cleaning industrial equipment, reactors, vessels and other good housekeeping practices to minimize dumps and spills so as to reduce statistical variation in industrial effluent profile. 6. Measurement of effluent toxicity of Industrial Wastewater using multiple confirmatory chronic and acute bioassay tests to on untreated

			elements to minimize man-animal conflict. 6. Prevention of contaminated stormwater runoff from polluting surface waters by requiring Industrial and Commercial Facilities (especially with open car parks) to establish stormwater pollution prevention plans, and construct and operate stormwater treatment facilities if deemed necessary prior to discharge into municipal sewers network or direct stormwater overflow facilities. 7. Waste minimization at industrial and commercial units should be achieved through incorporation of the following design elements: a) provisions for recirculation where an effluent stream contains raw materials, b) segregated effluent lines for clean and toxic or concentrated effluent streams,	samples to determine the required level of treatment to render it non-toxic for discharge into receiving bodies. Complimented by routine bioassay tests on treated samples. 7. Toxicity identification program for industrial effluent using effluent fractionation to determine specific cause of effluent toxicity. 8. All facilities gathering, storing, processing, transferring or distributing significant quantities of oil (more than 2500 liters above ground tanks or 1.6 lakh liter underground storage tanks) required to prepare and implement spill prevention, control and countermeasure (SPCC) program. 9. SPCC plan

			c) provisions for removal of concentrated wastes from vessels/reactors in semi-dry state as opposed to washing, d) reduction of waste through automatic-cut-off water dispensing devices (hoses, taps etc.) used for cleaning etc. 8. Pollutant discharge through stormwater can be reduced through provision of adequate diking around process areas, storage tanks and liquid transfer points, complimented by connection to the industrial waste treatment facility.	should address operating procedures that prevent spills and leaks, control measures installed to prevent a spill or leak from reaching soil or water, and countermeasures to contain, clean-up, and mitigate the effects of the spill or leak 10. All commercial laundry facilities in the township will be required to use Alkyl Benzene Sulfonates (ABS) and phosphate free detergents
Air	The Air (Prevention & Control of Pollution) Rules, Motor Vehicle Act	1. Failure to comply with directions regarding not operating certain industrial plants and or the standard limits of emissions or any remedial actions ordered by Central government or the Boards 2. Fail to inform emissions in excess of the	1. Air Pollution Control Technology such as Packed absorption scrubbers, Adsorption towers, cyclone, venturi scrubbers, baghouse filters and/or electrostatic precipitators (for controlling particulates) will be incorporated at all point-sources	1. Emissions Monitoring Stations will be set at all large industrial units to monitor emissions from point sources 2. Ambient Air Quality Monitoring station, equipped with audio-visual

		standards set or the possibility of such an occurrence to the Board, or other prescribed agencies or authorities	at Industrial and Commercial facilities with potential for release of Sulfur Dioxide, Nitrogen Dioxide and other Nitrogen Oxides, Lead, Respirable and Fine Particulate Matter (PM2.5 and PM10). 2. Compressed or Piped Natural Gas-based systems will used instead of Diesel or Coal fired boilers or steam generators in all Commercial establishments (especially Hotels and Hospitals) 3. Waste Heat Recovery and/or Combined Heat and Power (CHP) systems on all steam / power generating equipment will be installed where recovered heat can be used for residential, commercial, or Industrial water heating or pre-heating purposes. 4. Catalytic converters to control CO, NOx, SOx, and Unburned Hydrocarbons will be installed on all	alarm systems will be set-up at multiple locations concentrated in residential areas to alert neighbouring residents and CMS authorities in the event of high AQI or unacceptably poor air quality conditions. 3. Meteorological Monitoring Stations must be set-up at multiple locations in the township to evaluate pollution dispersal and fate and as a diagnostic tool for intervening during periods of poor air quality. 4. De-centralized air-quality monitoring networks involving residents as 'air-quality' police must be set-up through enabling tools such as cellphone based

			permanently / leased Diesel and Petrol Light and Heavy Duty vehicles of the township that are more than 10 years old. 5. Non-Motorized Transport Networks will be constructed and installed in the township to promote walking and bicycling through bicycle-share programs. 6. Renewable-Energy Fuelled Electric Vehicles (i.e. using electricity sourced from Wind, Solar Power plants – directly or through purchase agreements with utilities) and Fuel-Electric Hybrid-Drive Vehicles will be form a dedicated component of the vehicle fleet owned/leased by the township.	localized air-pollution measurement. Data gathered through these GPS enabled devices must be retrieved, displayed, and analyzed frequently to detect potential air quality degradation. in areas of the township. 5. An Air Quality Response program must be established that clearly defines the response plan and responsibility / authority of the CMS to identify the cause of threshold level air quality (i.e. moderate) detected by Ambient Air Quality Monitoring stations (i.e an AQI of 51 to 100) and the measures to be adopted to restore air quality to Good (i.e AQI of 0 to 50) through immediate intervention

				in the ongoing industrial, commercial, residential and/or agricultural activity in the township and surrounding region. 6. Use of bio-derived emissions-tested or ecolabelled fuel-additives will be required to be used for all petrol and diesel vehicles owned/leased by the township. 7. Fuel efficiency testing on DG sets will be mandated and carried out by CMS authorities. DG sets yielding a generating efficiency lower than 4 kWh/liter will be identified for phasing out within a stipulated timeframe. 8. Semi-Annual testing of fuel-quality supplied by petrol stations

				in the township wll be conducted to determine VOC content, sulfur content (in diesel) and other elements as deemed necessary over time. If needed local refineries supplying petrol to gas stations in the region will be required to reformulate gasoline if required to control VOC content (benzene), and sell oxyfuel – (petrol blended with alcohol-based oxygenated compounds), during cold months, to control carbon monoxide emissions. 9. A regression-based peer group comparison methodology-type green-car rating program to be established similar to the 5-star energy rating program

				established by the Bureau of Energy Efficiency. Above and beyond PUC programs, all vehicles entering and plying within Lavasa should undergo comprehensive emissions testing (CO, CO2, NOx, SOx, and PM10) at a township-controlled pollution measurement station to determine emissions per km when tested according to the Modified Indian Driving Cycle (MIDC). PUC certificates generated elsewhere shall not be accepted as a substitute. Bi-annually-revised emissions benchmarking curves (accounting for the autonomous energy efficiency improvement amongst the national

				vehicle stock) will be used to determine green-car rating program which will include prominently displayed stickers / labels on the vehicles. Vehicles below a specified rating will only be allowed to operate in demarcated regions of the township. Incentive programs for preferential-parking for high-rated vehicles will be instituted in major commercial premises such as malls, multiplexes, office complexes etc.
Effluents	The Manufacture, storage and Import of Hazardous Chemical Rules, The Hazardous Wastes (Management and Handling) Rules, Chemical Accidents (Emergency planning preparedness and		1. Large industrial units (**with a total installed machinery cost greater than X Cr**.) anticipated to release process effluents with the potential of containing hazardous chemical substances (as	1. Large industrial units (defined elsewhere), shall incorporate just-in-time supply chain inventory management to minimize the amount of stored

	response) Rules		defined by the CPCB list of Hazardous, Toxic and/or Flammable Chemicals) shall conduct a peer-reviewed Life Cycle Assessment (LCA) to identify manufacturing processes leading to potential Water Toxicity related impacts 2. Fluid Material Storage facilities at industrial units to be designed with following provisions: a) overflow alarms on all storage tanks, b) construction of secondary containment areas to withhold spilled material, c) space containers to facilitate inspection for damage and potential leakage, d) raising containers from floor to minimize corrosion from dew condensation on concrete floors 3. Manufacturing units that produce Products that require hazardous raw materials that use or have the potential of releasing heavy metals, toxic	material 2. Lavasa shall have a industrial pollution prevention program helmed by a support cell comprising members of academic institutions specializing in Industrial and Environmental and research institutions for disseminating best practice information related to alternative manufacturing strategies (recycling / reuse of materials in process effluent, improved reactor design and control, improved cleaning and degreasing operations, storage and spill prevention/alarm systems), green chemistry, and assisting in its incorporation into manufacturin

			organics (as identified by the Stockholm Convention on Persistent Organic Pollutants), and hazardous chemicals (as defined by the Rotterdam Convention) will be required to adopt product changes in a time-bound manner to diminish the need for such raw materials. 4. All Underground Storage Tanks (including those at Petrol Stations, and covering underground piping, underground ancillary equipment, and containment system) larger than 400 liters in size must be designed with corrosion control features, must undergo monthly leak detection, and be equipped with leak and overflow detection systems (including automatic shut-off valves, ball-float valves, flow restrictors during overfills, and leakage alarms).	g processes. 3. Any industrial raw materials containing polychlorinated biphenyls (PCBs) will be prohibited from entry and use in the township. 4. All public and commercial buildings (including schools) in the township will be required to be inspected for asbestos prior to commissioning and hand-over to occupants. As such, Asbestos containing materials (especially Asbestos sheets and other forma of asbestos in cement) in construction and industry will be banned from use in Lavasa. 5. All industrial and commercial operations (including small businesses) that that generate more

