Clarkdale Sustainability Park

A Plan for the Future of Our Town

White Paper

Dated December 24th, 2009

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Prologue

The Clarkdale Sustainability Park is a concept that is new and exciting, and the rewards for success are massive. This concept will fundamentally change the way we see our cities and towns, the way our municipalities are financed, the services they provide their citizens and how they are delivered. This project will forever change the prevailing paradigm of municipal governance and become a model for communities throughout the country. Clarkdale began life as a model community, built and nurtured by a spirit of determination to succeed and a drive to create new economic opportunities. Clarkdale once again has an opportunity to realize new horizons. It is fortuitous that the company that founded Clarkdale is once again in a position to help move our Town into that new economic reality. But the possibilities exceed economic development. They will extend to new sustainable practices in energy generation, water use and reuse, and even political stability gained by a robust and growing economic base. This plan provides all that and so much more, and the potential benefits to Clarkdale, the Verde Valley and the State of Arizona, are vast. In this concept we have the opportunity to do something great - to change our world for the better.

The Concept

The concept, at first glance, is a traditional master-planned industrial and commercial park. But this plan is unique in the component facilities' interdependence and synergy. The impact and benefits of the Park's individual components will be greater than the sum of their parts. This Park will be occupied by a mix of private and public interdependent enterprises all of which have one overarching principal: a dedication to environmental, energy, economic and social independence and sustainability. The Park will become the economic and social engine of the Town of Clarkdale. It will provide enough electrical power to supply the entire Town and much more. It will become a major enterprise fund for the citizens of Clarkdale. It will change the way we dispose of municipal wastes, hazardous wastes, and industrial pollutants. Rather than burying our trash, thereby polluting our land, air, and aquifers, we will turn it into profitable products, not the least of which is energy. The Clarkdale Sustainability Park will also be an educational opportunity for the other governments interested in sustainability for their citizens.

In keeping with today's accepted definition of sustainability, which is "practices which meet the needs of the present without compromising the ability of future generations to meet their own needs," this Park will be a shining example of how one community might meet that ideal.

While we endorse individual efforts to reduce greenhouse gasses and decrease energy demand by changing light bulbs and improving insulation, we realize that these efforts are probably too little and too late. We believe a more efficient and much faster solution is to make sustainability a community function. Our plan will do just that.

Property Location

The Clarkdale Sustainability Park (called the "Park" hereafter) would fit well in a few different locations in Clarkdale. Three present the best possibilities, and they are: 1) The industrial area of Town that runs from near the cement plant east to the slag pile. This property is owned by Clarkdale Metals, which operates the metals recovery operation at the old slag pile. 2) Lands to the west of town, and south of the cement plant. Most of this area is owned by Verde Exploration, Ltd. 3) The land owned by Freeport-McMoRan Copper & Gold, which acquired the land when it bought the Phelps Dodge Corporation in 2007.

This third parcel presents some unique community benefits that the other two lack. It includes Peck's Lake and surrounding acreage near Tuzigoot National Monument, and also contains the area of tailings recently remediated by Freeport McMoRan. The total area, including the lake, is approximately 977 acres. A map of the area and preliminary layout of the components of the Park is in Attachment A.

This area is currently subject to a development agreement originally written between Yavapai County and Phelps Dodge Mining Corp. in 1987, and assumed by the Town of Clarkdale when it annexed the property in 1991. Under that agreement Phelps Dodge and its successor, Freeport McMoRan, could place 900 homes and 52 acres of commercial properties on the land. Originally the area included a golf course, but that has been removed from the plan.

As a condition of the agreement, Phelps Dodge consented to construct a new wastewater treatment plant for Clarkdale on the property. The plant's initial improvements were put in place, but the plant was never completed. Part of that installation included a wastewater pipeline under the Verde River, terminating on the northeast part of the property near the site of the future wastewater facility. To our knowledge, that pipeline is still a usable conveyance for wastewater or potable water.

The eastern edge of the property is adjacent to Tavasci Marsh, which is now owned by the National Park Service and administered by Tuzigoot National Monument.

