APPENDIX J

Evaluation of Potential Impacts on the Martz Observatory, Rev 1

EVALUTION OF POTENTIAL IMPACTS ON THE MARTZ OBSERVATORY

CARROLL LANDFILL EXPANSION
CARROLL, NEW YORK

Prepared on behalf of:

Sealand Waste, LLC
85 High Tech Drive
Rush, New York 14543

Prepared by:

DAIGLER ENGINEERING P.C.
1711 Grand Island Blvd.
Grand Island, New York 14072-2131

October 2012

Revised May 2015

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Sealand Waste, LLC

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1 INTRODUCTION

The Carroll Landfill, located on Dodge Road in the Town of Carroll, Chautauqua County, New York, is currently a three-acre, closed Construction and Demolition (C&D) Debris landfill. Sealand Waste, LLC (Sealand) is proposing to purchase the 54.1-acre parcel and continue to develop the C&D landfill activity beyond the three acre limit allowed by the New York State Department of Environmental Conservation (NYSDEC) Permit (#9-0624-00025/00002-0 expired October 31, 2007) and add demolition debris recycling and yard waste composting to the operation. Once landfilling operations are complete, a final cover system will be deployed and the minimum 30-year post-closure activities will commence, including monitoring and maintenance.

The Marshal Martz Observatory, located one mile east-southeast of the site, is utilized by amateur astronomers to view the night skies. Constructed in the 1960s by Marshal Martz, an avid astronomer and mathematician, the Observatory is home to a 24-inch telescope and cameras which allow one to view the Milky Way, stars, and other celestial bodies. The Martz Observatory is an important educational facility which has had significant impacts on students, scouts, and the community in western New York, northwestern Pennsylvania, and beyond.

The purpose of this study is to identify and address the potential impacts to the functionality of the Martz Observatory that may result from the continued development of the existing facility. Additionally, measures to mitigate potentially adverse impacts associated with the proposed operation will be evaluated.

2 MARSHAL MARTZ OBSERVATORY

2.1 HISTORY

Located at 176 Robbin Hill Road in the Town of Carroll, New York, the Marshal Martz Observatory was established in the early 1960s by Mr. Marshal Martz. Mr. Martz was an astronomy and mathematics professor at Jamestown Community College where he bestowed his passion and love for the skies on his students. After passing away on August 21, 1979, Mr. Martz left behind a legacy which included a 30-inch reflecting telescope, the largest telescope in the world built by an individual, and construction of the Martz Observatory.

Mr. Martz's wife invited amateur astronomers to utilize the facility to continue the legacy set forth by her late husband. Strengthening the organization formed by Mr. Martz, Mrs. Martz, amateur astronomers, and volunteers established Marshal Martz Memorial Astronomical Association, Inc. The organization maintains a mission "To inform, educate, and inspire the general public and support teaching in the sciences of astronomy and physics through accessible, engaging, and entertaining programs." Today, the Association continues to promote and educate the public in the field of astronomy at the Marshal Martz Observatory.

2.2 EQUIPMENT AND OPERATION

The Martz Observatory currently houses a 24-inch Newtonian telescope which reflects light from a primary mirror onto a secondary, diagonal mirror that projects the scene into the viewing eyepiece. Attached to this telescope is a professional grade CCD-imaging camera which captures celestial images with its improved optics and precision tracking systems compared to the telescope originally developed by Mr. Martz. The camera used for astro-imaging contains a charge-coupled device (CCD) much like those in widely available photographic digital cameras used by professionals and consumers alike. The difference is that for astronomical applications, the CCD itself is cooled so it can have exposure times of several tens to perhaps several hundred seconds where as consumer cameras typical exposure is for much less than a second. When receiving input light from an astronomical object, the CCD converts the input to a digital signal which is then processed in a computer to produce an image that can be viewed on a computer monitor or printed; again much like familiar digital cameras. Astronomical imagers, unlike a consumer digital camera do not record in color but require multiple exposures using colored filters to reconstruct color images. The sensitivity of CCD chips can take advantage of the best conditions an observatory site and telescope optics have to offer to produce detailed, high resolution images of astronomical objects ranging from planets in our solar system to objects that are incredibly distant.

Recently, the Observatory obtained additional equipment. First, the Observatory has obtained a 16-inch telescope which will operate in conjunction with the main 24-inch telescope to enhance the Observatory's astro-imaging capabilities. A ten foot radio astronomy telescope dish and a solar telescope equipped with a real time CCD camera have been added to the inventory of equipment at the site as well as a 0.6 Meter Dahl Kirkham telescope. A 20-inch Cassegrain telescope manufactured by DFM Engineering was obtained when the Dr. R. Kohl Observatory was relocated to the Martz Observatory location.

The Martz Observatory is open to the public and welcomes students, scouts, and the community to visit the facility to view the starry skies. The Observatory is always open for viewing on Wednesday nights starting between 7:00 pm and 7:30 pm, regardless of weather. Depending on the clarity of the sky, viewing may continue throughout the night and into the early morning with the latest reported time of operation being 4:00 am. The Martz Observatory website (www.martzobservatory.org) provides a live camera feed, which if operating, indicates that staff are present at the Observatory and the public are able to call to determine if viewing is promising that evening. The Observatory also holds public viewing nights and informational seminars throughout the year which are posted on their online calendar. Real time acquisition of CCD images as described above has high public outreach and educational value and makes amateur astronomy a highly popular hobby that continues to make substantial contributions to our knowledge of the universe around us.

3 PROPOSED SOLID WASTE MANAGEMENT FACILITY DEVELOPMENT

The Carroll landfill is situated on a parcel of property with a total area of 54.1 acres. The property was originally the site of a small surface mine; however, on depleting the saleable mineral resources, permits were issued by the NYSDEC and the Town of Carroll Town Board for development of the construction and demolition debris landfill. At this time, the existing three-acre landfill has been capped with a soil barrier layer and topsoil layer. The topsoil layer supports a vigorous growth of a mixture of fescue, clover, and rye. This landfill is estimated to contain approximately 50,000 to 60,000 cubic yards of C&D waste. All waste loads delivered to the site were previously registered by container volume. Other areas of the site are undeveloped, or were used for stockpiling metal scrap for resale, and cover soil borrow areas. A metal pole building houses tools and equipment for minor repairs to facility equipment. Currently, no landfilling, recycling, or other operations are occurring at the site.

Sealand proposes to remove the existing waste from the three-acre footprint, and place the material inside the proposed liner system for the expanded approximate 38-acre landfill footprint in accordance with the applicable local, state, and federal requirements. The proposed facility will accept C&D waste and approximately 8.5 additional acres of the 54.1-acre parcel will be developed with ancillary and support facilities to include a scale house, office building, access roadways, leachate storage facility, maintenance building, and storm water management basins and structures. The remaining portions of the site are expected to be undeveloped forested and meadow or brush land.

In support of landfill operations, the proposed solid waste management facility will also include C&D waste recycling and yard waste composting to manage source separated yard waste delivered to the site. Other ancillary operations will include the excavation and placement of onsite structural fill soils, the screening of onsite soils for liner and leachate collection system construction, and the import of approximately 135,000 cubic yards of drainage aggregate for a portion of the primary leachate collection system drainage layer.

While in operation, the facility is scheduled to accept waste and recyclables six days per week, between 7:00 am to 5:00 pm Monday through Friday, and between 7:00 am and 2:00 pm on

Saturday. Employees will typically begin site preparations between 5:30 am and 6:00 am, and complete daily closure activities between 5:00 pm and 6:00 pm Monday through Friday and between 2:00 pm and 3:00 pm on Saturday. The facility will be closed on six holidays. During special circumstances, the facility may operate outside these hours to appropriately address the situation.

4 GEOGRAPHIC SETTING AND LANDSCAPE

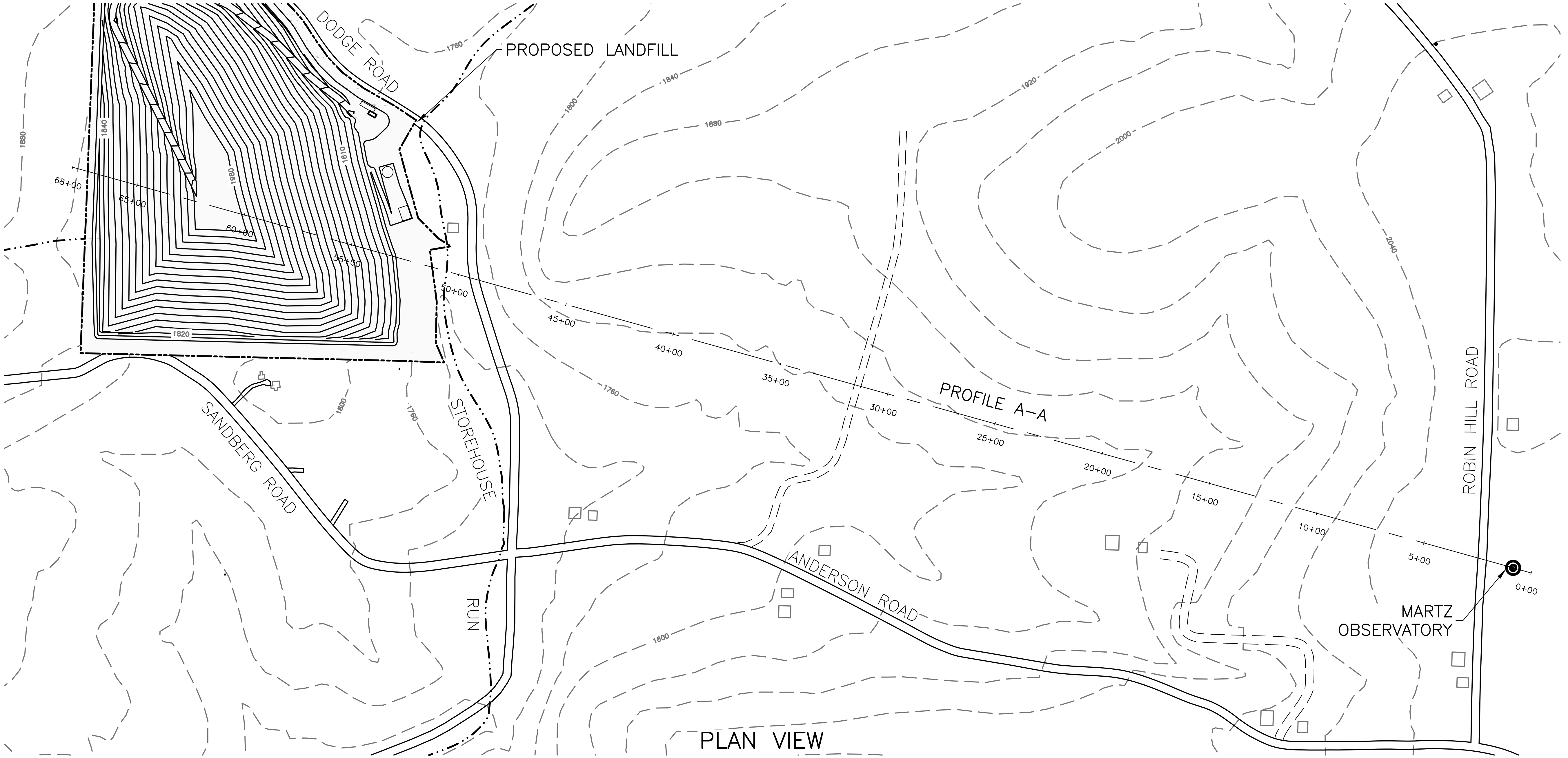
Chautauqua County is bordered by Cattaraugus County, about 1.2 miles to the east of the Carroll Landfill and Warren County, Pennsylvania, approximately 0.8 miles to the south. Bordering the site to the east and south are residential properties. The site vicinity is characterized by scattered rural development, agricultural lands, and large undeveloped mixed and deciduous forest which form the South Valley State Forest, the Allegheny State Park, and the Allegheny National Forest. The uplands are dissected by many narrow, relatively steep-sided valleys which typically contain swift flowing streams. The topography of the uplands is typified by rolling, irregular hills that rise approximately 700 feet above the valley floors. The highest elevation in the county occurs southeast of the site in the unglaciated, extreme southeastern corner of the county at approximately 2,100 feet MSL.

Approximately 9.3 miles to the northwest of the site lies the City of Jamestown, New York; the most populated city in the region. The city of Warren, Pennsylvania is about one-third the size of Jamestown and lies approximately 11.8 miles south-southwest of the site.

The undeveloped areas of the site are dominated by young, even age mixed and deciduous forest, successional old field, successional shrub land, conifer plantation, and wetland. The north and central portions of the site include areas of closed landfill with a vigorous grassy meadow, and disturbed areas associated with the former land disposal, recycling, and mining operations.

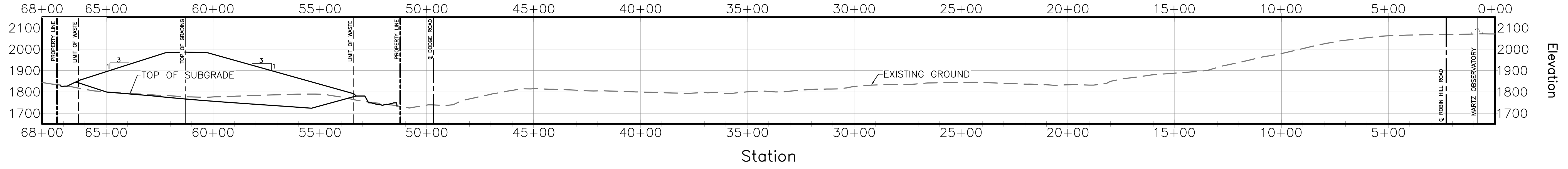
The property lies on the southeastern facing slope of a ridge that rises above the valley floor with ground surface slopes ranging from flat, five to 15 percent; and on a local basis, steeper. Ground surface elevations referenced for this project are based on the North American Vertical Datum of 1988 (NAVD88) and range from about 1,885 feet MSL in the northwestern corner of the site, down to about 1,710 feet MSL at the southeastern margins of the site. Once completed, the top of the landfill grading near the center of the site will be at an elevation of approximately 1,985 feet MSL with 3H:1V side slopes meeting the perimeter embankment. Embankment, roadway, and drainage channel gradings will slope up or down to the existing ground elevations near the property boundary. The site is nearly bisected from west to east by an intermittent drainage way that enters the property from the west and discharges into an unnamed tributary of Storehouse Run. The tributary enters Storehouse Run offsite, approximately 75 feet downstream.