			5. Corrosion control on steel USTs must include interior lining, and/or cathodic protection. 6. Spill protection for USTs requires construction of a catchment basin (bucket sealed around the fill pipe) to contain spills and adherence to safe industry standard filling practices. 7. Design facilities to clearly isolate discharges from hazardous waste generating sources on a industrial site with other material (especially stormwater) to prevent the entire mixture from being classified as hazardous waste and thereby needed excessive treatment.	than 100 kg waste per month or plan to store wastes for more than 90 days must notify the Environmental Department and obtain prior permission for generating/storing hazardous waste (temporarily). Subsequently, all generators of hazardous waste will be required to ship wastes to a Treatment, Storage, or Disposal Facility (TSDFs) outside the township. 6. Amongst the disposal options adopted at the eventual TSDF for hazardous waste from the township, land disposal of hazardous waste will only be permitted if the generator can prove that no migration of hazardous constituents

				from disposal unit would occur. 7. At the above mentioned TSDF, disposal of uncontained liquid hazardous materials using landfilling is not an acceptable method. All uncontained liquid hazardous wastes must be solidified before landfilling or treated by some other process to neutralise it. 8. All Underground Storage Tanks (USTs) must be registered with the Environmenta l Department of the township. 9. All USTs must undergo monthly monitoring using such methods as automatic tank gauging, vapour monitoring in adjacent soils, monitoring for liquids in

				the groundwater, and monitoring of interstitial space between the tank and secondary container. 10. Follow good-housekeeping practices in manufacturing/processing units such as: a) closing solvent containers when not in use, b) isolating liquid from solid wastes, c) developing a preventative maintenance schedule and enforcing its use, d) scheduling production runs to minimize cleaning frequency, e) prevention of mixing of effluents in common floor drains, f) education of all employees to promote awareness of waste reduction initiatives as well as enhance quality of

				their participation in preventing accidents, leaks, spills and reducing waste generation. 11. All large commercial and industrial units should implement a pollution prevention program which includes: a) establishing quantifiable wastewater reduction goals, b) implement facility-wide waste reduction techniques and water use minimizing strategies, c) monitoring or progress and readjustment of objectives. 12. Complete record keeping and documentation of critical process aspects including: a) process procedures, b) chemical specifications, c) chemical use, d) energy use, e) waste

				generation, and f) spill and accident frequencies is essential to identify areas of potential resource use and waste generation reduction.
Waste	The Batteries (Management and Handling) Rules	strict tracking of distrubution and sale of batteries, collection, auction , trasnport and re-processing of used batteries.Sale of re-processed lead by registered recyclers and sale of lead from all domestic producers or importers.		1. Lavasa will establish a township-wide lead-acid and dry-cell battery recycling program comprising segregated consumer-side disposal and transportation, complimented by effective consumer education through communication strategies. Collected batteries will be transferred to a established battery-recycling partner for effective recycling.
Waste	Plastic waste Management and Handling rule			1. The township will establish, through a 'Eco Commerce Board' (an entity comprising representatives of all relevant stakeholders – retailers, consumers, CMS) a managed program with declared targets for minimizing food packaging-related plastic consumption through a collaborative partnership with retailers including grocery supermarkets

				to transform their supply chain 2. The 'Eco Commerce Board' will be ban from entry into the township Plastic bags (virgin, recyclable, or compostable) lesser than 40 microns thickness. 2. The 'Eco Commerce Board' will phased-in and enforce in the township Eco-labelled Biodegradable or Compostable Plastic Bags compliant with ISO 17088:2008 for use at all retail and commercial spaces as a substitute for existing PVC bags by January 1, 2013. 4. Fiber (Cotton, Jute, Bamboo)-based carry-bags sharing/reuse programs will be established at all retail spaces in the township. All fiber-based bags will be sourced through certified organic suppliers by January 1, 2013 3. Segregation of plastic, metal, glass and biodegradable organic waste at source will be mandatory at all residential and commercial spaces in the township. 4. The township will

				set-up Plastic Recycling Facilities in accordance with the Indian Standard 14534:1998
Waste	E- waste Management and Handling rule			1. The township will require procurement tenders for major electronic products (cellular phones, televisions, desktop computers, laptop computers) directly or for commercial establishments in the township to include criteria related to 1) declaration of timelines for phaseout of PVC, chlorinated flame retardants (CFRs) and brominated flame retardants (BFRs) Materials, and 2) declaration of timelines for establishment of voluntary take-back and recycle program for their used products.

				2. The township will include criteria in procurement tenders (as delineated earlier) related to compliance with all 'Responsibilities' of Electronics Manufacturers as stated in the E-Waste (Management and Handling Rules), 2011
Waste	Municipal Solid Wastes (Management and Handling) Rules		1. Landfilling of wastes will not be permitted in the township. 2. 3-bin segregation at source will be enforced across the township in residential and commercial enterprises. This system will consist of segregation at source and consequently distinct waste management procedures for 3 categories of waste: biodegradable waste, recyclable waste, and reject waste. 3. Additionally, E-Waste and Hazardous Waste drop-off and collection sites will be	

			established in the township. 4. Any waste leaving the township for landfilling elsewhere must be disposed in Scientifically Design Containment	
Environmental	Noise Pollution(Regulation and Control)Rules			

2 Beyond Legal Compliances – Best Practices Overview with Specific Recommendations

Going beyond Environmental Compliance with business-as-usual (BAU) philosophy into the realm of economically feasible environmental leadership through a holistic quality-of-life based development approach that provides a roadmap for continual focus on the 'end goal' of development at Lavasa rather than focusing on BAU means.

The overarching program for aligning Lavasa's development with sustainability principles must be founded on the following fundamental frameworks and practices for directing the development of Lavasa that need to be institutionalized through the establishment of a planning, execution, and monitoring mechanism within the Environmental Department that will serve as the custodian of:

2.1 Environmental Sustainability Reporting and Urban Sustainability Index aligned Development Plan for Lavasa

Environmental Sustainability Reporting which includes:

- Environmental Indicator Framework Development
- Indicator Measurement and Tracking Mechanism
- Mechanism for affecting Environmental Policy alterations in response to Indicator trends,

are integral components of this imperative need for Lavasa. Lavasa must incorporate these components as part of its overall Town Planning and Environmental Department's functions. Environmental Indicators thus become an imperative component of the global-best-practice aligned guiding principles for future developments at Lavasa. The Sustainability Reporting Framework that must be established and deployed across Lavasa can be based on either of the following two models:

2.1.1 Global Reporting Initiative's (GRI) Sustainability Reporting Guidelines:

A compliant reporting process under this framework must include the following parameters:

1) Materials
2) Energy
3) Water
4) Bio-Diversity
5) Emission, Effluents & Waste
6) Products & Services
7) Compliance
8) Transport
9) Other Environmental Aspects

The performance indicators, related to the above parameters of Environmental Sustainability, the must be measured, tracked and incorporated into a continually evolving Development Plan for Lavasa are:

1) Materials
   - EN1: Materials used by weight or volume
   - EN2: Percentage of materials used that are recycled input
2) Energy
   - EN3: Direct energy consumption by primary energy source
   - EN4: Indirect energy consumption by primary source.
   - EN5: Energy saved due to conservation and efficiency improvements
   - EN6: Initiatives to provide energy-efficient or renewable energy based products and services, and reductions in energy requirements as a result of these initiatives
   - EN7: Initiatives to reduce indirect energy consumption and reductions achieved.
3) Water
   - EN8: Total water withdrawal by source
   - EN9: Water sources significantly affected by withdrawal of water
   - EN10: Percentage and total volume of water recycled and reused
4) Bio-Diversity
   - EN11: Location and size of land owned, leased, managed in, or adjacent to, protected areas and areas of high bio-diversity value outside protected areas
   - EN12: Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas
   - EN13: Habitats protected or restored
   - EN14: Strategies, current actions, and future plans for managing impacts on biodiversity
   - EN15: Number of IUCN Red List species and national conservation list species with habitats in areas affected by operations, by level of extinction risk
5) Emission, Effluents & Waste
   - EN16: Total direct and indirect green-house gas emissions by weight
   - EN17: Other relevant indirect green-house gas emissions by weight
   - EN18: Initiatives to reduce greenhouse gas emissions and reductions achieved
   - EN19: Emissions of ozone-depleting substances by weight
   - EN20: NO**x**, SO**x**, and other significant air emissions by type and weight
   - EN21: Total water discharge by quality and destination
   - EN22: Total weight of waste by type and disposal method
   - EN23: Total number and volume of significant spills
   - EN24: Weight of transported, imported, exported, or treated waste deemed hazardous under the terms of the Basel Convention Annex I, II, III, and VIII, and percentage of transported waste shipped internationally
   - EN25: Identity, size, protected status, and biodiversity value of water bodies and related habitats significantly affected by the reporting organization's discharges of water and runoff
6) Products & Services

EN26: Initiatives to mitigate environmental impacts of products and services, and extent of impact mitigation

EN27: Percentage of products sold and their packaging materials that are reclaimed by category

7) Compliance

EN28: Monetary value of significant fines and total number of non-monetary sanctions for non-compliance with environmental laws and regulations

8) Transport

EN29: Significant environmental impacts of transporting products and other goods and materials used for the organization's operations, and transporting members of the workforce

9) Overall

EN30: Total environmental protection expenditures and investments by type

The process for deploying this comprehensive framework can follow the following roadmap:

Table 1Environmental Sustainability Reporting Roadmap for Lavasa

Environmental Sustainability Parameter	**Domain (Operational), Scope (Relevant Parameters), Timeline (Schedule)**			
	Industrial Projects	**Commercial Projects**	**Residential Projects**	**Corporate / CMS / Directly Controlled Operations**
Material	Short Term	Medium Term	Long Term	Medium Term
Energy	Short Term	Short Term	Short Term	Short Term
Water	Short Term	Short Term	Short Term	Short Term
Bio-Diversity	Medium Term	Medium Term	Long Term	Medium Term
Emissions, Effluents & Waste	Short Term	Medium Term	Medium Term	Short Term
Products and Services	Medium Term	Medium Term	Long Term	Medium Term
Compliance	Short Term	Medium Term	Long Term	Short Term
Transport	Medium Term	Medium Term	Long Term	Medium Term
Overall	Short Term	Short Term	Medium Term	Short Term

The roadmap emphasizes the importance of Industrial Projects as well as the Corporate, City Managed Services and other directly controlled operations leading the process of adopting Environmental Indicator measurement and reporting as part of their intrinsic operational framework. The lessons learned during the nascent phases of implementation of indicator measurement etc. would translate into more streamlined processes and standard operating procedures that can be efficiently replicated across Commercial and Residential Projects following a customization process.