Peck's Lake, the dominant feature of this property is a shallow man-made lake which receives the bulk of its water from the Verde River through Brewer's tunnel at the northwest corner of the property. The diversion for that water can be seen just downstream from the Clarkdale Metals slag pile. Currently more water is flowing from the river through the lake than is needed to replace loss due to percolation and evapo-transpiration. The excess flow continues through a weir at the east end of Peck's Lake, thence through Tavasci Marsh. The National Park Service is exploring ways to divert or stop this excess flow, as it is considered to be highly detrimental to the natural health and diversity of the marsh. The lake is shallow, generally less than 10 feet deep, and thus, is choked with various invasive and noxious aquatic vegetation, most notably Eurasian Milfoil and two species of water lilies.

Peck's lake is in the process of eutrophication, which is a biological and chemical process that inevitably produces a wet meadow instead of a lake. In order to stop and reverse this eutrophication, the lake would need to be dredged or otherwise deepened and the noxious weeds removed. The lake is also home to many non-native fish, including Northern Pike,

Yellow Perch, Smallmouth Bass and several species of sunfish, such as Bluegill, Pumpkinseed, Green Sunfish and others. There are no known native fish breeding in Peck's Lake.

The lake area was originally built as a source of process water for the smelter and as a recreational facility for the people of Clarkdale. In addition to the lake, the area included a 9-hole golf course, lake, dance hall, clubhouse, and picnic areas. Until 2003 the lake and surrounding property were leased to the Town of Clarkdale and continuously used for recreation, nature watching, fishing, etc. In 2003 the Town's lease expired and was not renewed, and in December of that year, Phelps Dodge closed the property to the public and it has remained closed since then. The lake has continued to degrade over the years to the point that diversity of waterfowl and other birds is now less than half of what it was only 10 years ago.

The area identified in Exhibit A has several advantageous attributes that make it a very good candidate for the Park project. The old remediated tailings cannot be used for commercial or residential property without extensive additional remediation, but they may be suitable for such things as solar energy arrays which have minimal traffic. The area adjacent to Tavasci Marsh was used as a barrow, or topsoil source, to cap the tailings, and that area is now practically unusable for anything but industrial applications. The south end of the lake is a dead appendix, since the inflow to the lake is near the midpoint of the oxbow, and could easily be cut off from the rest of the lake to be filled in or used as it is for an algal fuel operation or other sustainable energy project. Since there is already a pipeline running from the current Clarkdale Wastewater Facility to the barrow area, that area could conceivably serve as a center for water purification and potable or non-potable reuse facilities. The land between the arms of the oxbow would be well suited to house the plasma converter, recycling center, interpretive center, biodiesel facility and other associated activities.

Park Component Facilities

Waste-to-Energy/Recycling Center

There are a wide range of "waste-to-energy" systems that could find a place in the Park. They range from biomass/Stirling combinations to plasma gasification. In no case would we be soliciting hazardous materials as feedstock for any system. Since the selection of specific technologies has not yet been made, it's impossible at this point to say which systems will fit within our environmental guidelines and which will accomplish the goals of the Park.

One promising technology is a plasma conversion system. In time these systems may be suitable, but as of this writing, we feel that they are not quite "ready for prime time." There is still considerable research to be done on that technology to demonstrate its economic potential, energy production, and most importantly to us, its environmental safety. Several companies, including a Waste Management/Westinghouse joint effort, have entered that field and are in the process of testing and perfecting their systems. We believe they still have a way to go to prove themselves.

These comments, though, could be made about any of the systems that the Park will employ. Seemingly simple, solar energy actually comes in dozens of varieties. Some are water

conservative and relatively environmentally inert, and some use lots of water and others have hazardous waste potential. Biomass remediation processes are the same, as are algae and photobioreactors. Each of these will be subjected to the same stringent environmental standards, and each will have to show that the potential for environmental harm will be negligible. The citizens of Clarkdale will demand and deserve no less.