The distance from the Martz Observatory to the closest point on the property boundary is approximately one mile in the west-northwest direction. The Observatory is located on the second highest peak in the county at an approximate ground elevation of 2,070 feet MSL. This ground elevation then is about 85 feet higher than the peak elevation of the landfill. A profile of the final landfill grading and existing topography of the area is provided in Figure 1.



PLAN VIEW

SCALE 1"=500'



Profile View of A-A

SCALE 1"=500' HORIZONTAL
1"=500' VERTICAL

Q:\Sealand\02-0104 Carroll Landfill\Martz Observatory\Reports\Cross Section.dwg 10/5/2012 12:10 PM

ALTERATION OF ANY SURVEY, DRAWING, DESIGN, SPECIFICATION OR REPORT MUST BE COMPLETED IN ACCORDANCE WITH SECTION 7209 PROVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

NO.	REVISION	BY	DATE

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JAMES A. DAIGLER, P.E.
NYSPE NO. 061689

DATE: October 2012

SCALE: NOTED

PREPARED FOR: SEALAND WASTE, LLC
DES. BY: AMZ DRW. BY: AMZ CHK. BY:
DWG: Cross Section.dwg

GEOGRAPHIC SETTINGS AND LANDSCAPE
MARTZ OBSERVATORY EVALUATION

TOWN OF CARROLL | CHAUTAUQUA COUNTY | NEW YORK

FIGURE
1

5 ISSUES AND CONCERNS

The location of the Martz Observatory was strategically chosen by Marshall Martz because it provided a good opportunity for a dark, clear sky conducive to view and study the night skies. Likewise, it is situated on the second highest peak in the county which provides for unobstructed viewing. With the expansion of the facility, questions arose about the possible impacts the site activities may have on the Martz Observatory, and the ability to view the night skies.

The president of Marshal Martz Memorial Astronomical Association, Inc. expressed concerns including the importance of this educational facility and the potential impacts to the cameras and telescopes due to heat, dust, lighting, and radio telescope signal interference produced by the daily site activities. He also noted that viewing is in the west and that little viewing is done toward the east. The President suggested that “heat coming off the [landfill] would cause wave and atmospheric problems” that would negatively impact an observer’s ability to view celestial bodies. Additionally, dust that may accumulate on the lenses may induce additional financial expense because the lenses of the telescopes would require more frequent cleaning. Similarly, the camera system is sensitive to dust as well as light, and lighting may interfere with the viewing capabilities which are “very, very important to astronomy”.

Additional concerns expressed by the local community and other members of Marshal Martz Memorial Astronomical Association, Inc. are included below. These quotes were taken directly from the public meeting transcript and submitted comments which are available in the Draft Scope of the Draft Environmental Impact Statement, May 2012. Sealand acknowledges the concerns of the community. The report to follow presents a scientific evaluation of the stated concerns.

- “Light pollution will also be a problem for the study of the skies as a dark sky is absolutely necessary for proper study. The development of the landfill will have lights for both operations and security that will illuminate the night sky.”

  - Resident of Frewsburg, NY

- “The CCD camera is sensitive to light. Stray light raises the background light sky level which interferes with the CCD camera being able to get good pictures. If there is any dust, that causes problems with the optics, then the extra light aggravates the problem. Images wind up with dark donut shapes on the picture. Raising the background level of light results in reducing the magnitude of the stars that can be seen"

-Anonymous

- "The observatory needs to have a dark sky and clean clear air to be able to operate."

  -Resident of Frewsburg, NY

- "Lights from the landfill and truck traffic would severely interfere with its [24-inch telescope] functions and the use of the sophisticated camera."

  -Conewango Township Resident

- "Bright lights and stirred up dust will greatly disrupt, perhaps render unusable…the Martz Observatory."

  -Anonymous

- "Dust emissions can scatter light having an adverse impact on the observatory."

  -Chautauqua County Executive

- "The landfill will produce airborne dust and particulate that will be magnified by the powerful telescope in use at the site, therefore, the observer will not be able to see the stars and galaxies."

  -Resident of Frewsburg, NY

- "Heat from decomposition and lack of ground cover will also cause air turbulence, which will disturb the images. The small area viewed by the telescope is sensitive to the air turbulence. The landfill will absorb heat in the daytime and radiate that heat in the night more than the natural trees or grass. Dust and other gases can cause other problems. Besides donuts on the images it can affect the mirror coating of the telescope."

  -Anonymous

- "The proposed landfill would end the usefulness of the telescope by (1) heat waves from the decomposition of the material would interfere with the vision. (2) Dust participles

> would cloud the vision. (3) Light of the landfill would reduce or end the effectiveness, as total darkness is required for optimum sighting."
>
> -Anonymous

It has been identified that the concerns of the community share a common theme; the potential hindrance on the ability to "see" the night sky. The following are potential factors which may affect the ability to see. These four factors will be evaluated and assessed to determine whether mitigation efforts are warranted:

1. Light;
2. The turbulence caused by heat convection;
3. Dust; and,
4. Radio telescope signal interference.

6 EVALUTION OF POTENTIAL IMPACTS

6.1 CLEAR SKY CHART

Several factors affect one's ability to observe astronomical objects with a telescope including primarily cloud cover, atmospheric transparency, seeing, and darkness. The astronomers forecast, developed by Allan Rahill of the Canadian Meteorological Center, shown in Figure 2 as a clear sky chart for June 26, 2012, predicts when the Martz Observatory will experience good conditions for astronomical viewing. The top row of numbers represents the time of day and the left most column describes the above four parameters which affect astronomical viewing.

Each parameter is symbolized by a range of colors. For example, cloud cover is symbolized by white blocks for overcast and dark blue blocks for clear or no cloud cover. Transparency and seeing vary from grey to dark blue with darker colors indicating a good time for astronomical viewing (seeing is not modeled during the daytime which is depicted by black blocks in the seeing row). Darkness ranges from white to orange to turquoise to black which depict light conditions to dusk/dawn to dark skies, respectively. The criteria in the chart is used as one evaluation of the ability to use the telescope at the Martz Observatory. Like any model based prediction, it is statistical in nature and real conditions can and will vary due to local meteorological variations; however many astronomers, amateurs, and professionals alike, use it as a guide.

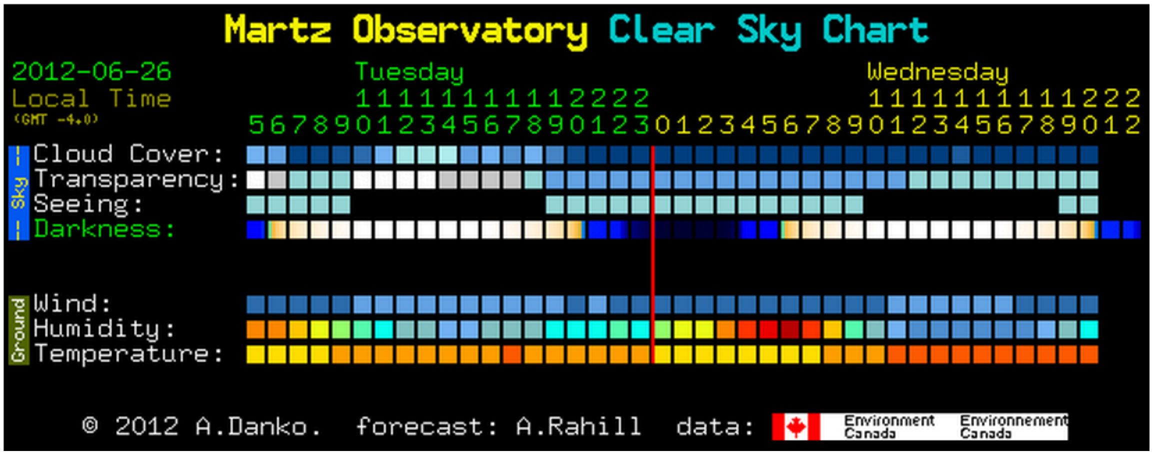


Figure 2: Martz Observatory Clear Sky Chart

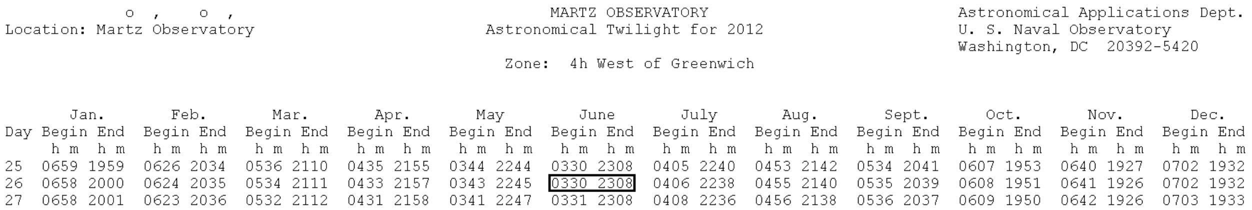
First, the seeing row, an experimental forecast, refines the prediction using the position of the jet stream and low and high pressure areas, to estimate the times when the atmospheric turbulence will be the least and telescopic images will be the sharpest and most still. When the blocks are dark blue, excellent seeing is predicted signifying that high magnification on a telescope will yield the ability to observe fine details on planets and star clusters. The ground parameters (wind, temperature, and humidity) on the clear sky chart will not determine whether one can observe, but may have affects on the instruments' ability to operate properly and its performance.

Cloud cover is a key aspect and provides the gateway to seeing the sky. Obviously, to best see the stars and other celestial bodies, a cloudless sky is desired.

Transparency is calculated based on the total water vapor in the air and is represented by a scale of grey to dark blue blocks which depict poor transparency to transparent conditions, respectively. Although above average transparency is preferred for good observation of low contrast objects (galaxies and nebulae), large globular star clusters and planets can often be observed during less than optimum transparency conditions.

The third parameter of primary importance on the clear sky chart is darkness, which does not take into account light pollution and assumes a clear sky. This row illustrates at what times viewing the night sky is best. White blocks represent daylight while deep blue shows interference from moonlight. The optimum time to view the night sky is after twilight and before dusk (turquoise and yellow on the clear sky chart, respectively), better known as astronomical dusk and astronomical dawn. Astronomical dusk and dawn are when the sun is between 12 and 18 degrees below the horizon after sunset and prior to sunrise, respectively.

Another important tool for astronomers is the United States Naval Observatory (USNO) astronomical twilight times chart. A portion of the chart is shown in Figure 3 for 2012. For June 26, 2012, astronomical dawn begins at 3:30 am and astronomical dusk ends at 23:08 or 11:08 pm. Justified by the clear sky and the USNO astronomical twilight charts, the optimal viewing times are before and after astronomical dawn and dusk; therefore, the best time for viewing is after 11:08 pm and before 3:30 am on June 26, 2012.



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         o  ,    o  ,                              MARTZ OBSERVATORY                          Astronomical Applications Dept.
Location: Martz Observatory                  Astronomical Twilight for 2012                   U. S. Naval Observatory
                                                                                              Washington, DC  20392-5420
                                                Zone:  4h West of Greenwich

       Jan.       Feb.       Mar.       Apr.       May        June       July       Aug.       Sept.      Oct.       Nov.       Dec.
Day Begin End  Begin End  Begin End  Begin End  Begin End  Begin End  Begin End  Begin End  Begin End  Begin End  Begin End  Begin End
     h m  h m   h m  h m   h m  h m   h m  h m   h m  h m   h m  h m   h m  h m   h m  h m   h m  h m   h m  h m   h m  h m   h m  h m
25  0659 1959  0626 2034  0536 2110  0435 2155  0344 2244  0330 2308  0405 2240  0453 2142  0534 2041  0607 1953  0640 1927  0702 1932
26  0658 2000  0624 2035  0534 2111  0433 2157  0343 2245  0330 2308  0406 2238  0455 2140  0535 2039  0608 1951  0641 1926  0702 1932
27  0658 2001  0623 2036  0532 2112  0431 2158  0341 2247  0331 2308  0408 2236  0456 2138  0536 2037  0609 1950  0642 1926  0703 1933
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Figure 3: USNO Astronomical Twilight Times for Martz Observatory[1]

The earliest time to experience optimal viewing during 2012 is 7:25 pm and the latest time is 7:04 am which occurs during early December and early January, respectively. During the months between late March and mid September, the latest time to view is before 5:30 am; therefore, seeing will not be affected by the solid waste activities but rather the rising of the sun. Similarly, during the winter months, when dust and heat are minimized by the ambient temperatures, observing times and site activities will overlap.

6.2 LIGHT

6.2.1 Components of Light Pollution

The upward spill of light, referred to as light pollution, has become increasingly problematic for those wishing to see the night sky. Permanent lighting at the proposed facility will be limited to only those areas where workers or traffic must have sufficient visibility to operate safely around site infrastructure. The location of the planned lighting fixtures is shown on PD-7 of the Permit Drawings. During the late fall, winter, and early spring months, mobile lighting will be used in operational areas when needed for safe operations.

There are three components of light pollution important to this evaluation; light trespass, glare, and sky glow. Light trespass is light which strays from the intended target area. Caused by poorly placed or designed outdoor lighting and is the primary cause of the degradation of star visibility to the unaided eye.[2] By utilizing full cut off or 100% shielded light fixtures (luminaires), upward directed light can be reduced significantly. Light trespass is easily quantifiable by measuring illuminance, using a standard light meter, or estimated via the

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[1] United States Naval Observatory. (2012). USNO Astronomical Twilight Times. Website: http://cleardarksky.com/cgi-bin/RiseSetTable.py?mn=CCD&id=MartzObs&type=4. Accessed on: June 26, 2012.