The timeframes presented in Table 1 are indicative of the following time periods for achieving complete coverage within an Operational Domain:

Short Term: 1 year following formal adoption of CER Policy

Medium Term: 2 to 3 years following formal adoption of CER Policy

Long Term: 4 to 5 years following formal adoption of CER Policy

Frameworks for Indicator Measurement and Reporting must be in place with immediate effect for all Industrial, Corporate, City Managed Services and other directly controlled operations as well as the Short-Term parameters for Commercial and Residential Project. The end of the first year serves as the milestone for ensuring complete coverage of all Operational Areas defined by the Short-Term Scope.

Frameworks for relevant Indicator Measurement and Reporting of Medium Term and Long Term parameters must be in place for the corresponding Operational Domains by the beginning date of the specified self-imposed compliance period (i.e. beginning of the 2-year time frame for Medium and Long Term periods)

2.1.2 Urban Sustainability Index by Columbia University, Tsinghua University, and McKinsey & Company

While the GRI's framework is robust and affords the potential for enhanced environmental planning, management and response through studying trends demonstrated by a wide spectrum of indicators, the framework is relatively resource intensive in its implementation as it involves measurement of parameters that are challenging to track in the context of cities in the developing world. A more relevant framework that can be established relatively rapidly in comparison to the GRI framework is the Urban Sustainability Index framework jointly developed by Columbia University, Tsinghua University, and McKinsey & Company.

The relevant indicators in this framework are fewer than those required by the GRI (18 indicators) with the following two added advantages:

a) of merging the results of reporting across these indicators to calculate periodic Urban Sustainability Indices for Lavasa.

b) specific focus on urban factors – especially the built environment, urban mobility, public green spaces, as well as relevant urban enviro-economic aspects.

The indicators included in USI framework are:

Table 2Urban Sustainability Index (Columbia University et. al.)

Category	Definition	Indicators	Description of Indicator (annual totals where applicable)
Basic needs	Access to safe water, living conditions, education and health services	1. Housing 2. Health 3. Water supply 4. Education	1. Living space (sq.m per capita) 2. Doctors per capita 3. Water access rate (%) 4. Student teacher ratio (primary school)
Resource efficiency	Efficient use of energy, power and water; waste recycling	1. Water Demand 2. Waste recycling 3. Power 4. Total electricity consumption 5. % GDP from heavy industry	1. Water consumption (liters per capita). 2. Rate of industrial waste recycled and utilized (%) 3. (kwh per GDP) 4. Heavy industry GDP/ Total GDP (crore INR)
Environmental cleanliness	1. Clean air and water 2. Waste management	1. Air pollution 2. Industrial pollution 3. Waste water treatment 4. Domestic waste collected & transported.	1. Concentration of SOx, NOx, PM10 (mg/cu.m) 2. Industrial SO2 discharged per GDP (tonnes/ crore INR) 3. Wastewater treatment rate (%) 5. tonnes per capita
Built environment	Dense, transitoriented, green, efficient design	1. Public green space 2. Mass transit usage 3. Urban density 4. Building efficiency	1. Public green space per capita (sq.m per capita) 2. Passengers using public transit (bus, trolley) 3. Persons per square kilometer of urban area 4. Building

			heating/cooling efficiency
Commitment to future sustainability	Investment in human and physical assets	1. Green Jobs 2. Investment on environmental protection	1. # of environmental professionals per capita 2. Amount of environmental sanitation funds per GDP

The USI framework has some recognizable limitations with respect to the emphasis on measurement of means of achieving the end-goal rather than measuring the success in achieving the end-goal directly. For instance, the emphasis on measurement of doctors per capita as a surrogate for measuring overall social health and physical well-being of citizens. Also, parameters for 'environmental cleanliness' – specifically, solid waste management – focus primarily on quantity of waste collected and treated but does not emphasize preventive mechanisms for waste reduction or beneficial re-use or resource utilization. These recognizable lacunae in the USI raises enough concern to warrant alterations to some of the parameters.

2.1.3 Other Urban Sustainability Indices

SILENT Model for Urban Sustainability Indexing

The Sustainable Infrastructure Land-use Environment and Transport Model (SILENT) is an advanced geographic information system (GIS) and indicator-based urban sustainability indexing model. The spatial indexing nature of the model is particularly useful for the analysis and the visualisation of comparative sustainability levels of urban localities. As a spatial indexing endeavour, the specific aim of the model is to incorporate all related domains affecting urban sustainability (i.e., demography, land-use, environment, transport and infrastructure) into a practical assessment method that informs planning and decision making processes. The SILENT Model is developed by following four logical steps similar to the OECD's Composite Indicators Methodology. The relevant parameters for this model are presented in the table below.

Table 3 Urban Sustainability Index (SILENT Model)

Indicator Categories	Indicator Sets	Individual Indicators
Demography	**Residential characteristics**	Population density
		Labour force participation
		Car ownership
	Employment characteristics	Jobs to housing balance
		Employment density
Land Use and Urban Form	**Housing compactness**	Mix use ratio
		Dwelling density
		Single-family parcel size
		Single-family dwelling density
		Multifamily dwelling density
	Local amenities	Recreation facility supply
		Socio-cultural facility supply
Transport	**Transit orientation**	Transit adjacency to residents, services
		Transit patronage ratio
	Non-automobile travel pattern	Transit adjacency to employment
		Transit proximity to employment
		Pedestrian network coverage
		Bicycle network coverage
	Automobile travel pattern	Home-based vehicle kilometres travelled
		Non-home-based vehicle kilometres travelled
		Number of home-based vehicle trips
		Number of non-home-based vehicle trips
		Parking supply in employment centres

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The suggested set of indicators under this framework include nine environmental indicators. The indicators for the aspects of Responsibility for Global Climate, Acidification of the Environment, Toxification of Ecosystems and Local Disturbances are designed to emphasize, together with the energy and water consumption indicators, the responsibility of a city towards the global environment. The local disturbances indicator, together with the air quality indicator, the urban mobility and the waste management indicators, expresses important aspects of the local quality of life linked to global considerations. The indicators of social justice, housing, urban safety and citizen participation represent key social elements of sustainability. Measurement and tracking of the quality of spaces, promoting public health, social life and cultural identity is achieved through measuring the quality of green, heritage and public spaces.

Specifically, the parameters emphasized by this model are:

1. GLOBAL CLIMATE INDICATOR (GCI):

   Definition: The contribution of cities to greenhouse gas emissions.

   Measure: tonnes of CO2e

2. AIR QUALITY INDICATOR (AQI):

   Definition: The number of days per year on which attention levels defined by law are exceeded in the most negative measurement.

3. ACIDIFICATION INDICATOR (AI):

   Definition: The deposition of acidic components.

   Measure: Acidification equivalents (Aeq) = total acidification caused by acidic compounds and deposited per hectare.

   Subindicators / Components Data: Deposition of SO2/hectare. Deposition of NO2/hectare. Deposition of NH3/hectare.

4. ECOSYSTEM TOXIFICATION INDICATOR (ETI)

   Definition: The emissions of toxic substances.

   Measure: Toxic Substances equivalent (TSeq) = total emission of priority substances and radioactive substances.

   Subindicators / Components Data: Emitted quantities of cadmium, polyaromatic hydrocarbons, mercury, dioxin, epoxyethane, fluorides and copper. Emitted radioactive substances.

5. URBAN MOBILITY INDICATOR (UMI) OR CLEAN TRANSPORTATION INDICATOR
   Definition: The use of environment-friendly means of transport, especially for enforced mobility, defined as mobility for commuting and basic needs.

   Measure: Urban Mobility equivalent (Umeq) = total number of passenger kilometres by non-environment-friendly means (private car) per inhabitant and per year. (If passenger kilometres cannot be estimated, trips can be used). Enforced Umeq (EUMeq) = total number of passenger kilometres – passenger kilometres by foot and bicycle – passenger kilometres by public transport, per inhabitant and for basic needs each year.

   Subindicators: Enforced Urban Mobility Indicator (EUMeq, mainly for commuting).

   Components Data: Total number of trips (and their length) by private car and number of trips (and their length) for commuting and basic needs/inhabitant/year.

6. WASTE MANAGEMENT INDICATOR (WMI)

   Definition: The total volume of waste disposed of.

   Measure: Disposal equivalent (Deq) expressed in tonnes per inhabitant and per year.

   Subindicators: Waste disposed of by incineration or in controlled landfills and in uncontrolled landfills; waste reused or recycled.

   Components Data: Building and demolition waste, Industrial waste., Domestic waste, Retail and service waste.

7. ENERGY CONSUMPTION INDICATOR (ECI)

Definition: The total amount of consumed energy.

Measure: Energy equivalent (Eeq) expressed in TOE (tonnes of oil equivalent) per inhabitant per year.

Policy Direction: Conservation and reduction.

Subindicators: Consumed energy according to the source of production (renewable energy, electricity, petrol, gas-oil, heavy fuel oil, natural gas, carbon and wood).

Components Data: Energy for: domestic use; industrial use; tertiary sector; public spaces.

8. WATER CONSUMPTION INDICATOR (WCI)

Definition: The total amount of water withdrawal.

Measure: Water equivalent (Weq) expressed in m3 per inhabitant per year.

Components Data: Water for: domestic use; industrial use; building sector; retail services; maintenance of public spaces.

9. NUISANCE INDICATOR (DI)

Definition: Nuisances created by noise, odour or visual pollution.

Measure: Nuisance equivalent (Neq) = percentage of the population affected by noise, odour or visual pollution.

Subindicator: Percentage of the population seriously affected by one of the above factors. Components Data: Percentage of the population adversely affected by: noise; odour; visual pollution.