Plasma converters, or plasma gasifiers are relatively new technolgies that use a very high temperature plasma stream (similar to the plasma torches commonly used to cut metals) to literally vaporize almost any material that is introduced into it. The equipment is manufactured by such companies as Westinghouse (http://www.westinghouse-plasma.com/), Startech Environmental (http://www.startech.net/), Plasco Energy Group (http://www.plascoenergygroup.com/), Plasma Waste Recycling (http://www.plasma-wr.com/default.html), and others. In essence, a plasma converter can break down municipal solid waste (MSW), hazardous wastes, medical wastes, and practically anything else into their elemental components. The bulk of the product from this treatment comes off as "syngas" or synthetic gas. Syngas is very rich in hydrogen, which can be burned in generators which will power the converter itself, and produce an average of about 30% excess electrical energy that can be used by other facilities on the property, or fed back to the electrical grid. The converter also produces heat which can be used as energy for various other operations in the Park, such as the water purification facility. These converters normally run 24 hours a day, 7 days a week, and can typically be maintained and parts changed while the units are operating.

In addition to heat and electricity, plasma converters can be configured to produce valuable metals from the waste, and possibly nanocarbons that are in very high demand for use in new battery technologies and other high-tech applications. Plasma converter facilities typically would include a modern recycling operation stationed at the front end of the process. In this operation, easily recyclable materials would be sorted out of the waste stream for recycling and the remaining waste shredded and fed into the converter.

The plasma converter would primarily be fed municipal solid waste as "feedstock," but any other waste material, such as construction waste, brush, hazardous materials, medical waste, and industrial wastes can also be used. The Verde Valley generates between 130 and 200 tons of solid waste per day, enough to feed an efficiently operating plasma converter.

Appendix A shows a 70-acre tract reserved for the waste-to-energy system and an additional 50 acres for feedstock preparation and recycling center. The actual area used will likely be less than half this.

Photobioreactor/Algal Fuel Facility

The emerging field of algal and photobioreactor fuel holds great promise as a way to help wean us from fossil fuels by creating a biodiesel from algae. Typically, the algae are grown in highly efficient, closed systems (systems not open to the environment). Algae grown in the facility will produce oils that can be converted easily to fuel oil. Typical yields are around 5,000-15,000 gallons of fuel per acre, per year, but recent advances in these photobioreactors may take yields much higher. This operation could occupy the area that

was the south end of Peck's Lake, the area adjacent to the tailings and slurry dam. This area covers around 33 acres.

Photovoltaic/Solar Concentrator Array

A solar energy array would occupy the area that has been reclaimed from the old tailing fields west of Tuzigoot National Monument. The array could hold approximately 100 acres of solar panels and/or reflectors, and could yield between 10 and 30 megawatts (MW) of electricity. A town the size of Clarkdale, with its 4,000 people, uses approximately 8.5 MW of electricity. Photovoltaic cells do not require water as a heat conveyance, so will not deplete an already-stressed groundwater supply. Solar concentrating systems are generally much more efficient, but may use large quantities of water, depending on the systems used. It will be necessary in our application to find ways to use little water, if ant, due to limited local reserves.

Biodiesel Facility

The Park would have ample space for a biodiesel production facility. Biodiesel is normally made from used cooking oil and other waste vegetable oils. This facility could be a perfect adjunct to the algal/photobioreactor fuel operation, converting not only waste cooking oil, but also the oils produced in those facilities. Appendix A shows about 45 acres reserved for biodiesel, but this is likely very generous, and 5-10 acres may be sufficient.

Potable Reuse Facility

The Potable Reuse Facility will be a state-of-the-art water treatment facility which will ultimately produce pure, potable water from wastewater effluent. The plasma converter could supply necessary electrical power to this facility and possibly also supply heat that could be used in a purification process. The treatment facility could receive treated effluent from the Clarkdale wastewater treatment plant across the river through the existing pipeline, or wastewater could be piped directly to the facility for primary, secondary and tertiary treatment, the product of which would be potable-quality water. Such a potable reuse facility could increase Clarkdale's water portfolio enough to avoid or forestall expensive new water resource acquisition for many years. The potable reuse facility in Appendix A sits on 70 acres, but actually only about 25 acres will probably be needed.