[2] State of New Hampshire. (2012). New Hampshire Department of Environmental Services. Website: www.des.nh.gov/organization/divisions/waer/wmb/repp/documents/ilupt_chpt_3.4.pdf. Accessed on: July 12, 2012.

following formula (developed for highway light modeling).[3] This relationship can be used to select the least intrusive lighting designed for the site. Additionally, the equation will aid in maximizing the energy efficiency and preventing unnecessary or overlapping light placed in close proximity.

$$E_{ave} = \frac{L * CU * LLF}{S * W}$$

Where E_{ave} = average illuminance of the area [lux]

L = luminous flux of the source [lumens]

CU = coefficient of utilization of the luminaires

LLF = light loss factor over time

S = spacing of light poles

W = width of area to be illuminated

Glare is defined as unwanted light emanating from a source which in large doses, can cause temporary blinding and discomfort. Glare is generally caused by light directly in or reflected into the line of sight of an observer. Mitigation efforts include aiming light downward from typical observing angles and using non-reflective coatings or materials on surfaces near the light source. Using fully shielded fixtures and minimizing glare results in the mitigation of light trespass. The following formula can be utilized (developed for highway light modeling)[4] to aid in the design of site lighting to minimize glare:

$$L_v = \sum_{i=1}^{n} \frac{10E_{vi}}{\theta^2 + 15\theta}$$

Where L_v = glare at the observer's location [cd/m^2]

E_{vi} = vertical illuminance on the plane of the observer's eye

Θ = angle between line of sight and luminaire [degrees]

n = number of luminaires in sight

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[3] Shaflik, Carl. "Environmental Effects of Roadway Lighting." *International Dark-Sky Association.* Aug. 1997.

[4] Shaflik, Carl. "Environmental Effects of Roadway Lighting." *International Dark-Sky Association.* Aug. 1997.

The final component of light pollution for this evaluation is sky glow, which is light emitted into the atmosphere and scattered or reflected off dust particles and water droplets as well as the molecules of nitrogen and oxygen that make up the atmosphere. Often, sky glow is associated with light from cities or highly populated areas. These areas emit light which can be brighter than most stars causing an inability to see them when viewing in the direction of a highly populated area. Similarly, sky glow is increased by the use of blue-rich lighting sources which are more easily scattered by molecules by a process known as Rayleigh Scattering. Rayleigh scattering can be minimized by employing high pressure or low-pressure sodium lamps which are “redder” than high intensity Mercury Vapor lamps frequently used in the past. To aid in minimizing light pollution, sky glow can be estimated as a function of the population of nearby cities and the distance to those cities from the Martz Observatory as described by the following relationship[5]:

$$I = 0.01 * P * r^{-2.5}$$

Where I = increase in sky glow above the ambient background
P = population of the city
r = distance from observing point to city [km]

6.2.2 Martz Observatory and Light Pollution

An important property to a good astronomical observing site is dark skies which require low light from terrestrial sources. Dark skies at the Martz Observatory are important because light limits the visibility of faint and extended objects such as the Milky Way, nebulae, and galaxies. Likewise, scattered light from terrestrial sources is an additional source of “noise” in CCD camera images.

As seen in Figure 4, the cross hairs in the center represent the location of the Martz Observatory. In this image, black and blue represent locations of darkness with low light from nearby population centers and the ability to see the Milky Way. On the other hand, white, red, and orange, with white representing the locations of greatest light pollution, are areas with many light domes and limited visibility of stars and constellations. The location of the Martz Observatory is

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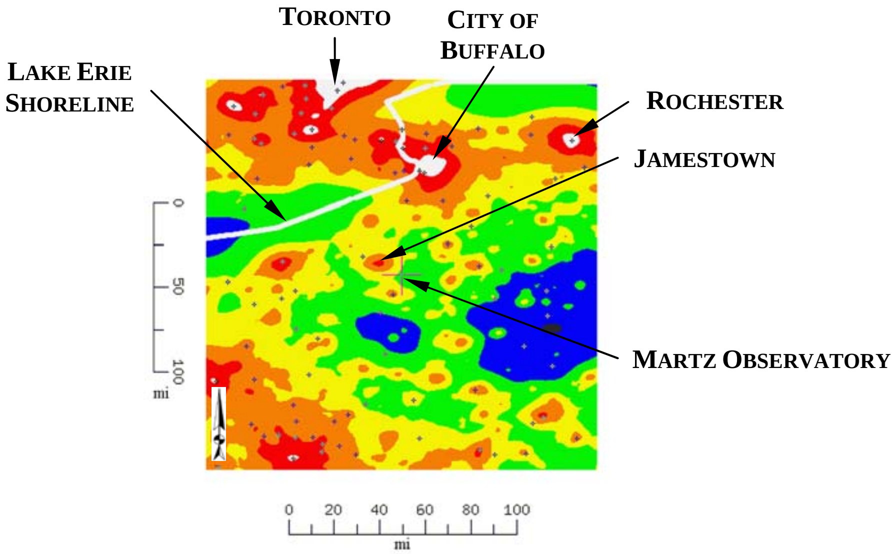
[5] Shaflik, Carl. "Environmental Effects of Roadway Lighting." *International Dark-Sky Association*. Aug. 1997.

surrounded by green which is characterized by zodiacal light being visible on the best nights and the Milky Way showing some dark lane structure.[6] The site is surrounded by yellow which results in a washed out Milky Way and the presence of light domes up to approximately 45 degrees. The light pollution map not only predicts the best direction for viewing based on darkness at the Martz Observatory located between the east and southeast cardinal directions, but, based on the large scale of the map, demonstrates that areas of significant skyglow which are hundreds of miles away from an observing location have an effect on the ability to view the sky.



Credit: P. Cinzano, F. Falchi (University of Padova), C. D. Elvidge (NOAA National Geophysical Data Center, Boulder). Copyright Royal Astronomical Society. Reproduced from the Monthly Notices of the RAS by permission of Blackwell Science.

Figure 4: Martz Observatory Light Pollution Map

The contribution of sky glow from Jamestown, New York was quantified as follows:

$$I = 0.01 * 29{,}355\,people * 14.97\,km^{-2.5}$$

$$I = 0.339$$

The calculated value represents an increase in sky glow of approximately 33.9% above the natural sky background due to the city of Jamestown on the Martz Observatory. Sky glow becomes an issue for observatories when the contribution is greater than 10% above the natural sky background[7]; therefore, the sky glow produced by the city of Jamestown affects the ability of

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[6] A. Danko. (2012). Martz Observatory Light Pollution Map. Website: http://www.martzobservatory.org/clearsky.html. Accessed on: July 12, 2012.

[7] "More About Sky Glow Calculations Using Walker's Law." *International Dark-Sky Association*. Oct. 1996.

the Martz Observatory to see the night sky towards the northwest. Additionally, because the city of Jamestown is in the same viewing direction as the proposed facility, the limited quantity of light produced by the operation would not materially affect observations at the Observatory. Warren, Pennsylvania, situated south-southwest of the site, was calculated to contribute 5.9% to sky glow. While below the 10% threshold, sky glow of this magnitude may still cause some interference.

As an example, if the proposed facility is constructed, an increase in sky glow assuming 15 employees on the site (it was predicted that eight to 15 employees would carry out the facility operation and construction requirements – Carroll Landfill Expansion Application Operation and Maintenance Manual, March 2012) would result in a 4.6% increase if lights were operating during the evening hours. This sky glow calculation is an extremely conservative estimation. It is expected that significantly less than a 4.6% increase will result since the sky glow equation is intended for population centers with a distribution of sources including street lights, residential, and commercial sources, and since the facility will essentially have a population of zero during the optimum nighttime viewing hours.

These results suggest the cities of Jamestown and Warren contribute to harmful sky glow while the proposed facility will not. This also confirms that the best viewing for the Observatory and the darkest skies are toward the east and southeast, opposite the direction of the proposed development, as indicated by the light pollution map and the location and contributions of sky glow by the surrounding cities. Furthermore, the Dark-Sky Directory reports the worst viewing horizon is toward the northwest of the Martz Observatory requiring a 20 degree cut off angle while the best horizon is towards the south requiring a three degree cut off angle.[8]

The proposed lighting scheme will not be materially different than the lighting used in residential properties and agricultural operations which are in the vicinity of the Martz Observatory. For instance, directly west of the Observatory (less than 100 yards) lies a metal roofed barn most probably with outdoor lighting fixtures. This establishment emanates light due to everyday residential activities and has apparently not evolved as a tenable problem.

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[8] Dark Sky Directory. (2011). Dark-Sky Sites: New York. Website: http://www.observingsites.com/ds_ny.htm#frews. Accessed on: September 26, 2012.

6.2.3 Mitigation Measures

To alleviate the concerns posed by the lighting at the proposed facility, the light fixtures, lamps, and duration of use will be described in detail and implemented. The facility design will incorporate a minimum number of properly designed low-pressure sodium light fixtures that will reduce the escape of light horizontally or upward, to a negligible degree, virtually eliminating sky glow impacts on the Martz Observatory. There are currently six proposed outdoor light fixtures, as shown in PD-7, which will be installed for safe operation of the site.

First, all light fixtures will be full cut off or 100% shielded so that no light is emitted above the horizontal plane. These luminaires will limit fugitive light and decrease the amount of glare and light trespass unintentionally emitted. Light will be prevented from escaping by selecting fixtures which cut off light at 15 degrees or more below the horizontal. A distance of approximately three times the fixture height corresponds to a cut off angle of about 18 degrees below the horizontal. Three times the height is also considered a sufficient working area before the light becomes ineffective; therefore, the 15 degree cut off will reduce glare and concentrate the light within an area while reducing sky glow.[9]

Because astronomers observe the sky in many wavelengths, full spectrum lighting emits ultraviolet radiation which can affect the ability of astronomical equipment to capture light from celestial bodies. By installing monochromatic luminaires such as low-pressure, sodium light bulbs at the proposed facility, the telescopes and other equipment will filter out any light that may escape the full cut off luminaires. Additionally, these yellow lights scatter less in the atmosphere and interfere less with human night vision than white light; therefore, dark night skies can be maintained. Glare will also be minimized by using anti-reflective materials, coatings, or dark colors for pavements, buildings, and other structures from which light has the potential to reflect.

Sealand will install motion sensors on all light fixtures. By doing so, light will only be emitted when necessary.

The types of luminaires which are proposed for use at the facility are manufactured by Visionaire Lighting. They are pole mounted, fully shielded fixtures which can illuminate 135W/180W low-

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[9] "Some Notes on Cutoff Angle and Glare." *International Dark-Sky Association*. June. 1997.

pressure, sodium lights (Model SUN-4). The fixtures are also proposed to include an S Series motion sensor manufactured by Hubbell with a 270 degree detection range.

6.3 HEAT

6.3.1 Atmospheric Turbulence and Effects on Telescopes

Atmospheric turbulence, which is caused by moving cells with small temperature differences in the atmosphere have the effect of blurring the image of an astronomical object seen through the atmosphere. When air at different temperatures is mixed, the resulting turbulence causes a wavering and undulation of objects. As a result, these air waves can impact the ability to capture sharp astronomical images due to fuzzing and rapid motion (scintillation). Although not always visible, these air currents can emanate from surfaces based on the temperature differences of the air masses and the changes in the refractive indices of the air above the objects. For example, on a hot, sunny day, air over hot asphalt pavement takes on a rippling appearance as radiant heat warms the air immediately above the pavement as it mixes with cooler air. However, heat waves are not seen emanating from one's grass lawn because less heat is absorbed by the grass (See Section 6.3.2) causing a smaller difference in temperature between the ambient air and the ground surface.

Several atmospheric turbulence models have been proposed. The most recent, developed by François Roddier in 1981, involves four types of turbulence; instrument, surface, geographic, and high atmosphere.

Instrument turbulence occurs inside the telescope and at an observatory. This type of turbulence includes thermal waves rising at the surface of the reflecting mirror, telescope structure, and even by temperature differences between the observer and the telescope's optical path. The second type of atmospheric turbulence is surface turbulence, which accounts for up to half of all observed irregularities in astronomical viewing. Surface turbulence is caused by the surrounding topography within 0.3 miles of the observatory. Because the facility is located approximately one mile from the observatory, the site activities will not contribute to this type of turbulence; instead, geographic turbulence, which can be a consideration within about four miles of the observing site and extending upwards approximately one mile will be the possible contributing factor. Geographic turbulence is affected by the surrounding landscapes which impact the thermal and moisture content of the atmosphere. The fourth type of turbulence is high atmosphere turbulence which is associated with the jet stream; accordingly, high atmosphere turbulence will not be further assessed in this report.

At sites like the Martz Observatory, the local oreographics and variable topography dominate and atmospheric turbulence is not easily quantified. Generally, the ground conditions and land use within 100 yards of the Observatory and weather conditions at the observing site will have a much greater impact on seeing than the activities that take place over a 100 yard distance. At the basic level, blurring of images is due to small scale turbulent variations is the refractivity of air which is proportional to the atmospheric pressure divided by the temperature. As a result, the better terrestrial sites are commonly at higher altitude (two to four kilometers) as distortions caused by any turbulence due to the proximate surface characteristics have less effect due to thinner, lower pressure air.

6.3.2 Heat Radiation due to Ground Cover

With a surface temperature of approximately 5,778K, the Sun is Earth's primary source of energy. Depending on the distance from the Sun, ocean and atmospheric effects, and the latitude at one's location, the temperature on Earth's surface also varies based on the type of cover (i.e. woodlands, soil, asphalt pavement, etc.). To quantify the effective temperature of the Earth's surface, the concept of albedo will be investigated.

