Tonopah Solar Energy, LLC

Crescent Dunes Solar Energy Project

N-86292

PLAN OF DEVELOPMENT

Submitted to:

BLM Tonopah Field Office
1553 South Main Street
Tonopah, NV 89049

Submitted By:

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Rev 1 5/15/09 - POD revised to incorporate comments from BLM

Rev. 2 11/21/09 – POD revised to incorporate comments from Engineering Review (GC Wallace)

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Acronyms and Abbreviations

(A)	amp
AC	alternating current
ACC	air cooled condenser
ACEC	Area of Critical Environmental Concern
ACOE	Army Corps of Engineers
AF	acre-feet
Afy	acre-feet per year
ANSI	American National Standards Institute
ARPA	Archaeological Resource Protection Act
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing Materials
BAPC	Bureau of Air Pollution Control
BCS	beam characterization system
bgs	below ground surface
BLM	Bureau of Land Management
BMPs	best management practices
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CETF	Clean Energy & Technology Fund
cf	cubic feet
CFR	Code of Federal Regulations
CO_2	Carbon Dioxide
CO	Carbon Monoxide
CSP	concentrating solar power
DC	direct current
DCS	Design Control Systems
DESCP	drainage erosion sediment control plan
DHS	Department of Homeland Security
DoD	Department of Defense
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPCRA	Emergency Planning and Community Right-to-Know
ESA	Environmental Site Assessment
ESA	Endangered Species Act

F	Fahrenheit
FEIS	Final Environmental Impact Statement
ft^2	square feet
gal	gallon
GSU	generator step-up transformer
GWh	Giga-Watt hour
HAC	heliostat array controller
HMBP	Hazardous Materials Business Plan
HTF	heat transfer fluid
HCS	heliostat control software
HV	high voltage
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input/Output
KNO_3	potassium nitrate
kV	kilovolt
lb	pound
LIDAR	light detection and ranging
LLC	Limited Liability Company
LORS	Laws, Ordinances, Regulations
LV	low voltage
m^2	square meters
MSDS	Material Safety Data Sheet
MW	megawatt
NAAQS	National Ambient Air Quality Standards
$NaNO_3$	sodium nitrate
NBC	Nevada Building Code
NDEP	Nevada Department of Environmental Protection
NDOW	Nevada Department of Wildlife
NDOT	Nevada Department of Transportation
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NHPA	National Historic Preservation Act
NNHP	Nevada Natural Heritage Program
NOI	Notice of Intent
NO_x	oxides of nitrogen
NPDES	National Pollution Discharge Elimination System
NRS	Nevada Revised Statutes

NV	Nevada
OHV	off-highway vehicle
OSHA	occupational Safety and Health Administration
Pb	Lead
PLC	programmable logic controllers
PM_{10}	Particulate Matter 10 micrometers or less
$PM_{2.5}$	Particulate Matter 2.5 micrometers or less
POI	Point of Interconnection
POD	Plan of Development
PPA	Power Purchase Agreement
PPE	Personal Protective Equipment
PRMP	Proposed Resource Management Plan
psia	absolute pressure per square inch
PSD	Prevention of Significant Deterioration
PUCN	Public Utilities Commission Nevada
RMP	Resource Management Plan
ROW	right-of-way
RPS	Renewable Portfolio Standard
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SCADA	supervisory control and data acquisition
scf	standard cubic feet
SDI	Sustainable Development Investments
sf	square foot
SHPO	State Historic Preservation Office
SO_2	Sulfur Dioxide
SPCC	Spill Prevention, Control and Countermeasures Plan
SPPC	Sierra Pacific Power Corporation
STG	steam turbine generator
SWPPP	Storm Water Pollution Prevention Plan
TES	thermal energy storage
UAT	unit auxiliary transformer
UEPA	Utility Environmental Protection Act (Nevada)
UPS	uninterruptible power supply
US	United States
USC	United States Code
USFWS	United States Fish and Wildlife Service

USRG	United States Renewables Group
UTC	United Technologies Corporation
V	Volt
VDC	volt direct current
VOC	Volatile Organic Compounds
VRM	Visual Resource Management
WMP	Waste Management Plan
%	Percentage
°	Degree

EXECUTIVE SUMMARY

This Plan of Development (POD) is submitted to the Bureau of Land Management (BLM) in support of an application for a Right-of-Way grant allowing a solar energy project to be constructed on land managed by the BLM. The proposed project will be a concentrated solar electric generating facility on a site located in an area northwest of Tonopah, Nevada within a portion of Nye County. The project will be capable of producing approximately 500 gigawatt-hours (GWh) of renewable energy annually, with a nominal net generating capacity of 100 megawatts (MW).

Tonopah Solar Energy's technology is a concentrating solar power (CSP) technology, utilizing a central receiver/tower and equipped with an integrated thermal storage system. The proprietary receiver and storage components are provided through an exclusive license with United Technologies Corporation subsidiary Hamilton Sundstrand Rocketdyne ("UTC" or "Rocketdyne").

Tonopah Solar Energy's technology generates power from sunlight by focusing energy from a field of sun tracking mirrors called heliostats onto a central receiver. Liquid salt, which has the viscosity and appearance similar to water when heated, is circulated through tubes in the receiver, collecting the energy gathered from the sun. The heated salt is then routed to an insulated storage tank where it can be stored with minimal energy losses. When electricity is to be generated, the hot salt is routed to a heat exchanger (or steam generator) and used to produce steam, which generates electricity in a conventional steam turbine cycle. After exiting the steam generator, the salt is sent to the cold salt thermal storage tank and the cycle is repeated. The salt storage technology was demonstrated successfully at the Solar Two facility in Barstow, CA in the late 1990's.

The benefits of this unique technology are as follows. First, salt in the liquid state has highly efficient heat transfer and storage properties. Because the salt is used as the heat transfer medium in the cycle, no natural gas is required for startup or to maintain steam cycle conditions during cloud cover, as with some solar technologies. Second, because the salt stores energy, the stored energy can be extracted upon demand to produce electricity even when there is no sunlight. Third, the storage capability provides flexibility to generate electricity in large quantities for short periods of time or in smaller quantities over longer periods of time, thereby matching the seasonal and varying electricity demands of the state.

The primary objective for the proposed project is to construct, operate and maintain an efficient, economic, reliable, safe and environmentally-sound, solar-powered generating facility. The site selected is located in an area within the state where excellent solar resources exist. In addition to a world-class resource, the Nevada solar market is being driven by the Renewable Portfolio Standard (RPS) adopted by the Nevada legislature. Under the standard, the state's investor-owned utilities must use eligible renewable energy resources to supply a minimum percentage of the total electricity they sell. The RPS requires Nevada's electric utilities to generate or acquire a minimum of 5 percent of electricity sold to retail customers from renewable energy systems in 2003 and 2004, and increases the standard by 2 percent biennially to 15 percent by 2013.

The solar facility will have the following features:

- A large field of heliostats or mirrors to reflect the sun's energy onto a central receiver or tower
- A conventional steam turbine to generate electricity
- Thermal storage tanks to store the hot and cold liquid salt

- A hybrid cooling system (i.e., an air cooled condenser with a wet cooling augmentation system designed to minimize water consumption by use only during times of high electricity demand)
- Associated equipment such as pumps, transformers, heat exchangers, and buildings
- Associated linear facilities including a transmission line and access road.

The project offers the following key benefits:

- The proposed solar facility is expected to generate approximately 500,000 MWh per year and can displace the use of natural gas and associated carbon dioxide (CO_2 – a greenhouse gas) emissions produced by fossil-fueled power plants. The project will assist the State of Nevada in developing renewable sources of energy and displacing older conventional power generation.
- The project will minimize the use of water by utilizing an air cooled condenser with a small wet cooling augmentation system (hybrid cooling system) to enhance energy production and to be used only during times of high demand.
- The project can provide flexibility for state renewable power supplies by being able to generate a large quantity of electricity for a short period of time or a smaller quantity of electricity over a longer period of time without changing the size of the solar array.
- The project is expected to promote economic development by creating approximately 40-45 permanent jobs and up to 400-500 peak construction jobs

1. INTRODUCTION

Tonopah Solar Energy submitted an Application for Transportation and Utility Systems and Facilities on Federal Lands (Standard Form 299) to the BLM to secure a Right-of-Way (ROW) Grant on November 5, 2008 to permit, build, construct, and operate a 100-180 MW solar power generating facility based on concentrating solar power technology (CSP). This technology utilizes heliostats (reflecting mirrors) to redirect sunlight on a receiver erected in the center of a solar field. The solar power facility is proposed to be located on BLM property located in Nye County, NV (hereinafter, the Site).

Commercial operation of the facility is anticipated to commence in the summer of 2013 or earlier, if all required permits and authorizations have been secured. Tonopah Solar Energy anticipates filing an application for a permit to construct a utility facility in compliance with the Nevada Utility Environmental Protection Act (UEPA) with the Nevada Public Utilities Commission in the fall of 2009. Construction of the facility will take approximately 30 months to complete.

This Plan of Development (POD) is submitted by Tonopah Solar Energy, LLC in support of the application for a ROW in accordance with guidelines recently provided by the BLM. (Appendix A, BLM Cross Reference Table, contains the information requested by the BLM for the POD as well as a cross-reference table indicating the location in this document of the information requested by the BLM.) The primary objective of the POD is to supplement the Standard Form 299 by providing the following project-related information:

- Project Description, including the purpose and need for the project, general facility description and design, and permitting requirements;
- Project construction methods;
- Related Facilities and Systems, including transmission facilities;

- Operations and Maintenance; and
- Environmental Considerations, which describes the anticipated impacts and proposed mitigation to various resources.

This revised POD is not intended to be a final and complete document but rather a dynamic document that may be amended to include supplemental information, analysis, or studies as the project progresses. An initial POD was submitted December 5, 2008. The initial POD was revised to reflect comments by BLM and resubmitted May 15, 2009. This version of the POD is revised to reflect comments from an third party engineering review by GC Wallace. Additional supplemental information anticipated to be submitted to the BLM before the environmental review process is completed will include, among other things, more detailed engineering and civil design drawings, project alternatives, facility management plans, and facility decommissioning plans.

2. PURPOSE AND NEED

The project is designed to meet the increasing demand for clean, renewable electrical power. The United States has a greater solar energy resource potential than that of any other industrialized nation. The multiple benefits associated with developing this resource have been recognized by both Federal and state policy-makers. Development of solar resources reduces reliance on foreign sources of fuel, promotes national security, diversifies energy portfolios and contributes to the reduction of greenhouse gas emissions.

The State of Nevada has taken a leadership role in the nation's effort to reduce its reliance on fossil fuels and foreign oil. Nevada enacted a renewable portfolio standard (RPS) as part of its 1997 restructuring legislation. Under the standard, the state's investor-owned utilities must use eligible renewable energy resources to supply a minimum percentage of the total electricity they sell. Nevada's Renewable Portfolio Standard increased July 1, 2009 to 25% of retail sales in 2025. In its most recent Integrated Resource Plan filed with and approved by the Public Utilities Commission of Nevada, NV Energy will spend approximately $2 billion to purchase and invest in new renewable energy by 2015. SolarReserve's construction and operation of the project will contribute to achieving Nevada's RPS goals as well as providing jobs in the local economy.

In addition to its environmental attributes, the project will contribute much needed on-peak power to the electrical grid that serves the western United States. The demand for power continues to grow in these states. The thermal storage capability of this technology allows renewable electricity to be produced even when the peak demand period extends into the late evening hours. As older technology fossil-fuel plants reach the end of their useful lives there is a benefit in replacing them with clean, reliable energy sources. The project responds to this need.

The project is proposed on lands administered by the BLM for several reasons. According to the National Renewable Energy Laboratory United States Solar Atlas, the project area maintains high insolation levels on a year-round basis, creating ideal conditions for solar energy generation. While many undeveloped parcels of land exist in Nevada, it can be difficult to acquire parcels from private parties and assemble the acreage needed for a concentrating solar power plant. If enough private land were acquired, permitting issues at a local level within a jurisdiction with no policy on solar development can be difficult. The BLM's general solar policy is to facilitate environmentally responsible commercial development of solar energy projects on public lands and to use solar energy systems on BLM facilities where feasible (BLM

Instruction Memorandum No. 2007-097). Given the BLM's solar policy and the advantage of the BLM controlling large acres of land in the southwestern U.S., the applicant is proposing this project on BLM administered land as opposed to private lands.

3. APPLICANT FINANCIAL AND TECHNICAL CAPABILITY

SolarReserve, doing business as "Tonopah Solar Energy, LLC", is a Santa Monica, California based energy company formed by US Renewables Group, a private equity firm focused exclusively on renewable energy. SolarReserve now holds the exclusive worldwide license to build solar plants that use equipment manufactured by United Technology Corporation's subsidiary, Hamilton Sundstrand, through its Rocketdyne division. More than $100 million has been invested to date by Rocketdyne, the US Department of Energy and others in the design and manufacture of these components. Hamilton Sundstrand brings a broad base of experience in building the most reliable power systems in the world and supports a multitude of other programs to support the further development and implementation of the technology.

US Renewables Group (USRG) is one of the largest private equity firms focused exclusively on investing in renewable power, biofuels and clean technology infrastructure. USRG was founded in 2003 and has mobilized $575 million of capital commitments and has made 17 diversified investments across two funds. USRG has offices in Los Angeles and New York.

The SolarReserve team, both solely and in cooperation with other energy firms, is developing a portfolio of opportunities to deploy solar energy plants in the United States, Europe, Africa, the Middle East, Latin America and Australia. The SolarReserve management team has successfully developed more than $7 billion in electricity generation projects at previous companies. This includes solar and wind energy projects as well as natural gas, cogeneration, and biomass-fired electricity generating facilities located in the United States and more than a dozen countries around the world.

SolarReserve recently closed a second round of funding totaling $140 million. The additional funds will enable the company to advance its development of utility scale power plants in locations across the globe. The financing was led by the renewable energy private equity group within Citi Alternative Investments, Sustainable Development Investments (SDI), and Good Energies, one of the largest private investors in the solar industry. Other investors include US Renewables Group, the founding investor in SolarReserve, along with PCG Clean Energy & Technology Fund (CETF), Nimes Capital, LLC and Credit Suisse.

The estimated cost of the project, including the transmission line and substation upgrades, is between $700 million and $800 million dollars and is generally broken down into the following cost areas:

- 30% Receiver, Tower, Salt Tanks & Heliostats
- 18% Steam Turbine Generator and Steam Generation
- 6% Cooling System and Water Treatment
- 7% Miscellaneous Process Equipment
- 9% Electrical and Instrumentation

- 2% Civil and Site Work
- 10% Structural
- 2% Buildings
- 11% Piping & Instrumentation
- 5% Mechanical Utilities.

Tonopah Solar Energy has already invested substantial resources for this project, including filing of an interconnection request and engaging qualified engineering and environmental consultants to support development efforts.

The project will be financed through a combination of private equity and debt financing. SolarReserve will also seek to be eligible for the American Recovery and Reinvestment Act and government Loan Guarantee programs. Project financing arrangements will be formalized upon receipt of final permits and a Power Purchase Agreement (PPA) approved by the Public Utilities Commission of Nevada.

Additional contributors to this POD are as follows:

• WorleyParsons —WorleyParsons has provided engineering support to a broad portfolio of clients in the utility-scale solar energy field, including utilities, major IPPs, and recently formed ventures. WorleyParsons' staff has extensive experience with all four types of concentrating solar technologies. Solar power staff has been involved in the design, construction, and operation of nineteen concentrating solar power facilities including the nine SEGS plants in Southern California, six dish/Stirling solar power systems, Solar I and II power tower systems and two compact linear reflecting Fresnel systems. Worley Parsons is currently completing solar plant engineering for FPL Energy and other project developers. Their world-class conventional power engineers have the capability to design and build the power block of solar power facilities rapidly and at a minimum cost. They also have experience with flat-plate and concentrating photovoltaic systems. Worley Parsons capabilities include solar resource assessment and site selection, plant design point and annual performance simulation, plant design and cost estimating, construction management, acceptance testing, and plant O&M. WorleyParsons will provide engineering services throughout the project's life from concept selection, plant configuration tailored to match utility load, preliminary engineering and detailed design. WorleyParsons commenced operations over 25 years ago and now employs 32,200 personnel in 118 office locations in over 38 countries and has an established track record of successfully executing major projects for its customers.

4. PROJECT DESCRIPTION

The proposed solar power project is based on concentrating solar power (CSP) technology. The proposed CSP technology utilizes heliostats/reflecting mirrors to redirect sunlight on a receiver erected in the center of the solar field (the power tower or central receiver). A heat transfer fluid (HTF) is heated as it passes through the receiver and then circulated through a series of heat exchangers to generate high-pressure superheated steam. The steam is then used to power a conventional Rankine cycle steam turbine/generator, which produces electricity. The exhaust steam from the turbine is condensed and returned via feedwater pumps to the heat exchangers where the high-pressure superheated steam is generated again.

Both the central receiver and type of heat transfer fluid used in the cycle distinguish Tonopah Solar Energy technology from other concentrating solar power technologies. With the Tonopah Solar Energy technology, salt, which is melted to a liquid form, is circulated through the tubes in the central receiver, collecting the energy gathered from the sun. The heated salt is then routed to an insulated storage tank (hot thermal storage tank) where the energy can be stored with minimal energy losses. When electricity is to be generated, the hot salt is routed to the heat exchanger (or steam generator) and used to produce steam at high temperature. The steam is then used to power a conventional steam turbine, generating electricity. After exiting the steam generator, the salt is sent to a "cold" salt thermal storage tank and the cycle is repeated.

The salt is a combination of sodium and potassium nitrate, with a melting temperature of approximately 460°F. In the liquid state, the salt has the viscosity and appearance similar to water. Salt is a heat storage medium that retains thermal energy very effectively over time. Once the salt is melted to a liquid form during construction, it will remain heated and in a liquid state throughout the plant's operating life, being reused again and again in the cycle. The salt utilized is a technical grade salt similar to commercial fertilizer.

A primary advantage of the central receiver technology using salt is that the heat transfer medium can be heated to temperatures over 1000°F. Steam can be generated at utility-standard temperatures, allowing the use of highly efficient steam turbine cycles.

Table 1
Solar Technology Comparison

Technology	Thermal Storage Capability – electricity production w/o sun	Steam Temp > 1000°F for greater efficiency	Disruption of power due to clouds/other
Tonopah Solar Energy	Yes	Yes	No
Photovoltaic	No	N/A	Yes
Trough	No *	No	Yes *

*Unless the plant is equipped with additional heat exchangers and a molten salt system

While Tonopah Solar Energy's technology is among the most efficient of solar technologies, one characteristic of the technology is a tall, central tower. The tall tower, described in further detail below, ensures that the large array of heliostats can focus the solar energy onto the receiver mounted on top of the tower.

Tonopah Solar Energy, in conjunction with Rocketdyne, has optimized the size of the solar array or heliostat field and tower height to achieve a technology which can operate at commercial scale and produce renewable energy at a competitive price. Thus, the tower height and size of the solar field are characteristics of the technology and will not vary based on plant output.

Additional information on the tower height and size of the solar array are provided below.

4.1 Project Location

The proposed project Site and generator transmission tie line (gen-tie line) are ~~is~~ located in south-central Nevada in Nye County. Located on lands administered by the Bureau of Land Management (BLM), the project encompasses approximately 2,950 acres (**Figure 1, Vicinity Map**) as located in the following lands when described by aliquot parts:

Solar Energy Project Site:

1. In Township 4N, Range 41E:
    a. The west half of sections 12 and 13
    b. Section 11 and 14
    c. The northwest, northeast and southeast quarter of section 15
    d. The southwest, northeast and southeast quarter of section 10
    e. The south half of the northwest quarter of section 10
    f. The east half of the southwest quarter of section 15

Gen-Tine and Substation:

1. In Township 4N, Range 41E:
    a. The east half of section 9
    b. The northwest, southwest, and southeast quarter of section 4
2. In Township 5N, Range 41E
    a. The northwest, southwest, and northeast quarter of section 33
    b. The east half of section 28
    c. Section 22
    d. The southeast quarter of section 15
    e. The west half of section 14
    f. The southwest, southeast, and northeast quarter of section 11
    g. The east half of section 2
    h. The northwest quarter or section 27

Potential Borrow/Gravel Pit:

1. In township 5N, Range 41E:
    a. The northeast quarter of section 19
    b. The west half of the northwest quarter of section 20
    c. The south half of the southeast quarter of section 18

The areas for the generator-tie line, substation, and Site are shown in more detail in Figures 1A and 1B, which show the area in aliquot parts as well as the proposed final right of way boundary. The final right of way boundary is proposed to be finalized and reduced later during detailed design, when the actual lands required are determined and final surveys are performed for a ROW grant.

The solar field, administration building areas, evaporation pond areas, generator transmission tie line, substation and other ancillary facilities will be located within the approximate 2,950 acres identified above and indicated on **Figures 1A and 1B as the "Proposed Final Right of Way Boundary**". However, temporary and permanent construction impacts will not affect this entire area. The estimated area of permanent disturbance and temporary disturbance within the Proposed Final Right of Way Boundary is approximately 1,527 acres (permanent) and 52 acres (temporary) as shown in **Figure 22, Disturbance Areas**. These areas comprise a portion of the Proposed Final Right of Way Boundary.

N
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Miles

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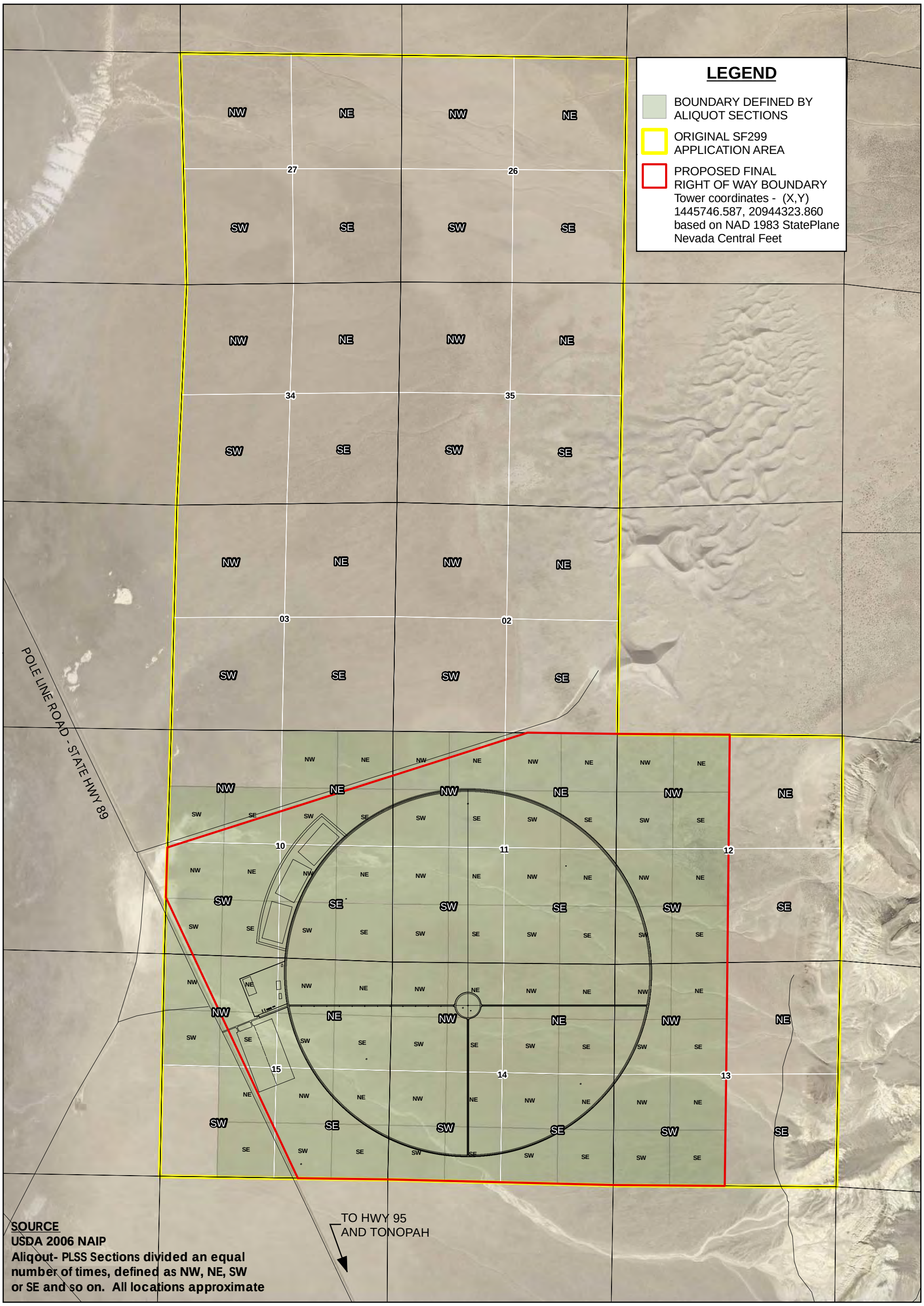
TONOPAH SOLAR ENERGY, LLC
BLM CASE NO. N86292

WorleyParsons
resources & energy

CRESCENT DUNES
NYE COUNTY, NV
VICINITY MAP

SWL	BA	11/2009
52006718		**1**



N
W E
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0 2,100
Feet

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BLM CASE NO. N86292

WorleyParsons
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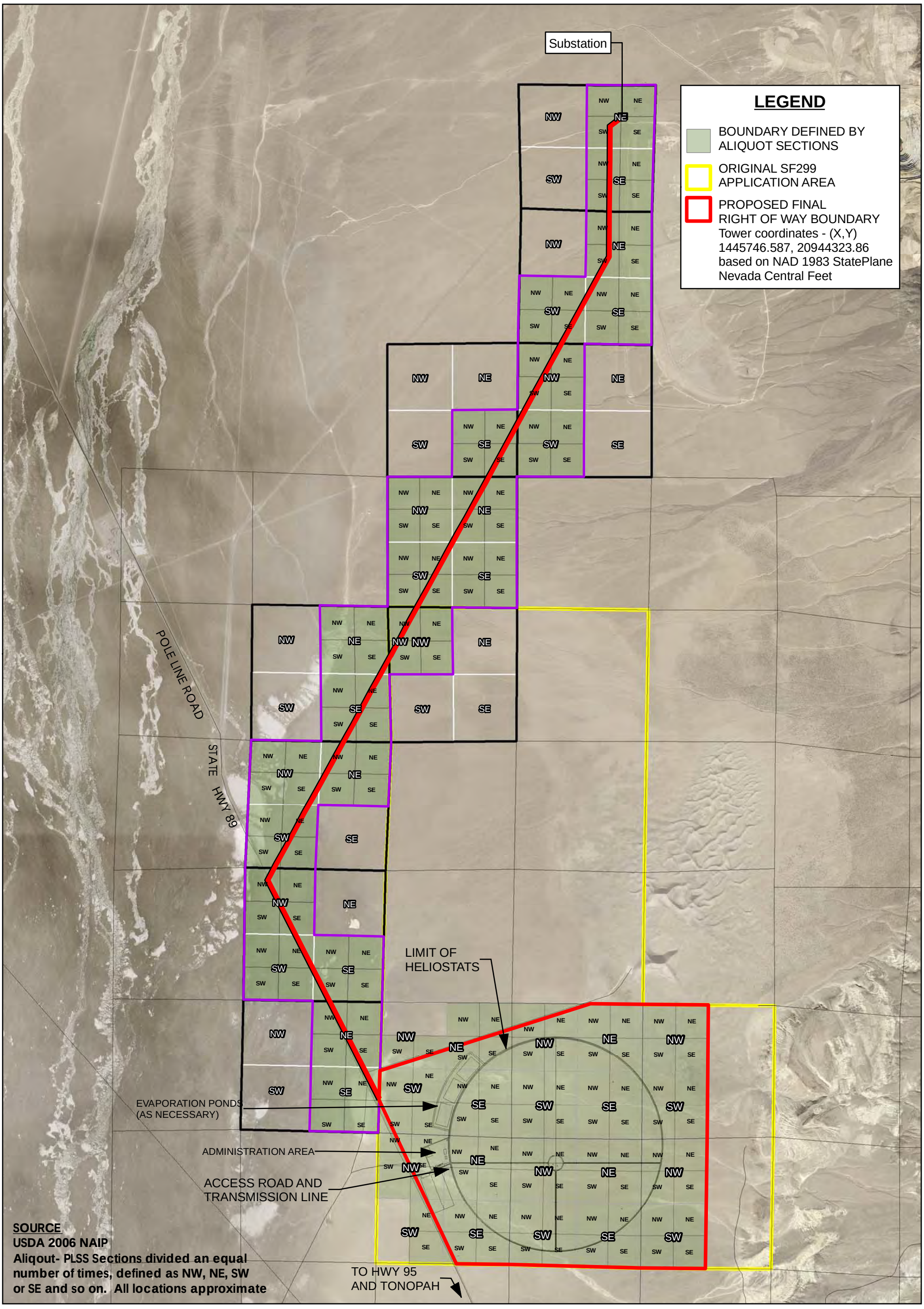
SWL	BA	11/12/09

Site Boundary by Aliquot Sections

52006718

Figure 1A



N
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Feet

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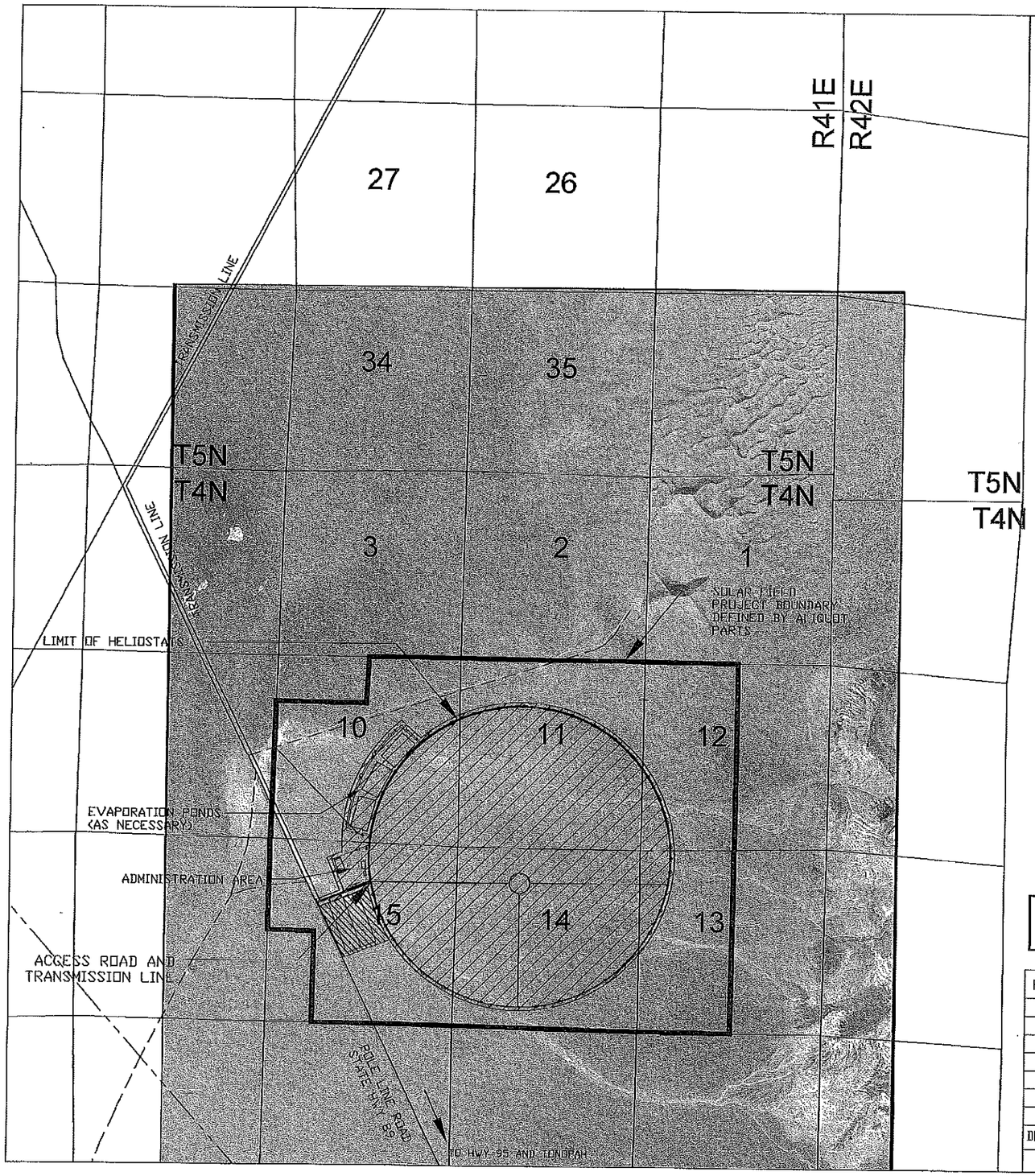
SWL	BA	11/2009

Boundaries Including Transmission Aliquot Sections

52006718

Figure 1B



BOUNDARY DEFINED BY ALIQUOT PARTS	3085± ACRES	
PERMANENT DISTURBANCE	1527± ACRES	
TEMPORARY DISTURBANCE	52± ACRES	

PROFESSIONAL ENGINEER-STATE OF NEVADA
DAVID H. AKOLA
Exp: 12-31-2010
CIVIL
No. 7072
11/23/09

N

SCALE: 1"-1500'-0"

1500 0 1500 3000 4500

PRELIMINARY
NOT FOR CONSTRUCTION

FIGURE 22

REVISION #	BY	DATE	DESCRIPTION
A	DA	11-18-09	FOR POD UPDATE

DRAWN BY: D. AKOLA

PROJECT MANAGER: BOB ANDERS

DISTURBANCE AREAS

TONOPAH SOLAR ENERGY, LLC
CRESCENT DUNES SOLAR SITE
NYE COUNTY, NV

WorleyParsons
resources & energy

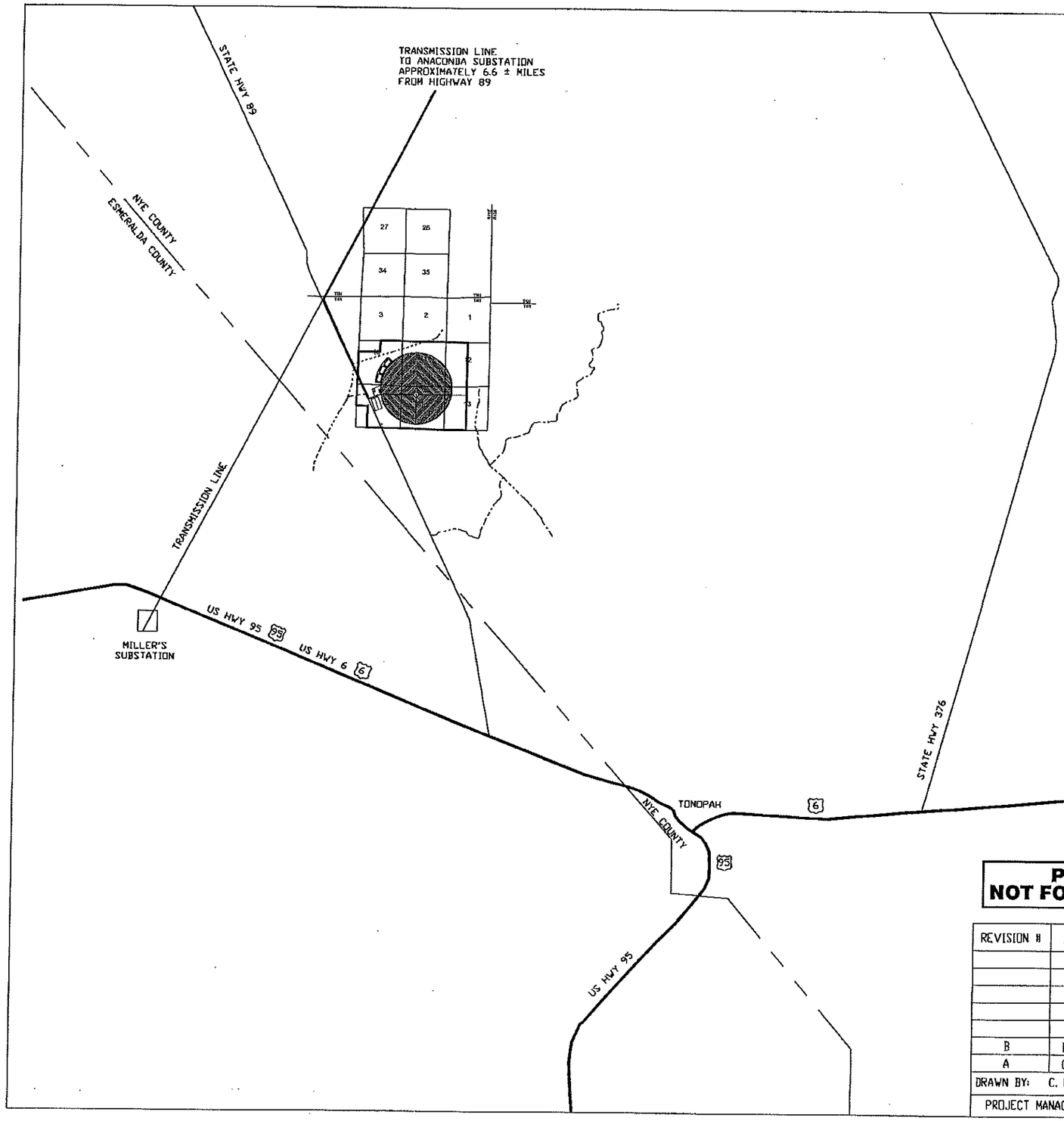
As illustrated on **Figure 2, Local Vicinity Map**, the nearest community to the Site is the town of Tonopah, NV, which is located to the southeast approximately 13 miles (from the Site, 8.5 miles south along Pole Line Road to Highway 95/6, and then 4.5 miles east along Highway 95/6 to Tonopah). The land necessary for construction of the proposed solar power plant, including the heliostat array, power block, and associated facilities consists of approximately 1,530 acres located within the land boundaries described above and shown on **Figure 3, Project Site Plan**. The proposed boundaries as filed in the SF-299 application are currently in excess of the minimum needed to site the physical equipment. Because the project is at the preliminary project design stage, the additional land will allow the applicant the flexibility to adjust the location of the central tower based on the results of soils/geotechnical, cultural, and biological baseline studies and then determine an adequate buffer between plant facilities and any adjacent uses before finalizing the equipment location within the Right-of-Way (ROW) and finalizing the plant boundaries.