10. SOCIAL JUSTICE INDICATOR (SJI)

Definition: The degree of social sustainability of a city.

Measure: Social Justice equivalent (Sjeq) expressed by the percentage of people affected by poverty, unemployment, lack of access to education, information, training and leisure.

Subindicators: Percentage of the population seriously affected by one of the above components. It is also essential to have subindicators for vulnerable groups of population (youth, women, the handicapped and long-term unemployed).

Components Data: Percentage of the population affected by poverty, unemployment, lack of access to education, information, training and leisure.

11. HOUSING QUALITY INDICATOR (HQI)

Definition: The degree to which inhabitants suffer from poor housing conditions.

Measure: Housing Quality equivalent (HQeq) = percentage of people affected by lack of housing or poor housing environments.

Subindicator: The number of homeless in percentage of the inhabitants and of those who might become homeless.

Components Data: Percentage of the homeless population; percentage of the population threatened by loss of housing; percentage of the population in poor housing conditions.

12. URBAN SAFETY INDICATOR (USI)

Definition: The degree to which people suffer from lack of urban safety.

Measure: Urban Safety equivalent (USeq) = total percentage of the population affected seriously by crime or traffic accidents.

Subindicator: total percentage of irreversible long-term injuries.

Components Data: Percentage of people attacked. Percentage of people affected by road accidents.

13. ECONOMIC URBAN SUSTAINABILITY INDICATOR (ESI)

Definition: The viability of the urban economy.

Measure: Economic Sustainability equivalent (ESeq) = city income - city fiscal deficit - environmental expenditure - pollution damage per inhabitant per year.

Components Data: City income (total individual incomes). City fiscal deficit (–) (city budget – taxes). Environmental expenditure (for waste collection, sewage, transport, water management). Pollution damage (air, water, land).

Composition of the ESeq = [CI – CFD – EE – PD]/population.

14. GREEN, PUBLIC SPACE AND HERITAGE INDICATOR (GPI)

Definition: The improvements needed for green, public spaces and heritage.

Measure: Green, Public Space and Heritage equivalent (GPSeq) = percentage of the green or public spaces and local heritage in need of improvement.

Subindicators: surface of green spaces per inhabitant, the surface of heritage spaces per inhabitant and the surface of public spaces per inhabitant.

Components Data: Percentage of green spaces needing improvement/total surface of green space. Percentage of heritage spaces in need of improvement/total surface of heritage space. Percentage of public spaces (including heritage sites) in need of improvement/total surface of public space.

15. CITIZEN PARTICIPATION INDICATOR (CPI)

Definition: The degree to which the local population participates in the decision making and improvement of the local quality of life.

Measure: Citizen Participation equivalent (CPeq) = total percentage of the population participating in local elections or as active members in associations for urban improvement and quality of life.

Components Data: Percentage of people participating in local elections. Percentage of people being active members of environmental, public health and cultural associations. Composition of the total percentage of the population active in local elections.

2.1.4 Suggested Sustainability Index Roadmap for Lavasa

A review of the relative advantages and disadvantages of various sustainability indices available for implementation at Lavasa – leads to the conclusion that a suggested index for Lavasa's internal benchmarking (i.e. year-on-year benchmarking relative to the baseline set in year 1) must be a modified amalgamation of the USI developed by Columbia University et.al and the Index developed by European Foundation for the Improvement of Living and Working Conditions as well as some unique criteria recommended as part of this effort for Lavasa. Specifically the indicators related to Health and Environmental Cleanliness in the USI must be replaced with the more rigorous indicators of the European Foundation Index. Hence, the recommended index should comprise of the following indicators:

Table 4 Recommended Urban Sustainability Index for Lavasa

Category	Definition	Indicators	Description of Indicator (annual totals where applicable)
Basic needs	Access to safe water, living conditions, education and health services	1. Housing 2. Health 3. Water supply 4. Education	1. Living space (sq.m per capita) 2. Annual Expense per capita on preventative medicine/health practices and Mean Body Mass Index (BMI) or residents 3. Water access rate (%) and Rainwater Harvesting Rate (% of Stormwater Recharged on-site) 4. Student teacher ratio (primary school)
Resource efficiency	Efficient use of energy, power and water; waste recycling	1. Water Demand 2. Waste recycling 3. Total electricity consumption	1. Water consumption (liters per capita). 2. Rate of industrial waste recycled and utilized (%) 3. (kwh per GDP)
Environmental	1. Clean air and water 2. Waste management	1. Air pollution 2. Industrial pollution 3. Waste water treatment 4. Domestic waste	1. Concentration of SOx, NOx, PM10 (mg/cu.m) 2. Industrial SO2 discharged per GDP (tonnes/ crore

		management. 5. Pollution Prevention	INR) 3. Wastewater treatment rate (%) and Wastewater Recycling Rate (%) 4. tonnes per capita landfilled, incinerated, composted, recycled. 5. Amount of environmental pollution prevention expenditure per GDP.
Built environment	Dense, transitoriented, green, efficient design	1. Public and green space 2. Mass transit usage 3. Urban density 4. Building efficiency	1. Public space and green space per capita (sq.m per capita) 2. total number of passenger kilometres by non-environment-friendly means (private car) per inhabitant and per year, total number of passenger kilometres – passenger kilometres by foot and bicycle, and passenger kilometres by public transport, per inhabitant 3. Persons per square kilometer of urban area 4. Average Energy Performance Index (EPI) of Residential and Commercial Spaces

Economic Sustainability	Investment in human and physical assets	1. Net Environmental Expenditure 2. Green Economy	1. Economic Sustainability equivalent (ESeq) = city income - city fiscal deficit - environmental expenditure - pollution damage per inhabitant per year. 2. % contribution of Ecolabelled / Certified Green Products and Services to GDP
Social Justice, Urban Safety, and Civic Participation			1. Social Justice equivalent (Sjeq) expressed by the percentage of people affected by poverty, unemployment, lack of access to education, information, training and leisure. 2. total percentage of the population affected seriously by crime or traffic accidents. 3. total percentage of the population participating in local elections or as active members in associations for urban improvement and quality of life.

2.1.5 Sustainability Index Aligned Development Planning

Measurement and Reporting are necessary but not sufficient conditions for achieving genuine Sustainability. Feedback incorporation from Sustainability Reports and Indicator Trend Analysis into the overall 1) Development Plan, and 2) Corporate Environmental Responsibility Policy are the critical end-goals enabled by the prior functions. Thus the DP and CER are dynamic policy documents reliant upon the outcomes of the annual Environmental Sustainability Measurement and Reporting exercise as a significant source of stimulus to enhance the Sustainability aspects of the Township.

The process of cross-irrigation of these two functions (Measurement and Policy Transformation) must be institutionalized and assured of unqualified Corporate support. Possible options for institutionalizing this critical linkage are (one or all of the following):

- Public Disclosure of Sustainability Indicators through a Sustainability Web Portal: 1st Party-validated Sustainability Indicator data and trends disclosed periodically with archives available to the public.
- Annual General Sustainability Conclave: A presentation-based conference for external stakeholders to publicly share the conclusions of the Annual Environmental Sustainability Reports and invite Environmental Expert as well as Public comments related to strategies for enhancement of Sustainability performance in the forthcoming year in the context of enhanced public environmental consciousness and access to improved environmental technological and management alternatives.
- Annual Internal Sustainability Conclave: A workshop-format conference for internal stakeholders, with Environmental Cross-Domain Experts with expertise in Environmental and Industrial/Commercial/Residential and City Management areas, revolving around the process of dissecting the learnings from distillation of trends / diagnostics from Annual Environmental Sustainability Reports, as well outcomes and consequent action-plans emerging from the corresponding General Conclave. Culminating in devising and public declaration of sector-specific strategies (Industrial, Commercial, Residential and Corporate/CMS/Directly Controlled Operations) to enhance Sustainability performance during the forthcoming year.

2.2 GHG Inventorying and Reporting

While environmental sustainability reporting is a ambitious and broad-based framework from which benefits and outcomes will require a prolonged time to materialise, a more tangible and immediate imperative for Lavasa a committed approach to decouple GDP growth of the region from GHG Emissions – in alignment with the National Goal of reducing the GHG Intensity of GDP by 20% to 25% relative by 2020 relative to 2005 levels.

Globally acceptable methodologies for conducting Corporate GHG Inventorying according to ISO 14064-1, IPCC 2006 Guidelines, GHG Protocol or an equivalent methodology can be adopted. As ISO 14064-1 is widely anticipated by Industry Experts to become the most relevant standard, it is recommended that this framework be adopted at the outset as a Best Practice GHG Inventorying

Protocol. GHG Inventorying must be operationalized by the Environmental Department with Activity Data gathering support from Industrial, Commercial, Residential Projects as well as CMS/Corporate Operations. The end-goal of this exercise is to develop:

- Transparent (through factual and coherent documentation),
- Accurate (avoiding under or over estimation),
- Consistent (across time series and operations),
- Comparable (across operations and inventories conducted for other similar organizations), and
- Complete (accounting for all sources and sinks),

GHG Inventories of the entire Operational Boundary (i.e. cumulative of Organizational Boundaries and Organizational Activities outside the Organizational Boundary).

The emission sources comprising the Activity Boundary for GHG Inventory calculation for Lavasa should include of the following:

Scope 1 Emissions: Physical Emissions from activities directly controlled by the organization. . These contributing directly to the GHG Inventory and represent activities where direct control can be exercised over the magnitude of activity and the Emission Factor through technological choices.

Scope 2 Emissions: Emissions arising as a consequence of activities directly under the control of the organization but occurring at sources owned or controlled by other organizations. These emissions therefore contribute indirectly to the GHG Inventory and represent activities where direct control can be exercised over the magnitude of activity but not the Emission Factor through technological choices.