The water produced by this facility will probably initially be recharged to a site that benefits Clarkdale's water portfolio. The most likely system will employ a membrane bioreactor, which is a combination of traditional activated sludge/bioreactor paired with a kind of super reverse osmosis system. These systems have consistently and reliably performed by producing water that meets the most stringent of drinking water standards. In fact, they will produce water as pure, or purer, than the groundwater that most of us drink today. That said, the public, and to some extent regulatory agencies, are not quite ready to embrace using this treated effluent directly as drinking water. The buffer afforded by recharging the water, then withdrawing it downstream after a prudent dwell time in the ground, eases the users and the regulators worries about potential pathogens and other compounds of concern.

Nature and Sustainability Interpretive Center/Day Use/Nature Trails

The land to the north and west of the lake could be a premier natural area, hosting a nature observation trail, picnic areas, interpretive center, and other civic and art facilities. A trail system through that area would be one of the finest birding trails in the Verde Valley, and it is actually inside the first Audubon Society "Important Bird Area" (IBA) in the state, the Tuzigoot IBA. This IBA lists more than 200 species of birds and untold other diversity within its boundaries, which stretch from Dead Horse Ranch State Park to Tapco, just upstream from the lake. It may be possible to remediate the lake from the Brewer's Tunnel inlet to the east end sufficiently to return it to an excellent habitat for waterfowl and other birds and native fish.

A modern interpretive and educational center would provide the public with learning opportunities centered on sustainability as well as local nature and history. The facility could house a small conference area and learning facility, as well as a traditional interpretive center, or museum. This facility could be a wonderful adjunct to the Tuzigoot museum, and could host seminars on sustainable energy, economies, etc. The facility might occupy the end of the peninsula between the arms of the oxbow, as well as the areas on the other side of the lake, to the west, north and east of the lake. Not only could this facility provide public learning and recreational opportunities, but also enhance the local tourist economy.

About 75 acres have been identified for these various uses.

Commercially Zoned Areas

The Park plan provides for approximately 150 acres of commercially zoned property. This commercial area might house businesses that are complimentary to the other facilities in the Park, such as supply and equipment houses, hotel/motels, restaurants, and various retail operations. In addition, there are over 200 acres of industrially-zoned land with rail access immediately west of the Park, and this area would be an excellent area for assembly, depot, and manufacturing that could benefit from synergies with Park energy producers.

Other Possible Occupancies

We are certainly not limited to the components described in this paper. There will be unforeseen opportunities that we cannot imagine today and we will need to keep our minds open to these new possibilities. A park like this can add other community and sustainability-related projects, such as a biomass-to-energy plant, community gardens, hydroponic and vertical hydroponic agriculture, dog park, outdoor event venue, and various demonstration or proof-of-concept operations.

Of the 977 acres included in the original development agreement, the Park covers only about 520, leaving another 450 acres available for other types of development. Much of this property is higher and overlooks the property from north of the lake.

Future Expandability

Appendix A shows most of the land used by the above Park component facilities, however, the areas reserved for most of these are extremely generous. The actual space used may actually be less than half of the area assigned in Appendix A. There should be around 250 acres available for additional projects and for expansion of existing facilities.

Alternate Locations

While the Peck's Lake area seems optimal for this project, there are several other locations in or adjacent to Clarkdale that could be suitable. The area to the south and west of Yavapai College, part of which is owned by the Yavapai College Foundation, part by Verde Exploration and the US Forest Service might serve well, as might the land currently owned by Verde Exploration to the west of town (southwest of the Phoenix Cement plant). Depending upon several factors, the land currently owned by Clarkdale Metals in the industrial area north of Town Hall may also be suitable.

Benefits to the Town of Clarkdale

Depending upon exactly how the ownership of the land and the various components is realized, the Town of Clarkdale stands to gain tremendous benefits from this project. The Town would probably be the owner of the Park, and therefore, the landlord. Rents would be charged on the various private enterprises operating in the Park. Franchise fees on electrical generation and sales could bring in additional revenue. If the Town retained ownership and operation of the plasma converter, tipping fees and other waste disposal fees would be a revenue source, as would sale of the syngas or hydrogen, nanocarbons, precious metals, and other by-products of plasma conversion. Facility rental fees would provide additional revenue. Sales and use taxes on new commercial businesses associated with the Park would be substantial. In total, estimates are that the Park could net approximately $500,000-$1 million per year in direct revenues. Add to this the beneficial effects of increased employment,, economic development and synergies created with other industrial and tourist operations in the Town, such as Clarkdale Metals and the Verde Canyon Railroad, and the benefits to Clarkdale's citizens become substantial.