Tonopah Solar Energy performed preliminary screening on additional BLM land near Anaconda substation. Tonopah Solar Energy's technology has specific siting requirements including a large open space of approximately four square miles, minimal slope, transmission access, water availability, road access, and high solar incidence. Tonopah Solar Energy is also limited to sites not already claimed by other developers.

The site selection process for the proposed project involved screening sites based on the following parameters:

- Siting area with minimum area of four square miles and contiguous in configuration
- Solar resource
- Distance from transmission lines and substations
- Land ownership
- Water data
- Topography
- Wind data
- Airport locations
- Highways/roads
- Faults
- Population centers
- Military bases
- BLM SF-299 applications pending
- Various environmental constraints

Based on the above criteria and BLM land available, the proposed Site was identified as a preferred siting location in Nye County. The Site is situated on a relatively flat piece of BLM land covering approximately 2,950 acres. The annual average direct normal solar resource for this site averages 7.4 $Wh/m^2/day$. NV Energy's Anaconda substation is located to the northeast of the Site. Additionally, the Site does not appear to be located in Areas of Critical Environmental Concern (ACECs) or areas of potential impact to military operations based on the DOD online screening tool. Other regional sites had the requisite minimum four square miles of contiguous BLM lands but were further away from transmission substations of interest compared to the proposed Site. The selected Site affords fewer impacts to BLM land as a result.



NOTES:

1. THE PROJECT BOUNDARY INCLUDES SECTIONS 11 AND 14 OF TOWNSHIP 4N, RANGE 41E, AND PORTIONS OF SECTIONS 10, 12, 13, AND 15 OF TOWNSHIP 4N, RANGE 41E.
2. THE FINAL LOCATION OF THE SOLAR FIELD WILL BE LOCATED WITHIN THE PROJECT BOUNDARY AND LOCATED TO MINIMIZE DISTURBANCE OF SENSATIVE RESOURCES.

PROFESSIONAL ENGINEER-STATE OF NEVADA
DAVID H. AKOLA
Exp: 12-31-2010
CIVIL
No. 7072
11/23/09

N

SCALE: 1"=6000'-0"
6000 0 6000 12000 18000

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FIGURE 2

REVISION #	BY	DATE	DESCRIPTION
B	DA	11-18-09	FOR POD UPDATE
A	CM	4-21-09	FOR POD

DRAWN BY: C. MAHER CAD FILE:

PROJECT MANAGER: BOB ANDERS

LOCAL VICINITY MAP

TONOPAH SOLAR ENERGY, LLC
CRESCENT DUNES SOLAR SITE
NYE COUNTY, NV

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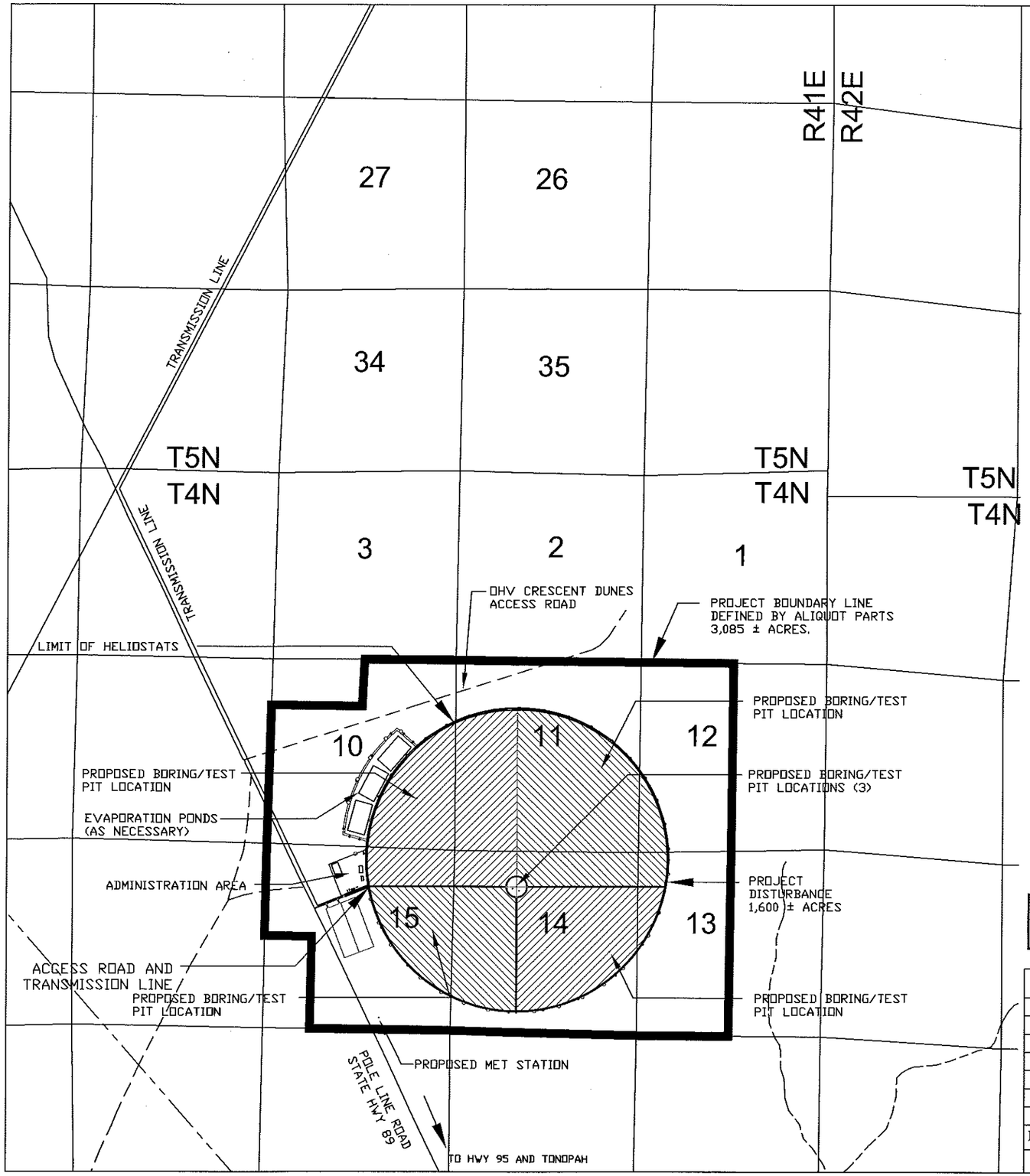

NOTES:

1. THE LOCATION OF THE SOLAR FIELD WILL BE LOCATED WITHIN THE PROJECT BOUNDARY NEAR WHERE IT IS SHOWN TO MINIMIZE DISTURBANCE OF SENSATIVE RESOURCES.

PROFESSIONAL ENGINEER-STATE OF NEVADA
DAVID H. AKOLA
Exp: 12-31-2010
CIVIL
No. 7072
11/23/09

N

SCALE: 1"=1500'-0"
1500 0 1500 3000 4500

PRELIMINARY NOT FOR CONSTRUCTION

FIGURE 3

REVISION #	BY	DATE	DESCRIPTION
B	DA	11-18-09	FOR POD UPDATE
A	CM	4-29-09	FOR POD

DRAWN BY: C. MAHER

PROJECT MANAGER: BOB ANDERS

PROJECT SITE PLAN

TONOPAH SOLAR ENERGY, LLC
CRESCENT DUNES SOLAR SITE
NYE COUNTY, NV

WorleyParsons
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4.2 Generating Facility Description

The overall site layout for the proposed facility is shown **on Figure 3, Project Site Plan and** includes the following components:

- The solar array, a circular field with a radius of approximately 4,300 feet where the heliostats are located.
- The power block, a circle with a radius of about 400 feet which houses the central receiver tower, storage tanks, steam turbine, air cooled condenser, transformers, heat exchangers, power block buildings, and other ancillary equipment.
- An administration building, warehouse, and evaporation ponds, which will be located along the outside perimeter of the solar array.
- Associated linear facilities including transmission and access road. The project will interconnect to the Anaconda substation located approximately six miles due north of the generating facility location. The Site is closely located to the transmission network into which the project will supply electrical power. The outgoing transmission line will follow the site access road to Pole Line Road, head north along Pole Line Road to where the Millers to Anaconda transmission line is located, and then parallel the Millers to Anaconda transmission line to the Anaconda Substation, where it will interconnect with the electricity grid (the Point of Interconnection-see Figures 7 and 23).

The Master Title Plat for the proposed facility is shown on **Figure 4, Master Title Plat**.

4.2.1 Solar Field

A solar power tower/central receiver system generates electric power from sunlight by focusing concentrated solar radiation on a tower-mounted receiver. The system uses thousands of sun-tracking mirrors called heliostats, which are arranged concentrically around the central receiver tower and reflect the incident sunlight onto the receiver.

The proposed facility will consist of up to approximately 17,500 heliostats occupying approximately 1,400 acres. Each heliostat will be approximately 670 square feet in size, yielding a total reflecting surface of about 12,000,000 ft2 (1,100,000 m2). The size and shape of the heliostats are shown in **Figure 21, Heliostat Front View and Figure 21A, Heliostat Back View**.

The arrangement of the heliostats within the array is optimized to maximize the amount of solar energy that can be collected by the field and arranged to avoid interference among heliostats as they track the sun during the day. The heliostats will be arranged in arcs around the solar receiver asymmetrically, as described below.

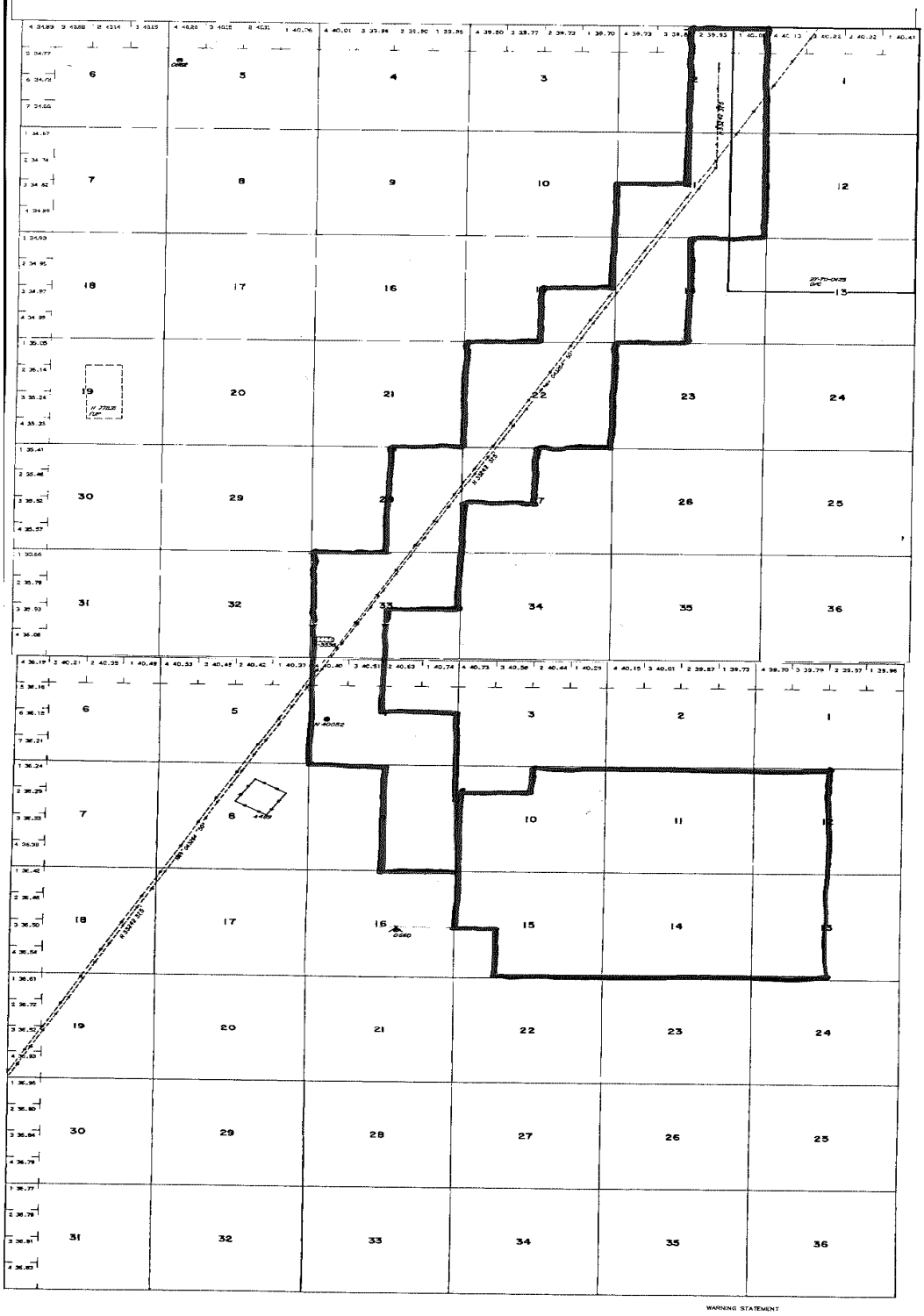
- The first row or line of heliostats has a radius of approximately 420 feet.
- The longest arc/line of heliostats, with a radius of approximately 5,100 feet, is in the northern section of the heliostat array. This is due to the greater collection efficiency of heliostats located north of the receiver tower for sites in the northern hemisphere of the world. With the sun predominantly in the southern sky, the cosine effect of incidence and reflection angles are less in the northern heliostats than in the southern ones. The converse – lower collection efficiency in the southern section – is also

TOWNSHIP 4&5 NORTH RANGE 41 EAST OF THE MOUNT DIABLO MERIDIAN, NEVADA

NYE COUNTY
BATTLE MTN GR DIST

STATUS OF PUBLIC DOMAIN
LAND AND MINERAL TITLES

MT PLAT



INDEX TO SEGREGATED TRACTS

RESURVEY			ORIGINAL SURVEY	
TRACT NO	T	R	SEC	SUBDIVISION

FOR ORDERS EFFECTING DISPOSAL OR USE OF UNIDENTIFIED LANDS WITHDRAWN FOR CLASSIFICATION MINERALS, WATER AND/OR OTHER PUBLIC PURPOSES REFER TO INDEX OF MISCELLANEOUS DOCUMENTS.

CURRENT TO	BY
11/28/09	MS

INDEX TO SEGREGATED TRACTS

RESURVEY			ORIGINAL SURVEY	
TRACT NO	T	R	SEC	SUBDIVISION

FOR ORDERS EFFECTING DISPOSAL OR USE OF UNIDENTIFIED LANDS WITHDRAWN FOR CLASSIFICATION, MINERALS, WATER AND/OR OTHER PUBLIC PURPOSES, REFER TO INDEX OF MISCELLANEOUS DOCUMENTS.

CURRENT TO	BY

WARNING STATEMENT

Tonopah Solar Energy, LLC
N-86292

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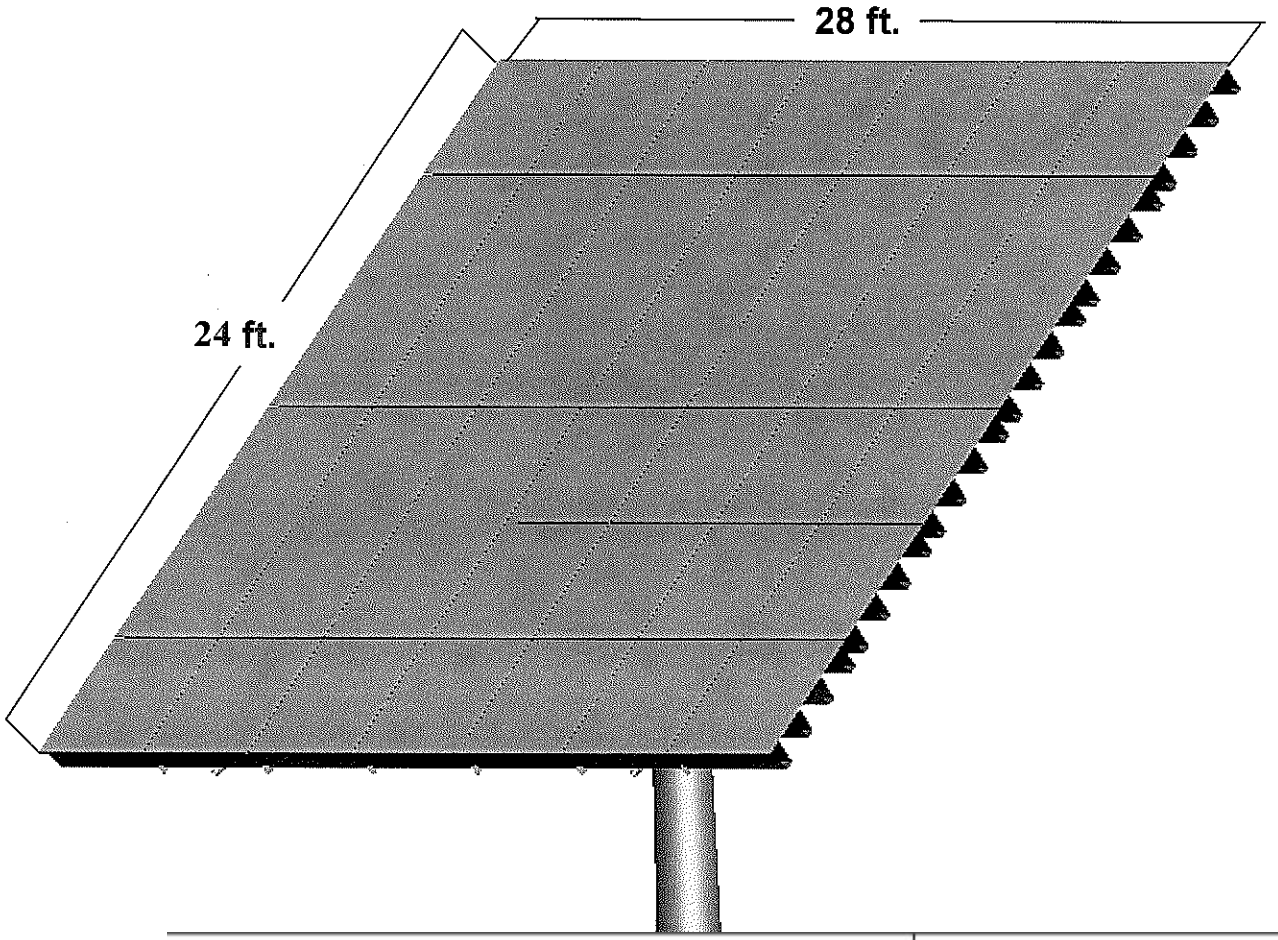
Master Title Plat

11/2009

52006718

Figure 4

62m^2 Heliostat – "Pathfinder 2"



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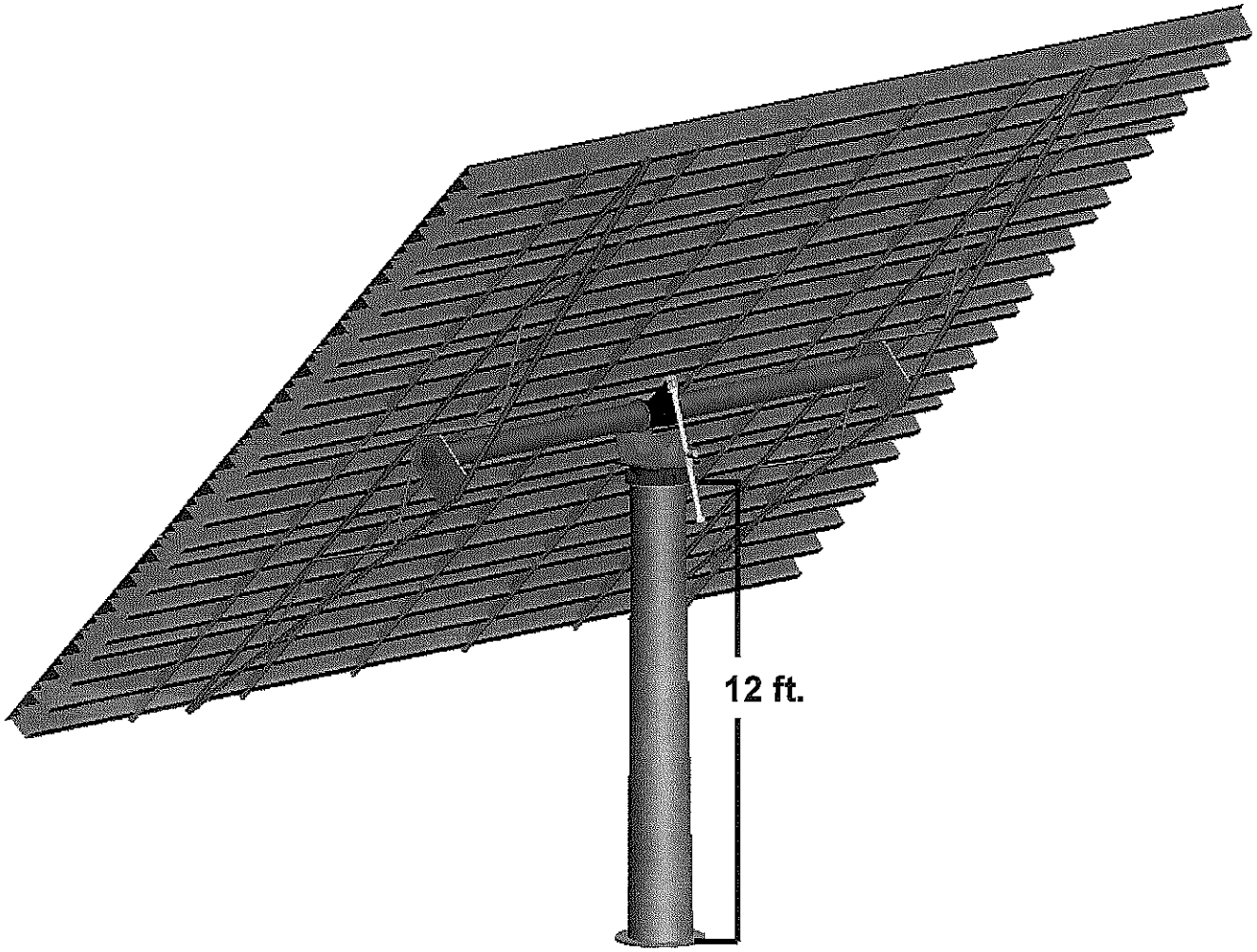
11/2009

Heliostat Front View

Figure 21

62m^2 Heliostat – "Pathfinder 2"



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Heliostat Back View

11/2009

Figure 21A

true; therefore, the maximum southern arc radius is the shortest, 3,580 feet, and the southern heliostat field is the smallest.

- The eastern sector of the heliostat is more valuable than the western sector for energy collection because afternoon energy collection, during on-peak utility hours, is more valuable than morning energy collection, during part-peak or off-peak hours. The maximum eastern row arc radius may therefore be greater than the maximum western row arc radius.

4.2.2 Central Receiver/Tower

The tower is a concrete structure, approximately 538 feet high, which supports a cylindrical receiver, approximately 95 feet tall, mounted on the top of the tower. The receiver is composed of tube panels through which the liquid salt or HTF flows. Therefore, the top of the receiver will be at a height of approximately 633 feet. A maintenance crane will also be mounted on top of the receiver, which is expected to be 20 feet tall. Structures in excess of 200 feet require a filing with the FAA to obtain a determination of no hazard prior to construction. Application has been made and is currently underway.

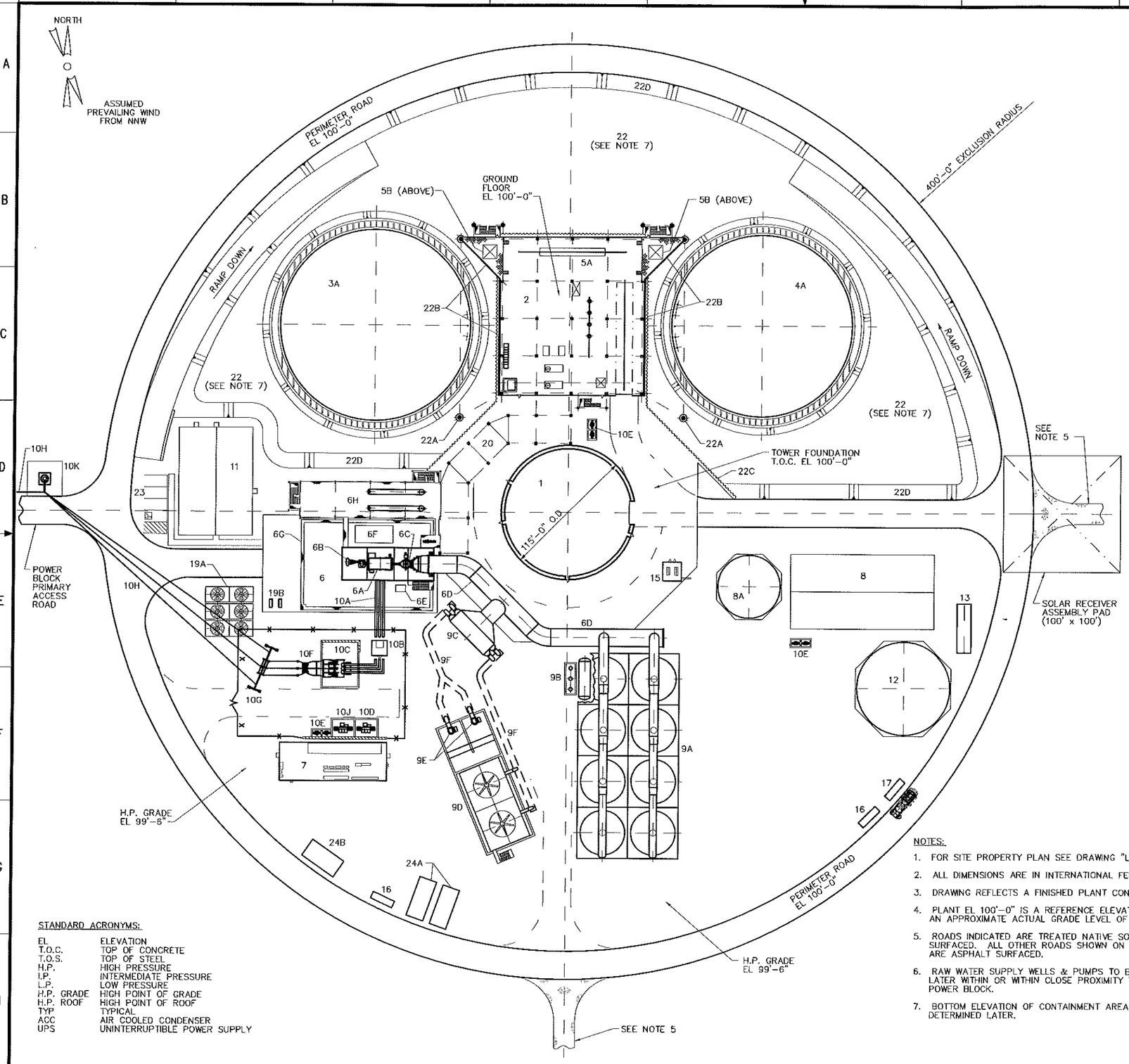
4.2.3 Power Block

The power block will include a steam turbine generator, multiple feedwater heaters, steam superheaters, lubricating oil system, hydraulic control system, valving, and feedwater pumps. Steam is generated at a temperature and pressure of 1,030°F and 1685 psia before entering the high-pressure section of the turbine. Steam exiting the high-pressure section of the turbine is reheated to increase its temperature before entering the immediate-pressure section of the turbine. Exhaust steam from the turbine is directed to the cooling system. The turbine drives a generator, which delivers electrical power via a main step-up transformer in the on-site substation to the utility grid. Extraction steam from the steam turbine is used to preheat the feedwater and for deaerating the feedwater.

This high-efficiency turbine is designed for reliable operation under conditions of daily start up and shutdown over the life of the plant. The solar field and power generation equipment may be started each morning after sunrise and insolation build-up. The solar field will shut down in the evening as the sun sets though the integral thermal energy storage system will allow the steam turbine to continue operating if there is demand for electricity.

The primary components of the power block include (See **Figure 5, Power Block Layout**):

- Solar Steam Generator System – The steam generator is the core of the steam supply system for the power block. The steam generator system includes a pre-heater, evaporator, superheater, reheater, and steam drum. High pressure feedwater enters the steam generator from the preheaters and leaves as saturated steam that subsequently flows to the superheaters.
- Solar Preheater – The solar preheaters are of a shell and tube design. High pressure feedwater enters the preheaters from the low pressure feedwater heaters and leaves as high pressure feedwater.
- Evaporator – The evaporator receives heated, high pressure water from the preheater and evaporates the water into saturated steam. The evaporator is of a shell and tube design.



LEGEND

1 SOLAR RECEIVER TOWER

2 STEAM GENERATION BUILDING

3 HOT SALT STORAGE TANK AREA
- 3A HOT SALT STORAGE TANK

4 COLD SALT STORAGE TANK AREA
- 4A COLD SALT STORAGE TANK

5 PUMP SUPPORT & MAINTENANCE AREA
- 5A PUMP MAINTENANCE AREA
- 5B PUMP REMOVAL HATCH

6 STEAM TURBINE/GENERATOR AREA
- 6A GENERATOR
- 6B H.P. TURBINE
- 6C I.P./L.P. TURBINE
- 6D TURBINE EXHAUST DUCT
- 6E HYDRAULIC OIL UNIT
- 6F LUBE OIL UNIT
- 6G FLOOR TRENCH
- 6H HEATER BAY
- 6J BOILER FEEDWATER PUMPS (NOT SHOWN)
- 6K DEAERATOR (NOT SHOWN)

7 ELECTRICAL BUILDING/PDC

8 WATER TREATMENT AREA/BUILDING
- 8A DEMINERALIZED WATER TANK
- 8B DEMINERALIZED WATER PUMPS (NOT SHOWN)
- 8C SERVICE WAER PUMPS (NOT SHOWN)

9 HYBRID CONDENSING SYSTEM AREA
- 9A AIR COOLED CONDENSER
- 9B CONDENSATE DRAIN TANK & PUMPS (UNDER ACC)
- 9C WATER COOLED CONDENSER
- 9D MECHANICAL DRAFT COOLING TOWER
- 9E CIRCULATING WATER PUMPS
- 9F CIRCULATING WATER PIPES (BURIED)

10 ELECTRICAL TRANSMISSION AREA
- 10A SEGREGATED PHASE BUS DUCT
- 10B GENERATOR CIRCUIT BREAKER SWITCHGEAR
- 10C GENERATOR STEP-UP TRANSFORMER
- 10D UNIT AUXILIARY TRANSFORMER
- 10E STATION SERVICE TRANSFORMER
- 10F STEP-UP CIRCUIT BREAKER
- 10G TRANSMISSION TOWER
- 10H OVERHEAD POWER LINES
- 10J BACKFEED UTILITY TRANSFORMER
- 10K TUBULAR STEEL POLE

11 CONTROL & OPERATIONS BUILDING

12 SERVICE/FIRE WATER STORAGE TANK

13 FIRE WATER PUMP HOUSE

14 NOT USED

15 FIRE WATER BOOSTER PUMPS

16 ABOVE GROUND DIESEL FUEL STORAGE TANK

17 HELIOSTAT WASH TRUCK FILL AREA

18 OIL/WATER SEPARATOR – LATER

19 AUXILIARY COOLING SYSTEM
- 19A FIN FAN COOLER
- 19B CLOSED COOLING WATER PUMPS

20 HIGH ENERGY PIPE BRIDGE

21 NOT USED

22 MOLTEN SALT CONTAINMENT AREA
- 22A CAISSON FOUNDATION
- 22B DIVERSION WALL
- 22C RETAINING WALL
- 22D 2:1 SLOPED SOIL

23 DESIGNATED PARKING AREA

24 HELIOSTAT UPS AREA
- 24A EMERGENCY GENERATOR
- 24B HELIOSTAT DISTRIBUTION SWITCHGEAR

25 RAW WATER SUPPLY WELLS & PUMPS (SEE NOTE 6)

REFERENCES:

1. LATER

PROFESSIONAL ENGINEER-STATE OF NEVADA
DAVID H. AKOLA
Exp: 12-31-2010
CIVIL
No. 7072
11/23/09

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NOTES:

1. FOR SITE PROPERTY PLAN SEE DRAWING "LATER".
2. ALL DIMENSIONS ARE IN INTERNATIONAL FEET.
3. DRAWING REFLECTS A FINISHED PLANT CONDITION.
4. PLANT EL 100'-0" IS A REFERENCE ELEVATION EQUAL TO AN APPROXIMATE ACTUAL GRADE LEVEL OF EL "LATER".
5. ROADS INDICATED ARE TREATED NATIVE SOIL OR GRAVEL SURFACED. ALL OTHER ROADS SHOWN ON THIS PLAN ARE ASPHALT SURFACED.
6. RAW WATER SUPPLY WELLS & PUMPS TO BE LOCATED LATER WITHIN OR WITHIN CLOSE PROXIMITY TO THE POWER BLOCK.
7. BOTTOM ELEVATION OF CONTAINMENT AREA TO BE DETERMINED LATER.