Albedo is the fraction of the Sun's radiation that is reflected from a surface. A higher albedo value results in a lower surface temperature. The following table illustrates the variations in albedo based on ground cover:

Table 1: Albedo Values for Common Ground Covers

Type of Cover	Characteristics	Albedo
Soil	Dark and Wet	0.05
	Light and Dry	0.40
Grass	Long	0.16
	Short	0.26
Forest	Deciduous	0.15-0.20
	Coniferous	0.05-0.15
Snow	Old-Fresh	0.40-0.95

Source: Oke, 1992 and Ahrens, 2006

The temperature of the Earth's surface at the site was determined based on ground cover for the pre-expansion, operational, and post-closure conditions. The following equation assumes the Earth is a perfect black body (an object which absorbs all radiation incident on it, heats up, and re-radiates according to its temperature) with no atmospheric affects and was used to calculate the effective temperature on the Earth's surface to assess relative effects:

$$T_o = \sqrt[4]{\frac{S_o}{4\sigma}\left(1-\alpha\right)}$$

Where T_o = effective temperature of the Earth's surface

S_o = solar radiative flux (the solar constant)

= 1367 W/m^2 (From: World Metrological Organization[10])

σ = Stefan-Boltzman constant

= 5.6703 x 10^{-8} W/m^{2}K^4

α = albedo

The following table states the parameters used to estimate the effective temperature at each stage of site development. These estimates are relative estimates as the effect of the atmosphere (i.e. weather) are ignored, and in most cases weather conditions will be dominant. This calculation is an overestimation of the likely outcome. The weighted effective temperature is also shown which averages the temperatures based on the percentage of the site with the specified ground cover:

Table 2: Albedo and Effective Temperature for Stages of Facility Expansion

Stage of Development	Description of Ground Cover	Albedo	Calculated Effective Temp (°F)	Weighted Effective Temp of Site (°F)
Current	12.2% Long Grass	0.21	20.5	17.9
	86% Deciduous Forest	0.175	18.3	
	1.8% Light & Dry Soil	0.40	-18.3	
Operating	30% Light & Dry Soil	0.40	-18.3	8.8
	70% Long Grasses	0.16	20.5	
Post-Closure	100% Long Grasses	0.16	20.5	20.5

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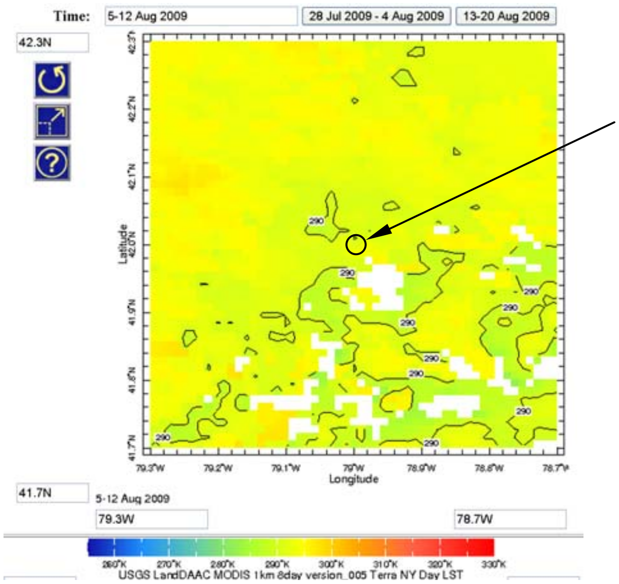
[10] Newport. (1996-2012). Introduction to Solar Radiation. Website: http://www.newport.com/Introduction-to-Solar-Radiation/411919/1033/content.aspx. Accessed on: June 29, 2012.

The post-closure surface temperature at the site, with predominantly long grass, has the potential to emit more heat radiation than the current ground cover conditions. The post-closure conditions, and therefore the post-closure effective temperature conditions, are similar to agricultural conditions, such as lands currently surrounding the Observatory and much of the land in the region. Therefore, the lands already surrounding the Observatory have the potential to emit a greater amount of heat radiation than the proposed facility during its current condition and operating stages.

During operation however, the surface temperature is more than two times lower than the current conditions. This suggests that an increase in the quality of astronomical viewing from the Observatory in the direction of the site could occur as a result of the less absorptive ground cover.

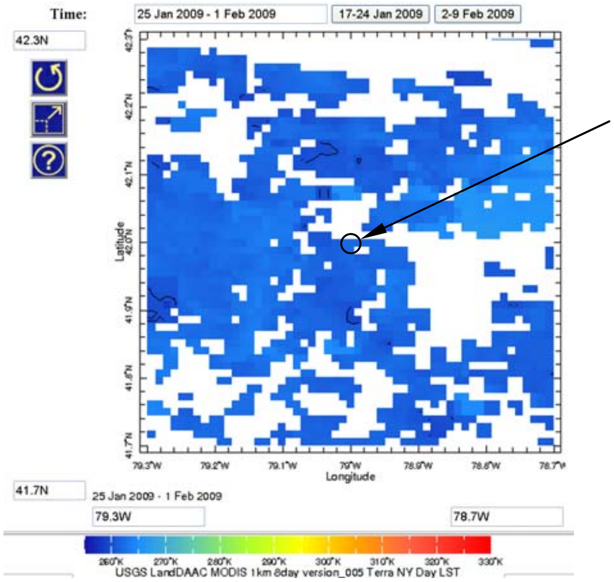
To further assess the above hypothesis, that closed landfills have the potential to emit more radiation due to changes in ground cover, the actual average temperatures at the Earth's surface, taking into account atmospheric affects, have been evaluated using the United State Geologic Survey (USGS) remote sensing technology. The following two figures show the land surface temperature in the region surrounding the site during the hottest and coldest times of the year. As indicated, the approximate land temperature ranges from 290K or 62.3°F to 260K or 8.3°F at the site. These figures demonstrate that the facility will pose little threat to the Observatory during the winter months since the ground will in large part be frozen and produce minimal thermal waves. Additionally, as seen by the high albedo value for snow (Table 1), the effective temperature of the earth's surface will in fact be low.


Time: 5-12 Aug 2009 | 28 Jul 2009 - 4 Aug 2009 | 13-20 Aug 2009

USGS LandDAAC MODIS 1km 8day version_005 Terra NY Day LST

APPROX. LOCATION OF MARTZ OBSERVATORY

Figure 5: Land Surface Temperature at Martz Observatory during August


Time: 25 Jan 2009 - 1 Feb 2009 | 17-24 Jan 2009 | 2-9 Feb 2009

USGS LandDAAC MODIS 1km 8day version_005 Terra NY Day LST

APPROX. LOCATION OF MARTZ OBSERVATORY

Figure 6: Land Surface Temperature at Martz Observatory during December

6.3.3 Heat Generation in C&D Landfills

Heat generation in landfills is primarily a result of decomposition or reactions, and are a function of several factors which include excess oxygen, temperature, moisture, waste compaction, reaction of waste constituents, and waste type. Whether aerobic or anaerobic degradation, the heat produced by these two decomposition methods depends on the amount of oxygen and the type of bacteria present. Aerobic degradation contributes more to heat generation than anaerobic degradation although anaerobic methanogenesis is an exothermic process. Another component which contributes to the generation of heat is the production of methane and moisture from precipitation and waste. When the moisture in the landfill increases, the ability of bacteria to decompose waste is accelerated and an increase in temperature is observed. The type of waste and amount of compaction are also factors due to the susceptibility of waste to react with the surroundings and the porosity of the waste which in turn affects how much of the surface area can be reached for degradation.[11]

Once heat is generated within the confines of the landfill, it escapes to the surrounding environment via heat transfer. This transfer is affected by subgrade thermal properties, waste thermal properties, waste placement rate, water infiltration, and insulating cover systems. The hottest temperatures in a landfill are near the middle-depths and occur after waste placement as shown in Figure 7. Over time, waste temperatures return to ambient ground temperatures. Likewise, locations near the surface and perimeter edge of cells have been proven similar to unheated ground temperatures, affected by climatic and subgrade conditions, throughout the life of a landfill. Temperature measurements obtained on geomembrane covers systems have also demonstrated that ground surface temperatures are virtually unaffected by heat generated inside the fill.

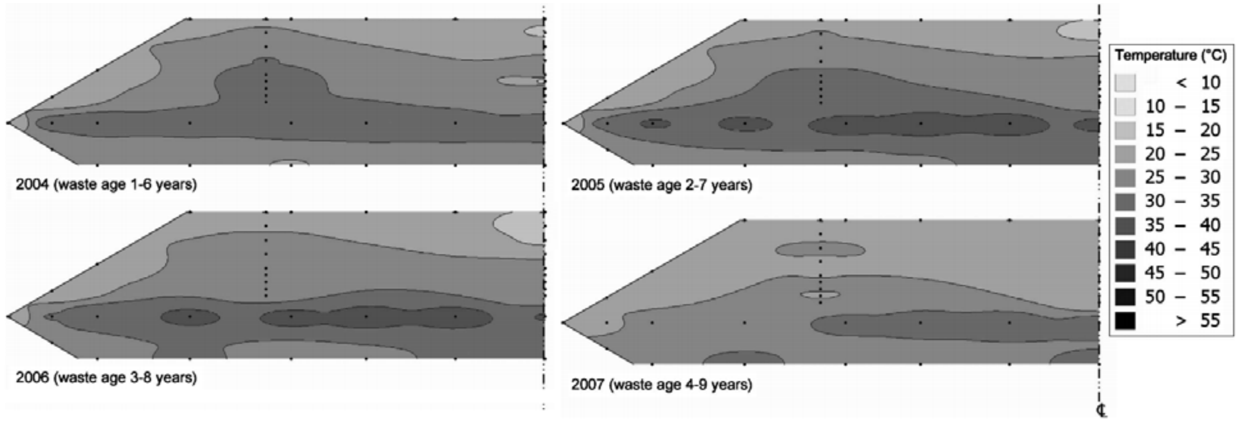


Figure 7: Temperature Contour Maps for MSW Landfill[12]

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[11] Oettle, Nicolas K. "Thermal Analysis of Landfill Barriers." California Polytechnic State University, July 2008. Web. 29 June 2012.

[12] Hanson et al. (2004). Spatial and Temporal Temperature Distributions in Municipal Solid Waste Landfills. Website: http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1194&context=cenv_fac. Accessed on: June 29, 2012.

Hanson et al. stated that the "overall, thermal regime of landfills is controlled by climatic and operational conditions".[13] In a separate study, ambient temperatures and diurnal cycling influenced the landfill surface temperatures.[14] These two studies suggest that although the locations at the middle-depths may be hotter than the ambient surroundings, generally, the ground temperature at the top surface of the landfill will be similar to that of the ground surface cover and seasonal air.

6.3.4 Martz Observatory and Heat Radiation

The altitude cut off to the northwest, in the direction of the site, for the Martz Observatory is 20 degrees above the horizontal.[15] Given the facility is approximately one mile from the observing location, viewing through the telescope towards the facility would yield a line of site located nearly 2,000 feet above the maximum height of the landfill.

While there may be increases in surface temperature due to changes in ground cover conditions, no significant increase in ground surface temperatures due to heat generated inside the solid waste cells will be observed. Recalling that immediately above dark pavement thermal turbulence is evident and quickly dissipates, and recognizing that the optics on modern telescopes may be more sensitive than the human eye, it is unreasonable to assume that the minimal increase in surface temperature that may be caused by solid waste activities will have an effect on the viewing path nearly 2,000 feet above the final elevation of the closed landfill. Additionally, the Observatory is immediately surrounded by residential and farming operations while the closest point to the proposed facility boundary is located approximately one mile away. Heat convection may cause turbulence in the air from the metal roof of the barn located less than 100 yards away, and this heat source would affect the viewing capabilities at the Observatory more than the proposed facility. The one mile distance to the facility is not considered proximate and the facility will not contribute to heat impacts on the ability to view the night skies.

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[13] Hanson et al. (2004). Spatial and Temporal Temperature Distributions in Municipal Solid Waste Landfills. Website: http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1194&context=cenv_fac. Accessed on: June 29, 2012.

[14] Koerner, G.R., and R.M. Koerner. (2006). Long-Term Temperature Monitoring of Geomembranes at Dry and Wet Landfills. Website: http://www.sciencedirect.com/science/article/pii/S026611440500004X. Accessed on: June 29, 2012.

[15] Dark Sky Directory. (2011). Dark-Sky Sites: New York. Website: http://www.observingsites.com/ds_ny.htm#frews. Accessed on: September 26, 2012.

For mid continental sites like the Martz Observatory, local topography affects, rather than the proposed facility, are considered dominant. The mildly variable terrain around the Observatory with varying cover from woodlot to pasture is not easily quantified by applicable models.

6.4 DUST

6.4.1 Particulate Matter

Particulate matter (PM) is a mixture of extremely small particles and liquid droplets suspended in the air[16] such as dust, soot, smoke, pollen, and mold. Characterized by their size, PM smaller than ten micrometers (PM-10) released at point sources is regulated by the federal and/or state authorities. Similarly, PM-2.5 applies to particulates which are 2.5 microns or less in diameter. Unlike point sources, fugitive dust is only regulated when it has been identified as a significant contributor to the PM-2.5 in an area.

An assessment of the potential PM emission rates at the facility has been prepared and documented in Appendix B of the Air Emissions Inventory. The PM from point sources onsite are negligible (less than 2% of the air emissions standard); however, fugitive particulates may be generated from unpaved roads due to waste delivery trucks and onsite vehicles as well as from general landfill operations due to bulldozing, compacting, truck unloading, excavating, front/backhoe loading, and truck dumping. The emission rates for the worst case scenario (potential-to-emit) were quantified in Appendix B. As indicated, unpaved roads contribute the most to particulate emissions. Thus, dust control measures will be employed at the facility to minimize dust production.

6.4.2 Dust Control Measures

Section 3.3 and 4.3 of the Contingency Plan (February 2012) specified the following dust control measures to be implemented at the site.

During construction, especially during a dry period, dust will be controlled by frequent watering of the site access roads and work areas (without damaging the construction elements) using the water truck kept at the site. Standard construction practices will be maintained to control excessive dust resulting from construction activities. In the event excessive dusting is

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[16] U.S. Environmental Protection Agency. (2012). Particulate Matter (PM). Website: http://www.epa.gov/pm/. Last Revised Date on: June 28, 2012. Accessed on: July 3, 2012.

encountered, the frequency of watering the access roads will be increased or additional water trucks will be deployed.

While the access roads and working areas of the landfill are generally removed from residential areas, during dry periods, fugitive dust may be a nuisance. Under these conditions, dust problems are localized and can generally be adequately managed with the equipment at hand. One 2,000 gallon water truck kept at the site will be used to control dust wherever a potential problem exists. Crushing and screening activities in the C&D Processing Operation onsite can also be significant sources of dust. The facility design includes a misting system to be employed as necessary to control dust.