The Clarkdale Sustainability Park will change the way the Town of Clarkdale is financed, where it gets its electricity, how its water and wastewater are supplied and treated, and will help ensure economic and environmental sustainability for our Town. It will, to a great extent, insulate the Town's economy from unpredictable economic cycles in Arizona, thus allowing a stable, continuous path of economic and cultural growth and prosperity.

Challenges

The challenges to success of the Park concept are significant, but manageable. Perhaps the most basic necessity for success will be maintaining the political will on the part of the Clarkdale Town Council and the citizens of Clarkdale to see that the project reaches fruition. It was persistent and unanimous agreement on the part of the Council which allowed the Town to purchase the water utility several years ago, and the same commitment will be necessary to complete this project.

Another significant challenge will be acquisition of the land needed for the Park. The Peck's Lake land is currently owned by Freeport McMoRan Copper and Gold, an international mining corporation with headquarters in Phoenix. Freeport acquired this property when they purchased the Phelps Dodge Mining Corporation several years ago. There is a significant possibility that the Town of Clarkdale and Freeport can reach agreement on a sales price for the necessary property that may include zoning changes beneficial to Freeport and other in-kind contributions. The remaining costs of the land acquisition may be provided by Industrial Development Bonds, public-private partnerships (PPP), or other traditional financing.

Permitting presents some unique and interesting challenges. These will be handled as all permitting is, with both the permitting agency and the Town recognizing that there will be new considerations and situations which may require creative thought. There will be vast benefits to that creativity.

Changes in the dominant paradigm are always challenging, but will be required for success. Close coordination with waste haulers in the area will be necessary to meet their requirements, and to convert them to using the plasma converter facility rather than traditional landfills. The benefits of tipping in Clarkdale, rather than at the Gray Wolf facility, 31 miles south of the Park, should be obvious. There may be a possibility of reclaiming and remediating the Gray Wolf facility and bringing the waste located there to the Clarkdale processing plant, thereby freeing up private land for future development by the owners. Changes in how the residents of the Verde Valley see their place in the environment will be a necessary and natural consequence to the Park.

Transportation into and out of the Park area, especially in the Peck's Lake tract, present a challenge. Currently there is a single entrance and exit from the area, over the 2-lane Tuzigoot Bridge off Broadway. Additional industrial traffic, including municipal solid waste deliveries and additional commercial traffic may require changes to Clarkdale's circulation plan. It is notable that during the Phelps Dodge tailings remediation, traffic was well managed and had minimal impact on the rest of the Town. The possibility of a second access, near the north end of the Park and aligned with the current industrial area, is attractive.

A project of this size and potential impact will have numerous unforeseen roadblocks to success. The Town Council and the Town's management team will need to remain completely committed to the goals of sustainability and economic independence in order to meet and solve each of these new challenges as they arise. Creativity and a willingness to turn apparent problems into opportunities will be essential. With that in mind, it will be absolutely imperative that the Town place the right people in the right positions to guide this process to completion. Staff, Council, and Clarkdale's citizens will be presented with many difficult decisions throughout the creation of the Park, and they must have the enthusiasm and drive to make these decisions in thoughtful and productive ways.

Education of the residents of Clarkdale, the Verde Valley and the political leaders in State and Federal government will be a major component of the project's success. Citizens and leaders must be given all the facts and must fully understand both the challenges and benefits to this Park, as their support and approval will be essential. Each of the components

of this Park is relatively new technology, so education about each of these will be an urgent and time-consuming job for our staff and Council. The public and political leaders must be engaged in the process for the project to succeed. The Council will be called upon to work even harder than it did during the acquisition of the water utility.