STANDARD ACRONYMS:

EL	ELEVATION
T.O.C.	TOP OF CONCRETE
T.O.S.	TOP OF STEEL
H.P.	HIGH PRESSURE
I.P.	INTERMEDIATE PRESSURE
L.P.	LOW PRESSURE
H.P. GRADE	HIGH POINT OF GRADE
H.P. ROOF	HIGH POINT OF ROOF
TYP	TYPICAL
ACC	AIR COOLED CONDENSER
UPS	UNINTERRUPTIBLE POWER SUPPLY

40 0 40 80 120

SCALE: 1" = 40'

REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/TECH SPECIALIST	PROJECT ENGINEER	PROJECT MANAGER
B	11/23/09	INCORPORATE COMMENTS CONCEPTUAL DESIGN	MW	BA	PL		BA	BA
A	07/23/09	INITIAL ISSUE FOR REVIEW AND COMMENT	SC	BA	PL		BA	BA

PRELIMINARY STATUS — DATE — REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.

LOC

APPROVED STATUS — DATE — REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.

LOC

ORIGINATING PERSONNEL

DRAWN BY: S. CHERRY

CHECKED BY: B. ANDERS

LEAD DESIGNER: P. LOUEN

ENGINEER/TECH SPECIALIST:

PROJECT ENGINEERING MANAGER: B. ANDERS

PROJECT MANAGER: B. ANDERS

Zetlin & Hahn

PROFESSIONAL ENGINEER'S SEAL

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF PE ___ STATE ___ LIC. NO. ___ DATED ___

WorleyParsons resources & energy

SolarReserve

CLIENT/PROJECT TITLE

TONOPAH SOLAR ENERGY, LLC
CRESCENT DUNES SOLAR ENERGY PROJECT, BLM CASE No N86292

GENERAL ARRANGEMENT
SOLAR POWER PLANT
POWER BLOCK PLAN

SCALE: 1" = 40'-0" | DRAWING SIZE: ARCH D (36" x 24")

WORLEYPARSONS DWG. NO.: SRTP-1-SK-111-002-002 | REV: B

SRTP-1-SK-111-002-002
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12:50PM

- Solar Superheaters/Reheaters – The saturated steam flows to a shell and tube superheater to reach the desired steam-turbine temperature and pressure-operating conditions. The reheater receives "cold" outlet steam from the high-pressure turbine stage and reheats the steam before being reintroduced into the intermediate-pressure stage of the turbine.
- Steam turbine – Once the pressurized steam has reached the optimum temperature in the superheater, it flows to the steam turbine, which extracts thermal energy from the steam.
- Feedwater heaters – The feedwater is heated to the required conditions using conventional turbine extraction steam in low pressure feedwater heaters.
- Deaerator – A direct contact steam deaerator will be included to eliminate dissolved oxygen in the condensate and steam.

4.2.4 Cooling System

Heat rejection in the facility utilizes a cooling system. Three cooling options were considered for the project. These include the following:

- Evaporative Cooling Tower: A mechanical draft, wet cooling tower where the heat is rejected via evaporation and convection and cooled water returns to the condenser.
- Air Cooled Condenser (ACC): An ACC uses mechanical draft (fans) to blow ambient air across a heat transfer surface which cools and condenses the steam
- A combination of the two above sometimes referred to as a "Hybrid" cooling system which minimizes water consumption but retains the ability to enhance performance during periods of peak electricity demand.

A hybrid cooling system will be employed at the site. The cooling system consists of a steam turbine, exhaust transfer duct exiting the steam turbine, air-cooled condenser, small evaporative cooler, condensate tank, and condensate pump. The system receives saturated turbine exhaust from the steam turbine, where it is piped through a transfer duct to a finned-tube air-cooled condenser. The air-cooled condenser blows ambient air across a heat transfer surface area, which cools and condenses steam. The finned tubes are usually arranged in the form of an A frame or delta over forced draft fans to reduce land area requirements. The evaporative cooling system will take the form of a small cooling tower to augment the heat rejection system of the air cooled condenser. The evaporative cooling system will only operate during periods of high temperatures, and will increase the electricity generated and cycle efficiency during periods of high temperatures. The condensed steam is gathered in a condensate tank and provided to the feedwater circuit through a condensate pump.

A typical air-cooled condenser can condense steam within 30°F to 50°F of the ambient dry-bulb temperature. Water consumption for the cycle is addressed in Section 4.6.2.

4.2.5 Thermal Storage System

The thermal storage system utilizes hot and cold liquid salt tanks to store solar heat energy for later steam generation as well as associated pumps and piping. Thermal storage provides the facility with several enhancements. The solar field is nominally sized to provide excess solar energy to the system during summer months, and such sizing intentionally results in collection of excess heat that cannot be

utilized instantly by the power block. The thermal storage capability allows the excess heat to be stored until utilized for power generation. Thermal storage can also extend the generation day of Tonopah Solar Energy power plants. The heated salt can be stored in insulated tanks to provide a steam heating source after the sun sets, allowing the facility to more closely satisfy the load demands of the electricity grid system, which typically peak in the late afternoon and evening hours. The thermal storage system includes an auxiliary electric heat source to keep the salt in a molten state through protracted maintenance outages.

The thermal storage system contains two storage tanks -- one “cold” tank storing liquid salt at 550°F and one “hot” tank storing liquid salt at 1,050°F. As the sun rises, cold liquid salt (or HTF) is pumped from the cold liquid salt tank through the tubes inside the receiver. After absorbing energy from the concentrated sunlight, the temperature of the HTF is increased to the design outlet temperature of 1,050°F. Part of the heated HTF is then pumped to a hot liquid salt tank for storage and part to a steam generating system that produces superheated steam for use in the conventional Rankine cycle turbine/generator system. After exiting the steam generator, the HTF is returned to the cold tank where it is stored and eventually reheated in the receiver. This arrangement allows for excess heat to be stored for power generation outside of the direct solar-heating period of the day. The system also includes piping, valves, pumps, expansion tanks, and heaters.

The HTF consists of sodium nitrate ($NaNO_3$) and potassium nitrate (KNO_3) in a “eutectic” mixture designed to remain liquid or molten over a wide temperature range. The HTF mixture has a melting point of 460°F and must be preheated and maintained above this minimum temperature in order to remain in liquid form.

4.3 Major Electrical Systems and Equipment

The bulk of the electric power produced by the facility will be transmitted to the electric grid under the control of Sierra Pacific Power Company. During operation, a small amount of electric power will be used to power station auxiliary loads such as pumps and fans, control systems, and general facility loads including lighting, heating, and air conditioning, heliostat movement and other uses. Additionally, electric power will be used for heat tracing which will provide energy to maintain the salt in fluid state during protracted maintenance outages. Some power would be converted from alternating current (AC) to direct current (DC), which would be used as backup power for control systems.

4.3.1 Electrical Components

Power will be generated by the steam turbine generator (STG) and stepped up through the generator step-up transformer to the utility high voltage system. The generator shall be connected to the step-up transformer by isolated phase bus duct. A low-side generator breaker shall be provided between the generator and the generator step-up transformer (GSU).

4.3.2 Main Generator

The generator will be synchronized to the utility's transmission system using the generator breaker. The STG will be supplied with metering quality current and potential transformers and meters capable of supplying signals to the control system and performance monitoring systems.

4.3.3 Generator Step-up Transformers (GSUs)

A two winding, delta-wye GSU transformer will be designed according to the Institute of Electrical and Electronics Engineers Standards (IEEE) C57.12.00-2000 and supplied for the STG generator. The neutral point of each high voltage (HV) winding will be solidly grounded. The GSU transformer will have metal oxide surge arresters adjacent to the HV terminals.

Accessories will include a local visual enunciator, magnetic liquid-level gauge, pressure-relief device, sudden pressure relay, oil preservation device, valves for top and bottom filter press connections, drain/sampling valves, grounding pads, bushing-mounted current transformers, combustible gas detector, on-line dissolved gas/water monitor with 4-20 milliamp signal out to the controller, and hot spot winding temperature elements.

The GSU will include manual de-energized tap changers located in the HV windings with taps ranging from 5 percent above normal to 5 percent below normal in 2.5 percent increments. GSU transformer auxiliaries will be powered from two 480 V, three-phase, three wire sources for each transformer. Each power supply will be fed from separate sources and routed in separate conduits.

4.3.4 Unit Auxiliary Transformer (UAT)

A two-winding, delta-wye UAT transformer will be designed according to the IEEE Standards C57.12.00-2000 and supplied for 4,160 V service. The UAT will be rated to supply facility startup and maximum operating power requirements. A system calculation showing all connected equipment loads for the UAT transformer will be used to determine the requirements prior to procurement of the UAT. The neutral point of the UAT low voltage (LV) winding will be 1,000 amp (A) low-resistance grounded.

4.3.5 Electrical Building

A plant electrical building will house the 4,160 V switchgear, 4,160 V motor controllers, low voltage switchgear, low voltage motor control centers, control panels, power and lighting panels, uninterruptible power supply (UPS), DC station batteries, DC switchboard, and other miscellaneous equipment, steam turbine control equipment and the control I/O cabinets.

4.3.6 Medium Voltage Switchgear

The medium voltage switchgear will be single-ended, rated 4,160 V nominal, three-phase, three-wire with ratings not to exceed 3,000 amps (A) continuous and the calculated fault current duty. The medium voltage switchgear will receive power from the unit auxiliary transformer through non-segregated phase bus duct.

The medium voltage switchgear lineups will be located indoors, will use vacuum interrupters, and will be rated to continuously distribute the full auxiliary load. Each lineup will contain auxiliary power metering and voltage transformers, a main incoming breaker, and feeder breakers as necessary to distribute the load. All medium voltage breakers will be electrically operated from the control system and equipped with a stored energy mechanism. Breakers will be provided with remote racking mechanisms.

4.3.7 Emergency Power Systems

The emergency power for the plant switchyard and many other plant critical loads will be supplied by the 125 volt DC (VDC) station battery system. Additionally, an emergency generator will be employed to provide emergency power to facilitate.

4.3.8 Lighting Systems

The project's lighting system will provide operation and maintenance personnel with illumination for both normal and emergency conditions. Project lighting will be designed to minimize light pollution through the use of sensor lights and directional lighting in cases where this would not compromise safety or security. Although the project is in a remote area, lighting on the Site will be limited to areas required for safety and shall be shielded from public view to the extent possible. Outdoor lighting shall be photocell controlled through contacts that control the outdoor lighting. To help reduce the visual impact created by outdoor lighting, the following mitigation measures shall be adopted:

Lights shall be directed on-site so that significant light or glare shall not be created. Highly directional, high-pressure sodium vapor fixtures shall be used.

Nighttime backscatter illumination shall be avoided by directional shielding of lights and providing on/off switch at the bottom taller equipment.

Switched systems shall be used to allow reduction of light in areas where work is not ongoing and where light is not needed for safety reasons. All light switches shall be clearly identified.

Lighting will not be provided for the solar field, but is expected to be provided in the following areas:

- Building interior equipment, office, control, maintenance, and warehouse
- Tower
- Building exterior entrances
- Outdoor equipment within the power block and tank area
- Power transformers
- Power block roadway
- Parking areas within the power block area
- Tank Area
- Entrance gate

- Water treatment area
- Air Cooled Condenser

4.3.9 Communication Systems

The major communication system on-site would be the SCADA (Supervisory Control and Data Acquisition) system. The SCADA system is composed of industrial PLC (Programmable Logic Controllers) hardware and software, field instrumentation, meteorological stations, and communications devices designed for site monitoring, control and historical trending of the solar power plant.

All data collected from the field would be transmitted to the site Control Room via a fiber or copper communications infrastructure. The Control Room would also contain a router for the point of connection to a T1 line or equivalent as well as phone lines for communication to the outside.

During construction, communication systems may be either hard wire or satellite communication system (dish) will be used. For the plant operations, it is expected that a “hard” wire communication source will be designed and installed to support the project. The communication line hard wire routing will follow the existing transmission line near the plant, and the new transmission corridor along Pole Line Road. This line will be designed and installed in cooperation with the applicable communications provider.

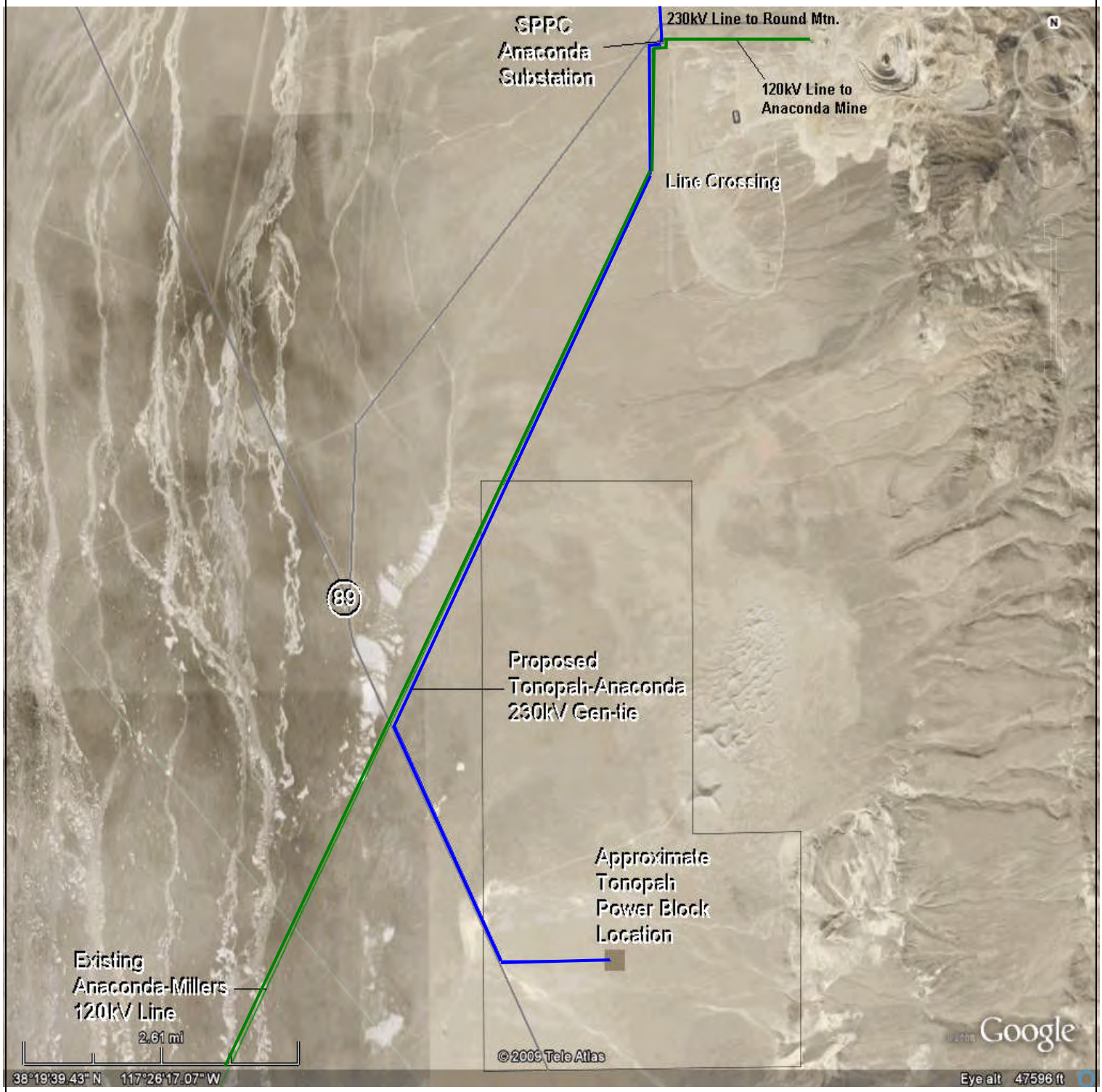
Communications will be provided via satellite if a hard wire communication line cannot be brought to the site along existing overhead power line structures. Additionally, a communication line will be constructed on the generation-tie line transmission poles between the Site and the Anaconda substation. The purpose of this fiber optics line is to provide SPPC/dba NV Energy the ability to “communicate” between the Anaconda substation and the facilities on-site. Additionally, it is anticipated that a new communications dish will need to installed on an existing tower at the Millers substation, located SW of the Site. The purpose of this new dish is to provide a second means of communication between the Anaconda substation and the Site.

4.4 Transmission System and Interconnection

4.4.1 Interconnection

The proposed project is planned to interconnect to the existing Sierra Pacific Power Company Anaconda Substation (ROW 033242) that is located north of the Site. In this case, a new transmission line will be constructed between the Site and the substation (generator tie-line). The proposed route for the generator tie-line will follow the site access road to Pole Line Road, head north along Pole Line Road to where the existing Millers to Anaconda transmission line is located, and then parallel the Millers to Anaconda transmission line to the Anaconda Substation, to interconnect with the electricity grid (see **Figure 7, Transmission Route, and Figure 23, Substation Detail**).

Therefore, for a majority of the distance between the Site and the Anaconda Substation, the new transmission line will parallel the existing transmission line (ROW 033242) (see **Figure 3, Project Site Plan).** An additional SF 299 will be required for the new transmission line and has been filed. (Refer to Section 4.1 for additional information).



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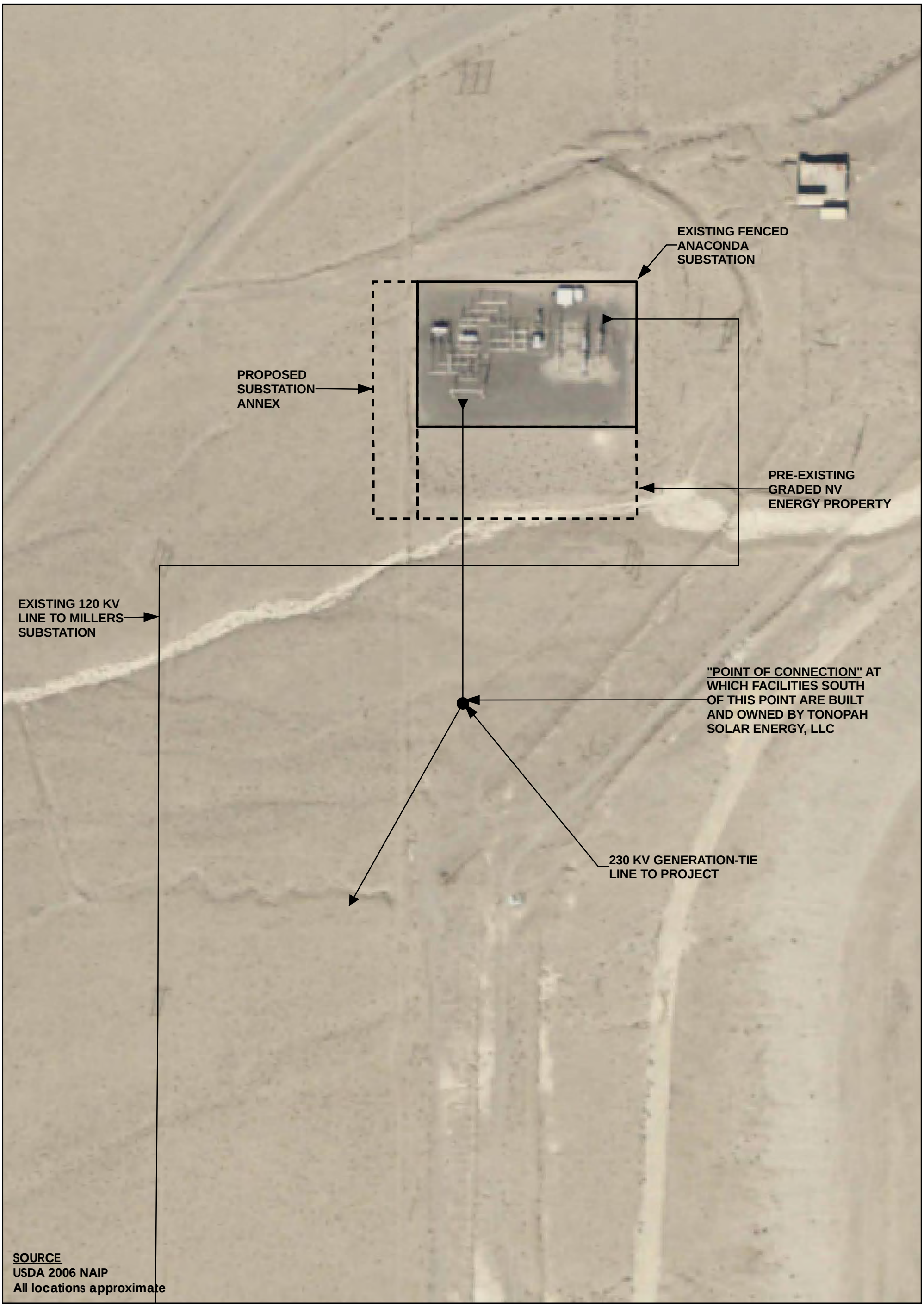
Transmission Interconnection Route

52006718

Figure 7



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CRESCENT DUNES SOLAR ENERGY PROJECT
TONOPAH SOLAR ENERGY, LLC
BLM CASE NO. N86292

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Substation Detail

SWL	BA	11/2009
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The plant switchyard and the transmission line between the plant switchyard and electrical system interconnection will be engineered, procured and constructed as part of this project. The high voltage interconnect from the plant to the electric utility will be made via a SF6-insulated, high voltage breaker with a single-circuit, overhead line from the plant switchyard to the utility substation.

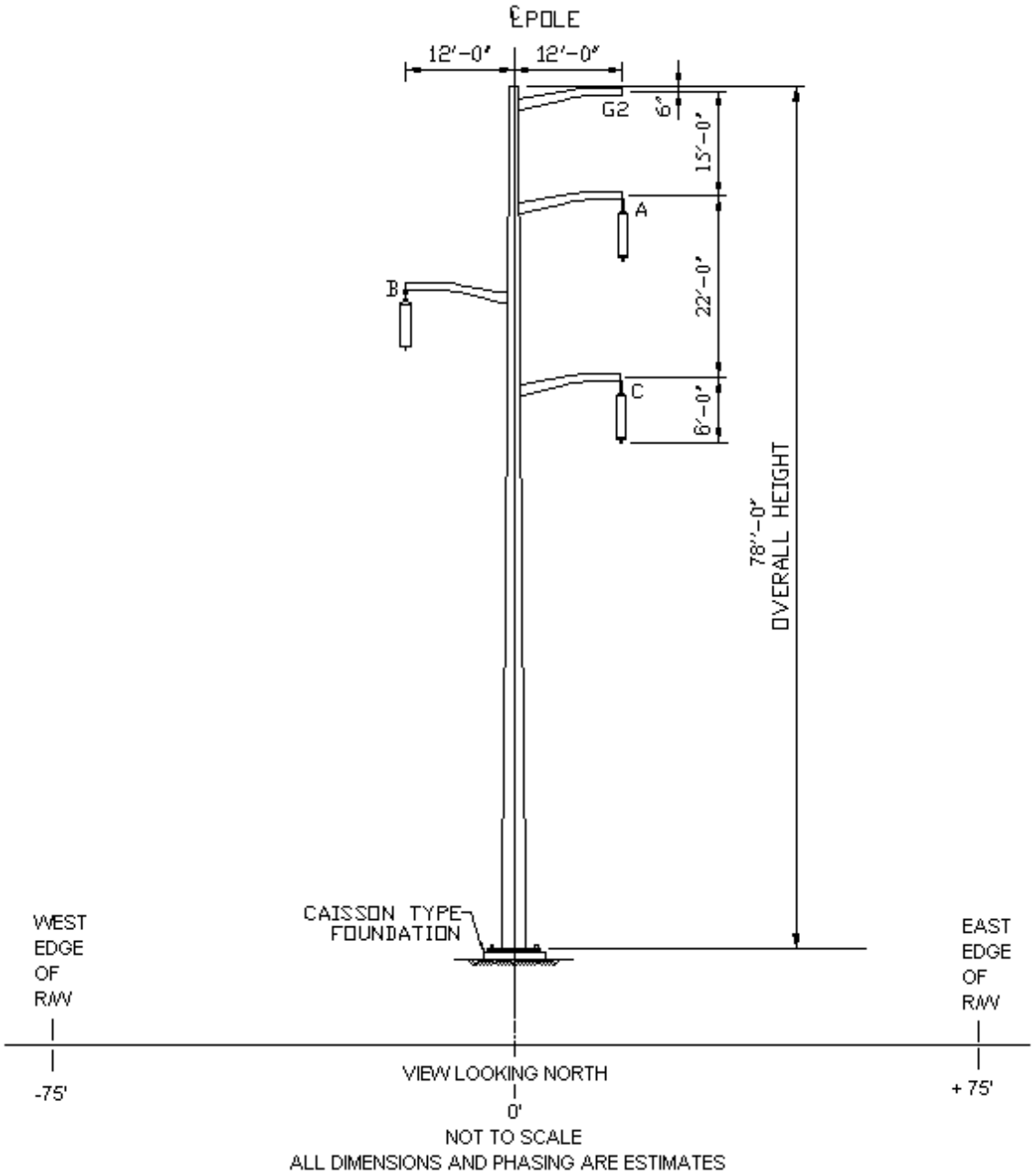
The anticipated pole configuration used for the new transmission line is a steel “mono” pole, and is shown on **Figure 6, Pole Elevation**.

The applicant is working closely with Sierra Pacific Power Corporation (SPPC)/NV Energy to finalize the interconnection location or Point of Interconnection (POI). At this time, the anticipated location is shown in Figure 23. A preliminary layout representing the location and components involved in the interconnection will be provided as soon as this is determined.

The applicant is in discussions with SPPC regarding construction and ownership of the new transmission line. At this time, it is expected that the new generator tie-line transmission line will be owned by the Applicant up to the POI, and SPPC will own interconnection facilities between the POI and the substation.

4.4.2 . Potential Transmission Route

The transmission line route is shown in Figure 7, Transmission Interconnection Route for interconnection to the Sierra Pacific Power Company Anaconda Substation. The interconnection line will exit the power block and follow the access road to Pole Line Road. At this location it will parallel Pole Line Road to the point where the existing Millers to Anaconda transmission line is located. The line will then turn northeast and follow the existing transmission line to the existing Anaconda Substation. A typical transmission line profile is illustrated on **Figure 8, Transmission Line Profile**. The applicant needs to coordinate with Sierra Pacific Power Company on the routing of the line as it enters Anaconda Substation and intends to file an additional right-of-way application within BLM controlled land once this route is confirmed and if the route extends beyond Sierra Pacific’s existing right-of-way.



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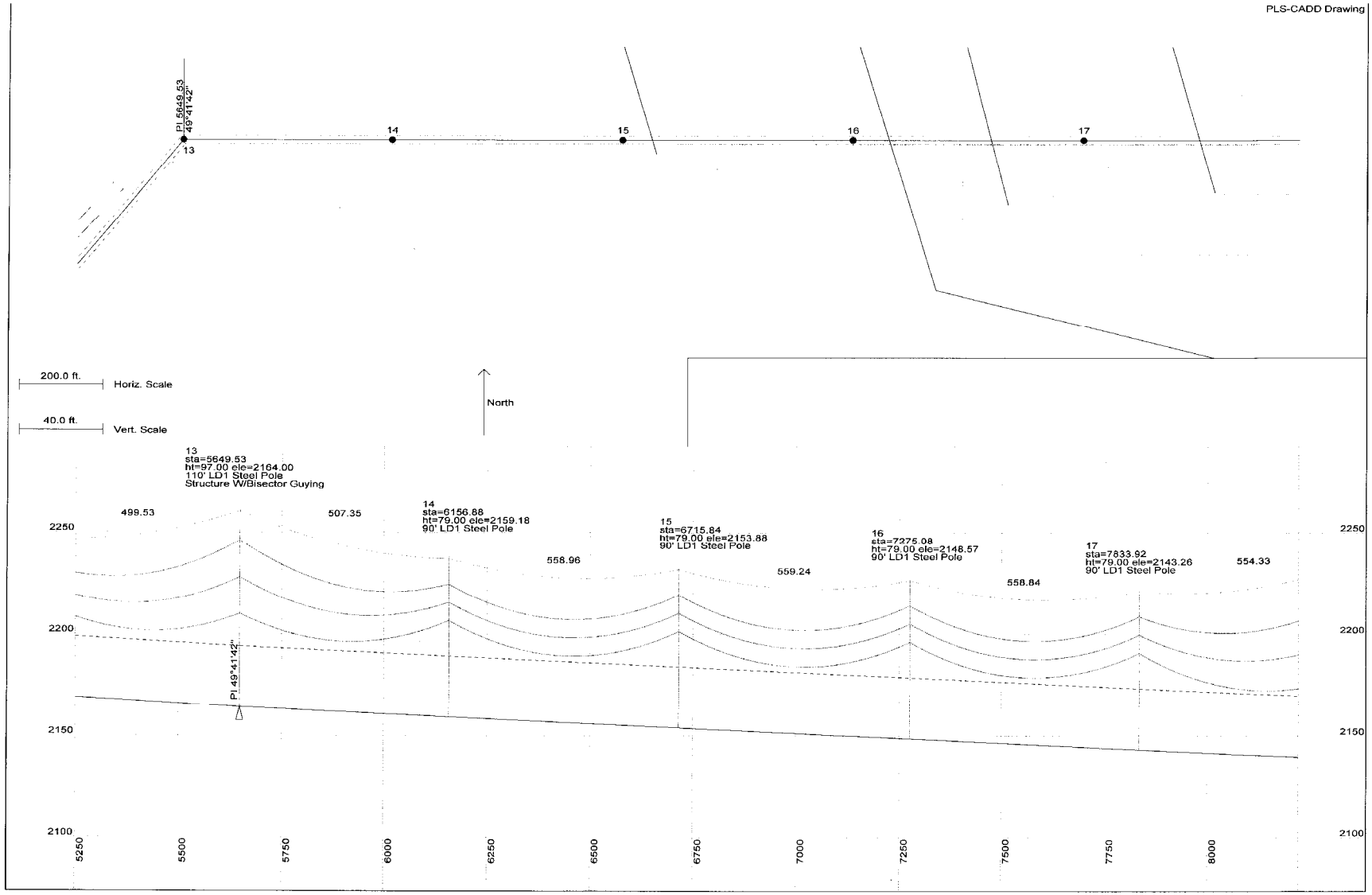
230 KV Single Circuit
Conceptual Pole Elevation

52006718

Figure 6



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Typical Transmission Line Profile

05/2009

52006718

Figure 8

4.5 Civil/Structural Features

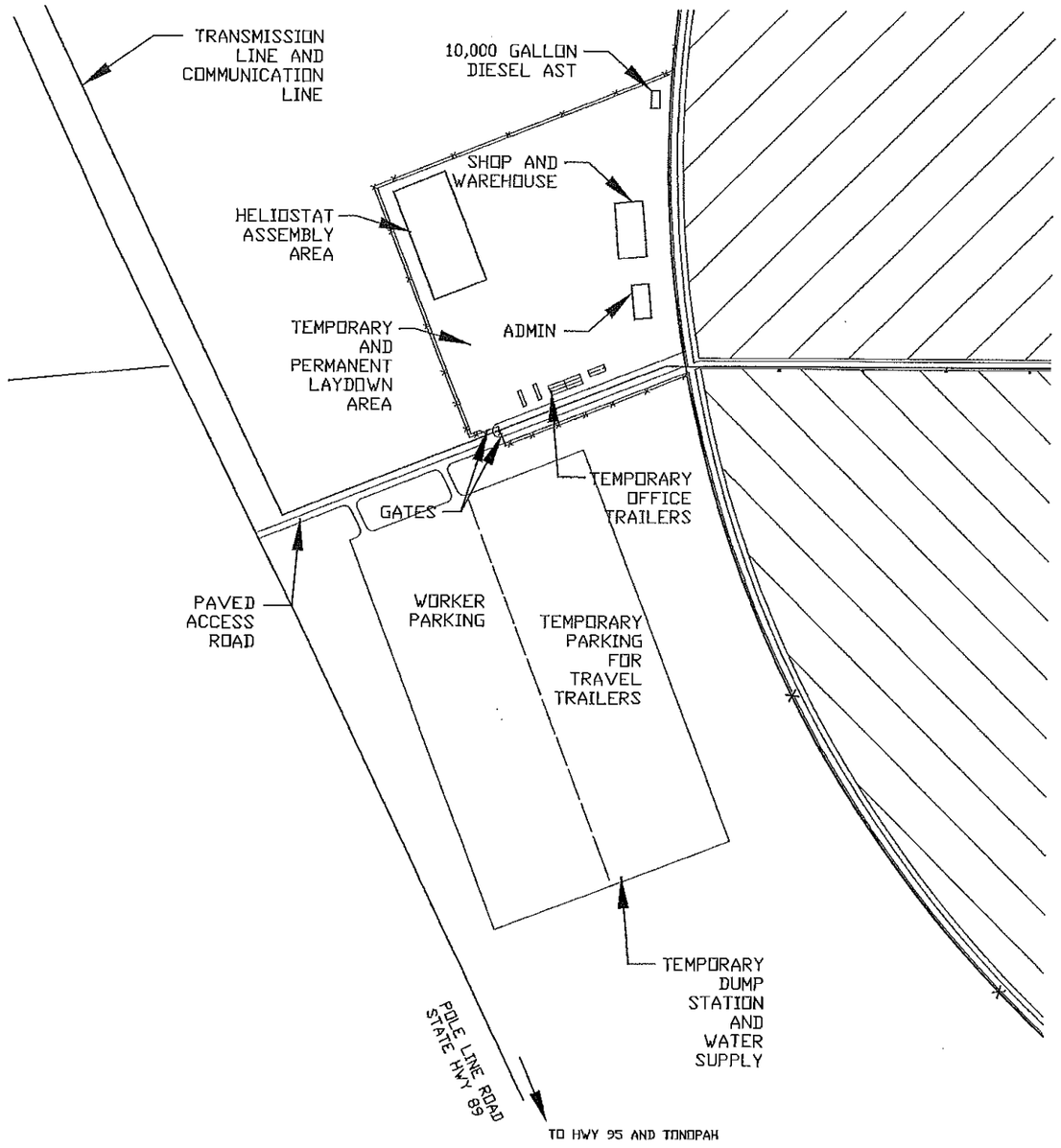
4.5.1 Access Roads

Access to the site will be provided from State Route 89 (Pole Line Road). Pole Line Road is a Nye County owned and maintained road near the Site location, and is asphalt surfaced from its intersection with State Highway 6/95 to north of the Site location. A short section of Pole Line Road from its intersection with Highway 95 to a location south of the Site is in Esmeralda County. This section of Pole Line Road, although located in Esmeralda County, is maintained by Nye County through the terms of a formal agreement. It is anticipated that this road will be maintained by Nye County in the future as it has been in the past. The access road to the Site will be connected directly to Hwy 89 near the southwest corner of the Site (see Figure 3, Project Site Plan). The paved surface of this road will be a two lane road, constructed with adequate width for two directions of travel with a minimum of two foot shoulders on each side of the road. This paved road will be extended to provide access to the power block. All roads within the power block will be surfaced with asphalt. The entry gate location is identified on **Figure 9, Ancillary Uses** and will be located a short distance east of Poleline Road in order to eliminate a backup queue on Rout 89. Grading for this access road will include the removal of existing vegetation, filling of ruts and depressions, and widening to a width of 24 feet. The solar field perimeter road will be groomed and surfaced with approximately 4 to 5 inches of road base. This road will then be compacted with a heavy roller to provide all-weather access. In addition, this road will be sloped to allow natural runoff or drainage structures (e.g., culverts) will be installed as needed. The proposed minimum road width is 24 feet for the main access road and 20 feet for the perimeter road – see **Figure 10, Road Sections**.