Scope 3 Emissions: Optional reporting category which includes all Indirect Emissions not covered under Scope 2 emissions. Generally, these are activities where direct control can neither be exercised over the magnitude of activity nor the Emission Factor through technological choices. Life-Cycle Analysis of all products and services used by the organization would be included in this category.

The 'Completeness' criteria of GHG Inventories requires reporting of all Scope 1 and Scope 2 emissions. Hence the roadmap for establishing routine calculation and reporting of Carbon Footprint of Lavasa must emphasize these emissions across all Operational Domains. Following the establishment of complete operational GHG Inventorying, Lavasa must extend its GHG Inventory Boundary to be compliant with the 'Equity Share' approach as specified under ISO 14064-1 Standard.

Table 5GHG Inventorying and Reporting Roadmap for Lavasa

GHG Inventory Parameter	**Domain (Operational), Scope (Relevant Parameters), Timeline (Schedule)**			
	Industrial Projects	**Commercial Projects**	**Residential Projects**	**Corporate / CMS / Directly Controlled Operations**
Scope 1	Short Term	Short Term	Short Term	Short Term

Emissions				
Scope 2 Emissions	Short Term	Short Term	Short Term	Short Term
Scope 3 Emissions	Medium Term	Long Term	Long Term	Medium Term

The timeframes presented in Table 5 are indicative of the following time periods for achieving complete coverage within an Operational Domain:

Short Term: 6 to 8 months following formal adoption of CER Policy

Medium Term: 1 to 2 years following formal adoption of CER Policy

Long Term: 2 to 3 years following formal adoption of CER Policy

GHG Inventorying provides a wide array of direct and indirect benefits to the Organization while serving as a Measurable, Reportable and Verifiable Indicator of improvement in its Sustainability Performance over time. These benefits to the Organization and its efforts to enhancing its Environmental balance include the following:

- GHG Inventorying will lead to the establishment of a GHG Emissions Baseline for Lavasa against which future efforts would be benchmarked for measurably and verifiably assessing the magnitude and impact of GHG mitigation measures.
- GHG Inventorying, if coupled with Carbon, Energy, and Water balance assessment (i.e. mapping and tracking of respective flows of these entities across operational zones and delineating the resource-based interactions of various stakeholders), serves as a rigorous basis for devising a rationalized mitigation roadmap by identifying high, medium and low priority areas for targeted interventions to achieve optimal energy, waster conservation and GHG Emissions Mitigation in alignment with financial / economic goals of the organization.
- Disaggregated GHG Emissions assessment identifying the contributions of various stakeholders within the Operational Boundary facilitates the process of identifying key contributors and processes to the overall Carbon Footprint. This in turn provides vital perspective that can inform the process of defining actions towards participative (i.e. involving all Stakeholders) mitigation of Climate Change impacts through Carbon Footprint minimization.

The process of GHG Inventorying must to be leveraged further through disclosure of Carbon Footprint through the most comprehensive global-platform established for this purpose – the Carbon Disclosure Project (CDP).

Marginal GHG Abatement Cost Analysis

As part of the institutionalization of GHG Inventorying within the Environmental Department, Lavasa must adopt the practice of commissioning periodic (every 2 to 4 years), a Marginal GHG Abatement Cost (MAC) Analysis to determine the most cost-effective means of mitigating GHG emissions from direct and indirect sources through technological interventions or modifications in management practices. This widely accepted approach is seen to be as a Best-Practice and vital input for determining the Environmental Department's capital expenditure for a given planning period. As GHG Mitigation costs are greatly dependent on financial parameters (such as inflation,

interest rates, cost of electricity, energy etc.) and we all new technological alternatives available over time, this activity is meaningful only when institutionalized as a periodic revision.

Ensuring Energy Efficiency, Water Conservation etc. projects are planned on the basis of the priority indicated by the MAC Analysis process will safeguard the financial sustainability of the Organization which in turn will bolster the overall Environmental Sustainability endeavours; reducing financial risk will ensure longevity of the Environmental program at large. It is therefore imperative that MAC Analysis be part of its Corporate Environmental Responsibility Policy.

Projected GHG Emissions for Lavasa

GHG Emissions Benchmarking for Lavasa

2.3 Life Cycle Assessment (LCA) of Industrial Products and Services

Life cycle assessment is a "cradle-to-grave" approach for assessing industrial systems and their products. "Cradle-to-grave" begins with the gathering of raw materials from the earth to create the product and ends at the point when all materials are returned to the earth. LCA evaluates all stages of a product's as interdependent processes. LCA enables the estimation of the cumulative environmental impacts resulting from all stages in the product life cycle, often including impacts not considered in more traditional analyses (e.g., raw material extraction, material transportation, ultimate product disposal, etc.). By including the impacts throughout the product life cycle, LCA provides a comprehensive view of the environmental aspects of the product or process and a more accurate picture of the true environmental trade-offs in product and process selection. Formalization of Life Cycle Analysis based approaches at Industrial Units at Lavasa (for instance, Bamboosa furniture), as a tool for optimization of product design, operational and manufacturing process, as well as supply chain mechanisms will ensure that Industrial manufacturing at the township does not operator on priciples divergent from the overall organizational goals of ensuring environmental, social and economic sustainability of the township and the ancillary economy enabled by it.

2.4 Project Level Best-Practices:

2.4.1 International Performance Measurement and Verification Protocol

As a means to enhance the measurability and verifiability of Water and Energy Efficiency (EE) Projects, either directly implemented by the Organization or at privately owned project location within the township, it is prudent practice for Lavasa to adopt the the International Performance Measurement and Verification Protocol (IPMVP) as the norm for validating savings achieved from these efforts. This protocol establishes the general practices to be used for measuring, computing and reporting savings achieved by energy or water efficiency projects at end user facilities. The IPMVP presents a framework and four measurement and verification (M&V) Options for transparently, reliably and consistently reporting a project's saving. M&V activities include site surveys, metering of energy or water flow(s), monitoring of independent variable(s), calculation,

and reporting.

While conservation projects in the absence of adhering to a M&V protocol can yield environmental benefits, the resource and cost savings achieved are essentially speculative in the absence of a validated baseline and a appropriately chosen metric for determining performance improvement. In this context, adhering to the IPMVP Protocol ensures that M&V activities produce verifiable savings reports with significant beneficial implications for all stakeholder's involved in the projects.

2.4.2 GRIHA for Construction Projects

Construction projects – especially commercial buildings (hotels, hospitals, office complexes) within Lavasa, present a sizeable opportunity to achieve significant energy conservation through institutionalized approaches towards ensuring green construction principles form the blueprint of all future construction projects.

The purpose of Energy Conservation Building Code (ECBC) is to provide minimum requirements for energy-efficient design and construction of buildings and their systems. The building sector represents about 33% of electricity consumption in India, with commercial sector and residential sector accounting for 8%and 25% respectively. Estimates based on computer simulation models indicate that ECBC-compliant buildings can use 40 to 60% less energy than conventional buildings. It is estimated that the nationwide mandatory enforcement of the ECBC will yield annual savings of approximately 1.7 billion kWh. The ECBC is expected to overcome market barriers, which otherwise result in under-investment in building energy efficiency.

While Lavasa has committed to complying with the ECBC for all commercial buildings to be built in the township, it is critical that the scope of assessing and mitigating the impact of building construction be broadened greatly beyond the relatively narrow lens of merely use-phase energy consumption. In this context, Lavasa must consider adopting a more rigorous framework for assessing environmental impacts of buildings and raise the bar for what are considered to be 'green' buildings.

GRIHA is a rating tool designed to assess the performance of buildings against nationally acceptable benchmarks. It evaluates environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'. The rating system, based on accepted energy and environmental principles, represents a confluence of established practices and emerging concepts, both national and international.

The system is designed to assist in design and evaluation of new buildings (buildings that are still at the inception stages). A building is assessed based on its predicted performance over its entire life cycle – inception through operation. The stages of the life cycle considered during evaluation are:

- Pre-construction stage (intra- and inter-site issues like proximity to public transport, type of soil, kind of land, location, the flora and fauna on the land before construction activity starts, the natural landscape and land features)
- Building planning and construction stages (issues of resource conservation and reduction in resource demand, resource utilization efficiency, resource recovery and reuse, and provisions

for occupant health and well being). Prime resources considered are land, water, energy, air, and green cover.

- Building operation and maintenance stage (issues of operation and maintenance of building systems and processes, monitoring and recording of energy consumption, and occupant health and well being, and also issues that affect the global and local environment).

This rating system is considered to be significantly superior in scope and more progressive than other similar green building certifications (LEED etc.) that were prevalent prior to its establishment as a nationally recognized framework.

2.4.3 Building and Apartment-Scale Energy Benchmarking (Energy Performance Index)

The national Energy Conservation Building Code (ECBC) and green building rating systems such as Leadership in Energy and Environment Design (LEED-India) and Green Rating for Integrated Habitat Assessment (GRIHA) are based on design intent rather than actual performance during building occupancy. They are not designed primarily to rate energy performance of existing buildings and to reward their performance through a systematic evaluation and award scheme. Further, they do not provide defendable energy consumption targets for new buildings based on contextual data. This often leads to cases where buildings believed to be 'green' based on these intent-based criteria are in fact not greatly different from peers in terms of actual performance. Thus leading to a detrimental complacency amongst buildings owners who believe their contribution to the local and global environment to be greatly beneficial whereas performance data might reveal impacts that are contrary to this perception.

Buildings, along with other consumers must continuously monitor and improve their performance in order to transit to an energy efficient economy. It is important to measure this performance against established benchmarks. The primary aim of this initiative is to improve the design, construction, maintenance and operation of buildings by measuring energy performance against established benchmarks, and recognize and reward exemplary performing buildings through a credible certification system.