Support for the Project

The project has received broad-based support from a wide range of stakeholders. As of this writing, we have received support letters from:

Arizona State Senator Steve Pierce
Arizona State Representative Lucy Mason
Arizona State RepresentativeAndy Tobin
Yavapai County Supervisor Chip Davis
The Yavapai-Apache Nation
The City of Sedona
The Town of Jerome
Arizona State University
Salt River Materials Group
Yavapai College

Conclusion

The core concept of the Sustainability Park is to produce energy, water and economies with as little environmental impact as is possible today. As the plasma converter creates clean electricity, it also cleans up landfills, reduces atmospheric carbon, and eliminates hazardous environmental pollutants. The other facilities in the Park will all be chosen to fulfill sustainability principals. The result will be that a major industrial center in Clarkdale can produce energy, municipal revenue, and local economic development, as well as a world-class nature center, all with a carbon footprint as low as possible. Each facility in the Park should have a relationship, either synergistic, interdependent, or as a supplier to one or more of the other facilities in the Park in a crucible or incubator atmosphere. The Clarkdale Sustainability Park will be a model for municipal operations that will teach sustainability and enhance America's energy and economic independence.

The reduction of greenhouse gases through reduced carbon footprint is a primary global goal, and one that cannot wait any longer. While individual efforts to reduce household energy consumption are appropriate and necessary, this plan will tackle that problem on a community-wide basis. In essence, when the Park is complete, it will have the same environmental benefits as if every house in Clarkdale had solar panels on the roof, everyone converted to compact fluorescent light bulbs, and we all drove hybrid vehicles!

It will be absolutely critical to the success of this project that we keep our minds open to new possibilities to enhance the way Clarkdale, and indeed all American cities and towns, operate. The plan outlined above is preliminary and conceptual, and must be expected and allowed to adapt to changing conditions and unforeseen opportunities. This process will be as evolutionary as it is revolutionary. The rewards for hard work and adaptive management of the project cannot be overstated.

References/Resources

Waste-to-Energy

Westinghouse Plasma Corporation: http://www.westinghouse-plasma.com/
Startech Environmental: http://www.startech.net/
Plasco Energy Group: http://www.plascoenergygroup.com/
Plasma Waste Recycling: http://www.plasma-wr.com/
St. Lucie County, Florida's Plasma Converter:
http://www.tcpalm.com/news/2007/nov/10/30trash-zapper-gets-shot-in-arm-from-crist/ and
http://www.usatoday.com/news/nation/2006-09-09-fla-county-trash_x.htm
Ottawa, Canada's Plasma Gasifier:
http://www.ottawa.ca/residents/environment/city_hall/getgreen/ecosystem/air/plasma_waste_conversion_en.html *Scientific American*'s article on Plasma Conversion:
http://www.scientificamerican.com/article.cfm?id=plasma-turns-garbage-into-gas&ec=su_garbagegas
Recovered Energy's web site on Plasma Conversion:
http://www.recoveredenergy.com/index.html
Advanced Plasma Power's web site: http://www.advancedplasmapower.com/
Biomass Magazine's article on Plasma Conversion:
http://www.biomassmagazine.com/article.jsp?article_id=1294&q=landfill
Wikipedia article on Plasma Arc Waste Disposal:
http://en.wikipedia.org/wiki/Plasma_arc_waste_disposal
Gasification Technology Council web site: http://www.gasification.org/

Solar

Wikipedia's article: http://en.wikipedia.org/wiki/Photovoltaics
The National Renewable Energy Laboratory's web site: http://www.nrel.gov/pv/
Stirling Energy Systems: http://www.stirlingenergy.com/
SolarReserve concentrating solar: http://www.solar-reserve.com/

Algal Fuel

Wikipedia's article: http://en.wikipedia.org/wiki/Algae_fuel
The Oilgae site: http://www.oilgae.com/
East Valley Tribune article: http://www.eastvalleytribune.com/story/134878
Bill Gates invests in Algal Fuel: http://news.cnet.com/8301-11128_3-10043996-54.html

Biodiesel

Verde Biotrailors: http://www.verdebiotrailers.com/index.html
Wikipedia's article: http://en.wikipedia.org/wiki/Biodiesel
National Biodiesel Board's web site: http://www.biodiesel.org/

Important Bird Areas

Audubon IBA web site: http://www.audubon.org/bird/IBA/

Sustainability

EPA web site on sustainability: http://www.epa.gov/Sustainability/
Wikipedia's article: http://en.wikipedia.org/wiki/Sustainability