The predominant traffic to/from the site will occur during construction, and will primarily be construction crew commuter traffic. Vehicle trips to and from the site will use Highway 95 to access the Site from the north (Reno) and south (Las Vegas), and Highway 6 to Highway 95 may be used for traffic coming from east of the town of Tonopah. The traffic associated with the project is not expected to produce permanent traffic impacts to Highway 95, as the peak truck traffic is expected to be approximately 90 trucks per day (at the peak) and 400 cars per day (at the peak) and will be temporary. The Project will receive deliveries of materials from local, regional and possibly international points of origin including bulk commodity materials, engineered equipment and machinery, and general materials of construction. The Site is not currently served by rail. The Site will rely on transport by truck for the final delivery of materials to the site including those materials which are brought in to the region by rail or ship. These materials will be loaded onto trucks at various ports and depots for delivery to site.

Heavy and oversize loads will be delivered using trucks and trailers equipped to handle specialized loads. Over-sized loads will be individually permitted to transport each such load to the site. Heavy and oversized loads for the project are typical of a common power plant or process facility and may include items such as the step-up transformer, the solar receiver panels, steam turbine, generator, and tanks.

Additionally, unpaved roads will be constructed from the power block to the east and south edges of the solar field. The unpaved solar field perimeter road will be constructed around the solar field, and is proposed to be surfaced with rock. A typical section of this road is shown on Figure 10, Road Sections.



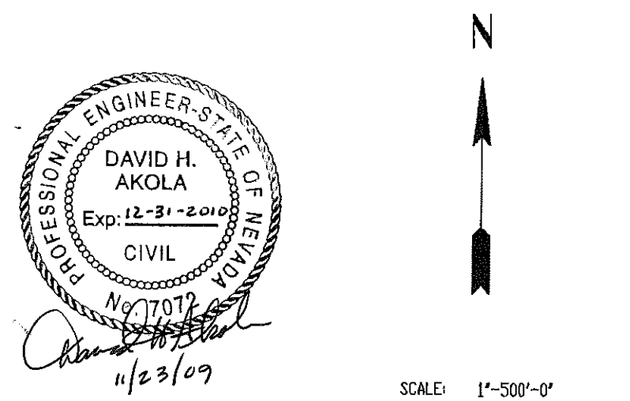


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FIGURE 9

REVISION #	BY	DATE	DESCRIPTION
B	DA	11-18-09	FOR POD UPDATE
A	CM	4-29-09	FOR POD

DRAWN BY: C. MAHER CAD FILE:

PROJECT MANAGER: BOB ANDERS

ANCILLARY USES

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NYE COUNTY, NV

WorleyParsons
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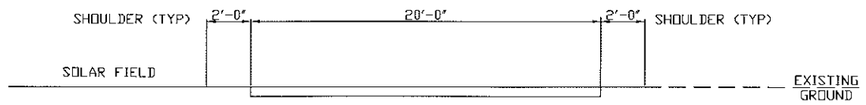
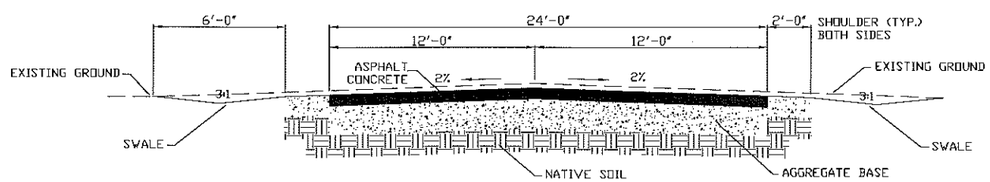


1 PERIMETER ROAD- AGGREGATE SURFACE DETAIL

NOT TO SCALE



2 ACCESS ROAD SECTION (TYP.)

NOT TO SCALE

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CIVIL
No. 7072
11/23/09

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FIGURE 10

REVISION #	BY	DATE	DESCRIPTION
A	CM	4-29-09	FOR POD

DRAWN BY: C. MAHER DRAWING NO.:

APPROVED BY: B. ANDERS

SOLAR FIELD-TYPICAL ROAD SECTIONS

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NYE COUNTY, NV

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The site access road will be directly connected to SR 89 (a.k.a. Pole Line Road). This roadway is a Nye County maintained roadway that does not have an associated ROW. Discussions were held with Nye County to confirm that a ROW does not exist, and there is no NDOT involvement with this roadway. According to Nye County, this roadway is owned and maintained by the County, and the NDOT will not be involved with the access road construction. Also, Nye County indicated that they will prepare paperwork to obtain ROW for Pole Line Road during the process associated with this project, and that the desired ROW width will be eighty (80) feet in width. According to Nye County representatives, the existing paved surface of Pole Line Road is between 24 feet and 28 feet.

4.5.2 Buildings and Enclosures

The following buildings and enclosures are planned as part of the project:

- Steam Generator Area Building (approximately 30,000 sf). This structure is planned to be located between the HTF storage tanks within the power block. The purpose of the building is to provide structural support and protection for the equipment associated with the heat exchange process.
- Steam Turbine Area/Enclosure (not considered a building). This structure will house the steam turbine generator and associated equipment, and is located within the power block. The STG may be enclosed in a building for protection, or it may be located outdoors.
- Electrical Building (approximately 2,500 sf): This structure will be located within the power block area and will house the switchgear, motor control centers, battery power supply and other primary plant electrical components.
- Administration/Maintenance Building (approximately 10,000 sf): This building will serve as the center for support staff for the project during operations. This facility is planned to be located outside the heliostat field, near the access road.
- Heliostat Assembly Building (approximately 80,000 sf): This building will be used as a protected environment for the assembly/construction of heliostats during construction of the plant. This facility will be temporary, yet may be converted to other uses at the completion of the construction of the project.
- Permanent Warehouse (6,000 sf): This building will provide for permanent warehouse space for the facility and will be located near the Administrative/Maintenance Building.
- Control Room Building (6,000 sf): This building will be located within the power block and will provide the control room functions for the project. This building will be located west of the Steam Turbine Area.
- Building Sanitation Facilities: The administration and maintenance building located on the perimeter of the heliostat field and the control building located within the power block will each be served by a permanent septic system (tank and leach field).

4.5.3 Material Storage

On site storage for spare field and power block components will be required for maintenance uses. In addition, onsite storage facilities for water pretreatment chemicals, cooling water treatment chemicals,

and boiler water treatment chemicals will be necessary. The HTF material (salt) will be delivered to the project as dry, solid pellets. The material will be delivered in 1-ton "super sacks" which can be stored on-site until melted for use in the plant process. The salt must be heated until fluid for use in the system, and will be stored within the lay down area of the site until it is heated, liquefied and sent to the storage tanks.

Potentially polluting substances will be managed in accordance with all applicable laws, ordinances, regulations and standards to protect worker health, prevent leaks and spills, and protect storm water quality as discussed further in Sections 4.9 and 4.14.

Construction lay down and storage will occur throughout the permanently disturbed areas. The power block, and the heliostat field immediately adjacent to the power block will be used for lay down and storage of the power block components. Equipment will be stored within the power block, and include cranes, loaders, fork lifts, generators, boom trucks, water trucks, etc. The earthmoving equipment will be stored in a central location each night near the area where the work is being undertaken, or near the west side of the heliostat field, where all the equipment can be most easily fueled. All these locations are within the perimeter of the permanent project facilities. Additionally, a small temporary lay down area, worker parking area, and trailer parking area will be used during construction of the facility and are shown in Figure 9, Ancillary Uses. The areas shown in Figure 9, and identified as "Temporary and Permanent Laydown Area", "Worker Parking", and "Temporary Parking for Travel Trailers", are the only areas outside the heliostat field perimeter fence that will be used for temporary laydown, storage, parking and other temporary uses. The features shown may be relocated during final project planning but will remain within the total area identified. The heliostat assembly building may be constructed permanently to be used during the life of the project, or may be removed after construction. Areas along the generation tie-line corridor and near the substation (less than 5 acres) may be used for storage of power poles during construction. These areas will remain with the area identified for Temporary Disturbance.

4.5.4 Storage Tanks

The following storage tanks will be located on-site:

- Demineralized Water Storage Tank: One demineralized water storage tank will be constructed to store demineralized water for use as mirror wash water, steam cycle make up, and for use in the hybrid cooling system.
- Fire/Service Water Storage Tank: One fire water/service water tank will be constructed to store water for fire protection, service water needs, and for raw water storage prior to treatment.
- HTF Storage Tanks: Two tanks will be constructed to contain the HTF. One will house the hot HTF (1,050 F), and the other will house the cold HTF (550 F).
- A lube oil storage tank will be associated with the STG.
- Additional ancillary tanks will be on-site for a variety of liquids within the power block area.

4.5.5 Pipelines

Project operational water will be obtained from on-site wells; therefore, an off-site pipeline would not be required. The CSP technology proposed for the project will not require a natural gas source.

During construction of the project, there will be a high water demand for soil moisture conditioning and dust control. The source of construction water will be from on-site wells.

4.5.6 Site Drainage

The Site is located on a portion of the Smokey Valley that slopes to the west at approximately 2%. The storm water drainage system will be designed to allow the storm flow to follow its pre-existing drainage paths. Currently storm flows drain from the San Antonio Mountains to the east and infiltrate across the nearly flat site on their way to Peavine Creek. At the Site location, the storm flows broaden out, and do not follow individual drainage courses. This allows increased infiltration as the flows move to the west towards Peavine Creek. Near the east end of the facility two gentle drainage paths are visible in the topographic survey of the site. These will be maintained, and the flows will be allowed to fan out, as they currently do, across the heliostat field.

The grading plan within the heliostat field, discussed later, will be such that storm flows follow pre-existing paths. The majority of the project site, within the perimeter fence, will not be graded. The majority of the project site will be smoothed to allow truck access throughout heliostat field.

Preliminary storm drainage for the overall facility can be seen on the grading plan included as **Figure 11, Preliminary Grading & Drainage Design**. More details of the power block are shown in **Figure 12, Power Block Grading and Drainage**. Appendix C includes the Conceptual Drainage Study for the Tonopah Crescent Dunes site which includes hydrology calculations showing the anticipated total storm flows associated with the watershed upstream from the Site. Small ditches will be constructed along roadways, as necessary, to provide a path of travel for water, and to allow infiltration of rainfall.

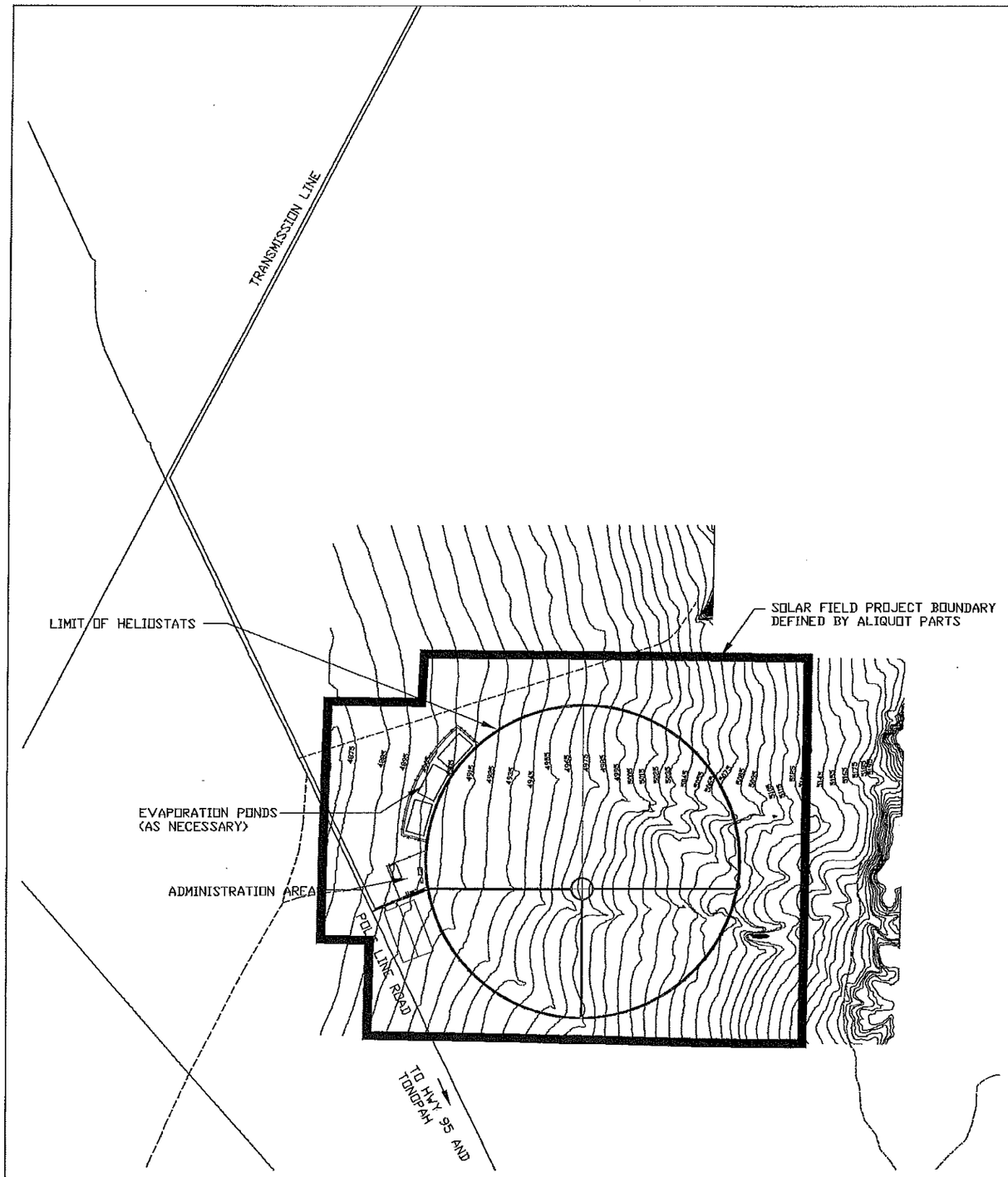
Grading near the power block, to the east side or uphill side of the power block will include a small berm and ditch to divert upstream flows around the power block. Additionally, the finish floor elevations of buildings and other structures subject to damage from storm water will be built a minimum of 12” above anticipated 100 year storm event levels in accordance with all applicable LORS.

Preliminary hydrology calculations were performed using TR-55 (SCS Method). It is proposed that the storm water drainage system be designed using the Soil Conservation Service (SCS) method (TR-55) to determine the amount of rainfall during a specific rainfall event, and in accordance with the Nye County Storm Water Design requirements.

A detailed technical drainage study may be required to be submitted for approval to Nye County’s Tonopah Public Works Office.

All surface water runoff during and after construction will be controlled in accordance with the requirements of the National Pollutant Discharge Elimination System (NPDES) Storm Water Runoff Permit and all other applicable laws, ordinances, regulations, and standards.

The power island will be graded such that all rainfall within the power island will be directed to the containment ponds adjacent to the on-Site salt tanks and allowed to infiltrate. Pipe culverts will be used, as required, where storm channels cross roads.



NOTES

1. FINAL GRADES WILL BE ADJUSTED AS NECESSARY TO BALANCE THE SITE. NO IMPORT OR EXPORT IS PLANNED AND ADJUSTMENT TO THE GRADES WILL BE MADE TO ENSURE THE SAME.
2. TOPOGRAPHY IS "DERIVED FROM 1/3 ARC SECOND USGS NED". DATA WAS CONVERTED FROM METERS TO FEET AND REPROJECTED TO NAD_1983_STATEPLANE_NEVADA_CENTRAL_FIPS_2702_FEET. NO ACTUAL TOPOGRAPHIC SURVEY WAS PERFORMED.

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DAVID H. AKOLA
Exp: 12-31-2010
CIVIL
No. 7072

11/23/09

N

SCALE: 1"-1500'-0"

1500 0 1500 3000 4500

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FIGURE 11

REVISION #	BY	DATE	DESCRIPTION
B	DA	11-18-09	FOR PDD UPDATE
A	CM	4-29-09	FOR PDD

DRAWN BY: C. MAHER CAD FILE:

PROJECT MANAGER: BOB ANDERS

PRELIMINARY GRADING & DRAINAGE

TONOPAH SOLAR ENERGY, LLC
CRESCENT DUNES SOLAR SITE
NYE COUNTY, NV

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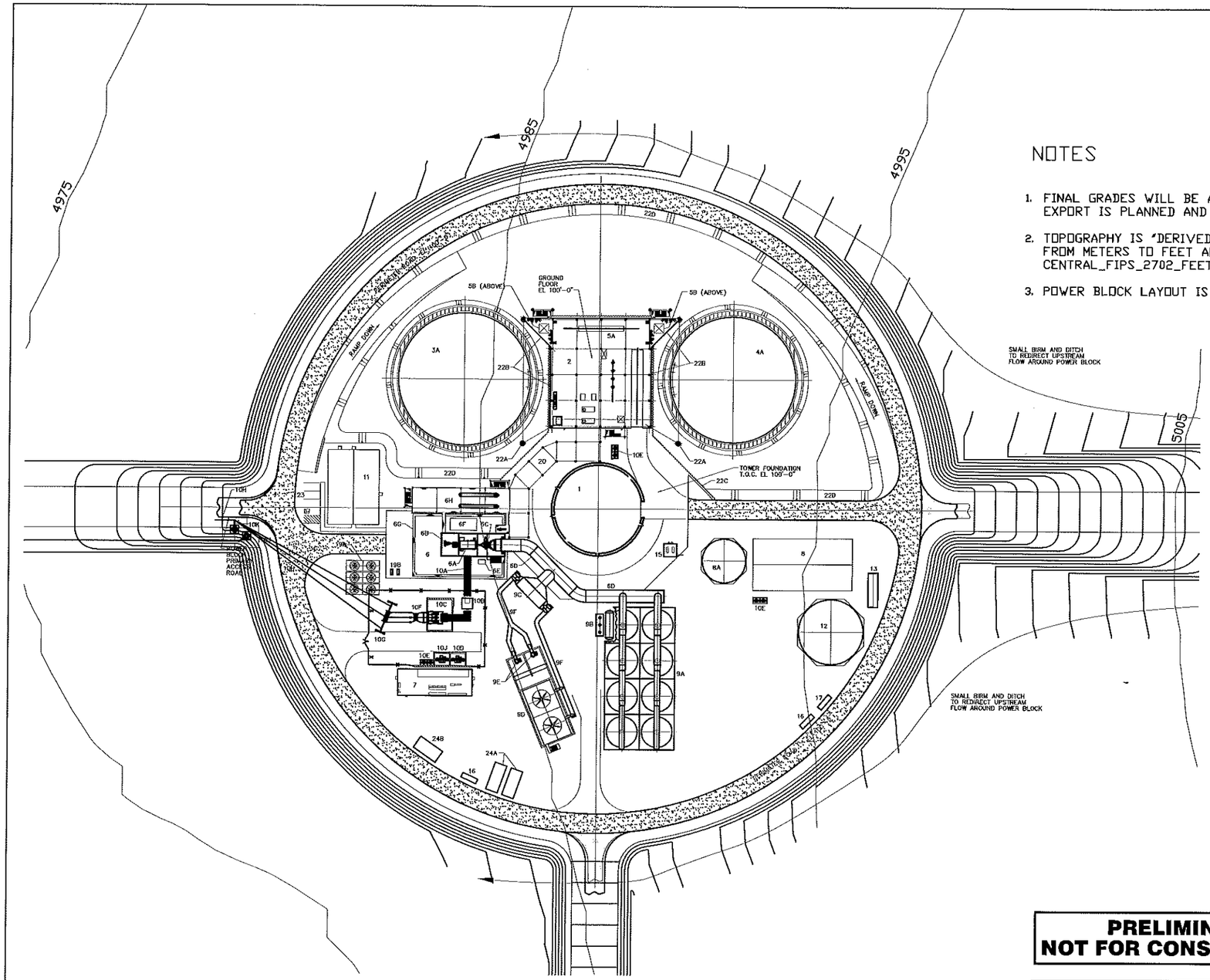

NOTES

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2. TOPOGRAPHY IS "DERIVED FROM 1/3 ARC SECOND USGS NED". DATA WAS CONVERTED FROM METERS TO FEET AND REPROJECTED TO NAD_1983_STATEPLANE_NEVADA_CENTRAL_FIPS_2702_FEET. NO ACTUAL TOPOGRAPHIC SURVEY WAS PERFORMED.
3. POWER BLOCK LAYOUT IS CONCEPTUAL AND SUBJECT TO CHANGE.

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DAVID H. AKOLA
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CIVIL
No. 7072
11/23/09

N

SCALE: 1" = 50'
50 0 50 100 150

PRELIMINARY
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FIGURE 12

REVISION #	BY	DATE	DESCRIPTION
B	DA	11-18-09	FOR POD UPDATE
A	DA	4-29-09	FOR POD

DRAWN BY: D. AKOLA CAD FILE:

PROJECT MANAGER: BOB ANDERS

POWER BLOCK GRADING & DRAINAGE

TONOPAH SOLAR ENERGY, LLC
CRESCENT DUNES SOLAR SITE
NYE COUNTY, NV

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Detention ponds, if determined necessary as part of the detailed technical drainage study, will be sized so that they do not fall within the jurisdiction of the State of Nevada's Dam Safety Division. Sizing the detention ponds with embankments above the specified height or with an impoundment greater than the allowed volume will invoke the requirements of dam safety. The location(s) of the detention pond(s) will be within the heliostat field and will be determined as part of the detailed technical drainage study and associated drawings.

4.6 Water Demand and Sources

4.6.1 Water Sources

The proposed source of water will be groundwater, extracted through a series of wells. A minimum of two wells, one for primary and one for back-up, will be drilled at the power block area. Based on well data from the Nevada Division of Water Resources well log database and the United States Geological Survey National Water Information System, the depth to water in the vicinity of the POD area ranges from approximately 55 to 104 feet below ground surface (bgs) and well depths range from approximately 100 to 200 feet bgs. Wells in the vicinity of the POD area were installed in unconsolidated alluvial materials. No wells were reported within the POD area.

The POD area is located within the southeastern portion of the Tonopah Flat sub area of the Big Smokey Valley groundwater basin, which is within the Central Hydrologic Region of Nevada. The Tonopah Flat sub area is a designated basin and the southern half of the POD area (Township 4N, Range 41 East, Sections 2, 3, and 10 through 15) is located in a preferred use area.

The Tonopah sub area reportedly has 12,000 acre-feet of annual recharge, 2,000 acre-feet of annual inflow, 6,000 acre-feet of annual evapotranspiration and 8,000 acre-feet of annual outflow (Buqo, 2004). The perennial yield (safe yield) is estimated at 6,000 acre-feet per year (Buqo, 2004). The total water rights demand through March 1999 was reportedly 26,724 acre-feet per year. However, this is the estimated committed water rights in the sub area and does not represent the actual groundwater withdrawal and consumption, which are significantly less (Buqo, 2004). The majority of the water rights are committed to irrigation, mining and milling.

There is very little data available on groundwater quality in the basin. The general quality of groundwater in Nye County is suitable to marginally suitable with total dissolved solids concentrations exceeding the state or federal general drinking water standards in portions of the Big Smokey Valley groundwater basin (Buqo, 2004).

Further investigation would be conducted to determine site specific groundwater conditions and to verify that a groundwater supply of adequate quantity and quality can be developed.

4.6.2 Water Demand

Water will be necessary for both the operation of the project as well as construction of the project. During construction of the facilities, water will be required for soil moisture conditioning during the earthmoving operations and for dust control. Based on the expected soil conditions (existing moisture content and the

optimal moisture of the soil necessary to achieve proper compaction), it is estimated that a total of approximately 500 acre-feet (AF) of water will be needed the first year of construction, while the major earthwork is on-going, and 150 AF of water will be needed per year of construction after the initial earth moving operations are complete for ongoing dust control during construction and moisture conditioning of soils for ongoing backfilling operations.

Water needs of the operating plant include three primary uses:

- Steam Cycle makeup water – estimated at 100 AF per year.
- Mirror wash water – estimated at 70 AF per year
- Hybrid Cooling System Augmentation – estimated at 430 AF per year

Although the steam cycle is a "closed system", operational steam blow down requires the addition of makeup water throughout the operating time frame. The heliostat mirrors' reflectivity will decrease in efficiency, and therefore the ability to generate electricity will decrease as the mirrors collect dust and other particles. A mirror wash program will be implemented that will wash the mirrors on a continual basis. This program may run up to 7 days/nights per week.

During the hottest and driest times of the year, the cooling system will be operated in "hybrid" mode. The "hybrid" mode of operation includes heat rejection through the ACC as well as heat rejection through the small evaporative cooler. The hybrid mode of operation will increase the efficiency of the plant and allow for the production of additional electricity during these times when electricity is in highest demand.

The process, fire and potable water needs will be met by use of groundwater from new wells. The construction water demand will be met by use of groundwater from new wells. The location, number, depth and design of any new groundwater wells that would be used to supply the project will be determined based on a groundwater investigation and test well program; however, at least two wells would be used for redundancy.

For operational use, water will be pumped into a raw water storage tank. Raw water will be treated through a reverse osmosis water treatment facility and converted to demineralized water for use in the steam cycle, for mirror washing, and for use in the hybrid cooling system. The need for additional pre-treatment such as water softening or ion exchange, if any, will be determined based on analytical data obtained during the groundwater investigation.

See Section 9.1.16 for discussion of water resources.

4.7 Site Investigations and Data Needs

The following site investigations and data needs may be undertaken and or required as part of the planning and permitting for the project and would be provided to BLM as supplemental submittals:

- Aerial (LIDAR) survey to support detailed civil grading and drainage design;
- Geotechnical investigation, including borings, test pits, soil sampling, and ground penetrating studies for foundation and earthwork design; See Figure 3, Project Site Plan for the proposed preliminary boring and test pit locations;
- Test well program and aquifer testing to evaluate potential on-site groundwater sources;
- Meteorological and Insolation Station with security fence for detailed solar field design and generation profile development; See Figure 3, Project Site Plan.
- Phase I Environmental Site Assessment (ESA) to investigate past and current land use for indications of the manufacture, generation, storage, use, and/or disposal of hazardous substances at the Site;
- Pile Test program – may be necessary to provide additional information about the soils and the lateral resistance of pile foundations.
- Biological and Cultural Assessments

4.8 Temporary Construction Facilities

The project construction contractor will mobilize and develop temporary construction facilities and laydown areas adjacent to the power block and outside the heliostat field (see Figure 3, Project Site Plan, and Figure 9, Ancillary Uses). Once a final design has been established, the contractor will prepare site maps showing the construction project in detail. Temporary construction facilities will include construction staging areas, employee parking areas, temporary shop buildings, office trailer complete with electrical, telephone, and internet service, temporary sanitary facilities, a temporary guard shack, and on-site dumpsters. Additionally, rock processing equipment and a portable batch plant will be mobilized for site development. A temporary concrete batch plant will be mobilized for use during project execution. The temporary batch plant will include cement storage, and a batching operation where the cement, water, and aggregate can be proportioned and mixed. This facility will be located in the temporary lay down area or in the heliostat field, just east of the temporary lay down area. The majority of these temporary facilities will be located within the construction logistics/lay down/parking areas and or within the heliostat field. Construction equipment will be staged near the location of active work. This will primarily be within the power block located near the center of the heliostat field. Additionally, temporary sanitary facilities will be located throughout the Site for use by construction personnel and will be sized and located in accordance with OSHA requirements. Several areas internal to the solar field will also be set up to temporarily store materials for the construction of the power block facilities, for the construction of the heliostats and for temporary storage and heat conditioning of solid HTF. The purpose of this is to locate material more closely to the point of installation.

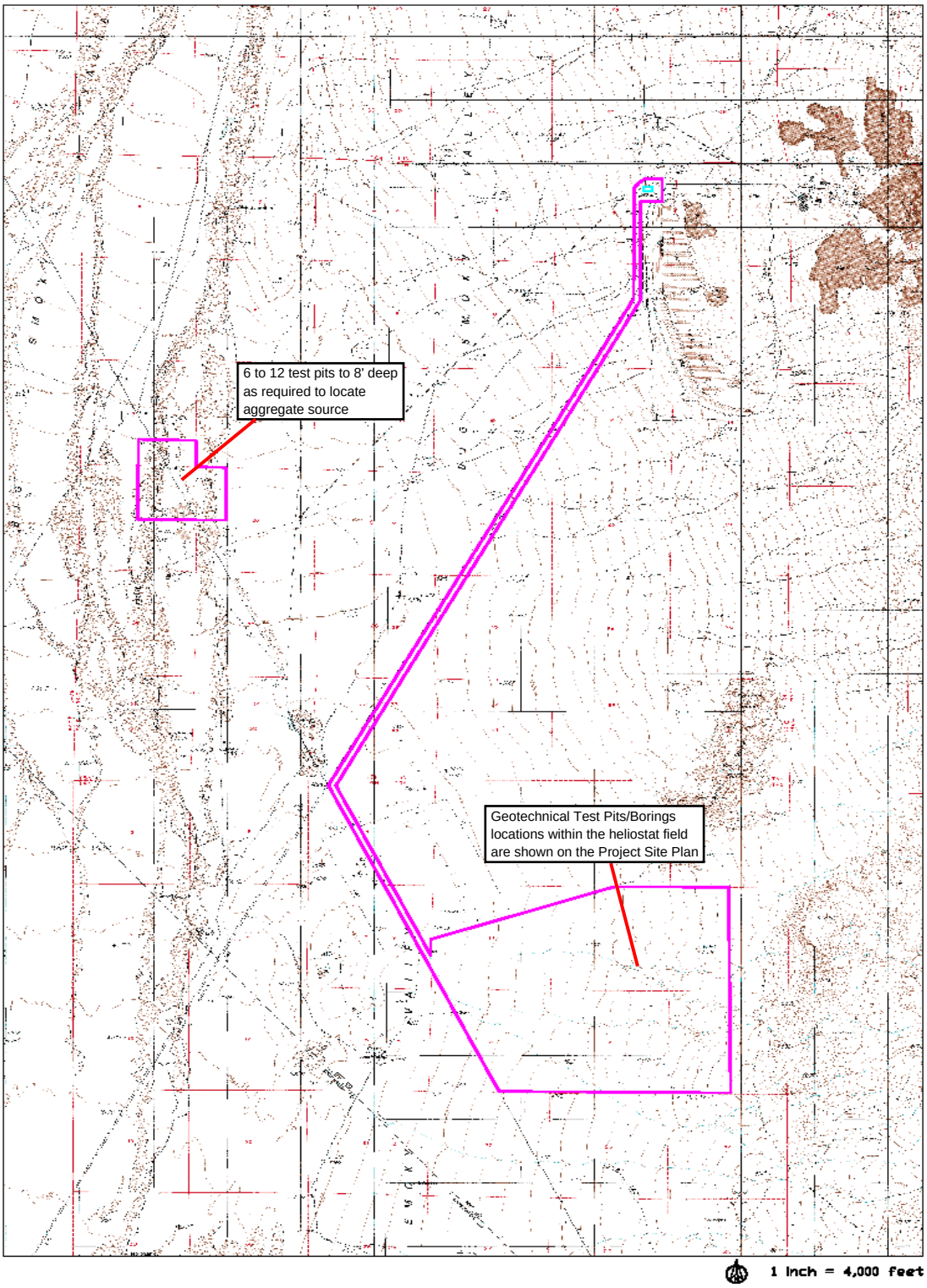
Until a geotechnical investigation is completed, it is not known if aggregate meeting the project requirements will be available on-site. In discussions with Nye County, it was learned that Nye County and the local community obtain aggregate from borrow sites located along Pole Line Road, near Peavine Creek. Therefore, aggregate needs for construction may be obtained from a local borrow area, rather than within the project excavation. The off site borrow area will require a new SF 299 application, and this potential borrow site is located northwest of the Site, very close to the existing borrow pits used by Nye County and the local community (see **Figure 13, Offsite Borrow Area**). If aggregate meeting project requirements is unavailable from the local borrow site (primarily high strength concrete), the aggregate will be trucked to the site.

All on-site construction operations can be completed within the limits of the SF 299 filed for this project, and the two additional SF 299 applications discussed above (one for transmission and one for gravel/aggregate). Therefore, contractors and subcontractors constructing the facility will not require additional land beyond those considered in this POD.

A temporary trailer park is planned near the contractor parking location. This facility will allow contractor employees to reside locally. The nearby community of Tonopah can support a certain number of construction employees, however, a lack of sizeable nearby communities will limit the number of construction employees that can commute from a nearby location.

A temporary 10,000 gallon above ground storage tank will be used to supply diesel during construction of the facility. This will be located in the temporary lay down area, and will be double walled, or located within a containment area per applicable regulations.

The sanitary needs of the construction force within the heliostats and power block area will be met with the use of portable toilets. The temporary construction trailers will use a temporary septic system that will be abandoned upon completion of construction.