Performance based rating systems serve as an excellent baseline "report card". They are useful for evaluating performance of existing buildings and to set meaningful targets for new buildings. It replaces guesswork with a scientific methodology to establish targets, evaluate performance and reward innovations.

In alignment with the most progressive modern townships being constructed in the developing world (for instance – Changwon City, South Korea), it is imperative that Lavasa establish a Energy Performance Index (EPI) for Residential Apartments, and Commercial Buildings (under the categories of Hotels, Restaurant, Hospitals, Retails Stores, Multiplexes, Malls, and Office Buildings) to award Energy-based Ratings as well as associated financial / service incentives to entities exhibiting higher EPI rating.

2.5 Specific Best-Practice Technologies and Management Systems

2.5.1 Energy: Renewables, Energy Efficiency, Alternative Energy

2.5.1.1 HVAC Systems Related

Economizers

An economizer is a collection of dampers, sensors, actuators and logic devices that together decide how much outside air to bring into a building. When the outdoor temperature and humidity are mild, economizers save energy by cooling buildings with outside air instead of by using refrigeration equipment to cool recirculated air.
A properly operating economizer can cut energy costs by as much as 10 percent of a building's total energy consumption, depending mostly on local climate and internal cooling loads.

Scale Control in Water Circuit

In a water-cooled air-conditioning system, heat is rejected from the refrigerant to the cooling water in the condenser. The impurities in the cooling water circuit get accumulated, and thus the scales and deposits are built up in the condenser tubes, creating scaling problems on the condenser heat transfer surfaces. This reduces the heat transfer efficiency of the condenser and thus increases chiller energy consumption. The use of soft water for condensers and chilled water system will reduce scale formation.

Solar Air Conditioning

The most common technique consists in using solar collectors to provide the heat that is directed toward an absorption chiller. This machine dissociates, by boiling point, a solution of water and bromide of lithium. After cooling, the recombination of the two components produces the cold air which is distributed then into the zones like classic air-conditioning. The sun can provide a substantial part of the energy needed for air-conditioning. It can be used, either as stand-alone systems or with conventional air conditioning, to improve the indoor air –quality of all types of buildings. The main goal is to utilize "zero emission" technologies to reduce energy consumption and CO2 emissions.

Screw Chillers

Compared to Centrifugal Chillers, Screw Chillers have several advantages. Centrifugal compressors are susceptible to shutdowns when loads fluctuate (causing surging); particularly if demand changes quickly or loads happen to drop below 50%. Contrastingly, screw compressors can withstand a wide range of operating conditions easily. It can operate from 100% load down to 25% load and accepts virtually instantaneous changes. This allows for low-energy operations during times of reduced load and the associated energy and environmental benefits of resource conservation realised during the periods of load-optimised operations. Another advantage of a screw compressor is that because of the infinite capacity (slide valve) control, stops and restarts are limited which also reduces the chances of motor or starter burnouts. And with our redesigned direct expansion chiller packages, customers can now achieve the best EER available with multiple, redundant refrigeration circuits.

Absorption-Chillers

Absorption chillers as opposed to compressor-based electric chillers at Lavasa will allow the use of waste heat from Industrial units or solar heat to generate cooling. Lavasa should promote the use of this type of HVAC system at Hotels, Malls and other large establishments where Central Air Conditioning is required.

Thermal-Storage ACs

Thermo-storage ACs, relative to a conventional compressor based systems, can reduce peak electrical load imposed during the afternoon peak cooling load periods on the local electric grid. This technology essentially relies upon standard chillers operating at off-peak hours to produce ice around which water is circulated through heat-exchanger systems during peak hours to produce chilled water that is circulated though the buildings HVAC systems. Thermal storage systems can be retrofitted into existing water-based central air conditioning systems and is a very useful advantage since it reduces barriers for rapid adoption on a wide scale. The technology is mature enough and has seen widespread application within Maharashtra (Thane District) and is ideally suited for applications such as Commercial Office Buildings, Mall and Multiplex AC systems proposed to be built in Lavasa.

It must be noted that Absorption chillers and thermo storage systems operate at a lower Coefficient of Performance (COP) relative to conventional systems i.e. the ratio of cooling energy output to input is lower. Typically, absorption chiller based systems provide a COP of 0.8 to 1.2 as opposed to 3.0 to 4.0. For thermo storage systems, the beneficial impact of reduced peak load would have to be adjusted for the increased electricity consumption during non-peak hours due to reduced process efficiency.

Evaporative Air Coolers

An evaporative cooler produces effective cooling by combining a natural process - water evaporation - with a simple, reliable air-moving system. Fresh outside air is pulled through moist pads where it is cooled by evaporation and circulated through a house or building by a large blower. As this happens, the temperature of the outside air can be lowered as much as 30 degrees. This technology can provide significant savings relative to conventional electric compressor-based AC systems in areas with low humidity. Furthermore, this system will drastically improve air quality for and occupational health of kitchen and office staff since these systems do not recirculate air unlike Air Conditioning systems. Incidences of building-sickness with these systems will be largely eliminated and will improve overall workforce productivity.

Desiccant Heat Recovery Systems

Properties of desiccants materials to readily attract water and thus dehumidify air can be used in HVAC applications to reduce cooling loads, improve chiller efficiency and widen the applicability of evaporative cooling, while providing improved indoor air quality and eliminating the use of CFC refrigerants. In combination with evaporative cooling, desiccant cooling can eliminate refrigerative Air conditioning in many climates.

Variable Refrigerant Flow (VRF) and Variable Air Volume (VAV) AC Systems

In VAV systems, chilled air is distributed to spaces from an air handling unit, and the temperature of individual spaces is controlled by throttling the quantity of air into each space. The throttling is accomplished by terminal units that are controlled by the space thermostats.

VAV systems were originally introduced as a more efficient alternative to constant-volume reheats systems. The VAV concept offers two major efficiency improvements: (1) it reduces or eliminates reheat and (2) it minimizes fan power.

VRF AC systems are ideal for use in commercial spaces which are expected to witness wide variations in cooling needs through the day or in various physical zones of a premises; for instance in offices, restaurants, movie theatres etc. These systems are generally believed to yield approximately 40% higher Coefficient of Performance (COP) compared to conventional systems. The approximate Energy Efficiency Ratio (EER) for VRF systems are in the vicinity of 4.3 relative to the EER's of the most efficient split-unit conventional compressor based systems of approximately 3.0 to 3.3; an improvement of approximately 37%.

Displacement Ventilation Systems

Incoming air is delivered to interior rooms by way of floor-level vents. This incoming air displaces upper air, which is exhausted through ceiling-level vents. Because displacement ventilation systems typically use 100% outdoor air, air pollutants generated within the building are removed at source and are not recirculated. In addition, heat generated by ceiling level lights is removed, and thus heat is not included when estimating building cooling loads.

Low Pressure Duct Work Design

Duct size should be increased to reduce duct pressure drop and fan speed. Resistance in the duct system can be reduced by improving the aerodynamics of the flow paths and avoiding sharp turns in duct routing. Increasing the size of ducting where possible allows reductions in air velocity, which in turn permits reductions in fan speed and yields substantial energy savings. Small increase in duct diameter can greatly lower pressure, resulting in fan energy savings, because the pressure drop in ducts is proportional to the inverse of duct diameter to the fifth power.

Variable Frequency Pumps

Viable-frequency drive pumps provide approximately 40% to 50% energy efficiency relative to conventional rotodynamic pumps (such as centrifugal pumps etc.). The energy efficiency is achieved by eliminating flow control valves to throttle flow and instead using variable-frequency drives to provide continuous control to match motor speed to the specific instantaneous head requirement. Besides drastically reducing energy consumption, the intervention also has beneficial impact on the longevity of pump impellers and other equipment which materialize as the indirect environmentally beneficial impacts of the technology.

Building Energy Management Systems

Energy Management Systems for smart control of HVAC and Lighting is a industry-wide best practice for commercial buildings in India. These control systems empower facility managers and shift engineers to dramatically reduce excess energy consumption especially with respect to unwanted lighting and excessive cooling in building zones which not only escalates energy consumption but also undermines thermal comfort of building occupants.

Motion-based HVAC and Lighting Controls

Energy consumption from building interiors and exteriors that do not require continual lighting and cooling due to infrequent occupancy (eg. stairwell and compound lighting in buildings and fan/light operation in toilets and elevators in commercial and residential premises) can be significantly diminished by use of Passive Infrared Sensors- PIR Sensors to controls HVAC and lighting fixtures. Incorporating PIR Sensor-control in tubelights, used 12 hours per day (approximate usage in stairwell lighting applications), can mitigate energy consumption by approximately 160 kWh per fixture.

Geothermal Cold-Storage/Heat Pump

Geothermal Cold-Storage/Heat Pump technology is ideal for application at Lavasa as an alternative to conventional electric compressor based Air Conditioning systems due to the proximity with large water bodies (i.e. reservoir). These systems essentially rely upon a embedded underground heat-exchanger network to cool water circulated through HVAC systems of the building above ground. Energy conservation is achieved through reduced electrical load required to achieve cooling purely through compressor-based cooling systems. Thermal pollution impacts of rejected warm water from the cooling cycle into the Reservoirs of the township needs to be studied through modelling to ascertain the possible impacts on aquatic life. The benefits of river water source based cooling/heating must be weighed against the possible adverse impacts of this phenomenon to eventually determine the true utility of this low-carbon development strategy on a city-wide or nation-wide basis.

2.5.1.2 Passive Energy Related

Double and Triple-Glazed Windows

Double and Triple-Glazed Windows enhance the insulation properties and reduce the operational energy requirement of the buildings. The advantage of these methods of insulation over other window systems which rely upon solar reflection (such as tinted and coated window films) is that they achieve heat gain reduction without greatly compromising visible light transmission. Solar reflection based systems, while achieving comparable heat gain reduction, are compromised by the increased interior lighting load necessitated by their application. Through Double and Triple Glazed Systems the heat gain/loss can be reduced by approximately 50% to 75% relative to Single Pane Glass Systems.