Haul trucks have the potential to track mud on their wheels and chassis when leaving the site onto area roadways, that when dry creates a potential for fugitive dust. A vacuum sweeper will be kept onsite and utilized on the paved portions of site access roads and adjacent sections of Dodge Road when necessary to prevent this situation. The use of the sweeper is determined by the daily visual inspection of road conditions by the Site Manager.

In the event of unusually dusty conditions, the site manager can rent or lease another water truck to assist in dust control.

6.4.3 Effects of Particulate Matter on Telescopes & Seeing

Dust on lenses or mirrors of telescopes scatters light and reduces contrast. It makes dark skies less dark and bright objects less crisp.[17] Harold Richard Suiter analyzed the effects of soiled optics mathematically in his book *Star Testing Astronomical Telescopes*. Suiter noted the following: "The maximum amount of dirt [that a perfectionist] should tolerate on the optics is about 1/1000 of the surface area, the size of a single obstruction about 1/30 of the diameter." For example, the Martz Observatory's 24-inch telescope would require an opaque dirt blot 0.8 inches across before a detectable effect on the contrast is noticed.

Telescopes, like one's window sill or car dash board, have the tendency to accumulate dust particles regardless of surrounding activities. Cleaning telescope lenses is a delicate task which

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[17] Allan MacRobert. (2000). Caring for Optics. Website: http://www.wwnorton.com/college/astronomy/astro21/sandt/optics.html. Accessed on: July 11, 2012.

should only occur when necessary. Cleaning can result in scratches on the surfaces of the optics which are a permanent problem. The cost of re-coating the 24-inch and six-inch Martz Observatory telescopes in 2004 was $2,000.00 which is generally conducted on an as-needed basis. A low cost alternative is frequent cleaning with carbon dioxide ice.

6.4.4 Wind Blown Dust

Wind is an important factor when considering the movement of particulate matter in the air. Shown in Figure 8 is a Google Earth image of the locations of the Martz Observatory and Carroll facility. An annual wind rose graph (Source: National Weather Service, Eastern Regional Headquarters, Jamestown Airport Wind Rose Graphs) is also presented on the figure to depict the direction and wind speeds in the area.

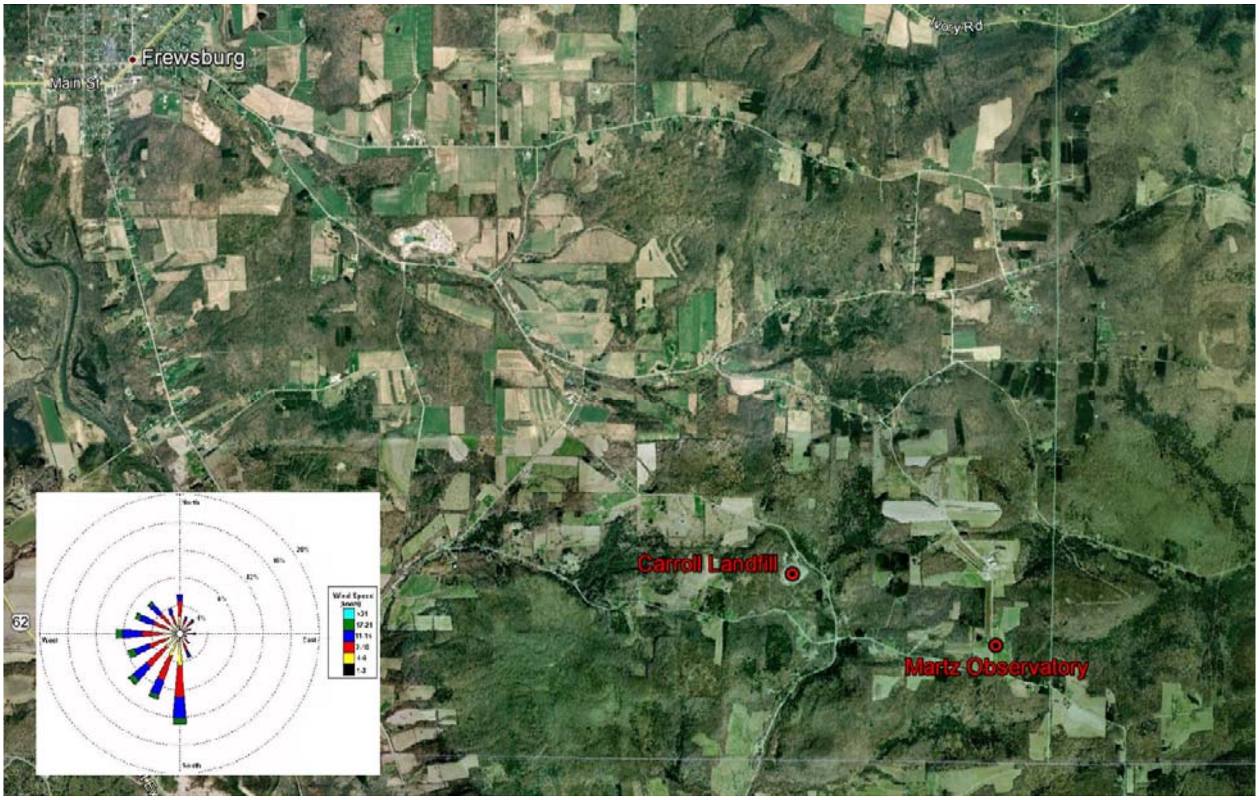

Figure 8: Wind Rose Graph and Locations of Observatory and Facility

As shown in the figure, the winds in the project area predominantly blow from the south and west directions (towards the east and north). The wind rose illustrates that for 50% of the time, the wind is blowing in this direction at an average speed of approximately 17 to 21 knots (19.5 to 24 mph); therefore, PM will also migrate in this direction 50% of the time. Conversely, wind blows 6% of the time from the site towards the Martz Observatory (in the east-southeast direction). When wind is blowing to the east and downhill from the facility (see Figure 1) towards the Observatory, particulate dust is likely to be trapped in the undulating terrain, intervening valley and vegetation of the landscape. As a result, it is believed particulate dust will be unable to migrate in any meaningful amount to affect the telescopes and seeing capabilities at the Observatory.

As seen in the aerial photo, agricultural fields surround the Observatory. These fields may cause a high ground temperature because heat is readily absorbed and dust is likely produced and dispersed in close proximity to the Observatory during agricultural activities.

6.4.5 Martz Observatory and Dust

It has been determined that the Martz Observatory is not likely to be affected by windblown dust due to the low percentage of wind towards the direction of the Observatory and the oreographic features between the solid waste facility and the Observatory. While more intensive, facility operations are similar to agricultural activity which occur in more immediately surrounding areas to the Observatory. The agricultural activities produce dust; however, the dust has not emerged as a tenable problem.

At times when fugitive dust is determined to be an issue at the site by facility staff, actions will be taken to reduce the migration of dust off site by watering access and haul roads with a tank truck or sweeping roads using a vacuum sweeper truck.

7 RADIO TELESCOPE SIGNAL INTERFERENCE

The Martz Observatory plans to or has installed a ten foot diameter radio astronomy telescope dish to collect and analyze radio waves emitted by distant celestial objects. For the purpose of assessing potential impacts to the operation of the Observatory, radio telescope signal interference is defined as any frequency signal that disrupts clarity of reception for the radio telescope. Radio telescope signal interference may prevent reception altogether, may cause a temporary loss of a signal, or may affect the quality of reception by masking the cosmic signals.

The most common causes of radio telescope signal interference are transmitters, electrical power lines and electrical equipment. Sealand will employ an internal communication system consisting of landline telephones in the scale house, maintenance building, and field office trailers (if used) and two-way radios for site supervision and select staff. Radios will emit electromagnetic energy just like citizen band radios, television and radio stations, earth orbiting satellites, cell phones, wireless computer networks, garage door openers and other electronic devices. Common electrical equipment to be used at the site will include copy/print/fax machines, refrigerators, air conditioners, electric motors for shop equipment and landfill gas collection and treatment systems, arc welders and the like.

By international agreement, radio frequencies are separated into a series of bands for different uses, designed to prevent one use from interfering with another. A number of frequency bands are allocated to radio astronomy, and transmitting from the radio astronomy bands or at frequencies near those assigned to radio astronomy can cause interference to radio telescopes. Good planning can eliminate unwanted signals that may threaten interference with the Martz Observatory radio astronomy telescope dish. Sealand will meet with and coordinate radio and electrical equipment selection with the radio astronomers at Martz. Together, Sealand and Martz representatives will select the appropriate radio equipment and frequencies to preclude radio telescope signal interference at the Observatory. Electrical equipment specifications will be prepared to require adequate protection for internal wiring, include proper shielding and/or sufficient filtering to eliminate or reduce transmission of unwanted electromagnetic signals.

8 CONCLUSION

It has been demonstrated that any increase in light, heat, dust, and/or radio telescope signal interference from the proposed development of the facility will not pose any threat to the quality of viewing capabilities at the Martz Observatory. The most important conditions for a mid continental observing site, such as the Martz Observatory, to see distant objects are a clear, dark sky. A clear sky relies primarily on the weather conditions, and to a lesser degree the close proximity of the observing site to sources of light, heat, and dust. Further, oreographic features and variable terrain, as opposed to the facility operation, will have a significantly larger affect on atmospheric turbulence, and thus on the “seeing” conditions.

Dark sky conditions will be maintained during site operations by implementing appropriate mitigation efforts and the design of proper lighting features. As described, mitigation efforts to eliminate stray light impacts include the use of full cut off, 100% fully shielded light fixtures and low-pressure sodium lamps. The six proposed outdoor lighting features will each be equipped with a motion sensor to prevent unnecessary light being emitted during nighttime hours. Despite stray light being mitigated by the described efforts, it is also believed that any stray light emitted from the facility would have minimal impacts compared to the sky glow from the city of Jamestown when viewing towards the northwest.

Although dust produced at the facility is not likely to impact the Observatory due to the minimum one mile separation from the Observatory, mitigation efforts addressing nuisance dust will focus on the use of a water truck to suppress dust on access and haul roads, and the sweeping of paved roads with a vacuum sweeper truck when necessary.

It is thought that if the existing conditions in the immediate vicinity of the Observatory do not create unmanageable conditions, the presence of the proposed facility will not have a negative impact on its operation due to its relatively distant proximity. As a result, the Martz Observatory will be able to continue the legacy of Mr. Marshall Martz and maintain its function as an educational facility for the neighboring regions.

ATTACHMENT 1

Letter of Peer Review

October 5, 2012

Daigler Engineering, P.C.
1711 Grand Island Blvd.
Grand Island, New York 14072-2131

Dear Mr. Daigler

This letter is a summary of my review of your report of October 2012 titled ***EVALUATION OF POTENTIAL IMPACTS ON THE MARTZ OBSERVATORY.*** As an educator and professional astronomer I have been involved in a range of facilities ranging from 8-36 inch optical telescopes for education, public outreach and amateur contribution to astronomical research to the most advanced 8-10 meter class telescopes at the very best sites on the planet. Facilities such as the Martz Observatory play an important role in our society as intellectual nurseries for young minds as well as productive outlets for creative and curious citizens. Astronomy is one of the most common sciences that stimulate young people to nurture an interest in science and engineering around the world. There is a strong argument that science and engineering has been and remains the greatest health and wealth creation endeavor known to man and by implication is very important to our nation. Thus the Martz Observatory is a valued facility and should be shielded to the extent possible from degradation. In evaluating your report, it is my professional opinion that your analysis and mitigations are correct and if properly implemented will not degrade the observatory's capability.

You identified light, turbulence caused by heat convection, dust and radio interference as the four areas to investigate for mitigation and I will comment on each.

Light pollution is by far the largest threat to Martz or any observatory. You indicate properly that pollution present at the Martz site from cities both distant and relatively nearby. These will compromise the sky whenever there is high haze or cirrus. Especially on clear, and often cold nights, locations like Martz can still enjoy very good observing conditions and it is more proximate lighting that can be an issue in this case. The vertical and below horizontal shielding combined with the light being off most of the time, in my opinion, properly mitigates the effect of the proposed facility.

I also agree with the conclusion that the proposed facility will not degrade the astronomical *seeing* at the Martz Observatory. As is common for mid continental and especially low altitude sites, their image quality will be dominated by the local topography and resultant low level atmospheric turbulence as well as heat sources within the Observatory itself.

Dust is always a threat to optics as well as precision mechanisms such as the telescopes and cameras. Again, your suggested mitigations properly implemented should reduce what would already be a small increased threat to a fully negligible level especially considering the observatory has several active agricultural fields much closer.

I also agree with your assessment of the radio interference risk. I do not see the proposed facility adding to the existing radio "light pollution" so pervasive in modern society.

Please let me know if you need any of the above issues addressed in more detail.

Sincerely,

Lawrence W. Ramsey, PhD.

ATTACHMENT 2

Curriculum Vitae of Peer Reviewer

Brief Biographical Sketch

Dr. Lawrence Ramsey is a Professor of Astronomy and Astrophysics at the Pennsylvania State University where he served as Department Head from 2003 through 2011. He completed his BS degree in Physics at the University of Missouri St. Louis. He worked for McDonnell-Douglas Corporation (now Boeing), as Aircraft and Spacecraft Simulator Systems Engineer from 1966-70 on Gemini spacecraft and military projects. After leaving industry, Dr. Ramsey obtained MS in Physics in 1972 from Kansas State University a PhD in Astronomy in 1976 from Indiana University. During that period he also spent a year working at the National Optical Astronomy Observatory (NOAO) in Tucson. He has been at Penn State since 1976 where he pursued research in solar like activity on stars, stellar seismology and astronomical instrumentation and more recently searches for planets around other stars. He has authored or co-authored over 100 scientific papers. A major focus since 1990 has been implementing the Hobby-Eberly telescope (HET) at McDonald Observatory in west Texas, the concept for which he and Penn State colleagues developed in 1983, and its successor, the Southern African Large Telescope (SALT). He served as project scientist for the HET from inception until 2004. Recently he served from 2003-2011 as department head of Astronomy and Astrophysics which is responsible for about 90 personnel and includes several large space astrophysics projects. He is currently engaged in a project to build an infrared instrument to search for planets using the HET. He is also working with several international observatories and serves on the Board of Directors for the Hobby Eberly telescope, the South African Large Telescope and the Large Synoptic Survey Telescope and Chairs the Board of directors for the International Gemini Observatory. Dr. Ramsey and his wife both enjoy the outdoors and spend their leisure time bird watching and on nature travel around the world.