Tonopah Solar Energy, LLC
N-86292

Worley Parsons
resources & energy

05/2009

Geotechnical Test Pits/Boring Locations

52006718

Figure 13

4.9 Erosion Control and Storm Water Drainage

4.9.1 Erosion Control

Construction and industrial operations at the site will be subject to the General Construction and General Industrial Storm Water National Pollution Discharge Elimination System (NPDES) permits, respectively. Compliance with these permits will require preparation and implementation of construction and operation Storm Water Pollution Prevention Plans (SWPPPs) that address the following requirements (among others):

- Identification of activities that may pollute storm water;
- Identification of Best Management Practices (BMPs) to control storm water pollution, including water erosion and wind erosion;
- BMP inspection, maintenance and repair;
- Training; and
- Site inspection and monitoring.

Erosion and sedimentation control BMP's will be designed and implemented to meet the requirements of the General Construction and General Industrial Storm Water NPDES permits as well as any requirements specified by the BLM. In addition, grading and earthwork will follow the general requirements of Nye County.

The area of soil disturbance for the project would be kept to a minimum to limit wind and water erosion and enhance successful site rehabilitation/restoration. The areas of soil disturbance would be limited to access roads, construction support areas, and the heliostat, power block and operational support facilities.

Soil stabilization measures would be used to prevent soil being detached by stormwater runoff or wind erosion. The Applicant would employ temporary and permanent BMPs to protect the soil surface by covering or binding soil particles or preventing the concentration of runoff. The project would incorporate erosion-control measures required by regulatory agency permits and contract documents as well as other measures selected by the engineer. Site-specific BMPs would be identified in the SWPPP, with final selection and design by the engineer, and associated figures to be included in the final active project SWPPP.

Project design features and or mitigation measures that will aide in the protection of soil resources could include at a minimum:

- Erosion and sedimentation control calculations performed to verify acceptable stormwater velocities, calculate BMP clean out frequencies and to size rip rap.
- Construction and final drainage designed to promote sheet flow, avoid un-necessary concentration of runoff, and control runoff velocity.
- Stone filters and check dams strategically placed throughout the Site to provide areas for sediment deposition and to promote the sheet flow of stormwater prior to leaving the Site

boundary. Where available, native materials (rock and gravel) would be used for the construction of the stone filter and check dams. A stone crusher may be provided on-site to utilize local stone for the production of gravel.

- Diversion berms, culverts and water bars would be utilized to redirect stormwater.
- Diversion channels would be armored as required to prevent erosion and scouring.
- Flat detention/infiltration ponds and ditches would be used.
- Where possible, maintenance roads would be designed not to disrupt regional flow patterns.
- Silt fences would be utilized extensively during each phase of construction to minimize wind and water erosion. Silt fence locations have yet to be determined and would be provided on the 90% engineering drawings.
- In areas of temporary disturbance (e.g., transmission line alignment, temporary construction support areas), the surface would be recontoured to promote sheet flow and restore and match the original or surrounding drainage function. Native vegetation would be restored to promote healing of the landscape.
- Periodic maintenance conducted as required after major storm events and when the volume of material behind the check dams exceeds 50 percent of the original volume. Stone filters and check dams are not intended to alter drainage patterns but are intended to minimize soil erosion and promote sheet flow.
- Erosion and Sedimentation control BMP design would be in accordance with applicable government codes and standards.

4.9.2 Storm Water Drainage

The proposed facility is located within the Site on a portion of the plain that slopes at a grade of approximately 2%. The storm water drainage system will be designed to allow the storm flow to follow its pre-existing drainage paths. Currently storm flows drain from the San Antonio Mountains to the east and infiltrate across the nearly flat site on their way to Peavine Creek. At the Site location, the storm flows broaden out, and do not follow individual drainage courses. This allows increased infiltrations as the flows move to the west towards Peavine Creek. Near the east end of the facility two gentle drainage paths are visible in the topographic survey of the site. These will be maintained, and the flows will be allowed to fan out, as they currently do, across the heliostat field.

The grading plan, discussed later, will be such that storm flows follow pre-existing paths. The majority of the project site, within the perimeter fence, will be very lightly graded to allow truck access throughout heliostat field.

The solar generating facility will be left in an “as-is” condition, as the majority of the heliostat field vegetation will be cut and heliostats will be installed at the current grades, without any on-site grading. Therefore, the flows will generally follow the predevelopment flow patterns. A detention facility will be constructed on the west portion of the solar field to detain the release of on-site flows to match pre development conditions, to allow infiltration, and to provide a location for sediment control before the storm water is discharged from the site.

Concentration of flows will be minimized by the use of check dams, stone filters, armored areas, and diversion swales that keep water from concentrating in areas of steeper slope. The detention facility

located in the west portion of the solar field will be constructed in order to slow the water, allow it to infiltrate, and to promote flow patterns into their existing drainage patterns.

The storm water drainage system will be designed using the Soil Conservation Service (SCS) method (TR-55) to determine the amount of rainfall during a specific rainfall event, and in accordance with requirements specified in the most current versions of the Nye County design requirements.

All surface water runoff during and after construction will be controlled in accordance with the requirements of the General Construction and General Industrial Storm Water NPDES Permit, the requirements of Nye County, and all other applicable laws, ordinances, regulations, and standards.

The power island will be graded such that all rainfall within the power island will be directed to the containment ponds adjacent to the on-site salt tanks and allowed to infiltrate. Pipe culverts will be used, as desired, where storm channels cross roads.

4.10 Vegetation Treatment and Weed Management

The developed portions of the site will be cleared of vegetation, grubbed and graded level (approximately 1,600 acres). This is necessary for construction access, fire prevention and to risk of damage to mirrors by vegetation when placed into stow position. The following additional vegetation management principles will be implemented.

- Soil disturbance in support of construction will increase the likelihood of noxious weed introductions. Regular weed monitoring and management during construction would be required. Ongoing maintenance activities within the solar field would also have the potential for ongoing introduction of weedy species through soil disturbance and equipment entrance. As a result, ongoing weed management will be required as discussed below.
- Where temporary access is needed to install facilities or site leveling is not required for drainage or access, no removal of existing vegetation or grading would occur. Rather, trucks and equipment would drive over and crush existing desert scrub vegetation without direct removal. Crushed vegetation is much more likely to show a rapid recovery than sites where vegetation is removed and reseeded, or where soils are more intensively disturbed.
- Revegetation with native species would be implemented to the extent feasible. Areas of temporary disturbance, such as pipeline routes, temporary construction roads and temporary construction support, staging and laydown areas will be recontoured and revegetated.

The Applicant will develop a Preliminary Weed Risk Assessment and Weed Management Plan (WMP) for the Site that describes the non-native, noxious or invasive weed species that occur or are likely to occur in the Site, and prescribes management actions that may be taken to monitor for and eradicate specified species, including mechanical and chemical methods approved by BLM. The WMP will also describe applicable regulations for the use of herbicides on federally managed lands in Nevada, and provide the basis for proper management and use of herbicides at the Site. A pre-emergent herbicide will be applied in the spring, and spot foliar applications will be used throughout the year to maintain the area free of vegetation.

Typical operations and maintenance requirements for native landscapes are low once established. The WMP will include weeding, annual pruning, and soil monitoring if necessary. Weeding should occur frequently, typically weekly, during the initial growth period to ensure that invasive plants do not mature and set seed. Weeding activities would follow the approved WMP. Once the native plant species are established, weeding frequency would drop to less frequent intervals.

4.11 Fire Protection

The project will rely on both onsite fire protection systems and offsite fire protection services during both construction and operations. The fire protection system would be designed to protect personnel and limit property loss and plant downtime in the event of a fire. The primary source of fire protection water would be the Service / Fire Water Storage Tank.

A Fire Protection and Prevention Plan will be prepared for construction and operation of the facility. The plans will include measures relating to safeguarding human life, preventing personnel injury, preservation of property and minimizing downtime due to fire or explosion. Fire protection measures will include fire prevention methods to prevent the inception of fires. Of concern are adequate exits, fire-safe construction, reduction of ignition sources, control of fuel sources, and proper maintenance of fire water supply and sprinkler systems.

During construction, the permanent facility fire suppression system will be placed in service as early as practicable. Prior to installation of the facility's permanent fire suppression system, fire extinguishers and other portable fire fighting equipment will be available onsite. These fire extinguishers will be maintained for the full construction duration, in accordance with local and federal OSHA requirements. During construction, water trucks would be first in and last out of the site for fire control purposes. Installation of a construction water source will be one of the first activities in order to provide an on-site source for construction and prevention water.

Locations of portable fire extinguishers would include, but not necessarily be limited to, portable office spaces, hot work areas, flammable chemical storage areas, and mobile equipment (e.g., passenger vehicles and earthmoving equipment). Fire-fighting equipment would be located to allow for unobstructed access to the equipment and will be conspicuously marked. Portable fire fighting equipment would be routinely inspected per regulatory requirements and replaced immediately, if defective, or if in need of recharge.

The facilities operating fire protection water system will be supplied from a dedicated portion of the water storage tank located on the plant site. One electric and one diesel-fueled backup firewater pump, each with a capacity of approximately 3,000 gallons per minute, will deliver water to the fire protection water-piping network. A smaller electric motor-driven pump jockey pump will maintain pressure in the piping network. If the jockey pump is unable to maintain a set operating pressure in the piping network, the diesel fire pump starts automatically.

A piping network will be configured in a loop so that a piping failure can be isolated with shutoff valves without interrupting the supply of water to a majority of the loop. The piping network will supply fire hydrants located at intervals throughout the power plant site, a sprinkler deluge system at each unit

transformer, and sprinkler systems at the STG lube oil equipment. Sprinkler systems would also be installed in the Administration/Control/Warehouse/Maintenance Building and Fire Pump enclosure as required by National Fire Protection Association (NFPA) and local code requirements. Handheld fire extinguishers of the appropriate size and rating would be located in accordance with NFPA 10 throughout the facility.

The vegetation within the limits of the project (generally within the confines of the perimeter fence) will be removed. Vegetation removal will be one of the early project activities, and this vegetation free area will provide protection from offsite fires during both construction and operations. Off site fires would burn to just outside the perimeter fence and extinguish themselves due to lack of fuel. The perimeter fence will be constructed of galvanized posts, and galvanized chain link fence (non-combustible material). The project will ensure that flammable material is not stored near the perimeter of the project, thus further reducing the risk from off site fires.

4.12 Site Security

Chain link security fencing will be installed around the site perimeter, switchyard and other areas requiring controlled access prior to beginning construction. Site perimeter fence will be 8 feet high and have an overall height of no more than 10 feet from the bottom of the fabric to the top barbed wire. The fence will have top rail, bottom tension wire, and three strands of barbed wire mounted on 45 degree extension arms. Posts will be set in concrete.

Controlled access gates will be located at the entrances to the facility. Site gates will be swing or rolling type access gates. Access through the main gate will require an electronic swipe card, preventing unaccompanied visitors from accessing the facility. All visitors will be logged in and out of the facility during normal business hours. Visitors and non-employees will be allowed entry only with approval from a staff member at the facility. Visitors will be issued visitor passes that are worn during their visit and returned at the main office when leaving.

Personnel will staff the facility 24 hours per day/seven days per week. Even when the solar power plant is not operating, personnel will be present as necessary for maintenance, to prepare the plant for startup, and/or for site security.

4.13 Hazardous Materials and Waste Management

There will be a variety of chemicals and hazardous substances stored and used during construction and operation of the project. The storage, handling, and use of all chemicals will be conducted in accordance with applicable laws, ordinances and regulations (see **Table 2**).

Table 2

Hazardous Waste Laws, Ordinances & Regulations (LORS)

LORS	Applicability
Federal:	
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund), 42 USC §9601 *et seq.,* 40 Code of Federal Regulations (CFR) Part 302, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA)	Requires notification to various agencies when there is a release of hazardous substances from a facility.
Emergency Planning and Community Right to Know Act (EPCRA), 42 USC §11001 *et seq.* 40 CFR Parts 350, 355, and 370	Requires inventory reporting, planning and reporting for hazardous and acutely hazardous materials.
Occupational Safety and Health Standards, 29 USC Section 65129; 29 CFR 1910 *et seq*. and Safety and Health Regulations for Construction, 29 CFR 1926 *et seq*.	Specifies standards for hazardous materials storage, handling, and worker protection in emergencies.
Oil Pollution Prevention, 40 CFR 112	Requires the preparation of a Spill Prevention Control and Countermeasures (SPCC) Plan.
Chemical Facility Anti-Terrorism Standard, 6 CFR Part 27	Requires facilities that use or store certain hazardous materials to submit information to the Department of Homeland Security (DHS) so that a vulnerability assessment can be conducted to determine what security measures should be implemented.
State:	
Storm Water Pollution Prevention, General Permit NVR100000	Requires the preparation of a Storm Water Pollution Prevention Plan for construction and industrial activities.
Local:	
International Fire Code, Nye County Code Section 15.16.010	Adopts the International Fire Code, 2003 Edition, into Nye County regulations.
Industry Codes and Standards:	
American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI) and American Society of Testing Materials (ASTM)	Sets forth standards for power plant design, including mechanical systems, electrical, and piping.
Uniform Fire Code, Articles 79, 80, and others	Sets forth requirements for the storage and handling of hazardous materials.
National Fire Protection Agency (NFPA)	Establishes fire prevention standards and guidelines.

The following planning documents will specify procedures for the proper storage and management of these substances at the Site.

Health and Safety Requirements - To comply with regulations set forth by the Occupational Health and Safety Administration (OSHA) and the Nevada Division of Industrial Relations, health and safety programs will be established for construction and operations at the Site that will document potential hazards and requirements for establishing and maintaining a safe working environment during construction and operation. The programs will include identification of all hazardous substances and chemicals used at the site, including Material Safety Data Sheets (MSDS), a communication and training program, labeling, and identification of hazards and safe work practices. In addition, safety showers and eyewashes would be provided adjacent to, or in the vicinity of, chemical storage and use areas. Plant personnel would use approved personal protective equipment during chemical spill containment and cleanup activities. Personnel would be properly trained in the handling of these chemicals and instructed in the procedures to follow in case of a chemical spill or accidental release. Adequate supplies of absorbent material would be stored onsite for spill cleanup.

Construction and Operating Stormwater Pollution Prevention Plans (SWPPP) – The project will comply with the requirements of the National Pollutant Discharge Elimination System (NPDES) through preparation and implementation of a SWPPP and filing of a Notice of Intent (NOI) to comply with the General Construction and General Industrial Stormwater NPDES Permit. The plans will include procedures to be followed during construction to prevent erosion and sedimentation, non-stormwater discharges, and contact between stormwater and potentially polluting substances.

Hazardous Materials Business Plans (HMBP) – Hazardous Materials Business Plans will be filed with Nye County for the construction and operation of the facility. The plans will inventory the hazardous materials and waste properties, quantities, storage containers and locations, and contingency planning and emergency response procedures.

Spill Prevention Control and Countermeasure Plans (SPCC) - SPCC Plans will be prepared for construction and operation of the Site. The plans will include spill prevention and countermeasures procedures to be implemented including (but not limited to) a spill record (if applicable), analysis of potential spills, description of containment facilities, fill and overfill prevention facilities, spill response procedures, personnel training and spill prevention. In addition, all spills will be reported to the BLM Hazardous Materials Coordinator.

A table of the chemicals and hazardous substances anticipated to be used at the Site and their storage locations is provided in **Table 3**, below. This list identifies each chemical by type, intended use, hazardous characteristics and estimated quantity to be stored onsite.

Table 3

Potential Project Hazardous Materials

Material	Chemical Abstract Service Number (CAS No.)	Use	Hazardous Characteristics	Estimated Quantity On Site
Carbon Dioxide (gas)	124-38-9	Generator purging	Asphyxiant, compressed gas	25,000 scf
Carbon Dioxide (liquid)	124-38-9	Fire suppression	Asphyxiant, compressed liquid, cryogen	25,000 lb
Diesel Fuel (No. 2)	68476-34-6	Fuel for emergency generator, fire water pump, and diesel storage for vehicle use	Toxic, combustible	11,500 gal
Ferric Chloride Solution	7705-08-0	Possible use for water pretreatment	Toxic	3,000 gal
Hydrogen	1333-74-0	Generator cooling	Toxic, flammable, explosive	24,000 scf
Hydrated Lime	1305-62-0	Possible use for water pretreatment	Toxic, corrosive	2,000 cf
Lubricating Oil	Various	Mechanical equipment lubrication	Toxic, combustible	25,000 gal
Mineral Oil	Various	Transformer oil	Toxic, combustible	100,000 gal
Nitrogen	7727-37-9	Blanketing	Asphyxiant, compressed gas	400 lb
Sodium Carbonate	497-19-8	Water pretreatment	Toxic	2,000 cf
Sulfur Hexafluoride	TBD	Contained in switchgear devices	Toxic	200 lbs
Sodium Hydroxide (50 % by weight)	1310-73-2	Possibly water demineralizer media regeneration	Toxic, corrosive	3,000 gal
Sulfuric Acid (29 % by weight)	7664-93-9	Batteries	Toxic, corrosive	2,000 gal
Sulfuric Acid (93 % by weight)	7664-93-9	RO feed pH control, possibly water demineralizer media regeneration	Toxic, corrosive	5,000 gal

The solar facility will require the use of large amounts of nitrate salt ($NaNO_3$, CAS 7631-99-4; and KNO_3, CAS 7757-79-1 at the site. The salt will be melted once during construction of the project and used throughout the project life at temperatures between 550° F and 1050° F. To ensure worker safety, the hot and cold HTF tank areas will be designed such that any release would be contained in a basin. The Construction SWPPP will specify procedures to prevent contact between HTF and stormwater during processing of this material prior to plant startup. In addition, the processing area would be cleaned to assure residual HTF is removed from surface soil after processing.

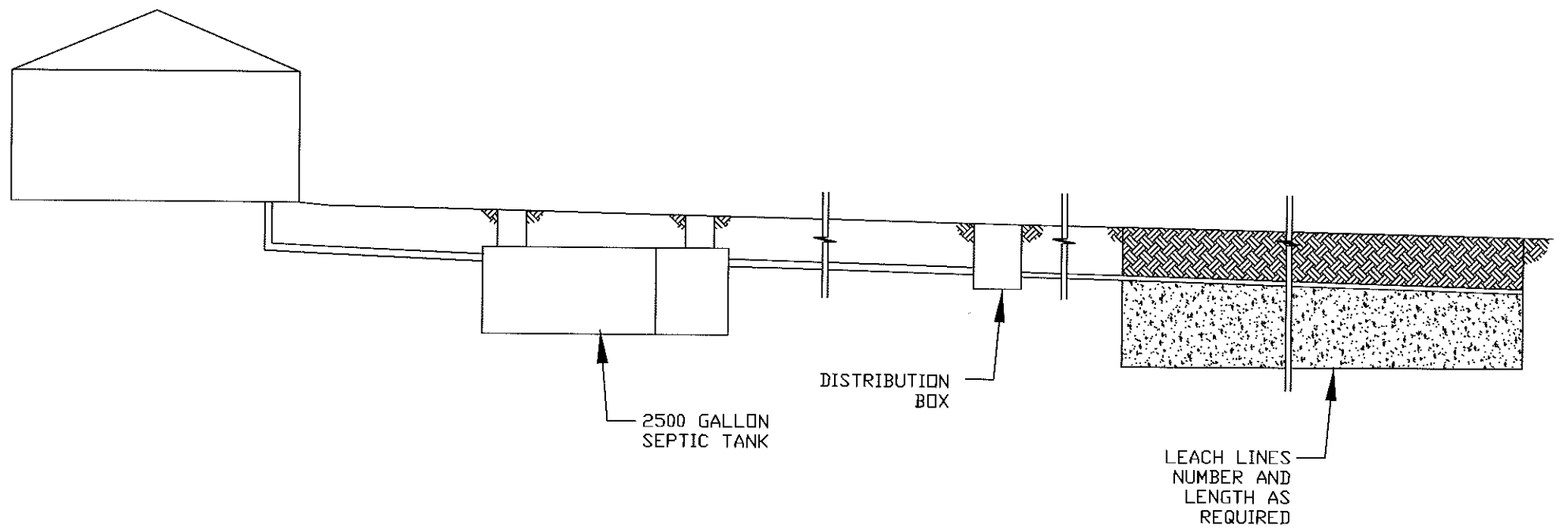
Industrial wastewater would consist of a relatively small amount of blowdown from the steam system and reverse osmosis treatment return flow. This wastewater would be disposed in evaporation ponds at the Site. A Technical Document will be submitted to the Nevada Division of Environmental Protection to permit evaporation ponds for industrial wastewater disposal at the site. The Technical Document will include waste characterization, impoundment design, leak collection and detection, construction and operating parameters for the ponds, and closure requirements.

Domestic wastewater will be treated and disposed at the site using a septic disposal system consisting of septic tanks and leach field permitted with the Nevada Division of Environmental Protection and Nye County. It is anticipated that separate septic and leach field systems would be constructed for each of the power blocks and administrative buildings. These would be designed in accordance with local and state regulations by a licensed engineer. A typical/proposed schematic of this is shown below in **Figure 14, Proposed Septic System.**

The project would produce maintenance and plant wastes typical of a power generation plant. These wastes will be managed in accordance with a Waste Management Plan. Wastes may include oily rags, broken and rusted metal and machine parts, defective or broken solar mirrors and electrical materials, empty containers, and other miscellaneous solid wastes including the typical refuse generated by workers. These materials would be collected by a local waste disposal company and disposed at a landfill permitted to receive these wastes. Waste collection and disposal would be in accordance with applicable regulatory requirements to minimize health and safety effects, prevent leaks and spills, and prevent potential contact with stormwater.

Several methods would be used to properly manage and dispose of hazardous wastes generated by the project. Waste lubricating oil would be recovered and recycled by a waste oil recycling contractor. Spent lubrication oil filters would be disposed of in a Class I landfill. Workers would be trained to handle hazardous wastes generated at the site.

Chemical cleaning wastes will consist of alkaline and acid cleaning solutions used during pre-operational chemical cleaning of heat exchangers after the units are put into service. These wastes, which can contain elevated metal concentrations, would be temporarily stored on-site in portable tanks, and disposed of off-site by a chemical cleaning contractor in accordance with applicable regulatory requirements.



PROFESSIONAL ENGINEER-STATE OF NEVADA
DAVID H.
AKOLA
Exp: 12-31-2010
CIVIL
No. 7072

11/23/09

PRELIMINARY
NOT FOR CONSTRUCTION

CRESCENT DUNES SOLAR SITE

SCALE: 1" = 10'

10 0 10 20 30

FIGURE 14

REVISION #	BY	DATE	DESCRIPTION
A	DA	4-29-09	FOR POD

DRAWN BY: D. AKOLA CAD FILE:

PROJECT MANAGER: BOB ANDERS

PROPOSED SEPTIC SYSTEM

TONOPAH SOLAR ENERGY, LLC
CRESCENT DUNES SOLAR SITE
NYE COUNTY, NV

WorleyParsons
resources & energy

4.14 Health and Safety Program

A Health and Safety Program will be established for construction and operation at the Site. The Program will include the following components:

- Policies and Responsibilities;
- Emergency response and contingency planning;
- Hazard identification and job safety analysis;
- Hazard communication;
- Safe work practices;
- Personal protective equipment;
- Hazardous work permitting systems;
- Special considerations for electrical safety, hazardous materials and wastes, fall protection, confined spaces and mobile equipment safety;
- Training requirements;
- Incident reporting and investigation; and
- Record keeping requirements.

The project would also develop and implement a Construction Safety Training Program that would be adapted to serve as an Operations Safety Training Program as the project transitions from construction into routine power generation facility operations. As mentioned above for the Health and Safety Program, the elements of the Safety Training Program will be essentially the same for operations as for construction, but specifics of the training would be adapted as needed to be suitable for the specific work activities associated with operations to the extent that the various activities differ between the two phases. Typical training courses and the employees who are required to receive the training are provided in **Table 4** below.

Table 4 – Training Program

Training Course	Target Employees
Injury and Illness Prevention Training	All employees.
Emergency Action Plan Training	All employees.
PPE Training	All employees.
Heavy Equipment Safety Training	Employees working on, near, or with heavy equipment.
Forklift Operation Training	Employees working with forklifts.
Excavation and Trenching Safety Training	Employees involved with trenching or excavation operations.
Fall Protection Training	All employees.
Scaffolding and Ladder Safety Training	Employees required to use or erect scaffolding and employees using ladders.
Hoist and Rigging Program	Employees and supervisors responsible for conducting hoists and rigging operations.

Table 4 – Training Program

Training Course	Target Employees
Crane Safety Training	Employees supervising, crane operators, and employees involved in crane operations.
Fire Protection and Prevention Training	All employees.
Confined Space Entry Program	All employees
Blood Borne Pathogens Training	First Responders
Hazard Communication Training	Employees working with or handling hazardous materials.
Electrical Safety Training	Employees performing work with electrical systems, equipment, or electrical extension cords. Additionally, employees working with lockout/tagout activities.
Hand and Portable Power Tool Safety Training	All employees.
Heat Stress and Cold Stress Safety Training	All employees.
Hearing Conservation Training	All employees.
Back Injury Prevention Training	All employees.
Safe Driving Training	All employees.
Pressure Vessel and Pipeline Safety Training	Employees supervising or working on pressurized vessel, pipes, or equipment.
Respiratory Protection Training	All employees required to wear respiratory protection equipment.
Hot Work Training	All employees working with welding, heating, or other equipment that generates ignition sources.

5. REQUIRED PERMITS AND AUTHORIZATIONS

All construction, operation, and maintenance activities associated with the proposed project would be conducted in compliance with all relevant federal, state, and local regulations and permit requirements.

Table 5 below, Potential Project Required Approvals and Permits provides a summary of the permits and authorizations that the Applicant may be required to obtain prior to construction and operation of the facility.

Table 5
Potential Project Required Approvals and Permits

FEDERAL PRELIMINARY LIST OF KEY APPROVALS AND PERMITS				
Regulatory Agency Level	**Agency**	**Permit Potentially Required**	**Regulatory Requirement**	**Comment or Application Type**
FEDERAL	BLM	Application for transportation and Utility Systems and Facilities on Federal Lands (SF 299) (Right-of-Way Authorization Permit)	This Right-of-Way Authorization permit serves all commercial solar energy facilities per BLM Instruction Memorandum No. 2007-097, April 4, 2007 (BLM Solar Energy Development Policy).	This application starts the process to gain right-of-way on BLM land; same as the BLM's previous Conditional Land Use Permit.
FEDERAL	BLM	Environmental Assessment (EA) or Environmental Impact Statement (EIS)	An evaluation of the Project's effects on natural and human resources to determine the potential for significant impacts.	Preparation of an EIS is required if significant impacts can not be mitigated.
FEDERAL	BLM	Plan of Development (POD)	Plan for construction and operation of solar facility must be completed prior to beginning of the NEPA process. POD provides full Project description including applicant information, site location, maps, and proposed operating plan.	
FEDERAL	BLM	National Historic Preservation Act (NHPA) Section 110; EO11593	Archaeological contractor needs to complete Class I inventory (e.g., file search for sites within area of potential effect (APE)). Contractor needs to complete 100 percent Class III survey of APE. If any historic structures are present, additional documentation could be needed.	

FEDERAL	BLM to contact Nevada SHPO and Tribal Historic Preservation Office	NHPA, Section 106 Review (36 CFR 800)	Information for Section 106 compliance would be based partly on findings of a Class III archaeological survey. Contractor would prepare draft letters.	The Nevada SHPO, Office of Historic Preservation, Department of Parks and Recreation and appropriate Tribal Historic Preservation Officers must be consulted when Projects are subject to review under Section 106 of the NHPA. This act requires that all federal agencies take into account the affect of their actions on historic properties (properties on or eligible for the National Register of Historic Places). Requirements of Section 106 review apply to federal undertaking, funding, license, or permit. The Advisory Council on Historic Preservation (ACHP) must be provided an opportunity to comment.
FEDERAL	BLM, State Office	BLM Cultural Resource Use Permit	Permit to be obtained by archaeological contractor; application includes outline of proposed work; name of institution and Project principal investigator; dates of field work; type of investigations; description of sites(s) with specific location information; and copy of agreement with institution where collections would be preserved.	Archaeological contractor to obtain Cultural Resource Use Permit from BLM prior to beginning work.
FEDERAL	BLM, Tonopah Field Office	BLM Field Use Authorization	Holder of Cultural Resource Use Permit obtains a Field Use Authorization for the Project from BLM field office.	Contact appropriate Field Office Archaeologist. Field Authorization Form requests specific information on the location, schedule and nature of the archaeological fieldwork and allows BLM to communicate specific constraints on a Project type, schedule or location.

FEDERAL	BLM	Archaeological Resources Protection Act (ARPA) of 1979, as amended Section 4	Holder of Cultural Resource Use Permit provides a research design and plan of work for the research Project to obtain an ARPA permit.	This permit would be needed if subsurface investigations are needed to identify the National Register of Historic Places significance of an identified site.
FEDERAL	U.S. DOD	DOD R-2508 Complex Sustainability Office Review and Approval	Review the Project and its potential impact on military overflights and operations	A letter from the DOD, stating that construction and operation of the array would not adversely affect DOD operations will be sufficient to meet this requirement; such a letter would be included in the EIS and submitted to the applicable County Planning agency.
FEDERAL	USFWS	Endangered Species Act (ESA) Section 7 Consultation	Informal consultation with the USFWS will determine if listed species are present on the Project site. A BA will be prepared as part of the information consultation. If listed species are present, formal consultation with the USFWS and preparation of a BA requires site surveys by qualified and certified wildlife biologists.	BLM will initiate informal consultation with USFWS
FEDERAL	USACE	Clean Water Act, Section 404 Permit	Placement of dredged or fill materials in waters and/or wetlands, as well as the performance of any work in navigable waters of the United States, requires a USACE permit. Need to delineate all wetlands and waters of the U.S. with the potential to be affected by the Project; quantify potential impacts and propose mitigation to offset impacts.	
FEDERAL	FAA	Federal Aviation Regulation Part 139 Sec. 139.331	Any airport under FAA certification must ensure that each classifiable obstruction is removed, marked, or lighted in accordance to FAA rules.	An object would be classified as an obstruction to air navigation if it is: (1) a height of 500 feet above ground level at the site of the object; (2) a height that is 200 feet above ground level or above the established airport elevation, whichever is higher, within 3 nautical

				miles of the established reference point of an airport, etc.
State or Local	NDEP Bureau of Air Pollution Control or local county Health Department, depending on project location.	Air Permit - PSD Permit (Authority to Construct).		
State	PUCN	UEPA to construct with PUCN.	NRS 704.820 – 704.900.	
State or Local, depending on location	NDEP Bureau of Air Pollution Control or Local county Health Department	Construction Permit - State/Local Permit to Construct /Operate. Same as the Authority to Construct (ATC) permit.		The Air Permit is the same as the ATC permit and the Construction Permit.
State or Local, depending on location	NDEP or local county Health Department	Solid Waste Disposal Facility Permit-operations		This permit is only necessary if disposing on-site.
State	NDEP	Dust Control Plan-Power Plant Site	NDEP, NRS 321.001.	
State	NDEP	Dust Control Plan-Laydown area and Parking	NDEP, NRS 321.001.	
State	Nevada Department of Transportation (DOT)	Occupancy Permit		Occupancy Certificate is issued after final inspection, once all occupied buildings are completed
State		Permit to Open State Highway		Included in Grading Permit
State		Temporary Power Permit		Requires Nevada State Licensed Electrical contractor to sign off on grounding.
State	NDEP Bureau of Air Pollution Control	CEMS Certification Plans		Continuous Environmental Monitoring Systems.
State	NDEP Bureau of Water Pollution Control	SPCC - Construction		

State	NDEP Bureau of Water Pollution Control	SPCC - Operations	
State	State of Nevada Fire Marshall	Health Permit for Hazardous Materials	This permit needs to be filed within the first 30 days of operation.
State		AST Permit/Notification (For Petroleum Storage)	
State	NDEP Bureau of Water Pollution Control	SWPPP	This permit is the SWPPP.
State	NDEP Bureau of Water Pollution Control	SWPPP for Operations	Provide a NOI for filing after stormwater discharge pond design has been developed. NOI and SWPP must be filed simultaneously within one month of the start of operation.
State	NDEP Bureau of Water Pollution Control	Soil Erosion and Sediment Control Plan - Operations	Part of SWPPP
State	NDEP Bureau of Water Pollution Control	Storm Water Detention Plan - Operations	Part of SWPPP
State	NDEP Bureau of Water Pollution Control	Groundwater Discharge Permit	
State	NDEP Bureau of Water Pollution Control	AST Permit/Notification (For Petroleum Storage)	
State	Nevada Division of Wildlife	Artificial Pond Permit	
State	NDEP Bureau of Water Pollution Control	On-site Sanitary Disposal System (Septic System) Permit	
State	NDEP Bureau of Water Pollution Control	Ground Water Well Approval (Point of Diversion Permit (Permanent))	
State	NDEP Bureau of Water Pollution Control	Ground Water Well Approval (Point of Diversion Permit (Temporary))	

Because the Applicant would need to obtain a Right of Way (ROW) from the Bureau of Land Management (BLM), this project would be subject to BLM jurisdiction. Under federal law, BLM is

responsible for processing requests for rights-of-way to authorize projects (such as the one described herein) and associated transmission lines and other appurtenant facilities to be constructed and operated on land it manages. In processing the applications, BLM must comply with the requirements of the National Environmental Policy Act (NEPA), which requires that federal agencies reviewing projects under their jurisdiction consider the environmental impacts associated with their construction and operation. In the case of solar thermal power plant projects, this would be accomplished through preparation of Draft and Final Environmental Impact Statements (EIS).

Separate consultation requirements and associated documentation are required for Section 106 of the National Historic Preservation Act and Endangered Species Act (ESA) section 7 consultations associated with the project, should they be required. These consultations would be completed by BLM. BLM is also responsible for Native American consultation, including Government to Government consultation. The result of this cooperative effort is intended to result in a public participation process and environmental document that fully meets BLM's requirements.

Table 6 below summarizes the estimated project development schedule. Section 6.1 includes a timetable indicating the anticipated duration and sequence of construction.

Table 6
Project Development Schedule

Phase	Schedule
Prepare, review and approve Plan of Development	Dec 2008 (with updates as needed)
Field studies and resource reports in support of the Environmental Impact Study (EIS)	May 2009 – February 2010
EIS Process	December 2009 – November 2010
BLM File ROD	December 2010
BLM issues ROW	December 2010
Construction	February 2011 – August 2013

6. CONSTRUCTION

6.1 Construction Process and Conceptual Schedule

Construction of the generating facility, from site preparation and grading to commercial operation, would be expected to take about 30 months. It would take about 100 man-years of construction workers' time to build the plant. The man loading will follow a bell shaped curve over the 30 months of construction and will peak at approximately 400 to 500 personnel of construction craft people, supervisory, support, and construction management personnel onsite during construction.