Contacts

Town of Clarkdale

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Other Related Projects and Contacts

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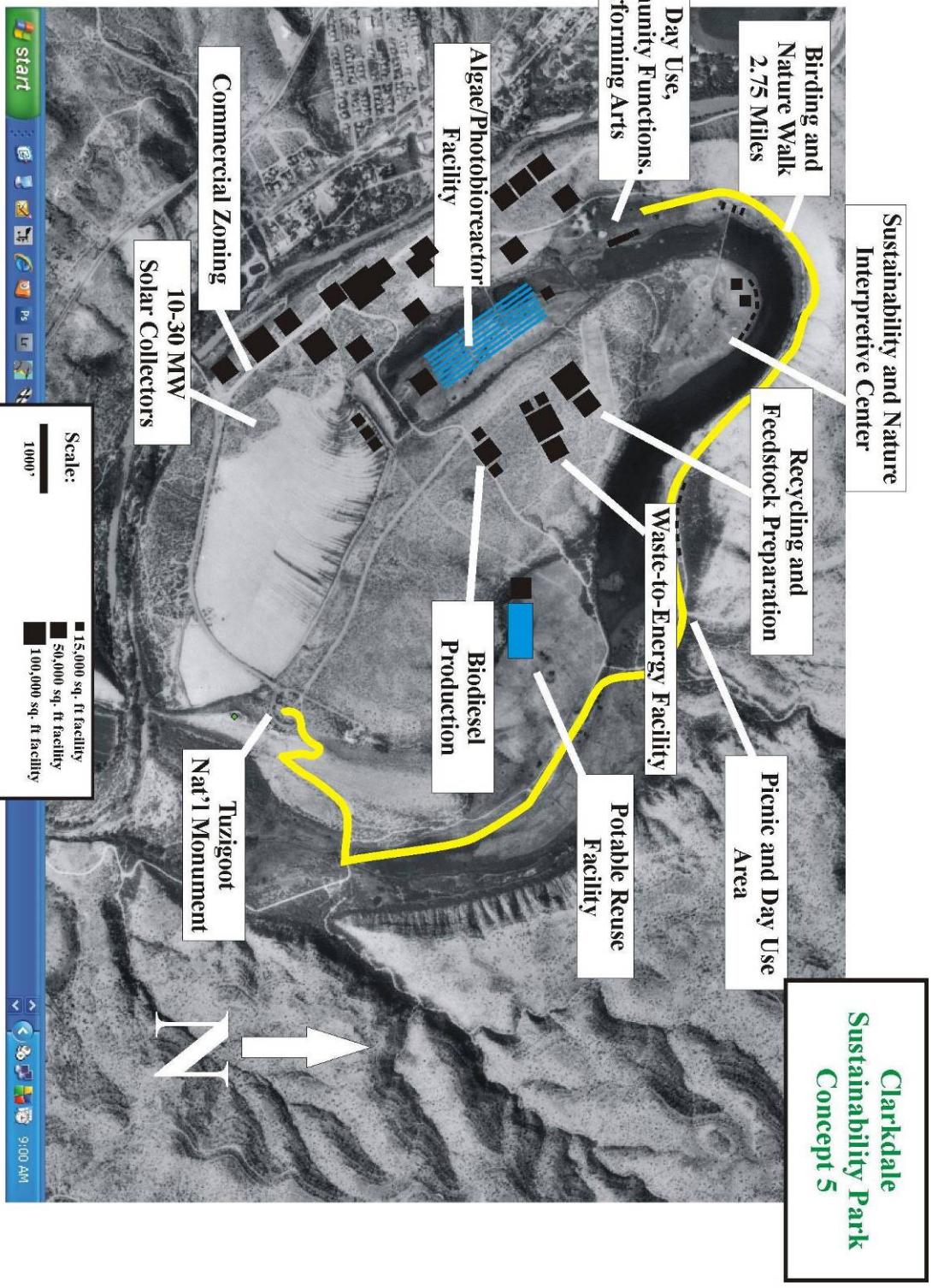
www.plascoenergygroup.com
and
http://www.ottawa.ca/residents/environment/city_hall/getgreen/ecosystem/air/plasma_waste_conversion_en.html

Appendix A



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