VITA of Lawrence W. Ramsey

PERSONAL

Born 14 March, 1945 in Louisville, Kentucky; Married to Mary Ellen Gessling, 1970. No children

EDUCATION

Ph.D. Astronomy, 1976, Indiana University
M.S. Physics, 1972, Kansas State University
A.B. Physics and Math, 1968, University of Missouri, St. Louis

POSITIONS HELD

7/88-Present Professor, The Pennsylvania State University.
7/82-6/88 Associate Professor, The Pennsylvania State University.
9/76-6/82 Assistant Professor, The Pennsylvania State University.
5/72-9/73 Research Assistant, Kitt Peak National Observatory.
9/66-8/70 Aircraft and Spacecraft Simulator Systems Engineer, Conductron Missouri Corp. (a division of the McDonnell-Douglas Corporation, now Boeing).

TEMPORARY APPOINTMENTS

7/1/2003-6/30/2011: Atronomy & Astrophysics Department Head
9/1999-7/2000: Atronomy & Astrophysics Interim Department Head
9/1994-2004: Senior Research Fellow at the University of Texas at Austin
1991-6/2003: Deputy Department Head
1/1990-10/2004: PSU/UT Hobby-Eberly Telescope (formerly SST) Project Scientist

9/1993-11/1993: Acting Astronomy & Astrophysics department head
1/1990-9/1990: PSU/UT Spectroscopic Survey Telescope (SST) interim Project Manager
Consultant for Nordic optical telescope instrumentation, Copenhagen Observatory, 1886-88

RECENT NATIONAL & INTERNATIONAL COMMITTEES

Chair, Gemini International Observatory Board of Directors, May 2010-present
Member, Large Synoptic SurveyTelescope (LSST) Board of directors, January 2008 present
Member, Southern African Large Telescope (SALT) Board of directors, January 2004 present
Member, Hobby-Eberly Telescope (HET) Board of directors, June 2003 to present
Chair, AURA NOAO Observatories Visiting Committee, 6/2008-2009
Chair, NOAO/AURA ALTAIR committee, 5/2008 until final report delivered in Feb 2009.
Chair, Associated Universities for Reseach in Astronomy (AURA) Oversight Committee for Gemini, 2002-2006
Member, Facilities Subcommittee of the National Science Foundation (NSF) Business and Operations Advisory Committee, 2/2005- 5/2006 (Dealt with MREFC processes)
Member, AURA Board of Directors, 2002- 2006
Member, AURA Oversight Committee for Gemini, 2000-2002
Member, AURA New Initiatives Office Oversight Committee October 2000- 2004
Member, International Gemini Science Advisory Committee, 1999-2002
Member, US Gemini Science Advisory Committee, 1996-2002

Memberships in professional societies:

American Astronomical Society
Society of Photo-Optical Instrumentation Engineers
Astronomical Society of the Pacific
International Astronomical Union

Honors and Awards

Named Eberly College of Science Distinguished Senior Scholar in 2011
K.R. Ramanathan visting Professor from January 12 to January 27 at the Physical Research Laboratory in Amadebad, India
Distinguished Alumni Award, University of Missouri, St. Louis, Sept 13, 2001
Eberly College of Science Alumni Society 1997 Distinguished Service Award
Finalist for 1997 Discover Magazine Award for Technological Innovation

RESEARCH PUBLICATIONS

Refereed Publications

1) Telluric Lines in the Vicinity of 5256 and 6562 A.
W. Livingston and L. Ramsey, Solar Physics **31**, 317, 1973.

2) Formation of the Luminosity Sensitive O I Multiplet at 7774 A
H.R. Johnson, R.W. Milkey, and L.W. Ramsey, Ap.J. **187**, 147, 1974.

3) High Resolution Profiles of Sodium and Potassium Lines in Alpha Orionis
L. Goldberg, L. Ramsey, L. Testerman and D. Ca**r**bon, Ap.J. **199**, 427, 1975.

4) On the Broadening of Solar Lines by Macroturbulence with Implications for Stellar Studies
J.C. Evans, L.W. Ramsey and L. Testerman, Astron. & Astrophys. **42**, 237, 1975.

5) High Dispersion Spectroscopy of Quiescent Prominences.   III VerticalStructure of the Line-of Sight Velocity Field.
L.W. Ramsey, Solar Physics, **51**, 307, 1977.

6) Spectrophotometry of Cool Angular Diameter Stars
R.K. Honeycutt, L.W. Ramsey, W.H. Warren and S. Ridgway, Ap.J. **215**, 584, 1977.

7) A Semi-Empirical Atmosphere for Alpha Tauri from Neutral Iron Lines
L.W. Ramsey, Ap.J. **215**, 603, 1977.

8) Observed Departures from LTE Ionization Equilibrium in Late-Type Giants
L.W. Ramsey, Ap.J. **215**, 827, 1977.

9) Variable Mass Loss in the Metal Deficient Giant HDE232078
L.W. Ramsey, PASP **91**, 252, 1979.

10) Limits on the Short Period Variability of H-Alpha Emission in AD Leo
L.W. Ramsey, A.J. **84**, 413, 1979.

11) HR1099 and the Starspot Hypothesis for RS Canum Venaticorum Binaries
L.W. Ramsey and H.L. Nations, Ap.J. Letters, **239**, L55, 1980.

12) Spectrum Variability in HR8752
S.C. Barden and L.W. Ramsey, PASP **92**, 497, 1980.

13) H-Alpha Variability in HR1099 and Other RS CVn Stars
H.L. Nations and L.W. Ramsey, A.J. **85**, 1086, 1980.

14) Evaluation of Some Optical Waveguides for Astronomical Instrumentation
S.C. Barden, L.W. Ramsey and R.J. Truax, PASP **93**, 154, 1981.

15) On the Nature of H-Alpha Outbursts in the RS Canum Venaticorum Binary SZ Piscium
L.W. Ramsey and H.L. Nations, PASP **93**, 732, 1981.

16) BVRI Photometry of the RS CVn Binary II Peg
H.L. Nations and L.W. Ramsey, A.J. **86,** 433, 1981.

17) Observations of the TiO 8860 A Band in M Giants
L.W. Ramsey, A.J. **86**, 557, 1981.

18) On the Ionization Equilibrium in Late Type Supergiants
L.W. Ramsey, Ap.J. **245**, 984, 1981.

19) NGC 7714: The Prototype Starburst Galactic Nucleus
D.W. Weedman, F.R. Feldman, V.A. Balzano, L.W. Ramsey, R.A. Sramek and C.C. Wu, Ap.J. **248**, 105, 1981.

20) Regular Variations in the H-Alpha Profile of FK Comae
L.W. Ramsey, H.L. Nations, and S.C. Barden, Ap.J. Letters **251**, L101,1981.

21) Emssion Line Widths in Galactic Nuclei
F.R. Feldman, D.W. Weedman, V.A. Balzano and L.W. Ramsey, Ap.J. **256**, 427, 1982.

22) A Spectroscopic Study of the Peculiar Giant FK Comae: I The Radial Velocity Variation and Its Implications
James K. McCarthy and L.W. Ramsey, Ap.J. **283**, 200, 1984.

23) Hydrogen Alpha Observations of RS Canum Venaticorum Stars: I II Peg
H.L. Nations and L.W. Ramsey, A.J. **89**, 115, 1984.

24) Hydrogen Alpha Observations of RS Canum Venaticorum Stars: III The Eclipsing Systems AR Lacertae and SZ Piscium
D.P. Huenemoerder and L.W. Ramsey, A.J. **89**, 549, 1984.

25) Hydrogen Alpha Observations of RS Canum Venaticorm Stars: II 1981 Observations for UX Arietis, HR1099, and BD+61 1211
H.L. Nations and L.W. Ramsey, A.J. **92**, 1403, 1986.

26) CCD Echelle Observations of the Active RS CVn System II Pegasi
D.P. Huenemoerder and L.W. Ramsey, Ap.J. **319**, 392, 1987.

27) A Flare Event on the Long Period RS Canum Venaticorum System IM Pegasi
D.L. Buzasi, L.W. Ramsey and D.P. Huenemoerder, Ap.J. **322**, 353, 1987.

28) Fiber Optic Echelle CCD Spectral Monitoring of UX Arietis
D.P. Huenemoerder, D.L. Buzasi and L.W. Ramsey, A.J. **98**, 1398, 1989.

29) Coordianted Optical and Ultraviolet Observations of IM Peg
D.P. Huenemoerder, L.W. Ramsey and D.L. Buzasi, Ap. J. **350**, 763, 1989.

30) Titanium Oxide Variations in II Pegasi
D.P. Huenemoerder, L.W. Ramsey and D.L. Buzasi, A.J. **98**, 2264, 1989.

31) Coordinated Optical and Ultraviolet Observations of DH Leo
J. Newmark, S. Barden, D. Buzasi, D. Heunemoerder, L. Ramsey ,A.J. **100**, 560, 1990.

32) Spectroscopy of the Highly Active RS CVn System SS Boo
J.C. Hall, D.L. Buzasi, D.P. Huenemoerder, and L.W. Ramsey, Ap.J. **358**, 610, 1990.

33) Dectection of Possible P-Mode Oscillations in Procyon
T.M. Brown, R.L. Gilliland, R.W. Noyes, L.W. Ramsey, Ap. J. **368,** 599-609, 1991

34) Short-Term Variability in the RS CVn System HR1099
D.L. Buzasi, D.P. Huenemoerder, and L.W.Ramsey, PASP 103, 1077, 1991.

35) BF Orionis: Evidence for an Infalling Circumstellar Envelope
A.D. Welty, S.C. Barden, D.P. Huenemoerder and L.W. Ramsey, A.J. **103**, 1673-1678, 1992.

36) Eclipse Observations of RS CVn Binaries I: A Survey for Extended matter
J.C. Hall and L.W. Ramsey, A.J. **104**, 1942-1959, 1992.

37) Scrambling Properties of Optical Fibers and the Performance of a Double Scrambler
T.R. Hunter and L.W. Ramsey, PASP **104**, 1244-1251, 1992.

38) A UV and Visual Spectroscopic and Visual Photometric Study of FK Comae Berenices in 1989
Huenemoerder, D.P., Ramsey, L.W., Buzasi, D.L. and Nations, H.L., Ap.J. **404**, 316-327, 1993.

39) Lithium Line Variations in Weak-Lines T Tauri Stars
Patterer, R.J., Ramsey, L.W., Huenemoerder, D.P. and Welty, A.D., 1993, Astron. J., **105**, 1519-1524.

40) A Far-Ultraviolet Flare on a Pleides G Dwarf
Ayres, T.R., Stauffer, J.R., Simon, T., Stern, R.A., Antiochos, Basri, G.S., Bookbinder, J.A., Brown, A., Dorschek, G.A., Ramsey, L.W., Walter, F.M., Ap.J. Letters **420**, 33.

41) A Long Term Study of Hα Line Variations in FK Comae Berenices
Welty, A.D., Ramsey, L.W., Iyengar, M., Nations, H.L., Buzasi, D.L. Pub. Astron. Soc. Pacific, **105**, 1427-1432.

42) Eclipse Observations of RS CVn Binaries II: A Parametric Model of Extended Matter
J.C. Hall and L.W. Ramsey, 1994, A.J. **107**, 1149.

43) ROSAT Observations of FK Comae Berenices

Welty, A.D. and Ramsey, L.W. 1994, Astron. J. **108**, 299.

44) The Shape of FK Coma Berenices: Evidence for a Recently Coalesced Binary
Welty, A.D. and Ramsey, L.W.1994 , Ap.J. **435**, 848.

45) The Activity of Weak-lined T Tauri Stars: I V410 Tauri
Welty, A.D. and Ramsey, L.W.1995 , A.J. **109**, 336.

46) On the Role of Mass transfer in X-Ray Emission of RS Cvn Stars
Welty, A.D. and Ramsey, L.W.1995 , A.J. **109**, 2187.

47) Li I enhancement during a long-duration stellar flare
Montes D., Ramsey L.W., 1998, Astronomy & Astrophyscis Letters, **340**, L5-L9

48) Library of medium-resolution Fiber Optic Echelle spectra of F, G, K and M field dwarfs to giants stars
Montes D, Ramsey,L.W. & Welty, A.D. 1999, ApJ Supplement **123**, p283-294.

49) The Low Resolution Spectrograph of the Hobby-Eberly Telescope II.Observations of Quasar Candidates from the Sloan Digital Sky Survey
D.P. Schneider, G.J. Hill, X. Fan, L.W. Ramsey, P.J. MacQueen, D.W. Weedman,J.A. Booth, M. Eracleous, J.E. Gunn, R.H. Lupton, M.T. Adams, S. Bastian, R. Bender, E. Berman, J. Brinkmann, I. Csabai, G. Federwitz, V. Grubani, G.S. Hennessy, G.M. Hill, R.B. Hindsley, Z. Ivezic, G.R. Knapp, D.Q. Lamb, C. Lindenmeyer, P. Mantsch, C. Nance, T. Nash, J.R. Pier, R. Rechenmacher, B. Rhoads, C.H. Rivetta, E.L. Robinson, B. Roman, G. Sergey, M. Shetrone, C. Stoughton, M.A. Strauss, G.P. Szolkoly, D.L. Tucker, G. Wesley, J. Willick, P. Worthington, and D.G. York, 2000, PASP, **112**, 6-11.