Heat Gain Reducing Paint

The Heat Gain Reducing Paint technology has the ability to reflect heat causing infrared rays from solar radiation. This intervention was designed to help reduce the internal temperature of the building i.e. reduce heat gain. Certification conducted by the Centre for Energy Studies and Research (CESR, India) indicates that Weather Shield Paints (i.e. solar reflective paints) can reduce the temperatures of walls by upto 5oCand that reflectivity rate for solar radiation through these paints is 0.40 relative to ordinary exterior wall paint which exhibit a reflectivity rate of 0.21. i.e. these paints are approximately twice as effective in curbing building wall temperature rise due to solar radiation.

Natural Lighting

Natural lighting through dormer windows, skylights, and transparent cement as well as optimal

positioning of windows can reduce the lighting load incorporated into building design. This intervention has the twin beneficial impact of reducing manufacturing related LCA impacts of lighting fixtures as well as reduced energy consumption. Some green architecture guidelines specify design lighting loads in the vicinity of 7.5 W/sq.m. For building occupancy of 10 hours/day, the average annual electricity conservation and GHG emissions mitigation per sq. m of naturally lit space relative to conventionally lit space is estimated to be 27 kWh/sq.m and 24 kgCO2e/sq. m.

Natural Ventilation

Natural ventilation through facilitation of wind draft through open walls and from under floor spaces, channelling through hollow support pillars and stairwells were some of the ways in which natural ventilation can employ. As in the case with natural lighting, natural ventilation has the twin beneficial impact of reducing manufacturing related LCA impacts of HVAC systems (by either eliminating it in some spaces or reducing the design capacity) as well as reduced energy consumption. The primary savings from natural ventilation systems are the consequence of reduced power consumption for air handling unit fans.

Sunshading

Sunshading, either through intrinsic design features such as Dougong Brackets (a design feature wherein the higher roof area to floor base ratio limits the heat gain caused by 45 degree solar radiation, i.e. the maximum diurnal solar influx) or through smart controlled window shades (to block the suns rays during periods of high solar intensity).

Building Integrated Photo Voltaic

In BIPV**,** modules have been integrated into roofing or other building materials as an alternative to traditional PV modules that are mounted above the roof on racks. Once installed, BIPV components protect the home from weather and also produce electricity for use. BIPV systems can be installed on a small scale to produce limited amount of energy or be large enough to power an entire building and send excess electricity to the utility.

Evaporative Reflective Roof

In this, roof design is composed of a concrete ceiling over which lies a bed of rocks in a water pool. Over this bed is an air gap separated from the external environment by an aluminium plate. The upper surface of this plate is painted with a white titanium-based pigment to increase reflection of a radiation to a maximum during the day. At night, the temperature of the aluminium sheet falls below the temperature of the rock bed mixed with water. Water vapour inside the roof condenses and falls by gravity. This heat pipe effect carries heat outwards and cold inwards.

Insulating Walls

Insulation of walls are important for reducing conduction losses especially where significant difference exists between inside and outside temperature. Many insulation materials require Air Barrier and Weather Relative Barrier to prevent air and moisture movement into and out of the conditioned space as well as for maintaining their installed R-value.

Infiltration and Exfiltration

Unwanted air movement through windows and envelope surfaces is caused by a pressure difference

(air moves from high pressure to a lower pressure). Limiting air infiltration and exfiltration can improve the energy efficiency. Implementing a continuous air barrier or roll-applied continuous air barrier can control the moisture in the buildings.

Green Roofs and Green Walls

A green roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. Similarly, a green wall is a wall, either free-standing or part of a building, which is partially or completely covered with vegetation and, in some cases, soil or an inorganic growing medium. The vegetation for a green façade is can be attached either to the outside walls or in the case of interior greening, they can be attached to the inner wall.

Green roofs and walls can serve several purposes for a building, such as absorbing rainwater, providing insulation, creating a habitat for wildlife, helping to lower indoor air temperature, combatting heat island effects while at the same time sequestering atmospheric carbon dioxide. Its impacts a therefore two-fold, indirect GHG mitigation through energy conservation and direct GHG mitigation through carbon sequestration.

Combining green roofs with food production and or organic waste composting has the potential to effectively address food supply inefficiencies (both, reduced economic cost and GHG emissions from avoided logistics and land-use change effect) as well as municipal solid waste management issues both from reduced system operational cost and reduced GHG emissions from avoided logistics, reduced landfill gas production and avoided NPK or urea based fertilizer production. Furthermore, green roofs can be seen as low embodied carbon alternatives to conventional sound-insulation materials employed in commercial buildings as they reduce noise penetration from outside. It has also been reported that green roofs reduce building penetration of electromagnetic pollution – again, an instance of avoided embodied carbon emissions from production of other conventional materials designed to mitigate these effects on building inhabitants

One aspect of green roof technology to be considered when designing overall urban planning policy is the competing technologies for utilization of roof space. In hotter climates, relative electrical conservation and consequent GHG mitigation benefits for solar thermal, solar PV, skylights etc. on a unit area basis must be considered in a comprehensive analysis to determine the most carbon efficient alternative for rooftop application on a wide scale.

Direct Evaporative Water Spraying Technology

This technology essentially comprises of spraying water on exterior building walls to reduce the temperature of the interior environment and thereby reducing Air Conditioning load and increasing operational energy efficiency of the built space. While this system does increase water consumption and the associated energy for pumping, these impacts might be mitigated by utilizing the grey water recycled or stored harvested rain water from the building rooftop during the wet months and putting it to use in the dry months. This technology is not expected to yield significant benefit in humid climates or seasons. Also, the paint selection for building exteriors must account for the increased fungal growth potential due to increased surface moisture – and hence must have strong anti-fungal properties.

2.5.1.3 Lighting Related

LED Lighting

Light Emitting Diode (LED) Lighting is known to be 50% more energy efficient (on a lum/W baisis) relative to Compact Fluorescent Lamp (CFL) Bulbs; CFL Bulbs are widely known to be 75% energy efficient relative to Incandescent Bulbs. The overall energy efficiency of LED lighting relative to GLS lamps is therefore approximately 87.5%. Furthermore, the lifespan of LED bulbs is significantly longer (generally 25,000 hours) compared to GLS Lamps (generally 1,500 hours) and CFL Bulbs (generally 8,000 to 10,000 hours). While this lighting technology is financially unviable for residential use (based on 2011 equipment and electricity prices), they offer immense potential for cost and energy conservation at a viable payback period for Commercial establishments.

Fiber-Optic Lighting

Fiber-optic lighting utilizes light-transmitting cable fed from a light source in a remote location. They generally energy-efficient and provides illumination over a given area. The only electrical connection needed for the system is at illuminator. No wiring or electrical connection us required along any part, either at the fiber-optic cable or at the actual point source fixture. This system provides many benefits and eliminates many problems encountered with conventional lighting systems. They require no voltage at the fixtures, us completely safe, emits no heat and is virtually maintenance free. This lighting technology is especially useful for retail settings, supermarkets and etc. because emits no heat or ultraviolet radiation.

2.5.1.4 Water Heating

Solar Thermal Water Heating Systems

On a per unit area basis, Solar Thermal Flat Plate Collectors with 55 % thermal efficiency can be expected to generate approximately 600 W/m2 and 830 kWh/m2/year. This is significantly higher (a factor of 6.0) than the specific power generation by Solar PVs under identical climatic conditions. Hence rooftops at Lavasa should be utilized first for satisfying Solar Thermal demand prior to their utilization for Solar PV applications.

2.5.2 Water: Conservation, Usage Efficiency, Recycling

An overarching trend that defines the environmental benefits from all water conservation and rainwater recycling technologies (especially when they result in reduced potable water consumption as well as reduced wastewater discharge to the sewage system) is that the indirect benefit but potent advantage of application if this technology on a township scale are two-fold: a) significant reduction in the design capacity of the water treatment, wastewater treatment and, stormwater management systems (in the cases of stormwater runoff prevention systems), required to convey and treat peak water supply and wastewater discharge flows , and b) reduced operational energy consumption for all the infrastructure facilities mentioned above stemming from their curtailed design capacity.

Water Saving Toilets

Water saving toilets can reduce water consumption by 65% (assuming a 1.6 gal/0.8 gal configuration) relative to a convention (5 gal/flush) system. The primary benefits from this intervention are reduced potable water consumption and associated pumping energy conservation.

Waterfree Urinals

Waterless urinals use no water at all and use a trap insert filled with a sealant liquid instead of water. The lighter-than-water sealant floats on top of the urine collected in the U-bend, preventing odors from being released into the air. Although the cartridge and sealant must be periodically replaced, the system saves anywhere between 15,000 and 45,000 gallons (approx. 55,000 and 170,000 liters) depending on the urinal traffic in BAU conditions. Some variants are based on an outlet system that traps the odor, preventing the smell often present in toilet blocks. Waterless urinals should be used extensively all across Lavasa to ensure high degree of potable or recycled water conservation as well as the associated pumping energy use.

Water Saving Faucets

Water saving faucets for commercial use in Hotel and Restaurant kitchens, bathrooms as well as in all residential bathrooms and kitchen are low-cost means of achieving significant levels of water conservation. Indian Green Building Council (IGBC) approved water fixtures with aerators and are considered to enable water savings of about 30%.

Greywater Recycling

Grey Water Recycling (i.e. recycling of bath and wash water, excluding sewage from toilets) can be mandated at all commercial and residential project locations as part of an augmented building design code applicable within the township . The primary benefits from this intervention are reduced potable water consumption stemming from reuse of treated grey water for non-potable uses (flushing, landscaping etc.) and associated pumping energy conservation.