Typically, construction would be scheduled to occur between 5AM and 7PM on weekdays and Saturdays. Additional hours may be necessary to make up schedule deficiencies, or to complete critical construction activities (e.g. pouring of concrete at night during hot weather, working around time-critical shutdowns and constraints). During some construction periods and during the startup phase of the project, some activities would continue 24 hours per day, seven days per week. The items of work that may occur 24 hours per day include, but are not limited to placing and finishing concrete (due to cooler nighttime temperatures), welding on critical pipe systems (these may be critical path items and need expediting), radiation testing of the welds on certain pipes (completed when staff is vacated from the area), electrical terminations, DCS wiring and programming, heliostat assembly (if this seems to be falling off schedule), and preparation for start up testing. Because this is a solar plant, testing of the facility requires adequate energy supply (i.e. the sun). Therefore, preparations may take pace overnight to ready the facility for start up tests the following day, when sun will provide the energy to power the start up testing.

Table 7 below represents a conceptual project schedule beginning with site mobilization. The activities listed below are representative of Tonopah Solar Energy projects.

Table 7
Project Schedule

Activity	Date/Timeframe
SITE CONSTRUCTION	
Start Construction	Month 1
Mobilization	Month 1
Delineate and mark the boundaries of the construction zone	Month 1
Stabilize construction entrance/exit and roadway. Install tire wash	Month 1
Establish parking and staging areas for vehicle and equipment storage, maintenance	Month 1
Establish laydown area(s) for materials storage/staging	Month 1
Establish concrete washout area	Month 1
Clear and Grub - Strip topsoil	Months 1-2
Install certified weed-free fiber rolls or silt fence at the base of slopes adjacent to delineated sensitive areas (i.e., wetlands), if any	Months 1-2
Construct stormwater infiltration/evaporation area	Month 3-6
Assemble and erect heliostats	Month 10-20
Power block construction	Month 6-24
Construct reinforced concrete foundations	Month 6-24
Construct administration/warehouse building	Month 20-22
Final stabilization of site	Month 27
Commissioning and testing	Months 27-30

6.2 Project Phasing

The construction phases for each of the proposed projects are expected to be as follows:

Site Disturbance – Within the heliostat array fields, the power block area, the permanent facilities located around the perimeter road and in the temporary construction logistics area, clearing would be performed. All vegetation would be removed with a brush rake in order to separate the vegetation from the soil.

Preparation – Parking areas for construction workers and laydown areas for construction materials would be prepared. Detailed information regarding the location of the construction parking is shown on Figure 9, Ancillary Uses.

Access Road – Primary access to the site would be from State Route 89 (Highway 89) along the access road and to the site. Access road beds would typically be 24-foot-wide asphalt roads with 2-foot-wide crushed rock shoulders. A stabilized entrance/exit would be provided to clean vehicle wheels prior to

exiting the construction area. Most construction staff and workers would come daily to the jobsite from Tonopah, located south east of the project location.

Site Grading – The existing site has a slope of approximately 2%. Where required, grading will take place to generally maintain the minor slopes of the terrain. The majority of the site is suitable at its current grade, and only the vegetation will be cut to provide a surface adequate for installing the heliostats. Where light grading is required, only nominal cuts and fills (generally less than 6") will be made to smooth out the heliostat field to create a drivable surface and for heliostat installation and maintenance. Nominal grading of the site would be limited to the power block areas, receiving towers, the access road, and any associated roadside ditches. The proposed grading plan for the power block is shown in Figure 12, Power Block Grading & Drainage. On this more detailed drawing, it can be seen that the more significant cuts and fills are limited to the power block. Excess sand, gravel and soils are not anticipated.

Foundation – All underground piping and wiring would be installed, followed by installation of the foundation for the new power blocks, solar towers, and associated structures.

Plant Construction – After final site design and prior to any soil disturbance, the Applicant would be required to finalize the Drainage, Erosion, and Sediment Control Plan / Construction SWPPP (DESCP / SWPPP). During construction, the Applicant would be required to follow the DESCP/SWPPP to prevent the offsite migration of sediment and other pollutants and to reduce the effects of runoff from the construction-site. Best Management Practices (BMPs) to be used at the site would be fully addressed in the DESCP/SWPPP; the DESCP/SWPPP would include the location of BMPs to be used, installation instructions, and maintenance schedules for each BMP.

Site Stabilization – It is expected that site stabilization will include soil binders, geo-grid or the use of aggregate surfacing to allow the movement of maintenance vehicles and mirror wash water trucks to travel within the solar array. The predominant surface soil is expected to be relatively well graded soil, sand, and gravel, very similar to the existing surface conditions that currently exist on the site. The power block area would be graded with moderate slopes to direct runoff into the salt containment basin. This will allow the storm water to infiltrate locally. The western area of the site will contain the detention pond that will provide an area to allow sediment to be deposited and on-site storm water to be controlled.

Demobilization – All temporary construction facilities would be removed and recontoured and revegetated as necessary. The project construction team or contractor would mobilize and develop temporary construction facilities and laydown areas adjacent to the power block. Once a final design has been established, the contractor would prepare site maps showing the construction project in detail. Temporary facilities would include:

- Approximately 10 single-wide full-length trailer offices or equivalent
- Chemical toilets
- Parking for approximately 500 vehicles
- Approximately 15 tool sheds/containers
- Equipment parking for approximately 20 pieces of construction equipment
- Construction material laydown area
- Solar field equipment laydown area

- Batch plant
- Rock processing equipment
- Construction Access and Material/Equipment Delivery

These items are more accurately shown in the figures provided with this POD update.

6.3 Construction Work Force and Equipment

The construction workforce will consist of a total of approximately 400 to 500 personnel at peak for construction, including supervisors and management personnel, with an average of approximately 250 crewmembers on-site at any given time. Project construction will also require additional support staff, including construction inspectors, surveyors, project managers, and environmental inspectors.

Prior to commencing construction, crews will mobilize to the Site. During this time, equipment and construction materials will be transported to the designated construction staging areas, and trailers and temporary shop buildings will be established. In addition, personnel will receive appropriate safety and environmental training. Signage may also be erected at this time to designate approved access, fueling, smoking, concrete washout, and exclusion areas. **Table 8** outlines the construction process.

Table 8 – Construction Process

Construction Phase	Description	Approximate Number and Type of Construction Equipment and Vehicles
Rough Grading	Grubbing, clearing and bulk grading, including approximately 500,000 cubic yard of cut and compacted fill	Approximately 5 Scrapers, 2 Compactors, 3 Graders, 2 Loaders, 4 Dozers, 5 Water Trucks, 3 Water Pulls
Finish Grading	Final grading to finish grade at a rate of approximately 960,000 sf/day (22 acres).	Approximately 2 Scrapers, 3 Graders, 1 Dozer, 4 Water Trucks
Roads, Foundations, Flatwork and Site Utilities	Construction of roads, excavation and construction of foundations for	Approximately 20 to 40 pieces of equipment will be present at any one time, including concrete trucks, concrete pumps, backhoes, excavators, loaders, graders, foundation drills, paving machines, drum rollers, fork lifts, tractors, dump trucks, small cranes and additional support vehicles.
Heliostat Assembly and Deployment	Field assembly of heliostats in temporary shop buildings constructed at the site. Installation of assemblies on cast-in-place piers, or other foundations.	Approximately 8 to 10 crews, each with one or two pieces of equipment including small cranes, forklifts, welding machines, trucks and tractors.

Power Block Construction	Construction of foundations, structural frames and buildings, installation of utilities and equipment, including the STG, condenser, pumps, buildings, ACC cooling structure, TES tanks, and central receiver tower.	An average of 12 to 18 pieces of equipment will be utilized for power block construction over the duration of the project, with more equipment being utilized during the early stages of foundation construction and frame erection. Equipment will include backhoes, excavators, foundation drills, concrete trucks, concrete pumps, forklifts, boom trucks, lifts, cranes, welders, trucks and other support vehicles.
Liquid Salt Preparation	Melting of the delivered dry salt product	Temporary propane, electric, or natural gas fired auxiliary boiler, forklifts, loaders, and trucks.

6.4 Site Preparation

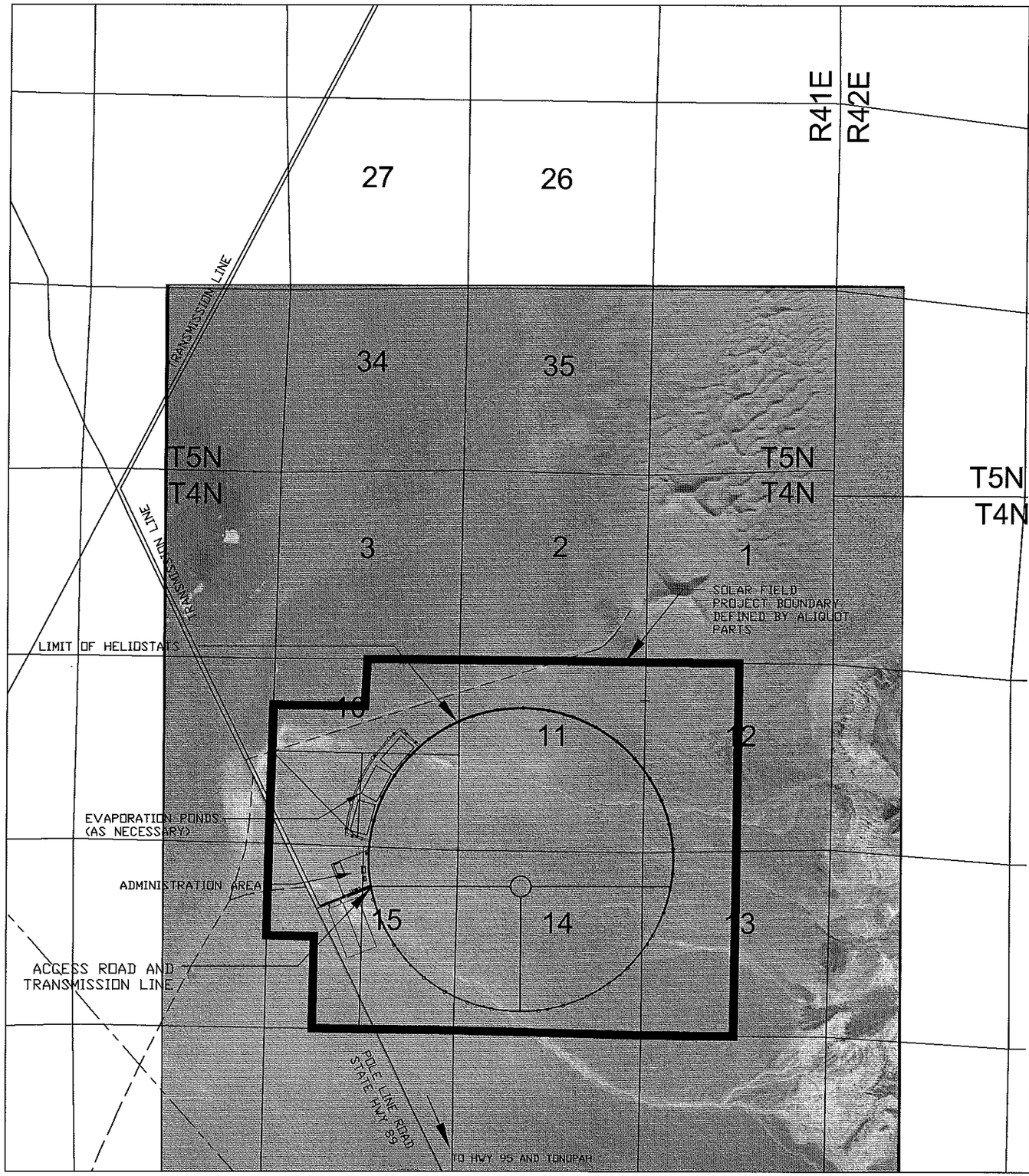
Although the site currently contains very little vegetation (refer to **Figure 15, Grading Aerial** and **Figure 16, Site Photos**), site preparation will include the removal of vegetation within all areas to be disturbed. Removal of plant material will be done with heavy equipment and may include the use of a bull dozer equipped with a brush rake. Waste vegetation will be chipped and incorporated into the topsoil, chipped and spread on disturbed areas that are not part of the permanent project, or burned. Any topsoil encountered that is not suitable for structural fill will be stockpiled temporarily and re-used in the disturbed areas outside the permanent project facilities (for example the construction lay down and parking area). A temporary fence will be installed around the construction lay down and parking area and the permanent plant fence facility will be installed as soon as doing so will not disrupt construction of the project.

6.5 Clearing, Grading, and Excavation

Excavation will require the removal of all vegetation from the areas to either be excavated (cut) or filled. Grading activities will be completed with traditional earthmoving equipment including but not limited to bull dozers, scrapers, motor graders, excavators, water trucks, water wagons, loaders, and compactors. The majority of the efforts to grade the site will be completed within the first year of construction activities. Early grading will be completed in the area of the roads (to provide access), the laydown area (to provide an early location for storage), and in the power block (to provide an early start to the power block construction activities). Completion of the earthwork within the solar field will follow immediately after or during the early grading activities in order to allow construction of the solar field heliostats.

As discussed above, grading within the heliostat field will not be required. Only minor cuts and fills will be necessary to level abrupt changes in grade to allow for maintenance truck and mirror washing trucks to travel easily to all locations in the heliostat field. The existing site grades are less than 2%, and the required grade change from one heliostat to another is limited to 3% in any direction. Therefore, in general, the existing topography is suitable for installation of the heliostats. Near the east edge of the heliostat field, there are some locations where the existing grades exceed the 3% requirement. In these areas, localized grading will take place to obtain grades within the heliostat field that are no more than 3% between the heliostats.

Minor grading will be ongoing in the form of excavation and backfill for foundations, pipelines, conduits and other miscellaneous facilities for the duration of construction.



NOTES:

1. THE LOCATION OF THE SOLAR FIELD WILL BE LOCATED WITHIN THE PROJECT BOUNDARY NEAR WHERE IT IS SHOWN TO MINIMIZE DISTURBANCE OF SENSATIVE RESOURCES.

N

SCALE: 1"=1500'-0"

1500 0 1500 3000 4500

PRELIMINARY
NOT FOR CONSTRUCTION

FIGURE 15

REVISION #	BY	DATE	DESCRIPTION
B	DA	11-18-09	FOR POD UPDATE
A	DA	4-29-09	FOR POD

DRAWN BY: D. AKOLA CAD FILE:

PROJECT MANAGER: BOB ANDERS

GRADING AERIAL

TONOPAH SOLAR ENERGY, LLC
CRESCENT DUNES SOLAR SITE
NYE COUNTY, NV

WorleyParsons
resources & energy

Looking North East toward the Site from Poleline Road.

Looking East toward the Site from Poleline Road.

Tonopah Solar Energy, LLC
N-86292

Worley Parsons
resources & energy

05/2009

Site Photos

52006718

Figure 16

6.6 Solar Array Assembly and Construction

The heliostat assemblies will be mounted on steel or concrete foundations. The geotechnical information and the potential pile test program will provide the information necessary to determine the most cost effective foundation. The most likely foundation will be a reinforced concrete pier foundation that is cast in a drilled hole. Alternate foundations could be concrete or steel piles.

The heliostats consist of glass mirror modules, structural support components, motor drives, a heliostat controller and a foundation. There are a total of approximately 17,350 heliostats each with a mirror surface area of approximately 670 ft^2 (62.4m^2). The total mirror surface area for the plant is approximately 12,000,000 sf^2 (1,081,200m^2). The support structure consists of a steel frame backing to support the mirror modules and a steel tubular post for supporting the heliostat in the ground. Finally, the heliostat assemblies will be mounted on steel or concrete foundations. The geotechnical information and the potential pile test program will provide the information necessary to determine the most cost effective foundation. The most likely foundation will be a reinforced concrete pier foundation that is cast in a drilled hole. Alternate foundations could be traditional concrete mat foundations, concrete piles, or steel piles.

The Heliostat Array Controller (HAC) includes all hardware and software to control the Collector Field and consists of the Heliostat Control Software (HCS) and Beam Characterization System (BCS). The HCS actively controls the pointing of each heliostat to ensure that the heliostat's image is properly positioned to ensure proper flux on the receiver. The actual pointing varies by the time of year and day, ambient temperature and mode of operation. Modes of operation include start-up, normal operation, shut-down and a number of off-nominal conditions (e.g., loss of heliostat power). The BCS automatically calibrates each individual heliostat using a BCS target located on the tower. There are sixteen (16) BCS targets on the tower and heliostat calibration is integrated into normal plant operations on a daily basis. Control/power wire for the HCS will be installed underground throughout the solar field.

6.7 Power Block Construction

The first phase of power block construction would consist of foundation work and underground mechanical work. Foundation construction would involve excavation, form, and rebar work preceding a number of concrete pours. The specific equipment in-use is more variable as the individual foundations and components are erected. The central receiver tower will be constructed of reinforced concrete using a slip-form process. Underground pipe work would require trenching, onsite welding, backfill, and compaction. When the foundations have cured adequately, major equipment and aboveground piping can be installed. During this phase of construction the steam turbine generator (STG), water treatment system, air-cooled condenser, generator step-up transformer, auxiliary transformers, and other ancillary equipment would be set on their corresponding foundations. Major equipment components would be installed and pump, turbine, and fan alignments would be performed.

With the equipment set on their foundations, aboveground piping and electrical activities can be completed. Piping and electrical cable would be terminated at equipment interfaces. High-voltage bus duct will be installed between the STG and generator step-up transformer. The final construction activities will include switchyard installation, site paving, and control system installation and programming. Once systems are installed and complete, commissioning will begin. Commissioning activities include operating pumps and motors, opening and closing valves, cleaning pipe systems by water flushes and air blows,

and energizing equipment. Equipment is operated isolated from other systems to ensure proper operation. Once systems are verified the plant as a whole is operated to ensure all systems function correctly. During start-up, all systems are operated and steam is generated to perform steam blows, which are used to clean the steam piping. Once the steam lines are cleaned steam is introduced into the steam turbine. Once the plant is running reliably, testing is performed to ensure emissions and performance guarantees are met.

Concrete, mechanical, and electrical works would be performed over a period of months, with the aid of graders, rollers, front loaders, dump trucks, trenching machines, concrete mixer and pump trucks, cranes, and pick-ups. Approximately 60,000 cubic yards of concrete will be used to construct the power block and heliostat fields.

Some of the above areas may impinge on areas intended for the later stages of solar field erection. As solar field erection nears completion in the power block area, temporary construction mobilization areas would be reduced as required. Solar field equipment and material laydown areas would be rotated through the site on the quadrants currently being assembled.

Miscellaneous, non-vehicle, motorized equipment will also be used over the length of the job, such as welding machines and compressors.

6.8 Thermal Medium Processing

The HTF system hot and cold tanks would be first preheated to help prevent against thermal shock to the tank and foundation. The cold tank, for example, will be maintained at the preheat temperature for at least a week or longer before fluid salt is pumped into the tank. It is expected to take approximately 2 to 3 months to melt and load the complete volume of salt. An external recirculation loop with a heater will then raise the temperature and maintain it at 550° F.

HTF processing will take place in an area surrounded by temporary earth dikes to prevent potential migration of the salt from the processing area with storm water. Incidental spills of salt would be cleaned up. In the event of inclement weather conditions, stockpiles and storage sacks of salt would be covered with plastic to prevent potential contact with storm water.

6.9 Gravel, Aggregate, and Concrete

Gravel will be required for the surfacing of roads, parking areas, and for use in concrete. A geotechnical investigation will provide information necessary to determine if adequate aggregate can be generated on-site. Based on visual observations of the site, it appears that gravel sources within the grading area of the Site may be available. If on-site gravel/sand is available (in quantity and quality), a portable rock processing operation will be used to generate select aggregate from on-site sources. The rock processing operation will include screens, crushers, and conveyors to generate material that meets the project requirements.

If adequate material is not available on-site, it is proposed that gravel and aggregate be generated from a nearby borrow source, located north west of the site, along Pole Line Road, near Peavine Creek or purchased from a nearby commercial source. Nye County operates a similar borrow pit to generate aggregate for road construction purposes, and the Community of Tonopah operates a similar borrow pit

where aggregate is obtained. If this option is selected, the mining, screening, and crushing operation would take place at the borrow pit location. Until test pits are performed at the site, and at the borrow pit location, it is not know which option will be selected.

The construction of the project will require a large quantity of concrete delivered to the site over the duration of the construction timeframe. Two options exist to serve the project needs. First, a portable concrete batch plant can be mobilized and used to batch the concrete necessary for the project. The second option is to obtain concrete from a commercial source nearby. It is anticipated that local sources will supply minor concrete needs for the project, while an on-site batch plant will support the vast majority of the concrete needs for the project.

6.10 Electrical Construction Activities

The transmission line will be constructed using steel poles. Foundation holes for the tower legs will be excavated, forms constructed, reinforcing bars installed, and concrete poured. The structures will be assembled in sections at a staging area and then transported to the site by truck or helicopter, placed by crane or helicopter, and bolted to the foundations. The design of the transmission line will be in accordance with standards established by the utility to which the project interconnects.

Before conductor installation begins, temporary guard structures will be installed at road crossings and other locations where the new conductors may inadvertently come into contact with electric or communications facilities and/or vehicular traffic during installation. These guard structures consist of one or two poles on either side of the feature crossed with a “V”-shaped cargo net tensioned between the guard structures.

The actual conductor-stringing operation begins with the installation of rollers attached to the cross arm of the transmission structure. The rollers allow the individual conductors to be pulled through each structure until the conductor is ready to be pulled up to the final tension position. When the pull and tension equipment is set in place, a sock line (a small cable used to pull in the conductor) is pulled from tower to tower using ground equipment. After the sock line is installed, the conductor is attached to the sock line and pulled in, or strung, using the tension-stringing method. This involves pulling the conductor through each tower under a controlled tension to keep the conductor elevated above crossing structures, roads, and other facilities. After the conductor is pulled into place, tension is adjusted to a pre-calculated level. The conductor is then clamped to the end of each insulator as the rollers are removed. The final step of the conductor installation is to install vibration dampers and other accessories.

6.11 Aviation Lighting

Aviation lights will be installed according to the recommendations of U.S. Department of Transportation Federal Aviation Administration’s Advisory Circular, AC 70/7460-1K, Obstruction Marking and Lighting.

6.12 Site Stabilization and Protection

The applicant would restore all temporarily disturbed areas to their preconstruction conditions, as required by the BLM. These include temporary construction areas and access roads as well as transmission alignments, and the aggregate borrow area as required. These areas would be regraded and revegetated to restore them to preexisting conditions.

It is expected that site stabilization will include soil binders, geo-grid or the use of aggregate surfacing to allow the movement of maintenance vehicles and mirror wash water trucks to travel within the solar array. Other procedures for Site stabilization and protection are discussed in Sections 4.9 and 4.10.

6.13 Low-Impact Development Methods

Extensive grading of the site would be limited to the power block areas, receiver tower, the ditches, and the major access roads (asphalt roads between power blocks and gravel roads servicing the receiving towers from the power blocks). With the heliostat array fields, grading cuts and fills would be limited, only as required to obtain smooth graded planes.

All vegetation within the heliostat array fields would be cut or removed to the soil surface to reduce the risk of fire. Occasional cutting of the vegetation would be required to control plant re-growth. All cut vegetation would not leave the site, but would buried, burned, or composted onsite to limit waste disposal. Heliostat foundations may consist of steel posts with concrete foundations or driven concrete filled steel pipes (exact method to be determined at a later date). Some re-grading for maintenance would most likely be required within the access road due to soil erosion and regular use.

Because the proposed site is located on federal land under the control of the BLM, the project is not under the direct authority of Nye County. However, for design purposes, the erosion and sedimentation control BMPs will be engineered to meet the requirements of the County, unless other specific direction is provided by the BLM. Construction of the project would also be subject to requirements of the state National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Construction Activities. BMPs would be developed and implemented to provide an effective combination of erosion and sediment controls.

Source controls and structural controls are proposed for management erosion and sedimentation as discussed in Section 4.9.

Because low-impact development practices will be incorporated into the project design, construction, and operation, the increase in sediment yield from the Site is not expected to be substantially greater than pre-project condition.

6.14 Decommissioning and Reclamation

The procedures described for decommissioning are designed to ensure public health and safety, environmental protection, and compliance with applicable regulations. It is assumed that decommissioning of the permanent plant facilities would begin 30-50 years after the commercial operation date of the solar plant. Decommissioning of temporary facilities including but not limited to temporary septic systems, temporary underground conduit, temporary power poles, temporary concrete pads, and similar items will be completed during the plant commissioning timeframe or within the first 6 months of facility operation following completion.

The project goals for site decommissioning are as follows:

- Remove above ground structures unless converted to other uses;

- Restore the lines and grades in the disturbed area of the site to match the natural gradients of the site; and
- Re-establish native vegetation in the disturbed areas.

The proposed implementation strategy to achieve the goals for site decommissioning could include the following:

- Use industry standard demolition means and methods to decrease personnel and environmental safety exposures by minimizing time and keeping personnel from close proximity to actual demolition activities to the extent practical;
- Plan each component of the decommissioning project such that personnel and environmental safety are maintained while efficiently executing the work;
- Conduct pre-decommissioning activities such as final decommissioning and restoration planning that addresses the "as-found" site conditions at the start of the project;
- Remove all residual materials and chemicals from the Site prior to demolition for reuse at other facilities or for proper disposal at licensed facilities;
- Demolition of the above-ground structures (dismantling and removal of improvements and materials) in a phased approach while still using some items until close to the end of the project. For instance, the water supply, administrative building and some electrical power components will be modified to be used until very late in the decommissioning project;
- Demolition and removal of below-ground facilities (floor slabs, footings, and underground utilities) as needed to meet the decommissioning goals;
- Soils cleanup, if needed, with special attention applied to retention pond and hazardous materials use/storage areas to ensure that clean closure is achieved;
- Disposal of materials in appropriate facilities for treatment / disposal or recycling;
- Recontouring of lines and grades to match the natural gradient and function of the site; and
- Revegetation with native plants.

Although various types of decommissioning and demolition equipment will be utilized to dismantle each type of structure or equipment, dismantling will proceed according to the following general staging process. The first stage consists of dismantling and demolition of above-ground structures to be removed. The second stage consists of concrete removal as needed to ensure that no concrete structure remains within 3 feet of final grade (i.e., floor slabs, below-ground walls, and footings) as appropriate. The third stage consists of removal/dismantling of underground utilities within 3 feet of final grade. The fourth stage is excavation and removal of soils, and final site contouring to return the originally disturbed area of the site to near original conditions while disturbing as little of the other site areas as is practical.

Above ground demolition entails breakdown and removal of above-ground structures and facilities. Residual materials from these activities would be transported via heavy haul dump truck to a central recycling / staging area where the debris will be processed for transport to an off site recycler. A project recycle center (either at each power unit as the work progresses or at the central admin area) would be established to:

- Size reduce and stage metals and mirrors for transport to an off site recycler:
- Crush concrete and remove rebar;
- Stockpile concrete for later use at the Site;
- Stage rebar for transport to an off site recycler; and
- Temporarily store and act as a shipping point for any hazardous materials to an approved TSD facility.

The strategy for demolition consists of use of mechanized equipment and trained personnel in the safe dismantling and removal of the following above-ground structure:

- Heliostats and related equipment using low environmental impact equipment;
- Towers using explosives to put the towers on the ground, then conventional heavy equipment to size reduce and transport for recycling (this is the industry standard for safe demolition of large towers and massive concrete structures);
- Removal of the turbine generators, condensers and related equipment, transmission lines and towers, and above ground pipelines using conventional demolition equipment and techniques; and
- Near the very end of the project, the removal of site related fencing.

The below-ground facilities to be removed include concrete slabs and footings that would remain within 3 feet of final grade at the end of the project. It is anticipated that any and all site related piping and utilities, including water lines, below ground electric / control / communication lines, and gas lines would be completely removed, regardless of the depth below final grade. These materials would be excavated and transported to the recycling area(s) for processing and ultimate recycling. The resulting trenches would be backfilled with suitable material of similar consistency and permeability as the surrounding native materials and compacted to 85 percent relative compaction.

The need for, depth and extent of contaminated soil excavation will be based on observation of conditions and analysis of soil samples after removal of the evaporation pond and hazardous materials storage areas, and upon closure of the recycling center(s) and waste storage areas using during decommissioning. At this time, removal of contaminated soil is assumed not to be needed. If required, removal would be conducted to the extent feasible and as required to meet regulatory cleanup criteria for the protection of groundwater and the environment. If contaminated soil removal is required, the resulting excavations would be backfilled with native soil of similar permeability and consistency as the surrounding materials and compacted to 85 percent relative compaction.

Recontouring of the site would be conducted using standard grading equipment to return the land to match within reason the previously existing surface and surrounding grade and function. Grading activities would be limited to previously disturbed areas that require recontouring. Efforts would be made to disturb as little of the natural drainage and vegetation as possible. Concrete rubble, crushed to approximately 2-inch minus size, would be placed in the lower portions of fills, at depths at least 3 feet below final grade. Fills would be compacted to approximately 85 percent relative compaction by wheel or track rolling to avoid over-compaction of the soils. To the extent feasible, efforts would be made to place a layer of coarser materials at the ground surface to add stability.

After recontouring, the Site would be revegetated using native plants where appropriate. This would be conducted with a native seed collection company.

7. STATUS OF AGREEMENTS

7.1.1 Power Purchase Agreements

The Applicant has executed a Power Purchase Agreement for the sale of electricity from the facility, effective as of November 4, 2009. The PPA is scheduled to be submitted to the Public Utilities Commission of Nevada (PUCN) on December 1 for approval. The PUCN has up to 180 days for review and approval of the PPA.

7.1.2 Interconnect Agreements

The Applicant has filed an application for interconnection for this project and a Facilities Study has been completed by SPPC/dba NV Energy. The Applicant anticipates completing negotiations for a Large Generator Interconnection Agreement within the next few months. Updates to the application filed, or any new applications for interconnection associated with this project will brought to the attention of the BLM.

8. OPERATIONS AND MAINTENANCE

8.1 Overview

Management, engineering, administrative staff, skilled workers, and operators would serve the solar plant. It is expected to employ up to 40-45 full-time employees during operation and 400-500 during project construction. The facility may be operated up to 7 days a week, and 10 or more hours per day. The facility would be expected to have an annual availability of up to 92 to 95 percent (of no cloudy, daylight hours).

The facility may be operated in one of the following modes:

- The facility could be operated up to its maximum output as dictated by the available solar insolation and the available thermal storage, for as many hours per year as possible.
- The facility would be placed in standby mode every night when the solar insolation or thermal energy storage level drops to a point which results in the STG dropping below its minimum load.
- A full shutdown would occur if forced by equipment malfunction, transmission line disconnect, or scheduled maintenance.

8.2 Maintenance

Long-term operation of the facility would include periodic maintenance and overhaul of all balance-of-plant and solar facility equipment such as STG, pumps, piping, etc. in accordance with manufacturer recommended schedules. Periodic cleaning of the heliostats with demineralized water will be necessary to maintain the desired mirror reflectivity.

Routine inspections of substation and electric transmission line would be conducted by certified site personnel on a monthly basis or as needed under emergency conditions. All of the substation structures

will be inspected from the ground on an annual basis for corrosion, misalignment, and foundation condition. Ground inspection will include the inspection of hardware, insulator keys and conductors.

Regular inspection of electric lines, support systems, and instrumentation and controls is critical for the safe, efficient, and economical operation of the project. Various inspection processes, including aerial inspection, ground inspection, and climbing may be conducted. Ground inspection includes checking of the hardware, insulators, and conductors for corrosion, breaks, broken insulators and failing splices. The frequency of inspection may vary depending on factors such as the age of the system, structure type, and vegetation conditions.

8.3 Operations Workforce and Equipment

It is planned that plant personnel will be on-site in two 12-hour shifts, seven days a week to ensure that the facility is staffed at all times. A full-time staff will be required for operations and maintenance of the Power Plants: including one operator for every 12-hour rotating shift, four relief operators, four maintenance technicians, four mirror washers, one to two process/performance engineer, one maintenance manager, and five to seven administrative staff members per day. An additional part-time staff of five to 15 subcontractor personnel will be on-site daily to conduct occasional maintenance of the facility, including cleaning or repairing equipment; system testing; removing, repairing, and/or installing insulation before and after maintenance; scaffold installation and removal; and personnel facility-related activities.

9. ENVIRONMENTAL CONSIDERATIONS

9.1 Resource Values and Environmental Concerns

9.1.1 Biological Resources

Biological resources potentially affected by the proposed project include vegetation, wildlife, corridors, and riparian resources. Potential impacts to these resources may be either directly or indirectly impacted by the project and may be either permanent or temporary in nature. Examples of potential impacts as they pertain to the proposed project are described below.

- **Direct:** Any alteration, disturbance, or destruction of biological resources that would result from Project-related activities is considered a direct impact. Examples include clearing vegetation, encroaching into wetlands, diverting natural surface water flows, and the loss of individual species and/or their habitats.
- **Indirect:** As a result of Project-related activities, biological resources may also be affected in a manner that is not direct. Examples include elevated noise, dust, misc. air emissions, soil compaction, increased human activity, decreased water quality, and the introduction of invasive wildlife (domestic cats and dogs) and plants (weeds or other non-native species).
- **Permanent:** All impacts that result in the long-term or irreversible removal of biological resources are considered permanent. Examples include constructing a building or permanent road on an area containing biological resources.

- **Temporary:** Any impacts considered to have reversible effects on biological resources can be viewed as temporary. Examples include the generation of fugitive dust during construction, or removing vegetation for underground pipeline trenching activities and either allowing the natural vegetation to recolonize or actively revegetate the impact area. Surface disturbance that removes vegetation and disturbs the soil is considered a long-term temporary impact because of slow natural recovery in arid ecosystems. Therefore, all such impacts in the project area are considered permanent.

Although no "jurisdictional" channels or drainages appear to be present on the Site, shallow channels may convey flow during storm events and spring runoff. During the general survey process, any jurisdictional wetlands/waters detected on the Site will be formally delineated per Army Corps of Engineers (ACOE) protocol. If any are identified and determined to be jurisdictional, permits for impacts to jurisdictional waters would be required. A "Request for an Approved Jurisdictional Determination of Isolated Waters" has been submitted to the U.S. Army Corp of Engineers for confirmation that no jurisdictional drainages will be impacted by the project.

Research and surveys are necessary to determine exactly how the potential impacts listed above may affect biological resources on the Site. Biological surveys were performed by JBR Environmental Consultants in June 2009 and provided to BLM under separate cover. The survey area is indicated on Figures 17 and 18, Biological & Cultural Survey Areas and Biological & Cultural Survey Area at Substation. A review of the Tonopah Resources Management Plan indicates that the Site contains a salt desert shrub vegetation type. The Tonopah Resource Area is comprised of a broad range of individual and overlapping types of wildlife habitat including mule deer, antelope, desert bighorn sheep, rocky mountain elk, waterfowl, sage grouse and raptors. There are several special status species, both plant and animal, in the Resource Area including the Williams combleaf (*Polyctenium williamsiae*), desert tortoise (*Gopherus agassizii*) and Railroad Valley springfish (*Crenichthys nevadae*). The survey yielded no known listed, proposed, or candidate plants or wildlife species in the study area. Two BLM sensitive plants, the sanicle biscuitroot and Nevada oryctes were observed. The former was fairly widespread and the latter was found at only one location in the proposed transmission line corridor. Three cactus species were observed at 20 locations. The loggerhead shrike was the only BLM sensitive animal species observed. Any necessary focused surveys, agency consultation, project planning, design and permitting, and implementation of appropriate mitigation measures will ensure that potential impacts to biological resources are either avoided and/or minimized to the maximum extent feasible. Proposed project design features and mitigation measures could include the following.