50) Observations of Faint, Hard-Band X-ray Sources in the Field of CRSS J0030.5+2618 with the Chandra X-ray Observatory and the Hobby-Eberly Telescope.
Brandt, W.N., Hornschemeier, A.E., Schneider, D.P., Garmire, G.P., Chartas, G., Hill, G.J., MacQueen, P.J., Townsley, L.K., Burrows, D.N., Koch, T.S., Nousek, J.A., and Ramsey, L.W., 2000, AJ, **119**, 2349-2359.

51) The Missing Link: Early Methane ("T") Dwarfs in the Sloan Digital Sky Survey.
S.K. Leggett, T.R. Geballe, X. Fan, D.P. Schneider, J.E. Gunn, R.H. Lupton, G.R. Knapp, M.A. Strauss, A. McDaniel, D. Golimowski, T. Henry, E. Peng, Z.I. Tsvetanov, A. Uomoto, W. Zheng, G.J. Hill, L.W. Ramsey, S.F. Anderson, N.A. Bahcall, J. Brinkmann, B. Chen, I. Csabai, M. Fukugita, G.S. Hennessy, R.B. Hindsley, Z. Ivezic, D.Q. Lamb, J.A. Munn, J.R. Pier, J.A. Smith, C. Stoughton, A.R. Thakar, and D.G. York, 2000, ApJL, **536**, 35-38.

52) The Chandra Deep Survey of the Hubble Deep Field North Area. II. Results from the Caltech Faint Field Galaxy Redshift Survey Area.
A.E.Hornschemeier, W.N.Brandt, G.P.Garmire, D.P.Schneider, A.J.Barger, P.S.Broos, L.L.Cowie, L.K.Townsley, M.W.Bautz, D.N.Burrows, G.Chartas, E.D.Feigelson, R.Griffiths, D.Lumb, J.A.Nousek, L.W.Ramsey, W.L.W.Sargent**.** ApJ, **554**, 742-777 2001

53) High-Redshift Quasars Found in Sloan Digital Sky Survey Commissioning Data V: Hobby-Eberly Telescope Observations.
D.P. Schneider, X. Fan, M.A. Strauss, J.E. Gunn, G.T. Richards, G.J. Hill, P.J. MacQueen, L.W. Ramsey, M.T. Adams, J.A. Booth, G.M. Hill, G.R. Knapp, R.H Lupton, D.H. Saxe, M. Shetrone, J.R. Tufts, D.E. VandenBerk, M.J. Wolf, D.G. York, J.E. Anderson, S.F. Anderson, N.A. Bahcall, J. Brinkmann, R. Brunner, I. Csabai, G.S. Hennessy, Z. Ivezic, D.Q. Lamb, J.A. Munn, A.R. Thakar, Astronomical Journal , 121, 1232-1240 (2001).

54) *The Chandra Deep Survey of the Hubble Deep Field North Area. II. Results from the Caltech Faint Field Galaxy Redshift Survey Area*
A.E.Hornschemeier, W.N.Brandt, G.P.Garmire, D.P.Schneider, A.J.Barger, P.S.Broos, L.L.Cowie, L.K.Townsley, M.W.Bautz, D.N.Burrows, G.Chartas, E.D.Feigelson, R.Griffiths, D.Lumb, J.A.Nousek, L.W.Ramsey, W.L.W.Sargent, Astrophysical Journal 554, 742-777 (2001).

55) *L Dwarfs Found in Sloan Digital Sky Survey Commissioning Data II. Hobby-Eberly Telescope Observations*
Donald P. Schneider, Gillian R. Knapp, Suzanne L. Hawley, Kevin R. Covey, Xiaohui Fan, Lawrence W. Ramsey, Gordon T. Richards, Michael A. Strauss, James E. Gunn, Gary J. Hill, Phillip J. MacQueen, Mark T. Adams, Grant M.

Hill, Zeljko Ivezic, Robert H. Lupton, Jeffrey R. Pier, David H. Saxe, Matthew Shetrone, Joseph R. Tufts, Marsha J. Wolf, J. Brinkmann, Istvan Csabai, G.S. Hennessy, Donald G. York, Astronomical Journal, 123, 458-465 (2002)

56) *Rotational modulation of the photospheric and chromospheric activity in the young, single K2-dwarf PW And*
J. Lopez-Santiago , D. Montes , M.J. Fernandez-Figueroa , L.W. Ramsey, Astronomy and Astrophysics, v.411, p.489-502 (2003) .

57) *SparsePak: A Formatted Fiber Field Unit for the WIYN Telescope Bench Spectrograph. I. Design, Construction, and Calibration*
Bershady, Matthew A.; Andersen, David R.; Harker, Justin; Ramsey, Larry W.; Verheijen, Marc A. W., The Publications of the Astronomical Society of the Pacific, Volume 116, Issue 820, pp. 565-590.

58) The First Extrasolar Planet Discovered with a New Generation High Throughput Doppler Instrument
Jian Ge, Julian van Eyken, Suvrath Mahadevan, Curtis DeWitt, Stephen R. Kane, Roger Cohen, Andrew Vanden Heuvel, Scott W. Fleming, Pengcheng Guo, Gregory W. Henry, Donald P. Schneider, Lawrence W. Ramsey, Robert A. Wittenmyer, Michael Endl, William D. Cochran, Eric B. Ford , Eduardo L. Martin, Garik Israelian, Jeff Valenti, David Montes, Astrophysical Journal 648, 648-683 (2006).

59) A Planetary-Mass Companion to the K0 Giant HD 17092
Niedzielski, A.; Konacki, M.; Wolszczan, A.; Nowak, G.; Maciejewski, G.; Gelino, C. R.; Shao, M.; Shetrone, M.; Ramsey, L. W., The Astrophysical Journal, Volume 669, Issue 2, pp. 1354-1358 (2007)

60) A pathfinder Instrument for precision radial velocities in the near-infrared
Ramsey, L. W. Barnes, J. Redman, S. Jones, H.R.A., Wolszczan, A, Bongiorno, S, and Engel, L.and Jenkins, J., PASP 120 pp 887-894, (2008)

61) A Rotational Velocities for M Dwarfs
Jenkins, J. S.; Ramsey, L. W.; Jones, H. R. A.; Pavlenko, Y.; Gallardo, J.; Barnes, J. R.; Pinfield, D. J., ApJ, **704**, 975 (2009)

62) The Infrared Spectrum of Uranium Hollow Cathode Lamps from 850 nm to 4000 nm: Wavenumbers and Line Identifications from Fourier Transform Spectra
Redman, Stephen L.; Lawler, James E.; Nave, Gillian; Ramsey, Lawrence W.; Mahadevan, Suvrath
2011 ApJS 195, 24R

Conference proceedings or parts of books

1) Spectroscopic Evidence for Starspots on HR1099
L.W. Ramsey and H.L. Nations in *Cool Stars Stellar Systems and the Sun*, ed. A.K. Dupree, SAO Special Report **#389**, p97.

2) A Flare Event in the Peculiar Giant FK Comae
L.W. Ramsey and H.L. Nations, in *Cool Stars, Stellar Systems, and the Sun*, eds. M. Giampapa and L. Golub, SAO Special Report #**392**, p225, 1981.

3) The Penn State Spectroscopic Survey Telescope
L.W. Ramsey and D.W. Weedman in IAU Colloquium No. **79**, *Very Larege Telescopes, Their Instrumentation and Programs* (ed. M.H. Ulrich and K. Kjar, ESO Munich) p851, 1984.

4) A Versatile Fiber Coupled CCD/Echelle Spectrograph System
L.W. Ramsey and D.P. Huenemoerder, Proc. S.P.I.E. **627**, *Instrumentation in Astronomy V*I, p282, 1986.

5) The Light Curve, H-Alpha Modulation, and Possible Prominences of the Short Period Binary DH Leo
S.C. Barden, L.W. Ramsey, R.E. Fried, E.F. Guinan and S. Wacker, in *Cool Stars, Stellar Systems, and the Sun*, Proceedings of the Fourth Cambridge Workshop (ed. M. Zeilik and D. Gibson, Springer-Verlag, Heidelberg), p241, 1985

6) A CCD/Echelle Spectroscopy System for Study of Active Cool Stars
L.W. Ramsey and D.P. Huenemoerder in *Cool Stars, Stellar Systems, and the Sun*, Proceedings of the Fourth Cambridge Workshop (ed. M. Zeilik and D. Gibson, Springer-Verlag, Heidelberg), p241, 1985

7) The Spectroscopic Survey Telescope

L.W. Ramsey and D.W. Weedman in *The SHIRSOG Workshop: Proceedings of a Workshop on Prospects for a New Synoptic High Resolution Spectroscopic Observing Facility*, (ed. M. Giampapa, NOAO Tucson) p177, 1986.

8) T*he Penn State Fiber Coupled CCD/Echelle Spectrograph*
L.W. Ramsey in *The SHIRSOG Workshop: Proceedings of a Workshop on Prospects for a New Synoptic High Resolution Spectroscopic Observing Facility* (ed. M. Giampapa, NOAO Tucson) p80, 1986.

9) Focal Ratio Degradation in Optical Fibers
Lawrence W. Ramsey (**Invited Review**) in *Fiber Optics in Astronomy* ASP Conf Series Vol. 3, ed S. Barden, p26, 1988.

10) A Progress Report on the Spectroscopic Survey Telescope
L.W. Ramsey, D.W. Weedman, F.B. Ray and C. Sneden in ESO Conference on *Very Large Telescopes and their Instrumentation*, (ed. M.H. Ulrich), p119, 1988.

11) Optical and UV Spectra of RS CVn Stars
L.W. Ramsey (**Invited Review**) in *Cool Stars, Stellar Systems,and the Sun* (ed G. Wallerstein) PASP Conference Series **9**, 195, 1989.

12) FK Comae and the Evolution of Close Binaries
Huenemoerder, D.P., Ramsey, L.W., Buzasi, D.L. and Nations, H.L. To appear in IAU Symposium 151 (Cordoba, Aug. 1991), Evolutionary Processes in Interacting Binary Stars. eds. R.F. Sistero and Y. Kondo. (Kluwer).

13) Robotic Telescopes with Fiber Coupled Spectrographs
L.W. Ramsey (**Invited Paper**), in *Robotic Telescopes in the 1990's*, ASP Conference Series, ed A. Filipenko, 1992

14) A Survey for Extended Matter in RS CVn Binaries
J.C. Hall and L.W. Ramsey in *7th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun*, ASP Conference Series **26**, ed M.S. Giampapa & J.A. Bookbinder, 1992, p359.

15) Use of Optical Fibers in Spectrophotometry
L.W. Ramsey, in *2nd Workshop on Improvements to Photometry*, (ed. B. Borucki, NASA/NBS), p277, 1987.

16) Optical Spectroscopy of Chromospherically Active Binary Systems in Conjunction with the ROSAT All-Sky Survey
A.D. Welty, J.C. Hall, R.J. Patterer, and L.W. Ramsey in *7th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun*, ASP Conference Series **26**, ed M.S. Giampapa & J.A. Bookbinder, 1992., p116

17) The Spectroscopic Survey Telescope: Concept and Performance
Lawrence W. Ramsey (**Invited Paper**), in *Optical Astronomy from the Earch and Moon,* ASP Conference Series, Vol. 55, 1994 Diane M. Pyper and Ronald J. Angione(eds), p35 -44.

18) The Spectroscopic Survey Telescope Project
L.W. Ramsey, T.A. Sebring and C. Sneden, in Proceedings of SPIE Conf. 2199, *Advanced Technology Optical Telescopes V*, Kona HI, March, 1994.

19) The Hobby-Eberly telescope medium resolution spectrograph
L.W. Ramsey, **(Invited Paper)** in Proceedings of SPIE Conf. **2476**, *Fiber Optics in Astronomical Applications,* Orlando, FL, April, 1995.p. 20-32.

20) Design and status of the spectroscopic survey telescope
T.A. Sebring, J. Booth, J. Good, V. Krabbendam, F. Ray and L.W. Ramsey, in Proceedings of SPIE Conf**. 2199**, *Advanced Technology Optical Telescopes V*, Kona HI, March, 1994.p. 565-572.

21) The Hobby-Eberly telescope: A progress report
T.A. Sebring and L.W. Ramsey, in Proceedings of SPIE Conf. 2871, *Optical Telescopes of Today and Tomorrow*, Landskrona, Sweden, June, 1996, p. 32-37.

22) The extremely large telescope: A twenty-five meter aperture for the twenty fitrst century
F.N Bash, T.A. Sebring, F. B. Ray and L.W. Ramsey, in Proceedings of SPIE Conf. **2871**, *Optical Telescopes of Today and Tomorrow*, Landskrona, Sweden, June, 1996. p. 576-582.

23) The early performance and present status of the Hobby-Eberly telescope

L.W. Ramsey, M.T. Adams, T.G. Barnes, J.A. Booth, M.E. Cornell, J.R. Fowler, N. Gaffney, J.W. Glaspey, J. Good, P.W. Kelton, V.L. Krabbendam, L. Long, F.B. Ray, R.L. Ricklefs, J. Sage, T.A. Sebring, W.J. Spiesman, M. Steiner in Proceedings of SPIE Conf. 3352, *Advanced Technology Optical Telescopes V*, Kona HI, March, 1998.p. 34-43.

24) The Extremely Large Telescope: Further Adventures in Feasibility
T. A. Sebring, F. N. Bash, F. B. Ray, L. W. Ramsey in Proceedings of SPIE Conf. 3352, *Advanced Technology Optical Telescopes V*, Kona HI, March, 1998.p. 792-801.

25) The Hobby-Eberly Telescope: Commissioning Experience and Observing Plans
J. W. Glaspey, M. T. Adams, J. A. Booth, M. E. Cornell, J. R. Fowler, V. L. Krabbendam, L. W. Ramsey, F. B. Ray, R. L. Ricklefs, and W. J. Spiesman in Proceedings of SPIE Conf. 3349, *Advanced Technology Optical Telescopes V*, Kona HI, March, 1998.p. 50-54.

26) The Hobby-Eberly Telescope medium resolution spectrograph and fiber instrument feed
S. D. Horner, L. G. Engel, and L. W. Ramsey in Proceedings of SPIE Conf**. 3355**, *Optical Astronomical Instrumentation*, Kona HI, March, 1998.p. 399-408.