Irrigation Water Conservation

Programmed micro-irrigation (trickle irrigation) and sprinkler-irrigation can save approximately 60%, while sprinkler irrigation technology can save approximately 50% relative to conventional surface irrigation technology. Commercial facilities such as Hotel and Golf Course Lawns should be mandated to adhere to this method of lawn irrigation during evening hours.

Rainwater Harvesting / Recycling

Despite the anticipated abundant levels of potable water availability at Lavasa, stemming from the artificial reservoirs through damming of rivers, rooftop rainwater capture, storage and recycling technology must be applied on a large scale across the entire township. While water availability might not be a cause for concern at this time (2011), water supply involves significant energy consumption. The primary benefits of this de-centralized system of water self-sufficiency and localized management are reduced potable water consumption stemming from reuse of captured rainwater for non-potable uses (flushing, landscaping etc.) and associated pumping energy conservation.

Stormwater Runoff Prevention

Permeable paving technology comprises a range of materials and techniques for paving roads, cycle-paths, car-parks and pavements that allow the movement of water and air around the paving material. Common types of permeable pavement employed are porous asphalt, porous concrete, plastic grid systems, and rubber pavers. This intervention, relative to conventional non-porous paving materials, has the primary benefit of reducing storm water runoff from paved areas. Furthermore, permeable paving can reduce thermal as well as sediment and chemical pollution of receiving water bodies (into which stormwater runoff is discharged, except for Combined Sewer Overflow systems, wherein this occurs only during heavy rainfall events which exceed the design capacity of the treatment system). Both forms of water body pollution pose a threat to aquatic ecosystems. The system is designed to reduce flow velocity of stormwater run off by absorbing it through joints between paving blocks, which are filled with grit instead of the sand that is used in conventional paving, and stored in a special sub base beneath the paving. The sub-base, comprising of aggregate, subsequently filters and reduces the pollutant concentration in the eventual discharge released into nearby streams, allowed to percolate into the underlying earth, or conveyed into the drainage system through pipes.

General technical specifications from global sources reveals removal efficiencies of 82-95% for sediments, 65% for total Phosphorous, 80-85% for total Nitrogen. Studies also indicate a potential for reducing stormwater runoff volumes from 60% to almost 100% (under usual precipitation conditions).

While Lavasa is characterized by superior stormwater drainage capability owing to the proximity of receiving water bodies, the potential for flooding due to anomalously high rainfall storm events cannot be ignored. As part of its Climate Change Adaptation strategy, Lavasa much incorporate permeable pavements to allow for widespread gradual recharge of rainwater into the groundwater table to aid the conventional systems of stormwater management.

2.5.3 Waste: Reduction, Management

Mechanical Biological Treatment

Mechanical Biological Treatment (MBT) systems for treatment of biodegradable kitchen waste for conversion into compost were implemented as a waste management strategy. Benefit of MBT based waste management is the generation of high-nutrient compost as the end product of the beneficial-reuse process. Hence, MBT systems also provide the added benefit of avoided NPK-based or urea-based fertilizer production for local urban agricultural and greening activities. Estimates indicate that 1 kg of biodegradable waste can generate a quantity of compost to (which replaces conventional NPK fertilizers) mitigate 60 grams of CO2e emissions.

Non-Mechanized Aerobic Composting Systems

Mechanized systems might be unavoidable for large volumes of biodegradable waste processing (for eg. from Hotels and large canteens). However, small residential units at Lavasa should ideally incorporate non-mechanized aerobic composting units made from low-environmental impact / local materials such as locally sources clay. Such systems ensure de-centralized waste management within communities, reducing the need for transport infrastructure for waste management as well

lead to direct reduction in methane emissions from landfilling of domestic solid waste.

Alternative Wastewater Treatment Technology

Wastewater treatment based on engineered ecological systems such as Biotreatment System (Bacillus Subtilis) and Constructed Wetlands are designed to activate microbial processes that stimulate the natural breakdown of polluting compounds in a specific waste water situation. Organic pollutants are broken down as a food source by the micro-organisms whilst other contaminants, such as metals or PCB's are fixed in humic acid and caution exchange bonds in the soil or mineral substrates in which these plants are rooted.

Contrary to conventional notions of these systems being fragile, they can provide a more robust treatment alternative in many domestic wastewater sewage applications. Furthermore, they are ideally suited for decentralized and localized treatment of wastewater and/or grey water treatment which further curbs the environmental impacts related with heavy infrastructure construction related to wastewater treatment collection networks. Additionally, the system minimizes land-use change effects.

2.5.4 Mobility: Efficiency, Alternate Modes of Transport

Green Commuter Card

A green commuter card can be used on all public transportation including metro, Bus Rapid Transit (BRT), buses and taxis. This helps the public to use more public transport and give opportunity for passengers to offset their carbon footprint by purchasing the card indicated that within a reasonable cost range the public has the awareness and willingness to offset carbon footprint.

Automated Public Bicycle Sharing System (ATCAG)

The Automated Public Bicycle Sharing System (ATCAG) is a smartcard-based application. Using the card the passenger can get the bicycle from docket where it is stationed and return it within timeframe. This system helps the public to use green mode of transport and reduces GHG emissions from private and public transport.

A vital development that seeks to provide significant systemic thrust to ushering Sustainable Modes of transport in Indian cities is the National Mission for Sustainable Habitat being implemented by the Ministry of Urban Development. A landmark communication circulated by the Ministry to Principal Secretaries of the Urban Development Department, Local Self Governments, and of Transport Departments of all States and Union Territories of India (dated August 3, 2011) unequivocally calls for establishment of systems / infrastructures / incentives to promote a modal shift towards public transport and promoting green travel habits including non-motorized transport. The circular emphatically supports alternative/public transit modes of transport as the core of the next phase of transportation planning in existing cities and as the blueprint for future Indian cities.

Specifically, the Ministry proposes to provide institutional support to demonstration projects with 100% funding from Government of India (if financially unviable through Public Private Partnership models) in the following project categories:

a) Common Mobility Card to encourage seamless payment and access transition across all public transport options available to commuters in cities to increase utilization of these

modes relative to private automobile use.

b) Public Bicycle Scheme – this has particular applicability for Lavasa which can rapidly establish the requisite infrastructure and systems (involving a fraction of the capital costs involved in setting up conventional unsustainable transport infrastructure) to host a city-wide network which would satisfy the criteria for a government-backed demonstration project

c) Passenger Information System for disseminating critical route and timetable related information pertinent to busses at bus stations and through IT-enabled services on mobile and internet-based communication platforms.

This catalytic progressive development within the pivotal policy-making bodies of the country is a clear signal for Lavasa to proceed with actioning the idea of establishing the first Bicycle Sharing System on a city-wide scale in India thereby pioneering this paradigm-shift towards sustainable transport as a core of its sustainability policy amongst modern Indian Urban Habitats.

2.5.5 Consumable Materials: Reduced embodied energy and carbon, reduced downstream impacts)

Biodegradable Detergents

Soap Nuts (fruits of the soap nut tree and contain 'Saponin') which is a 100% natural alternative to chemical laundry detergent and cleansers. When in contact with water, it creates mild suds, which is similar to soap. Soapnuts are highly-effective as substitutes to normal detergents which increase the nutrient loading (Phosphates) of domestic wastewater – thereby increasing treatment capacity at downstream treatment plants. Soap nuts can be used as Lavasa on a wide scale as laundry detergent, as a liquid soap, cleaning and shining ornaments, and household cleaners. If, however, performance specifications for Commercial operations at Lavasa do not permit the use of Soap Nuts, all commercial laundry facilities in the township should be required to use Alkyl Benzene Sulfonates (ABS) and phosphate free detergents.

Recycled Paper

All printer and photocopy paper used by Lavasa controlled operations at the township must be composed of a high-percentage of post-consumer recycled paper. Switching from virgin printer / photocopy paper to 100% recycled paper can reduce your paper footprint by 37%. Recycled printer papers are now manufactured using techniques that provide finishes nearly equivalent to virgin paper. This material-switch must be greatly encouraged event across commercial and residential operations across the township through effective communication campaigns as well as ensuring access to these alternative products in local supermarkets / stores.

2.5.6 Construction Materials: Reduced embodied carbon, use-phase passive energy conservation)

Hollow Silt Bricks, Reinforced hollow bricks with fly ash

Hollow Silt Bricks, Reinforced hollow bricks with fly ash can be used as an alternate construction material. Research indicates carbon emissions of mud bricks is approximately 90% lower than conventional brick. Also, reuse of power plant slag in the form of gypsum plates can also greatly reduce the embodied Carbon emissions relative to conventional insulation materials. Construction impacts are also greatly dependent on building design, post-use plans for the construction materials, and dismantling practices adopted followed during post-use site clearance. Impacts can be greatly mitigated by designing structures that are modular and composed of easily reusable materials wherein no energy intensive processes are involved in re-deploying them at other construction sites.

Bamboo Construction

Bamboo can be used as an alternative construction material. It reduces the usage of Steel, cement and eliminates aluminium during construction. Also reduces foundation weight of the building and consequently reduce concrete utilization for its construction. The bamboo construction yields significant GHG emissions benefits and has implications for low-carbon construction pathways that must be adopted on a larger scale.

Plywood and Wood Alternatives

GreenPly (Indian Brand) or other Forest Stewardship Council should be used for interior construction where such products would be required (e.g. Furniture, partition walls). Greenply is one of the first Indian Brands to get certified with FSC (CoC) among many other sustainability measures undertaken by the company. A greener alternative than plywood are honeycomb panels. These panels can be used to replace regular plywood, blockboard, wood) which are used for doors, furniture & partition walls. These are sandwiched honeycomb panels with either particle board/mdf/hdf/fibre cement boards on either sides and can be finished off the same way as plywood i.e. paint, laminate, veneer