- All construction areas will be minimized by providing taped and flagged boundaries to delineate where surface disturbance will not be allowed to occur. The Project Environmental Compliance staff will review all site plans and provide written approval prior to any surface disturbance. Setting and flagging construction area boundaries will limit surface disturbance and habitat impacts only to those areas needed for construction, thereby preventing unnecessary impacts.
- Off-road travel will be prohibited in sensitive biological areas and all native habitats during construction and operation. Such areas will be posted prior to initiation of construction and parking areas will be designated as appropriate.
- Speed limits on and near the Site will be posted and limits will be developed with consideration for potential wildlife mortality, in cooperation with BLM.

- An environmental awareness program will be developed to educate employees about sensitive biological resources and to provide background and reasons for restrictions, legalities, and appropriate procedures to be followed. This measure will be implemented prior to construction, and written material and other information will be provided to employees at project orientation. This information also will be provided to all contractors and subcontractors that will be working at the job site.
- A trash and litter control program will be developed for the project in order to reduce the possibility of animals ingesting or becoming entangled in foreign matter. In addition, trash control will reduce predator attraction and consequent increased predation, and will serve to increase overall pride in the area and foster environmental awareness.
- Restoration of disturbed right-of-ways and other temporary disturbance areas in native habitat will follow recommended procedures including ripping, seeding, and mulching, as appropriate. Seed mixtures will include shrubs and other species of utility as wildlife habitat. This measure will provide mitigation for temporarily-disturbed areas and will restore habitat for use by wildlife.
- Field surveys to determine the potential for the site to support sensitive wildlife will be conducted. If it is determined that state or federally protected species and or their habitats are located within the site, assistance to BLM in completing consultation pursuant to Section 7 of the Endangered Species Act and assistance to the USFWS and NDOW to mitigate any adverse effects will be provided. Unavoidable impacts to habitats of federal, as well as state, listed threatened or endangered species will be mitigated as appropriate.
- Tortoise Fencing (only if required)

9.1.2 Cultural Resources

Ground-disturbing construction activities have the potential to directly impact cultural resources by altering site integrity and the qualities that make the resources significant. In addition, in the case of built resources, impacts can occur to the setting of a resource, even if the resource is not physically damaged.

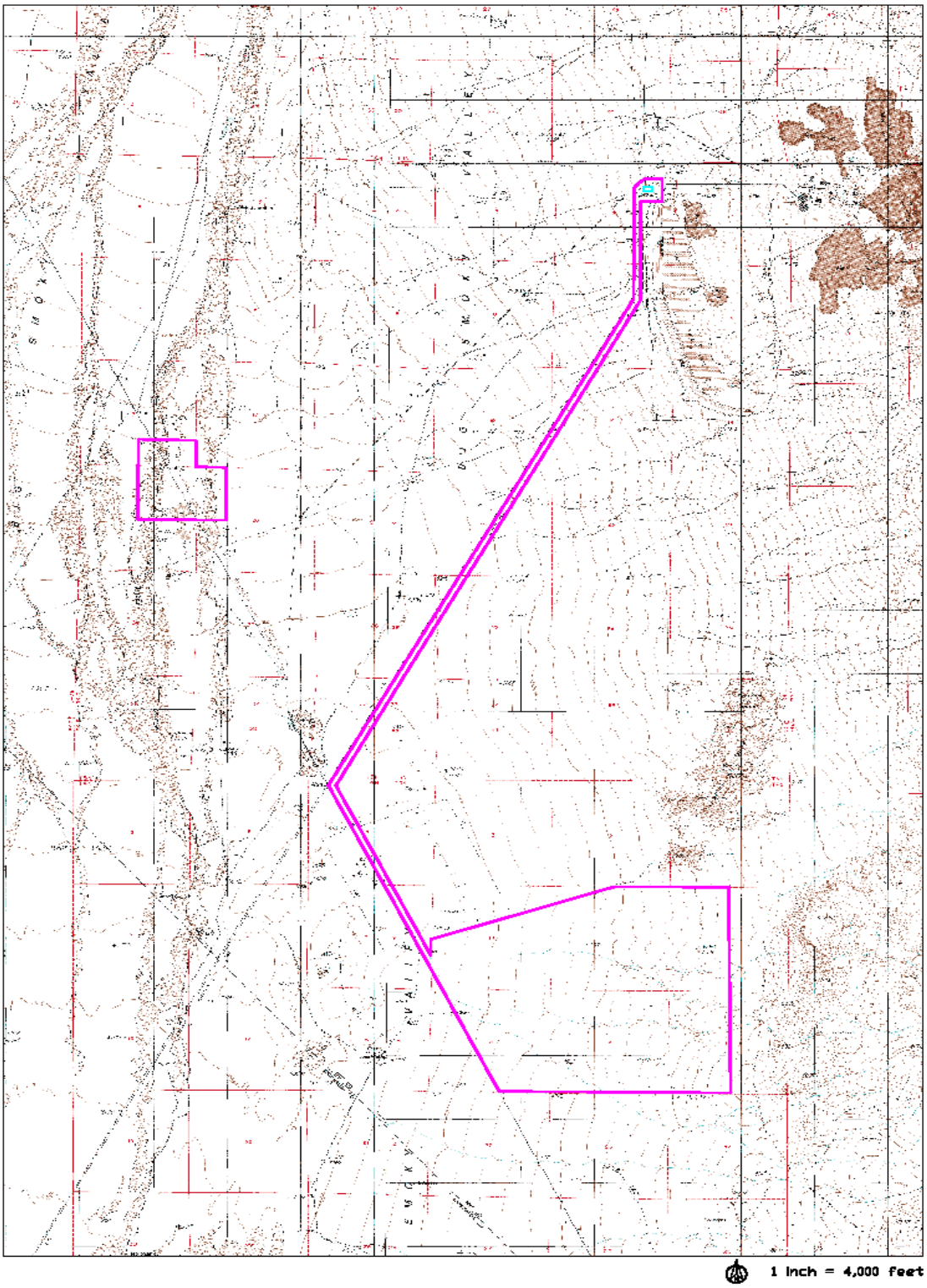
The Proposed Tonopah Resource Management Plan and Final Environmental Impact Report (BLM 1994) indicates that prehistoric site types known to occur in the area include long-term habitation sites, temporary camps, task specific sites, pinyon caches, scatters of heat altered rock, rock shelters, petroglyphs and pictographs, rock alignments including “geoglyphs,” and quarry sites. Sensitive locations for prehistoric sites include areas near permanent and seasonal water sources, upland pinyon-juniper zones and upper bajada slopes. During the Late Pleistocene, lakes existed within eight of the valleys in the RMP area. During the Holocene, some of these same areas may have supported marshy environments. These lake margins and marshy areas are sensitive areas for cultural and paleontological resources. Paleontological resources in the RMP area are found in geological formations or unnamed strata. Additional fossils may be found in many other formations which occur in the RMP area only in the subsurface.

Historic site types known to occur with the RMP area include the remains of homesteads and mining camps, townsites, Chinese borax mines, charcoal kilns and platforms, minim/milling sites, trash dumps, trails, roads, and railroad grades. A cultural resources inventory for the project site was performed by Kautz Environmental Consultants in September 2009. The survey report was submitted to BLM under

separate cover. The survey area for cultural resources is indicated on **Figures 17 and 18, Biological & Cultural Survey Areas and Biological & Cultural Survey Area at Substation.** Appropriate consultation including BLM consultation with the State Historic Preservation Office (SHPO) and Native

Americans in addition to project planning and design, and implementation of relevant mitigation measures will ensure that potential impacts to cultural resources are either avoided and/or minimized to the maximum extent feasible. Proposed project design features and mitigation measures could include the following:

- Additional cultural resources inventory will be conducted for the Site, if necessary. This inventory may include a pedestrian field survey of the potential area of disturbance to locate previously identified cultural resources as well as to survey areas that have not yet been reviewed. Upon completion of surveys, the applicant will consult with the SHPO for Section 106 compliance for the project, inclusive of the preparation of a Cultural Resources Technical Report. The report will contain recommendations as appropriate on how to address any resources found during the records search and ground survey.
- Wherever possible, the applicant will avoid cultural resource sites identified as eligible for inclusion on the NRHP. Where avoidance is infeasible, effects to resources will be mitigated through a treatment plan developed through consultation between BLM, SHPO, and applicable Tribes.
- A paleontological survey will be conducted to determine the potential for paleontological resources at the site. This information will be included in the Cultural Resources Technical Report. If there is potential for paleontological resources, a paleontological monitoring program will be developed to minimize any impacts to those resources during construction.
- Prior to the start of project construction, a cultural resources specialist will be designated to implement the cultural resource monitoring and mitigation plan. This will include a programmatic agreement and/or an Unanticipated Discovery Plan.
- Prior to the start of project construction, the cultural resources specialist will conduct a worker education session for the construction crew and supervisory personnel to explain the importance of and legal basis for the protection of significant archaeological resources. Construction crews will be briefed regarding identification of suspected new sites, reporting and preservation of existing and suspected new sites.
- A cultural resources monitor will be present at the construction site at times when excavation (subsurface disturbance) is taking place in areas of high cultural sensitivity. These areas will be identified by the cultural resources specialist.
- If a new cultural resources site is discovered during construction, and determined to be significant, the cultural resources specialist will notify and implement a mitigation plan in accordance with federal and state regulations on public lands.
- The cultural resources specialist will arrange for the curation at a qualified curation facility of any cultural materials collected during the construction monitoring and mitigation program.



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Biological & Cultural Resources Survey Area

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Figure 17

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Biological & Cultural Resources Survey Detail at Substation

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Figure 18

9.1.3 Land Use

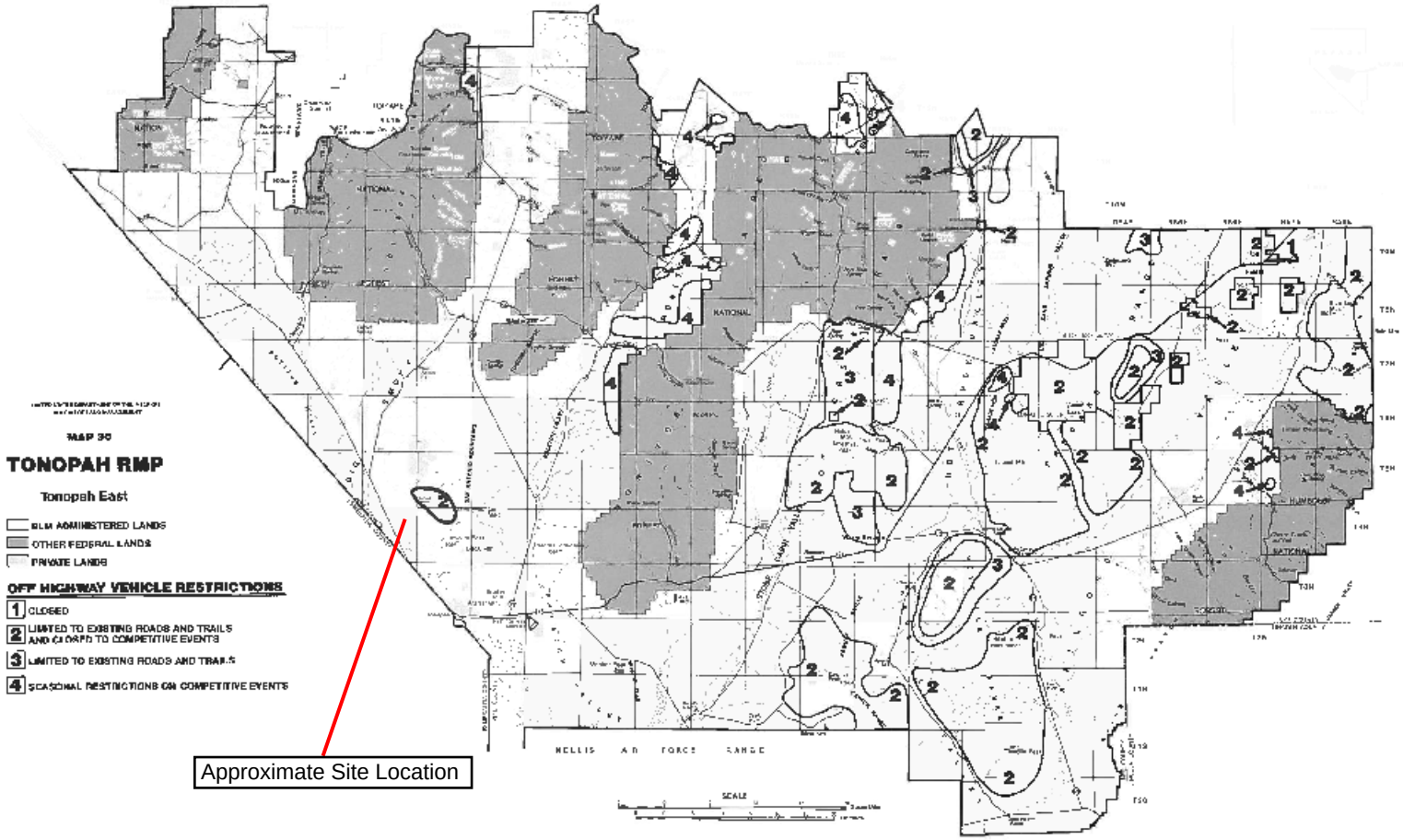
The proposed project is located on unincorporated lands administered by the BLM within Nye County, Nevada. The project area is guided by the Tonopah Planning Area Proposed Resources Management Plan/Final Environmental Impact Study (PRMP/FEIS). The Tonopah RMP was approved in October 1997 and is scheduled for revision beginning Fiscal Year 2009. Based on a review of the PRMP, the project Site appears not to be subject to any grazing allotments, herd management area boundaries, right-of-way avoidance areas, withdrawals, areas of critical environmental concern (ACEC), recreation opportunity spectrums, fluid mineral potential, mineral leasing restrictions, or fire management zones. Development of the proposed project and any existing land use restrictions would be discussed with the BLM prior to environmental review.

9.1.4 Native American Tribal Considerations

As with any project site, the potential also exists for resources to be unearthed during project construction. As such, during the planning and permitting process, BLM consultation with Native Americans in compliance with Executive Orders regarding Government-to-Government relations with Native Americans and other federal and state laws and regulations would take place.

9.1.5 Recreation and OHV Conflicts

The Tonopah Resource Management Area offers a wide variety of recreation opportunities such as hunting, camping, off-highway vehicle (OHV) use, hiking, photography, historical sightseeing, and OHV competitive events. Through aerial photo research and site reconnaissance it is known there is an existing OHV road that provides access from Pole Line Road to the sand dunes “Crescent Dunes”. The location of the road in relation to the project can be seen in Figure 3, Project Site Plan. According to the RMP, the Site is located in an area that is “Limited to Existing Roads and Closed to Competitive Events” as indicated on **Figure 19, BLM OHV Area**. The project was located within the Site so as to not affect the existing OHV Road.



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BLM OHV Map

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Figure 19

9.1.6 Other Environmental Concerns

9.1.6.1 Aesthetics

The project will change the visual appearance of the area. When viewed from eye level, during most hours of the day, the solar field would be relatively unobtrusive, with the power block only slightly visible in the distance (if at all), and the view of the project will be dominated by the central tower and receiver. Operations would require onsite nighttime lighting for safety and security. To reduce offsite lighting impacts, lighting at the facility would be restricted to areas required for safety, security, and operation. Exterior lights would be hooded, and lights would be directed onsite so that light or glare would be minimized. Low-pressure sodium lamps and fixtures of a non-glare type would be specified. Switched lighting would be provided for areas where continuous lighting is not required for normal operation, safety, or security; this would allow these areas to remain un-illuminated (dark) most of the time and thereby minimizing the amount of lighting potentially visible offsite. There will be a small amount of additional visible nighttime lighting associated with the project structures and open site areas. At times when light are turned on, the lighting will not be highly visible offsite and would not produce offsite glare effects. The offsite visibility and potential glare of the lighting would be minimized by specification of non-glare fixtures and placement of lights to direct illumination into only those areas where it is needed. To help reduce the visual impact created by outdoor lighting, the following mitigation measures shall be adopted:

- Lights shall be directed on-site so that significant light or glare shall not be created. Highly directional, high-pressure sodium vapor fixtures shall be used.
- Nighttime backscatter illumination shall be avoided by directional shielding of lights and providing on/off switch at the bottom taller equipment.
- Switched systems shall be used to allow reduction of light in areas where work is not ongoing and where light is not needed for safety reasons. All light switches shall be clearly identified.

Project construction activities typically would occur during normal Monday through Friday working hours, although nighttime activities may occur at certain times during the construction period depending on the project schedule. When and if nighttime construction activities take place, illumination would be provided that meets State and Federal worker safety regulations. To the extent possible, the nighttime construction lighting would be erected pointing toward the center of the site where activities are occurring, and would be shielded. Task-specific lighting would be used to the extent practical while complying with worker safety regulations. In spite of these measures, there may be times, when and if there is nighttime construction, when the Site may temporarily appear as a brightly lit area as viewed from nearby locations.

Construction of the project's transmission line would involve installation of steel power poles. The insulators will be made of a non-reflective and non-refractive material, and the conductors will be non-specular (i.e., their surfaces will have a dulled finish so that they do not reflect sunlight). The proposed routing would follow the existing lines.

The BLM evaluates federally-managed lands under its Visual Resources Management (VRM) system. The proposed project Site is located in an area designated by the BLM as Visual Resource Management (VRM) Class IV (BLM, 1994) as indicated on **Figure 20, BLM VRM Map**. The BLM's objective on VRM Class IV lands is to provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. Therefore, visual resource management is not expected to hinder solar facility development within the Site. However, the project would be evaluated by the BLM using the Visual Contrast Rating System to minimize visual impacts and ensure that measures are applied to mitigate potentially adverse visual impacts. Key observation points will be from the Pole Line Road and the dunes. Project design features that could mitigate visual impacts include:

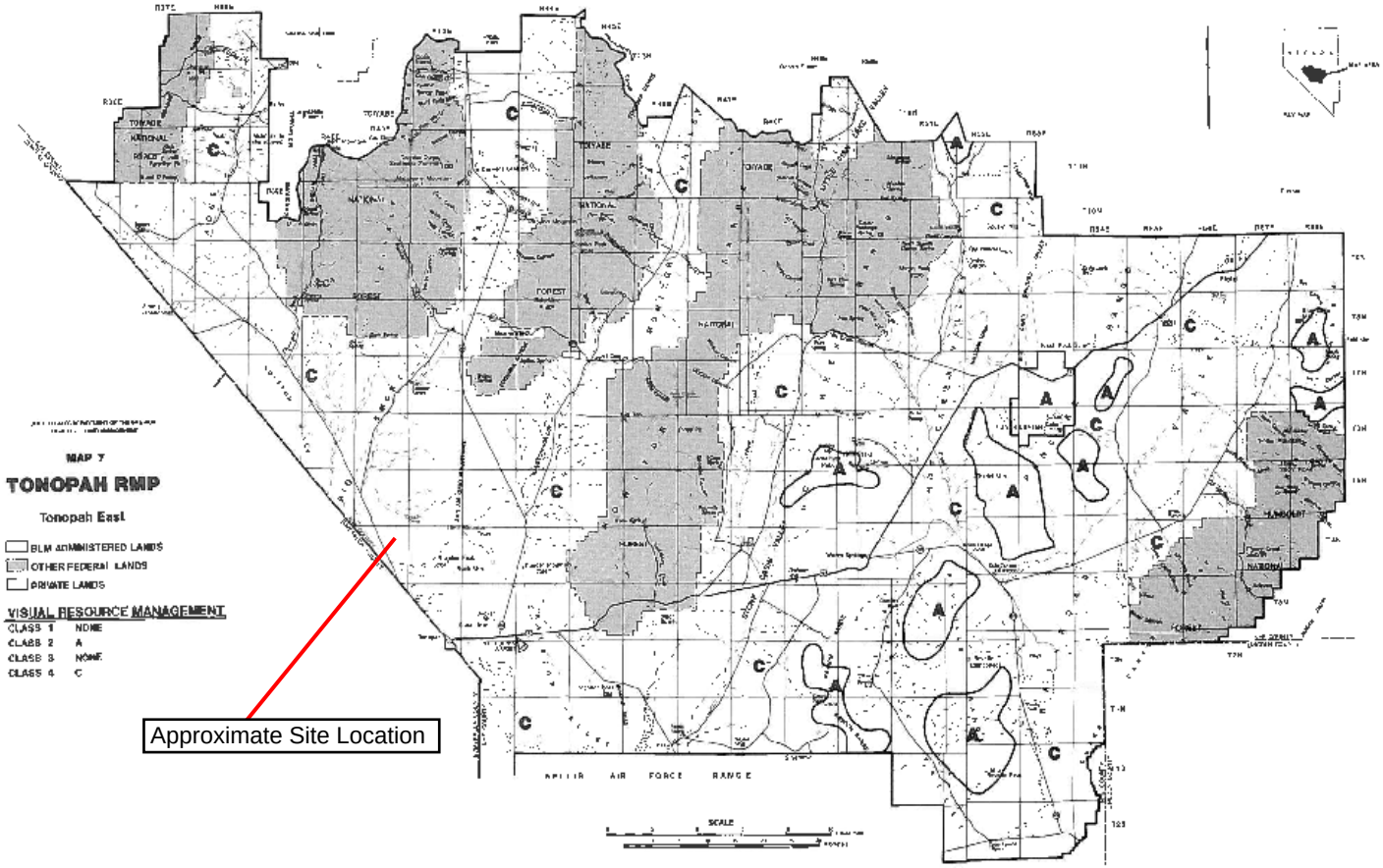
- Project equipment other than the solar arrays would have non-reflective surfaces and neutral colors to minimize their visual impacts to the extent practicable.
- A paint color acceptable to the BLM would be used on all project facilities that can be painted to blend the facility with the existing setting.
- Nighttime lighting would be limited to areas required for operations or safety and would be directed on-site to avoid backscatter. Whenever possible, nighttime lighting would be directed or shielded from major roadways.
- Lighting at high illumination areas not occupied on a continuous basis would be controlled by switches or motion detectors to light the areas only when occupied.

9.1.6.2 Air Quality

Ambient air quality is protected by Federal, State, and local regulations. The EPA has established National Ambient Air Quality Standards (NAAQS) for criteria pollutants for the purpose of protecting human health (primary standards) and public welfare (secondary standards). These criteria pollutants are: nitrogen dioxide (NO_2), carbon monoxide (CO), ozone, SO_2, lead (Pb), PM_{10}, and $PM_{2.5}$.

The EPA established designations for a new 8-hour ozone standard, which are now in effect while the 1-hour ozone standard was revoked on June 15, 2005 in most areas, including the Project area. In addition to the Federal NAAQS, State ambient air quality standards have been established for Nevada. The Nevada ambient air quality standards are the same as the Federal standards.

The proposed Project is potentially subject to a variety of Federal, State, and local regulations pertaining to the construction or operation of air emission sources. The CAA, 42 USC 7401 et seq., as amended in 1977 and 1990, and Title 40 CFR Parts 50 through 99 are the basic Federal statutes and regulations governing air pollution in the United States. In general, the Bureau of Air Pollution Control (BAPC) of the Nevada Department of Environmental Protection (NDEP) is the agency responsible for air quality-related permitting in Nevada. The Nevada Bureau of Air Quality Planning is responsible for air quality monitoring, planning and program management.



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BLM Visual Resources Map

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Figure 20

The proposed project will generate air emissions during both construction and operation. Construction emissions for the proposed project will be closely evaluated using site- and project-specific data during the project design, permitting and certification process. The main sources of emissions from the proposed project would be short-term emissions during construction. Construction-related emissions will include the exhaust from construction equipment (including vehicles transporting personnel, equipment, and supplies) and fugitive dust and particulate matter (PM10) from grading, earth moving, and equipment/vehicles traveling on paved and unpaved roads.

Another source of construction related emissions comes from the use of diesel powered construction equipment which has been known to produce ozone precursor emissions and combustion related particulate emissions. To help address these emissions the project would include standard mitigation measures for construction equipment.

The proposed project is anticipated to generate very little or no NOx, CO, or VOC pollutants during its normal operation. The project would not utilize supplemental gas firing, and would therefore generate very little air pollution. Additional studies regarding air emissions from the proposed project would be conducted to verify exact air emissions and impacts. The Applicant will obtain the necessary construction and operation permits from the BAPC/NDEP. The Applicant will also work with the BAPC/NDEP to determine any needed mitigation measures.

9.1.6.3 Geologic Hazards and Soils

According to the BLM Tonopah Field Office PRMP/FEIS (1994), the soils in the RMP area are mainly mineral soils of two types: those which do not have water continuously available for three months when the soil is warm enough from plant growth (Aridisols) and soils showing little evidence of the soil forming process, the development of horizons or layers (Entisols). The surface soils on the Site are characterized by sandy-clay and wind-eroded gravels. The areas of undisturbed surface gravels are stable and tend not to be dust producing. Areas of disturbance could become dusty or muddy. The site does not have any known geotechnical issues affecting development. A detailed engineering geotechnical report will be commissioned prior to detailed design to identify specific design parameters required to be implemented as part of the design of the project.

Proposed project design features could include the following:

- The design of the project would be in accordance with all applicable federal, state, and county building and construction ordinances.
- Engineering and construction requirements for the project would incorporate the necessary precautions to successfully operate the project in a seismically active area. The State of Nevada is a known seismic area, however no known faults are located on the site and it is anticipated that traditional engineering and construction techniques can be implemented to mitigate for the required lateral forces caused by the site ground acceleration levels. The exact ground acceleration levels will be determined by the geotechnical investigation.
- Site-specific geotechnical assessments to determine the presence or absence of liquefiable deposits and other geotechnical hazards would be conducted. The assessment will address items including but not limited to geologic hazards, seismic considerations, subsurface soil

conditions, groundwater levels, suitable foundation design, earthwork considerations, allowable bearing pressures, and settlement considerations. Design-level geotechnical investigations, including test borings at selected locations, as well as an analysis of existing data to assess the possibility of liquefaction and other hazards, would be conducted as part the assessment. Design of the project would include appropriate measures to mitigate for any hazards identified during the assessment. It is estimated that this geotechnical investigation will be completed in the 2nd and 3rd quarter of 2010.

- An engineering geologist(s), certified by the State of Nevada, would be assigned to the project to carry out the duties required by the Nevada Building Code (NBC), including preparation of an Engineering Geologic Report, and to periodically monitor geologic conditions during construction, approve actual design features and mitigation measures used to protect the project from geologic hazards and prepare the final Geologic Grading Report.

9.1.6.4 Mineral and Energy Resources

The state of Nevada is a large producer of gold as well as oil and gas. In addition, Nevada has the largest BLM mineral management program. The state is also a producer of geothermal energy. A variety of mineral resources are present in the Resource Area including sand and gravel, cinders, basalt, and decorative rock. Further study of the mineral and energy resources located both on and near the Site would be contained in future analyses.

9.1.6.5 Noise

The proposed project is located in an undeveloped area where existing noise levels are likely to be relatively low. Noise sensitive receptors can include facilities or areas where excessive, disconcerting, or high levels of noise would conflict with the intended use (e.g., residential areas, hospitals, schools, certain recreation areas, etc.).

During construction, various types of heavy equipment would be used that could result in a temporary increase in noise levels. Additionally, during operation of the facility, use of pumps, blowers, fans, generators, compressors, and high-pressure steam blows will contribute to noise emissions in the project vicinity.

Further research will be conducted to determine current noise emissions in the project vicinity and the impact of the proposed project on the noise environment. Project design and mitigation measures could include the following:

- The applicant would evaluate plant noise emissions during the design and permitting phase of the project in accordance with BLM and NDEP guidelines and local requirements (if applicable).
- Prior to construction, the applicant would submit a noise control program to BLM and NDEP (if necessary) for review and approval. Construction noise would be managed to reduce employee exposure and comply with Federal and State standards and County ordinances.
- During the construction and operation phases of the project, the applicant would document, investigate, evaluate, and attempt to resolve all project related noise complaints.

During construction, heavy equipment would be utilized along the proposed right-of-way and could result in temporary increases in noise levels.

9.1.6.6 Water Resources

The project Site is not impacted by obvious drainage pathways. Areas near the Site contain small drainage scars which are periodically wet and may contain water for extended periods during spring runoff. Drainage from this area is primarily shallow sheet flow, infiltration and evaporation.

The perennial yield (safe yield) of the Tonopah Flat groundwater basin sub area is reportedly 6,000 acre-feet per year and the total water rights demand through March 1999 was reportedly 26,724 acre-feet per year. Although there is an apparent groundwater deficit, the estimated committed water rights in the sub area and do not represent the actual groundwater withdrawal and consumption, which are significantly less (Buqo, 2004). The actual groundwater budget in the Tonopah Flat groundwater basin sub area is unknown. There is little data reported regarding well yields and aquifer characteristics in the vicinity of the POD area and further research would be conducted to investigate the quantity and quality of groundwater available.

Because the facility will utilize hybrid cooling technology, the total process and operational water demand is expected to use up to approximately 700 afy. Groundwater would be utilized to meet this demand.

The anticipated construction water demand is approximately 900 afy over the course of the 30-month construction schedule. Construction water demand would be met by pumping groundwater on-site, or through off site wells on a temporary basis.

10. REFERENCES

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APPENDIX A
Cross Reference Table and BLM Outline

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Cross Reference Table and BLM Outline

Crescent Dunes Solar Energy Plan of Development Table of Contents and BLM Cross Reference

SolarReserve Table of Contents Section		Cross Referenece to Solar POD Outline (BLM, July 2008)	
Section #	**Document sections**	**Section #**	**Document sections**
EXECUTIVE SUMMARY		**1**	**Project Description**
1.0 Introduction		1.a	Introduction
1.0 Introduction & 4.0 Project Description		1.a.1	Describe type of facility, planned uses, generation output
5.0 Required Permits and Authorizations & 6.1 Construction Process and Conceptual Schedule		1.a.2	Applicants schedule for project, including anticipated timelines for permitting, construction and operation, and any phased development as appropriate
2.0 Purpose and Need		1.b	Proponents Purpose and Need for the Project
4.2 Generating Facility Description & 4.3 Major Electrical Systems and Equipment & 8.0 Operation and Maintenance		1.c	General Facility Description, Design and Operation
4.1 Project Location		1.c.1	Project location, land ownership and jurisdiction
4.1 Project Location		1.c.2	Legal land description of facility (federal and non-federal lands)
4.1 Project Location & 4.2.1 Solar Field		1.c.3	Total acreage and general dimensions of all facilities and components
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APPENDIX B
MSDS Information

APPENDIX B
MSDS Information

BOC GASES

MATERIAL SAFETY DATA SHEET

PRODUCT NAME: CARBON DIOXIDE, GAS

1. Chemical Product and Company Identification

BOC Gases,
Division of
The BOC Group, Inc.
575 Mountain Avenue
Murray Hill, NJ 07974

TELEPHONE NUMBER: (908) 464-8100
24-HOUR EMERGENCY TELEPHONE NUMBER:
CHEMTREC (800) 424-9300

BOC Gases
Division of
BOC Canada Limited
5975 Falbourne Street, Unit 2
Mississauga, Ontario L5R 3W6

TELEPHONE NUMBER: (905) 501-1700
24-HOUR EMERGENCY TELEPHONE NUMBER:
(905) 501-0802
EMERGENCY RESPONSE PLAN NO: 20101

PRODUCT NAME: CARBON DIOXIDE, GAS
CHEMICAL NAME: Carbon Dioxide
COMMON NAMES/SYNONYMS: Carbonic Anhydride
TDG (Canada) CLASSIFICATION: 2.2
WHMIS CLASSIFICATION: A

PREPARED BY: Loss Control (908)464-8100/(905)501-1700
PREPARATION DATE: 6/1/95
REVIEW DATES: 6/7/96

2. Composition, Information on Ingredients

INGREDIENT	% VOLUME	PEL-OSHA[1]	TLV-ACGIH[2]	LD_{50} or LC_{50} Route/Species
Carbon Dioxide FORMULA: CO_2 CAS: 124-38-9 RTECS #: FF6400000	99.8 TO 99.999	5000 ppm TWA	5000 ppm TWA 30,000 ppm STEL	Not Available

[1] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)
[2] As stated in the ACGIH 1994-95 Threshold Limit Values for Chemical Substances and Physical Agents

3. Hazards Identification

EMERGENCY OVERVIEW

Oxygen levels below 19.5% may cause asphyxia. Carbon dioxide exposure can cause nausea and respiratory problems. High concentrations may cause vasodilation leading to circulatory collapse.

ROUTE OF ENTRY:

Skin Contact	Skin Absorption	Eye Contact	Inhalation	Ingestion
Yes	No	Yes	Yes	Yes

HEALTH EFFECTS:

Exposure Limits	Irritant	Sensitization
Yes	No	No
Teratogen	Reproductive Hazard	Mutagen
No	No	No
Synergistic Effects None reported		

Carcinogenicity: -- NTP: No IARC: No OSHA: No

EYE EFFECTS:
No adverse effects anticipated.

SKIN EFFECTS:
No adverse effects anticipated.

INGESTION EFFECTS:
No adverse effects anticipated.

INHALATION EFFECTS:
Carbon dioxide is the most powerful cerebral vasodilator known. Inhaling large concentrations causes rapid circulatory insufficiency leading to coma and death. Asphyxiation is likely to occur before the effects of carbon dioxide overexposure. Chronic, harmful effects are not known from repeated inhalation of low concentrations. Low concentrations of carbon dioxide cause increased respiration and headache.

Effects of oxygen deficiency resulting from simple asphyxiants may include: rapid breathing, diminished mental alertness, impaired muscular coordination, faulty judgement, depression of all sensations, emotional instability, and fatigue. As asphyxiation progresses, nausea, vomiting, prostration, and loss of consciousness may result, eventually leading to convulsions, coma, and death.

Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

NFPA HAZARD CODES	HMIS HAZARD CODES	RATINGS SYSTEM
Health: 1	Health: 1	0 = No Hazard
Flammability: 0	Flammability: 0	1 = Slight Hazard
Reactivity: 0	Reactivity: 0	2 = Moderate Hazard
		3 = Serious Hazard
		4 = Severe Hazard

4. First Aid Measures

EYES:
Never introduce oil or ointment into the eyes without medical advice! If pain is present, refer the victim to an ophthalmologist for further treatment and follow up.

SKIN:
No adverse effects anticipated.

INGESTION:
Not anticipated.