27) Fiber optic instrumentation and the Hobby Eberly Telescope
L W. Ramsey (**Invited Paper**), in *Fiber Optics in Astronomy III*, ASP Conference Series Vol **152**, eds. S. Arribas, E. Mediavilla and F. Watson, 1998, p 235-246.

28) The Hobby-Eberly teescope fiber instrument feed
S.D Horner, L.G. Engel and L W. Ramsey, in *Fiber Optics in Astronomy III*, ASP Conference Series Vol **152**, eds. S. Arribas, E. Mediavilla and F. Watson, 1998, p 247-252.

29) Galaxy Kinematics with Integral Field Spectroscopy on the Hobby-EberlyTelescope
M.A. Bershady, D. Andersen, L W. Ramsey and S.D. Horner, in *Fiber Optics in Astronomy III*, ASP Conference Series Vol **152**, eds. S. Arribas, E. Mediavilla and F. Watson, 1998, p 253-257.

30) A long-duration flare in the X-ray/EUV selected chromospherically active binary 2RE J0743+224
Montes D., Ramsey L.W., 1998, in ASP Conf. Ser., Solar and Stellar Activity: Similarities and Differences (meeting dedicated to Brendan Byrne, Armagh 2-4th September 1998) C.J. Butler and J.G. Doyle, eds. In press

31) Chromospheric activity of ROSAT discovered weak-lined T Tauri stars
Montes D., Ramsey L.W., 1998, in ASP Conf. Ser., Solar and Stellar Activity: Similarities and Differences (meeting dedicated to Brendan Byrne, Armagh 2-4th September 1998) J. Butler and G. Doyle, eds. In press

32) The Extremely Large Telescope (ELT),A Scientific Opportunity; An Engineering Certainty
Sebring, T.A., Moretto, G., Bash, F.N., Ray, F., Ramsey, L.W., Bakaslog Swedend ELT conference, in press, 1999.

33) Early science results from the Hobby-Eberly telescope
Hill, Gary J.; MacQueen, Phillip J.; Ramsey, Lawrence W.; Robinson, Edward L. Proc. SPIE Vol. 4005, Discoveries and Research Prospects from 8- to 10-Meter-Class Telescopes, ed. J. Bergeron, (April, 2000), p. 240-251

34) Commissioning Experience with the 9.2-m Hobby - Eberly Telescope
Thomas G. Barnes III, Mark T. Adams, John A. Booth, Mark E. Cornell, Niall Gaffney, James R. Fowler, Gary J. Hill, Grant M. Hill, Craig Nance, Francois Piché, Lawrence W. Ramsey, Randall L. Ricklefs, William J. Spiesman, and P. Thomas Worthington, SPIE Vol. 4004, Telescope Structures, Enclosures, Controls, Assembly/Integration/Validation, and Commissioing" ed. T. Sebring, T Andersen, (April, 2000), p. 14-25.

35) Issues in scaling the ELT up to 100 meters
Frank B. Ray, Frank N. Bash, Lawrence W. Ramsey, Thomas Sebring, SPIE Vol. 4004, Telescope Structures, Enclosures,Controls,Assembly/Integration/Validation, and Commissioing" ed. T. Sebring, T Andersen, (April, 2000), p. 405-418.

36) Performance testing of the Hobby-Eberly Telescope primary mirror array
Mark T. Adams, John A. Booth, Grant M. Hill and Larry W. Ramsey SPIE Vol. 4004, Telescope Structures, Enclosures, Controls, Assembly/Integration/Validation, and Commissioing" ed. T. Sebring, T Andersen, (April, 2000), p. 471-480.

37) Hobby-Eberly Telescope operations model
Mark T. Adams, Thomas G. Barnes III, Craig E. Nance, Larry W. Ramsey, SPIE Vol. 4010, Observatory Operations to Optimize Scientific Return II, ed. P. Quinn (April, 2000), p. 16-24.

38) *All Sky Surveys with Exosolar Planet tracker*
J. Ge, J.C. van Eken, S. Mahadevan, C. DeWitt , L. Ramsey in *Future Research Directions and Visions for Astronom,y* SPIE vol. **4835**-27, Waikoloa, HI, August 2002.

39) *Mirror Alignment Recovery System (MARS) on the Hobby-Eberly Telescope*
M. Wolf, P. Palunas, J. Booth, M. Ward, A. Wirth, G. Wesley, D. O'Donoghue, L. Ramsey, in *Large Ground Based Telescopes,* SPIE vol. **4837**-82, Waikoloa, HI, August 2002.

40) *The Hobby-Eberly Telescope Completion Project*
J. Booth, M. Wolf, J. Fowler, M. Adams, J. Good, P. Kelton, E. Barker, P. Palunas, F. Bash, L. Ramsey, G. Hill, P. MacQueen, M. Cornell, E. Robinson, in *Large Ground Based Telescopes,* SPIE vol. **4837**-109, Waikoloa, HI, August 2002.

41) *Performance of the facilty instruments on the Hobb-Eberly telescope*
G. Hill, P. MacQueen, L. Ramsey in *Instrument Design and Performance for Optical/Infrared Ground Based Telescopes,* SPIE vol. **4841**-06, Waikoloa, HI, August 2002.

42) *Medium resolution Spectrograph for the Hobby-Eberly telescope*
L. Ramsey, L. Engel, N. Sessions, C. DeFilippo, M. Graver, J. Mader in *Instrument Design and Performance for Optical/Infrared Ground Based Telescopes,* SPIE vol. **4841**-112, Waikoloa, HI, August 2002.

43) *Fiber-fed spectral calibration with the Hobby-Eberly telescope*
J. R. Tufts, G. Hill, P. MacQueen, L. Ramsey, G. Wesley in *Instrument Design and Performance for Optical/Infrared Ground Based Telescopes,* SPIE vol. **4841**-125, Waikoloa, HI, August 2002.

44) *The Hobby-Eberly Telescope medium resolution spectrograph and fiber instrument feed*
Lawrence W. Ramsey, Leland G. Engel, Nicholas Sessions, Christopher DeFilippo, Michelle Graver, Jeffery Mader Proc. SPIE Vol. 4841, p. 1036-1044, Instrument Design and Performance for Optical/Infrared Ground-based Telescopes; Masanori Iye, Alan F. Moorwood; Eds. Mar 2003

45) *The Hobby-Eberly Telescope Completion Project*
Booth, John A.; Wolf, Marsha J.; Fowler, James R.; Adams, Mark T.; Good, John M.; Kelton, Philip W.; Barker, Edwin S.; Palunas, Povilas; Bash, Frank N.; Ramsey, Lawrence W.; Hill, Gary J.; MacQueen, Phillip J.; Cornell, Mark E.; Robinson, Edward L. *Large Ground-based Telescopes*. Edited by Oschmann, Jacobus M.; Stepp, Larry M. Proceedings of the SPIE, Volume 4837, pp. 919-933 (2003).

46) *The Hobby-Eberly Telescope: performance upgrades, status, and plans*
Booth, John A.; Adams, Mark T.; Barker, Edwin S.; Bash, Frank N.; Fowler, James R.; Good, John M.; Hill, Gary J.; Kelton, Philip W.; Lambert, David L.; MacQueen, Phillip J.; Palunas, Povilas; Ramsey, Lawrence W.; Wesley, Gordon L. Proceedings of the SPIE, Volume 5489, pp. 288-299 (2004).

47) *Performance of the Hobby-Eberly telescope facility instruments*
G.H. Hill, P.J. MacQueen, L.W. Ramsey and M.D. Shetrone on" Proceedings of the SPIE **5492**, 94-104 (2004)

48) *Stellar Astrophysics on the Hobby Eberly Telescope*
L. W. Ramsey in *Stellar Astrophysics with the World's Largest Telescopes: First International Workshop on Stellar Astrophysics with the World's Largest Telescopes*, Proceedings of the conference held 7-10 September, 2004 in Torun, Poland. Edited by Joanna Mikolajewska, and Arkadiusz Olech. AIP Conference Proceedings, Vol. 752. New York: American Institute of Physics, 2005., p.3-12.

49) *Precision radial velocity spectrograph*
Jones, Hugh R. A.; Rayner, John; Ramsey, Larry; Henry, David; Dent, Bill; Montgomery, David; Vick, Andy; Ives, Derek; Egan, Ian; Lunney, David; Rees, Phil; Webster, Adrian; Tinney, Chris; Liu, Mike
Proceedings of the SPIE, Volume 7014, *Ground-based and Airborne Instrumentation for Astronomy II*. Edited by McLean, Ian S.; Casali, Mark M. pp. 70140Y-70140Y-12 (2008).

50) *The image quality of the Southern African Large Telescope*
O'Donoghue, Darragh E.; Atad-Ettedgui, Eli; Balona, Luis; Bigelow, Bruce C.; Booth, John A.; Botha, Lucian; Brink, Janus D.; Buckley, David A. H.; Charles, Phil; Christians, Alrin; Clemens, J. Christopher; Crause, Lisa A.; Crawford, Steven M.; Evans, Geoffrey P.; Gajjar, Hitesh; Hashimoto, Yas; Hendricks, Malcolm; Kniazev, Alexei; Koeslag, Anthony R.; Koorts, Willie P.; Kriel, Herman J.; Loaring, Nicola S.; Love, Jonathan; Marang, Fred; Metcalfe, Douglas; Meyer, Brennan; O'Connor, James; du Plessis, Charl A.; Ramsey, Lawrence W.; Romero-Colmenero, Encarni; Sass, Craig; Scholtz, Johann C.; Sefako, Ramotholo; Siyengo, Sandisa; Still, Martin; Strydom, Ockert J.; Swat, Arkadiusz; Du Toit, Johann F.; Vaisanen, Petri; Wells, Martyn; Worters, Hannah
Proceedings of the SPIE, Volume 7018, *Advanced Optical and Mechanical Technologies in Telescopes and Instrumentation* Edited by Atad-Ettedgui, Eli; Lemke, Dietrich. pp. 701813-701813-15 (2008).

51*) Warm Planets Around Cool Stars: Searches for Habitable Zone Planets Around Late M Dwarfs*
Ramsey, L.; Wolszczan, A.; Bongiorno, S.; Redman, S.; Engel, L.; Barnes, J.; Jones, H. R. A. in *Extreme Solar Systems*, ASP Conference Series, Vol. 398, proceedings of the conference held 25-29 June, 2007, at Santorini Island, Greece. Edited by D. Fischer, F. A. Rasio, S. E. Thorsett, and A. Wolszczan, p.505.

52) *Precision Radial Velocities in the Infrared*
Jones, Hugh R. A.; Rayer, John; Ramsey, Larry; Dent, Bill; Longmore, Andy; Vacca, Bill; Liu, Mike; Webster, Adrian; Wolscznan, Alex; Barnes, John *Science with the VLT in the ELT Era*, Astrophysics and Space Science Proceedings, Volume . ISBN 978-1-4020-9189-6. Springer Netherlands, 2009, p. 415

53) *The Habitable Zone Planet Finder Project: A Proposed High Resolution NIR Spectrograph for the Hobby Eberly Telescope (HET) to Discover Low Mass Exoplanets around M Stars*
Mahadevan, S.; *Ramsey, L.*; Redman, S.; Zonak, S.; Wright, J.; Wolszczan, A.; Endl, M.; Zhao, B. Pathways Towards Habitable Planets, proceedings of a workshop held 14 to 18 September 2009 in Barcelona, Spain. Edited by Vincent Coudé du Foresto, Dawn M. Gelino, and Ignasi Ribas. San Francisco: Astronomical Society of the Pacific, p.272 (2010)

54) *The Pathfinder testbed: exploring techniques for achieving precision radial velocities in the near infrared*
Ramsey, Larry W.; Mahadevan, Suvrath; Redman, Stephen; Bender, Chad; Roy, Arpita; Zonak, Stephanie; Sigurdsson, Steinn; Wolszczan, Alex, Ground-based and Airborne Instrumentation for Astronomy III. Edited by McLean, Ian S.; Ramsay, Suzanne K.; Takami, Hideki. Proceedings of the SPIE, Volume 7735, pp. 773571- 773571-6 (2010).

55) *The habitable zone planet finder: a proposed high-resolution NIR spectrograph for the Hobby Eberly Telescope to discover low-mass exoplanets around M dwarfs*
Mahadevan, Suvrath; *Ramsey, Larry*; Wright, Jason; Endl, Michael; Redman, Stephen; Bender, Chad; Roy, Arpita; Zonak, Stephanie; Troupe, Nathaniel; Engel, Leland; Sigurdsson, Steinn; Wolszczan, Alex; Zhao, Bo, Ground-based and Airborne Instrumentation for Astronomy III. Edited by McLean, Ian S.; Ramsay, Suzanne K.; Takami, Hideki. Proceedings of the SPIE, Volume 7735, pp. 77356X- 77356X-11 (2010).

56) *Visible and Near-Infrared Properties of Optical Fibers Coupled to the Pathfinder High-Resolution NIR Spectrograph*
McCoy, K.; Ramsey, L., Proceedings of the Advanced Maui Optical and Space Surveillance Technologies Conference, held in Wailea, Maui, Hawaii, September 13-16, 2011, Edited by S. Ryan, The Maui Economic Development Board, 2011., p.E69

57) *Laser Frequency Comb Supported Stellar Radial Velocity Determination in the NIR: Initial Results.*
Osterman, Steve; Diddams, S.; Quinlan, F.; Ycas, G.; Mahadevan, S.; Ramsey, L.; Bender, C.; Terrien, R.; Botzer, B.; Redman, S., American Astronomical Society, Extreme Solar Systems meeting #2, #2.05, held in Jackson's Hole WY, Sept 2011

58) Precision RVs In The NIR First On-sky Velocities With A U/ne Lamp And A Laser Frequency Comb
Mahadevan, Suvrath; Ramsey, L.; Redman, S.; Bender, C.; Terrien, R.; Roy, A.; Botzer, B.; Osterman, S.; Diddams, S.; Ycas, G.; Quinlan, F., American Astronomical Society, Extreme Solar Systems meeting #2, #2.06, held in Jackson's Hole WY, Sept 2011