INHALATION:
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE TO CARBON DIOXIDE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given mouth-to-mouth resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

5. Fire Fighting Measures

Conditions of Flammability: Nonflammable		
Flash point: None	Method: Not Applicable	Autoignition Temperature: None
LEL(%): None	UEL(%): None	
Hazardous combustion products: None		
Sensitivity to mechanical shock: None		
Sensitivity to static discharge: None		

FIRE AND EXPLOSION HAZARDS:
None. Nonflammable

6. Accidental Release Measures

Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with inert gas prior to attempting repairs. If leak is in container or container valve, contact the appropriate emergency telephone number listed in Section 1 or call your closest BOC location.

7. Handling and Storage

Electrical Classification:
Non-Hazardous

Dry carbon dioxide can be handled in most common structural materials. Moist carbon dioxide is generally corrosive by its formation of carbonic acid. For applications with moist Carbon Dioxide, 316, 309 and 310 stainless steels may be used as well as Hastelloy ® A, B, & C, and Monel ®. Ferrous Nickel alloys are slightly susceptible to corrosion. At normal temperatures carbon dioxide is compatible with most plastics and elastomers.

Use only in well-ventilated areas. Carbon dioxide vapor is heavier than air and will accumulate in low areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when connecting cylinder to lower pressure (<3000 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the system.

Protect cylinders from physical damage. Store in cool, dry, well-ventilated area away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 125°F (52°C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders being stored for excessive periods of time.

For additional storage recommendations, consult Compressed Gas Association's Pamphlet P-1.

Never carry a compressed gas cylinder or a container of a gas in cryogenic liquid form in an enclosed space such as a car trunk, van or station wagon. A leak can result in a fire, explosion, asphyxiation or a toxic exposure.

Maximum use for potable water 100 mg/l.

8. Exposure Controls, Personal Protection

EXPOSURE LIMITS[1]:

INGREDIENT	% VOLUME	PEL-OSHA[2]	TLV-ACGIH[3]	LD_{50} or LC_{50} Route/Species
Carbon Dioxide FORMULA: CO_2 CAS: 124-38-9 RTECS #: FF6400000	99.8 TO 99.999	5000 ppm TWA	5000 ppm TWA 30,000 ppm STEL	Not Available

[1] Refer to individual state of provincial regulations, as applicable, for limits which may be more stringent than those listed here.
[2] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)
[3] As stated in the ACGIH 1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents.

IDLH (Carbon Dioxide): 50,000 ppm

ENGINEERING CONTROLS:
Use local exhaust to prevent accumulation of high concentrations so as to reduce the oxygen level in the air to less than 19.5% and the carbon dioxide concentration below the exposure limit.

EYE/FACE PROTECTION:
Safety goggles or glasses as appropriate for the job.

SKIN PROTECTION:
Protective gloves of any material appropriate for the job.

RESPIRATORY PROTECTION:

Positive pressure air line with full-face mask and escape bottle or self-contained breathing apparatus should be available for emergency use.

OTHER/GENERAL PROTECTION:
Safety shoes.

9. Physical and Chemical Properties

PARAMETER	VALUE	UNITS
Physical state (gas, liquid, solid)	: Gas	
Vapor pressure at 70 ^{o}F	: 856	psia
Vapor density at 70 ^{o}F, 1 atm (Air = 1)	: 1.53	
Evaporation point	: Not Available	
Boiling point (CO2 Sublimes)	: -109.3	^{o}F
	: -78.5	^{o}C
Freezing point	: -69.8	^{o}F
	: -56.6	^{o}C
pH	: Not Available	
Specific gravity	: Not Available	
Oil/water partition coefficient	: Not Available	
Solubility (H20)	: Very soluble	
Odor threshold	: Not Applicable	
Odor and appearance	: A colorless, odorless gas.	

10. Stability and Reactivity

STABILITY:
Stable

INCOMPATIBLE MATERIALS:
Certain reactive metals, hydrides, moist cesium monoxide, or lithium acetylene carbide diammino may ignite. Passing carbon dioxide over a mixture of sodium peroxide and aluminum or magnesium may explode.

HAZARDOUS DECOMPOSITION PRODUCTS:
Carbon monoxide and oxygen when heated above 3092 ^{o}F (1700°C). Carbonic acid is formed in the presence of moisture.

HAZARDOUS POLYMERIZATION:
Will not occur.

11. Toxicological Information

REPRODUCTIVE:
Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

Exposure of female rats to 60,000 ppm carbon dioxide for 24 hours has produced toxic effects to the embryo and fetus in pregnant rats. Toxic effects to the reproductive system have been observed in other mammalian species at similar concentrations.

OTHER:

Carbon dioxide is the most powerful cerebral vasodilator known. Inhaling large concentrations causes rapid circulatory insufficiency leading to coma and death. Chronic, harmful effects are not known from repeated inhalation of low (3 to 5 molar %) concentrations.

12. Ecological Information

No data given.

13. Disposal Considerations

Do not attempt to dispose of residual waste or unused quantities. Return in the shipping container PROPERLY LABELED, WITH ANY VALVE OUTLET PLUGS OR CAPS SECURED AND VALVE PROTECTION CAP IN PLACE to BOC Gases or authorized distributor for proper disposal.

14. Transport Information

PARAMETER	United States DOT	Canada TDG
PROPER SHIPPING NAME:	Carbon Dioxide	Carbon Dioxide
HAZARD CLASS:	2.2	2.2
IDENTIFICATION NUMBER:	UN 1013	UN 1013
SHIPPING LABEL:	NONFLAMMABLE GAS	NONFLAMMABLE GAS

15. Regulatory Information

SARA TITLE III NOTIFICATIONS AND INFORMATION

SARA TITLE III HAZARD CLASSES:
Acute Health Hazard
Sudden Release of Pressure Hazard

16. Other Information

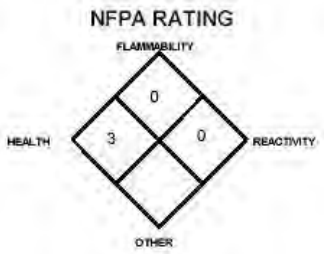
Compressed gas cylinders shall not be refilled without the express written permission of the owner. Shipment of a compressed gas cylinder which has not been filled by the owner or with his/her (written) consent is a violation of transportation regulations.

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES:
Although reasonable care has been taken in the preparation of this document, we extend no warranties and make no representations as to the accuracy or completeness of the information contained herein, and assume no responsibility regarding the suitability of this information for the user's intended purposes or for the consequences of its use. Each individual should make a determination as to the suitability of the information for their particular purpose(s).

MSDS CO2-L Revision Date: March 29, 2009

Material Safety Data Sheet: Liquid CO2

Section 1 : PRODUCT AND COMPANY IDENTIFICATION
Section 2 : COMPOSITION/ INGREDIENT INFORMATION
Section 3 : HAZARD IDENTIFICATION
Section 4 : FIRST AID MEASURES
Section 5 : FIRE FIGHTING MEASURES
Section 6 : ACCIDENTAL RELEASE MEASURES
Section 7 : HANDLING AND STORAGE
Section 8 : EXPOSURE CONTROLS / PERSONAL PROTECTION
Section 9 : PHYSICAL AND CHEMICAL PROPERTIES
Section 10 : STABILITY AND REACTIVITY
Section 11 : TOXICOLOGICAL INFORMATION
Section 13 : DISPOSAL CONSIDERATIONS
Section 14 : TRANSPORT INFORMATION
Section 15 : REGULATORY INFORMATION
Section 16 : OTHER INFORMATION



Section 1 : PRODUCT AND COMPANY IDENTIFICATION

Product name: Carbon dioxide (Liquid),

Supplier/ Manufacturer: Universal Industrial Gases, Inc.
2200 Northwood Avenue, Suite 3
Easton, PA 18045-2239 USA
(610) 559-7967.

Emergency phone: (610) 559-7967.

Section 2 : COMPOSITION/ INGREDIENT INFORMATION

C.A.S.	CONCENTRATION %	Ingredient Name	OSHA PEL	ACGIH TLV	OSHA STEL
124-38-9	> 99.8	CARBON DIOXIDE	5000 PPM	5000 PPM	30,000 PPM

Section 3 : HAZARD IDENTIFICATION

Emergency Overview: Carbon Dioxide is a colorless gas or a colorless, cryogenic liquid. At low concentrations, the gas is odorless. At higher concentrations it has a sharp, acidic odor. It will act as an asphyxiant and an irritant.

Carbon Dioxide is a powerful cerebral dilator. At concentrations between 2 and 10%, Carbon Dioxide can cause nausea, dizziness, headache, mental confusion, increased blood pressure and respiratory rate. Above 8% nausea and vomiting appear. Above 10%, suffocation and death can occur within minutes.

Contact with the cold gas can cause freezing of exposed tissue. Moisture in the air can lead to formation of carbonic acid that can irritate the eyes. All forms of Carbon Dioxide are noncombustible.

Carbon Dioxide is heavier than air and should not be allowed to accumulate in low lying areas.

Route of entry: Inhalation, skin and eye contact.

Effects of acute exposure

Eye contact: Can cause frostbite (liquid form).
Vapor may cause a stinging sensation.

Skin contact: Can cause frostbite (liquid form).

No adverse effects from gas.

Inhalation: May cause dizziness.
Asphyxiant.
Can cause vomiting.
May result in unconsciousness.
May cause excitation, excess salivation, rapid breathing.
May cause headaches and drowsiness.
May cause stinging of the nose and throat.

Ingestion: Not a likely route of exposure.

Effects of chronic exposure: Damage to retinal ganglion cells and central nervous system may occur due to the presence of carbon dioxide.

Reproductive effects: Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

Section 4 : FIRST AID MEASURES

Skin contact: Remove contaminated clothing.
Treat for frostbite if necessary by gently warming affected areas.
Consult a physician.

Eye contact: Immediately flush eyes with plenty of water for at least 15 minutes.
Consult an ophthalmologist.

Inhalation: **RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO THIS PRODUCT WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus should be worn.**

Remove victim(s) to fresh air, as quickly as possible. If not breathing qualified personnel should administer artificial respiration. Get medical attention.
If breathing is difficult, administer oxygen.

Ingestion: No first aid should be needed.
Not considered a potential route of exposure.

Section 5 : FIRE FIGHTING MEASURES

Flammability: Not flammable.

Conditions of flammability: Will not burn.

Extinguishing media: Use appropriate extinguishing media for surrounding fire.

Special procedures: Self-contained breathing apparatus required.
Firefighters should wear the usual protective gear.
Cool fire exposed containers with water spray.
Personnel should be evacuated, if necessary, to upwind area.
Remove containers from fire area if without risk.

Auto-ignition temperature: Not applicable.

Flash point (°C), method: Not applicable.

Lower flammability limit (% vol): Not applicable.

Upper flammability limit (% vol): Not applicable.

Explosion Data

Sensitivity to mechanical impact: Avoid impact against container.

Explosive power: Closed containers may rupture or explode due to pressure build-up when exposed to extreme heat.

Section 6 : ACCIDENTAL RELEASE MEASURES

Leak/Spill: Evacuate all non-essential personnel.
Stop leak without risk.
Wear gloves and goggles
Use a self-contained breathing apparatus.

Ventilate area. Monitor the surrounding area for Carbon Dioxide and Oxygen levels. Carbon Dioxide must be below the 5000 PPM TLV/PEL level shown in Section 2 and Oxygen must be at least 19.5% before personnel may be allowed into the area without self-contained breathing apparatus.

A portion of the released liquid may form dry ice. Clear the area and allow the solid to sublime/ evaporate and dissipate. If the area must be entered by emergency personnel, self-contained breathing apparatus, Kevlar gloves, and appropriate foot and leg protection must be worn. Solid pieces of dry ice may be picked up with tongs and gloves, placed into a thermally insulated and vented container and moved to a safe disposal location.

Section 7 : HANDLING AND STORAGE

Handling procedures and equipment: Never allow any unprotected part of the body to touch uninsulated pipes or vessels that contain cold fluids. The extremely cold metal of the container will cause moist flesh to stick fast and tear when one attempts to withdraw from it.

Protect system components against physical damage. Check all hoses and transfer equipment before filling them with the liquid. Replace any worn or cut hoses prior to use.

Liquid Carbon Dioxide is extremely cold and is under pressure. A leak will result in the formation of "Dry Ice" particles which will be forcibly ejected from the system, possibly injuring the operator. A complete hose failure can result in a large release of Carbon Dioxide and violent movement of the hose and associated equipment, which may cause severe injury or death. Special care must be taken when depressurizing and disconnecting hoses.

Releasing the contents of a liquid-filled line to atmospheric pressure may result in the formation of a solid dry ice plug in the line. This plug will prevent further removal of the liquid behind the plug, resulting in either an unexpected, rapid release of Carbon Dioxide as the line warms, or the catastrophic failure of the line as the liquid warms behind the plug. Sufficient vapor pressure must be applied and maintained behind the liquid before opening a discharge valve. This action will prevent the depressurization of the liquid to the point of solid formation before it exits the line.

Use adequate ventilation.
Avoid inhalation.
Never work on a pressurized system.
If there is a leak, close the upstream valve, blow down the system by venting to a safe place, then repair the leak.

Storage requirements: Use storage containers, piping, valves and fittings designed for storage and distribution of Liquefied Carbon Dioxide and vaporized (Gaseous) Carbon Dioxide.

Section 8 : EXPOSURE CONTROLS / PERSONAL PROTECTION

Precautionary Measures

Gloves/Type:

Insulated neoprene.

Respiratory/Type: NIOSH/ MSHA air purifying respirator for concentrations up to 10 times TLV; air supplied for higher concentrations.

Eye/Type: As per local regulations.

Footwear/Type: Safety boots per local regulations.

Clothing/Type: Wear adequate protective clothes.

Other/Type: Eye wash facility should be in close proximity.
Emergency shower should be in close proximity.

Ventilation requirements: Mechanical ventilation is satisfactory. Ensure oxygen concentration remains above 19.5% and Carbon Dioxide

concentration does not exceed 5000 ppm,
Local exhaust at points of emission preferred.

Section 9 : PHYSICAL AND CHEMICAL PROPERTIES

Physical state: Liquid

Appearance & odor: Colorless, odorless.

Odor threshold (PPM): Odorless.

Vapor pressure at 70°F: 830 psig

Vapor sp. gravity (air=1): 1.52 @ 70°F (21°C)

Volatiles (% by volume) 100%

Boiling point : Sublimes.
-78.5°C (760 mmHg)
-109.3°F

Freezing point : -56.6°C
-69.8°F

Solubility in water (%): Slight.

Section 10 : STABILITY AND REACTIVITY

Chemical stability: Product is stable.

Conditions of reactivity: Heat

Hazardous polymerization: Will not occur.

Incompatible substances: Alkali metals.
Chromium.
Metal acetylides.
Alkaline earth metals.
Titanium above 550°C.
Uranium above 750°C.

Hazardous decomposition products: An electrical discharge can cause Carbon Dioxide to decompose into carbon monoxide and oxygen.

Carbon Dioxide will combine with water vapor or liquid to form carbonic acid.

Section 11 : TOXICOLOGICAL INFORMATION

LD50 of product, species & route: Not available.

LC50 of product, species & route: Not available.

Section 13 : DISPOSAL CONSIDERATIONS

Waste disposal: Gas will dissipate in air.

Section 14 : TRANSPORT INFORMATION

DOT/ TDG classification: For bulk liquid shipments
Carbon dioxide refrigerated liquid
UN 2187
Class 2.2 (Non-Flammable Gas)

North American Emergency Response Guidebook Number: 120

Section 15 : REGULATORY INFORMATION

WHMIS classification:

A

DSL status: Appears on DSL.

Section 16 : OTHER INFORMATION

Definitions and other useful data:

CAS #: The Chemical Abstract Service Number which uniquely identifies each constituent.

ACGIH - American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits.

TLV - Threshold Limit Value - an airborne concentration of a substance which represents conditions under which it is generally believed that nearly all workers may be repeatedly exposed without adverse effect.

OSHA - U.S. Occupational Safety and Health Administration.

PEL - Permissible Exposure Limit - The same value as a TLV, except it is enforceable by OSHA.

IDLH - Immediately Dangerous to Life and Health **-** A concentration from which one can escape within 30-minutes without suffering permanent injury.

NATIONAL FIRE PROTECTION ASSOCIATION:
Health Hazard Rating Scale (Blue):
0 (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials);
1 (materialsthat on exposure under fire conditions could cause irritation or minor residual injury);
2 (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury);
3 (materials that can on short exposure could cause serious temporary or residual injury);
4 (materials that under very short exposure could cause death or major residual injury).
Flammability Hazard Rating Scale (Red):
0 (minimal hazard);
1 (materials that require substantial pre-heating before burning);
2 (combustible liquid or solids; liquids with a flash point of 38-93°C [100-200°F]);
3 (Class IB and IC flammable liquids with flash points below 38°C [100°F]);
4 (Class IA flammable liquids with flash points below 23°C [73°F] and boiling points below 38°C [100°F].
Reactivity Hazard Rating Scale(Yellow):
0 (normally stable);
1 (material that can become unstable at elevated temperatures or which can react slightly with water);
2 (materials that are unstable but do not detonate or which can react violently with water);
3 (materials that can detonate when initiated or which can react explosively with water);
4 (materials that can detonate at normal temperatures or pressures).

TOXICOLOGICAL INFORMATION:

Possible health hazards as derived from human data, animal studies, or from the results of studies with similar compounds are presented. Definitions of some terms:
LD50 -Lethal Dose (solids & liquids) which kills 50% of the exposed animals;
LC50 - Lethal Concentration (gases) which kills 50% of the exposed animals;
ppm concentration expressed in parts of material per million parts of air or water;
mg/m3 concentration expressed in weight of substance per volume of air;
mg/kg quantity of material, by weight.

REGULATORY INFORMATION:

EPA is the U.S. Environmental Protection Agency.

WHMIS is the Canadian Workplace Hazardous Materials Information System.

DOT and **TC** are the U.S. Department of Transportation and the Transport Canada, respectively, which assign DOT and **TDG** (Transportation of Dangerous Goods) identification numbers, hazard classifications, and proper shipping name and shipping label information. This material is hazardous as defined by 49 CFR 172.101 of the US Department of Transportation and Dangerous Goods as defined by Transport Canada Transportation of Dangerous Goods Regulations.

USE OF THIS INFORMATION:

Universal Industrial Gases, Inc. offers this information to customers, employees, contractors, and the general public to promote the safe use of this product through awareness of product hazards and safety information. Customers and others who use or transport or sell this

product to others should: 1) Disseminate this information internally to all workplace areas, employees, agents and contractors likely to encounter this product; 2) Provide supplemental hazards awareness, safety information, operation and maintenance procedures to the workplace areas and employees, agents and contractors likely to encounter this product; 3) Furnish this information to all their customers who purchase this product; and 4) Ask each purchaser or user of the product to notify its employees and customers of the product hazards and safety information.

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Contact Us

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Phone (610) 559-7967 Fax (610) 515-0945

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MSDS SUMMARY SHEET

Manufacturer:
Name: PHILLIPS PETROLEUM COMPANY
Address 1:
Address 2:
Address 3:
CSZ: BARTLESVILLE **State:** OK **Zipcode:** 74004
Emergency phone: (800) 424-9300
Business phone: 800-762-0942

Product:

Ferndale MSDS#: 1354 **Version # :** 6
Manufacturer MSDS#: 0041
Current? : 2002
Name:

NO. 2 DIESEL FUEL

Synonyms:

CARB **Diesel** TF3
CARB **Diesel**
CARB **Diesel** 10%
Diesel Fuel Oil
EPA Low Sulfur **Diesel** Fuel
EPA Low Sulfur **Diesel** Fuel – Dyed
EPA Off Road High Sulfur **Diesel –** Dyed
Fuel Oil No. 2 – CAS # 68476-30-2
No. 2 **Diesel** Fuel Oil
No. 2 Fuel Oil – Non Hiway – Dyed
No. 2 High Sulfur **Diesel** – Dyed
No. 2 Low Sulfur **Diesel** - Dyed
No. 2 Low Sulfur **Diesel** - Undyed
Crude column 3rd IR
Crude column 3rd side cut
Atmospheric tower 3rd side cut
Ultra Low Sulfur **Diesel** No. 2
Finished **Diesel**
DHT Reactor Feed
Straight Run **Diesel**
Diesel
Middle Distillate

Product/Catalog Numbers:
MSDS Date: 01/01/2002 **(received:** 01/14/2002**)**

NFPA codes:
Health: 0 **Flammability:** 2 **Reactivity:** 0

MATERIAL SAFETY DATA SHEET
No. 2 Diesel Fuel

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name: No. 2 Diesel Fuel
Product Code: Multiple
SAP Code:
Synonyms:
1354
CARB Diesel TF3
CARB Diesel
CARB Diesel 10%
Diesel Fuel Oil
EPA Low Sulfur Diesel Fuel
EPA Low Sulfur Diesel Fuel – Dyed
EPA Off Road High Sulfur Diesel – Dyed
Fuel Oil No. 2 – CAS # 68476-30-2
No. 2 Diesel Fuel Oil
No. 2 Fuel Oil – Non Hiway – Dyed
No. 2 High Sulfur Diesel – Dyed
No. 2 Low Sulfur Diesel - Dyed
No. 2 Low Sulfur Diesel – Undyed
No. 2 Ultra Low Sulfur Diesel – Dyed
No. 2 Ultra Low Sulfur Diesel - Undyed
Intended Use: Fuel
Chemical Family:
Responsible Party: Phillip's Petroleum Company
Bartlesville, Oklahoma 74004
For Additional MSDSs: 800-762-0942
Technical Information:

The intended use of this product is indicated above. If any additional use is known, please contact us at the Technical Information number listed.

EMERGENCY OVERVIEW

24 Hour Emergency Telephone Numbers:
Spill, Leak, Fire or Accident
Call CHEMTREC
North America: (800) 424-9300
Others: (703) 527-3887 (collect)

California Poison Control System: 800-356-3120

Health Hazards/Precautionary Measures: Causes severe skin irritation. Aspiration hazard if swallowed. Can enter lungs and cause damage. Use with adequate ventilation. Avoid contact with eyes, skin and clothing. Do not taste or swallow. Wash thoroughly after handling.

Physical Hazards/Precautionary Measures: Flammable liquid and vapor. Keep away from heat, sparks, flames, static electricity or other sources of ignition.

Appearance: Straw-colored to dyed red
Physical Form: Liquid
Odor: Characteristic petroleum

HFPA Hazard Class:
Health: 0 (Least)
Flammability: 2 (Moderate)
Reactivity: 0 (Least)

HMIS Hazard Class
Not Evaluated

2. COMPOSITION/INFORMATION ON INGREDIENTS

HAZARDOUS COMPONENTS	% VOLUME	EXPOSURE GUIDELINE		
		Limits	Agency	Type
Diesel Fuel No. 2 CAS# 68476-34-6	100	100* mg/m3	ACGIH	TWA-SKIN
Naphthalene CAS# 91-20-3	<1	10ppm	ACGIH	TWA
		15ppm	ACGIH	STEL
		10ppm	OSHA	TWA
		250ppm	NIOSH	IDLH

All components are listed on the TSCA inventory

Tosco Low Sulfur No. 2 Diesel meets the specifications of 40 CFR 60.41 for low sulfur diesel fuel.

Note: State, local or other agencies or advisory groups may have established more stringent limits.
Consult an industrial hygienist or similar professional, or your local agencies, for further information.

*Proposed ACGIH (1999)

3. HAZARDS IDENTIFICATION

Potential Health Effects:

Eye: Contact may cause mild eye irritation including stinging, watering, and redness.

Skin: Severe skin irritant. Contact may cause redness, itching, burning, and severe skin damage. Prolonged or repeated contact can worsen irritation by causing drying and cracking of the skin, leading to dermatitis (inflammation). Not actually toxic by skin absorption, but prolonged or repeated skin contact may be harmful (see Section 11).

Inhalation (Breathing): No information available. Studies by other exposure routes suggest a low degree of toxicity by inhalation.

Ingestion (Swallowing): Low degree of toxicity by ingestion. ASPIRATION HAZARD – This material can enter lungs during swallowing or vomiting and cause lung inflammation and damage.

Signs and Symptoms: Effects of overexposure may include irritation of the nose and throat, irritation of the digestive tract, nausea, diarrhea and transient excitation followed by signs of nervous system depression (e.g., headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue).

Cancer: Possible skin cancer hazard (see Sections 11 and 14).

Target Organs: There is limited evidence from animal studies that overexposure may cause injury to the kidney (see Section 11).

Developmental: Inadequate data available for this material.

Pre-Existing Medical Conditions: Conditions aggravated by exposure may include skin disorders and kidney disorders.

4. FIRST AID MEASURES

Eye: If irritation or redness develops, move victim away from exposure and into fresh air. Flush eyes with clean water. If symptoms persist, seek medical attention.

Skin: Immediately remove contaminated shoes, clothing, and constrictive jewelry and flush affected area(s) with large amounts of water. If skin surface is damaged, apply a clean dressing and seek immediate medical attention. If skin surface is not damaged, cleanse affected area(s) thoroughly by washing with mild soap and water. If irritation or redness develops, seek immediate medical attention.

Inhalation (Breathing): If respiratory symptoms develop, move victim away from source of exposure and into fresh air. If symptoms persist, seek medical attention. If victim is not breathing, clear airway and immediately begin artificial respiration. If breathing difficulties develop, oxygen should be administered by qualified personnel. Seek immediate medical attention.

Ingestion (Swallowing): Aspiration hazard; Do not induce vomiting or give anything by mouth because this material can enter the lungs and cause severe lung damage. If victim is drowsy or unconscious and vomiting, place on the left side with the head down. If possible, do not leave victim unattended and observe closely for adequacy of breathing. Seek medical attention.

5. FIRE FIGHTING MEASURES

Flammable Properties:

Flash Point: >125°F/>52°
OSHA Flammability Class: Combustible liquid
LEL %: 0.3 / UEL %; 10.0
Autoignition Temperature: 500°F/260°C

Unusual Fire & Explosion Hazards: This material is flammable and can be ignited by heat, sparks, flames, or other sources of ignition (e.g., static electricity, pilot lights, or mechanical/electrical equipment, and electronic devices such as cell phones, computers, calculators, and pagers which have not been certified as intrinsically safe). Vapors may travel considerable distances to a source of ignition where they can ignite, flash back, or explode. May create vapor/air explosion hazard indoors, in confined spaces, outdoors, or in sewers. Vapors are heavier than air and can accumulate in low areas. If container is not properly cooled, it can rupture in the heat of a fire.

Extinguishing Media: Dry chemical, carbon dioxide, or foam is recommended. Water spray is recommended to cool or protect exposed materials or structures. Carbon dioxide can displace oxygen. Use caution when applying carbon dioxide in confined spaces. Water may be ineffective for extinguishment, unless used under favorable conditions by experienced fire fighters.

Fire Fighting Instructions: For fires beyond the incipient stage, emergency responders in the immediate hazard area should wear bunker gear. When the potential chemical hazard is unknown, in enclosed or confined spaces, or when explicitly required by DOT, a self contained breathing apparatus should be worn. In addition, wear other appropriate protective equipment as conditions warrant (see Section 8).

Isolate immediate hazard area, keep unauthorized personnel out. Stop spill/release if it can be done with minimal risk. Move undamaged containers from immediate hazard area if it can be done with minimal risk.

Water spray may be useful in minimizing or dispersing vapors and to protect personnel. Cool equipment exposed to fire with water, if it can be done with minimal risk. Avoid spreading burning liquid with water used for cooling purposes.

6. ACCIDENTAL RELEASE MEASURES

Flammable. Keep all sources of ignition and hot metal surfaces away from spill/release. The use of explosion-proof equipment is recommended.

Stay upwind and away from spill/release. Notify persons down wind of the spill/release, isolate immediate hazard area and keep unauthorized personnel out. Stop spill/release if it can be done with minimal risk. Wear appropriate protective equipment including respiratory protection as conditions warrant (see Section 8).

Prevent spilled material from entering sewers, storm drains, other unauthorized drainage systems, and natural waterways. Dike far ahead of spill for later recovery or disposal. Use foam on spills to minimize vapors (see Section 5). Spilled material may be absorbed into an appropriate material.

Notify fire authorities and appropriate federal, state, and local agencies. Immediate cleanup of any spill is recommended. If spill of any amount is made into or upon navigable waters, the contiguous zone, or adjoining shorelines, notify the National Response Center (phone number 800-424-8802).

7. HANDLING AND STORAGE

Handling: Open container slowly to relieve any pressure. Bond and ground all equipment when transferring from one vessel to another. Can accumulate static charge by flow or agitation. Can be ignited by static discharged. The use of explosion-proof equipment is recommended and may be required (see appropriate fire codes). Refer to NFPA-704 and/or API RP 2003 for specific bonding/grounding requirements.

Do not enter confined spaces such as tanks or pits without following proper entry procedures such ASTM D-4276 and 29CFR 1910.146. The use of appropriate respiratory protection is advised when concentrations exceed any established exposure limits (see Sections 2 and 8).

Do not wear contaminated clothing or shoes. Keep contaminated clothing away from sources of ignition such as sparks or open flames. Use good personal hygiene practices.

High pressure injection of hydrocarbon fuels, hydraulic oils or greases under the skin may have serious consequences even though no symptoms or injury may be apparent. This can happen accidentally when using high pressure equipment such as high pressure grease guns, fuel injection apparatus or from pinhole leaks in tubing or high pressure hydraulic oil equipment.

“Empty” containers retain residue and may be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition. They may explode and cause injury or death. “Empty” drums should be completely drained, properly bunged, and promptly shipped to the supplier or a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

Before working on or in tanks which contain or have contained this material, refer to OSHA regulations, ANSIZ49.1 and other references pertaining to cleaning, repairing, welding, or other contemplated operations.

Storage: Keep container(s) tightly closed. Use and store this material in cool, dry, well-ventilated areas away from heat, direct sunlight, hot metal surfaces, and all sources of ignition. Post area “No Smoking or Open Flame.” Store only in approved containers. Keep away from incompatible material (see Section 10). Protect container(s) against physical damage. Outdoor or detached storage is preferred. Indoor storage should meet OSHA standards and appropriate fire codes.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering controls: If current ventilation practices are not adequate to maintain airborne concentration below the established exposure limits (see Section 2), additional ventilation or exhaust systems may be required. Where explosive mixtures may be present, electrical systems safe for such locations must be used (see appropriate electrical codes).

Personal Protective Equipment (PPE):

Respiratory: A NIOSH certified air purifying respirator with an organic vapor cartridge maybe used under conditions where airborne concentrations are expected to exceed exposure limits (see Section 2).

Protection provided by air purifying respirators is limited (see manufacturer's respirator selection guide). Use a positive pressure air supplied respirator if there is a potential for an uncontrolled release, exposure levels are not known, or any other circumstances where air purifying respirators may not provide adequate protection.

A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrants a respirator's use.

Skin: The use of gloves impervious to the specific material handled is advised to prevent skin contact, possible irritation and skin damage (see glove manufacturer literature for information on permeability). Depending on conditions of use, apron and/or arm covers may be necessary.

Eyes/Face: Approved eye protection to safeguard against potential eye contact, irritation, or injury is recommended. Depending on conditions of use, a face shield may be necessary.

Other Protective Equipment: Eye wash and quick-drench shower facilities should be available in the work area. Thoroughly clean shoes and wash contaminated clothing before reuse. It is recommended that impervious clothing be worn when skin contact is possible.

9. PHYSICAL AND CHEMICAL PROPERTIES

Note: Unless otherwise stated, values are determined at 20°C (68°F) and 760 mm Hg (1atm).

Appearance: Straw-colored to dyed red
Physical State: Liquid
Odor: Characteristic petroleum
pH: unavailable
Vapor Pressure (mm Hg): 0.40
Vapor Densisty (air=1):>3
Boiling Point/Range: 320-700°F /160-371°C
Freezing/Melting Point: No Data
Solubility in Water: Negligible
Specific Gravity: 0.81-0.88 @ 60°F
Percent Volatile: Negligible
Evaporation Rate (nBuAc=1): <1
Viscosity: 32.6-40.0 SUS @ 100°F
Bulk Density: 7.08 lbs/gal
Flash Point: >125°F / >52°C
Flammable/Expolsive Limits (%): LEL: 0.3 / UEL: 10.0

10. STABILITY AND REACTIVITY

Stability: Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. Flammable liquid and vapor. Vapor can cause flash fire.

Conditions To Avoid: Avoid all possible sources of ignition (see Sections 5 and 7).

Materials to Avoid (Incompatible Materials): Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite, calcium hypochlorite, etc.

Hazardous Decomposition Products: The use of hydrocarbon fuels in an area without adequate ventilation may result in hazardous levels of combustion products (e.g., oxides of carbon, sulfur and nitrogen, benzene and other hydrocarbons) and/or dangerously low oxygen levels. ACGIH has included a TLV of 0.05 mg/m3 TWA for diesel exhaust particulate on its 1999 Notice of Intended Changes. See Section 11 for additional information on hazards of engine exhaust.

Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Diesel Fuel No. 2 (CAS# 68476-34-6)

Carcinogenicity: Chronic dermal application of certain middle distillate streams contained in diesel fuel No. 2 resulted in an increased incidence of skin tumors in mice. This material has not been identified as carcinogen by NTP, IARC, or OSHA. Diesel exhaust is a probable cancer hazard based on tests with laboratory animals.

Target Organ(s): Limited evidence of renal impairment has been noted from a few case reports involving excessive exposure to diesel fuel No. 2.

Naphthalene (CAS# 91-20-3)

Carcinogenicity: Naphthalene has been evaluated in two year inhalation studies in both rats and mice. The National Toxicology Program (NTP) concluded that there is clear evidence of carcinogenicity in male and female rats based on increased incidences of respiratory epithelial adenomas and olfactory epithelial neuroblastomas of the nose. NTP found some evidence of carcinogenicity in female mice (alveolar adenomas) and no evidence of carcinogenicity in male mice. Naphthalene has not been identified as a carcinogen by IARC or OSHA.

12. ECOLOGICAL INFORMATION

Not evaluated at this time

13. DISPOSAL CONSIDERATIONS

This material, if discarded as produced, would be a RCRA “characteristic” hazardous waste due to the characteristic(s) of ignitability (D001) and benzene (D018). If the material is spilled to soil or water, characteristic testing of the contaminated materials is recommended. Further, this material, once it becomes a waste, is subject to the land disposal restrictions in 40 CFR 268.40 and may require treatment prior to disposal to meet specific standards. Consult state and local regulations to determine whether they are more stringent then the federal requirements.

Container contents should be completely used and containers should be emptied prior to discard. Container ?insate? could be considered a RCRA hazardous waste and must be disposed of with care and in compliance with federal, state and local regulations. Large empty containers, such as drums, should be returned to the distributor or to a drum reconditioner. To assure proper disposal of smaller containers, consult with state and local regulations and disposal authorities.

14. TRANSPORT INFORMATION

DOT Shipping Description: Diesel Fuel, NA1983
Non-Bulk Package Marking: Diesel Fuel, 3, NA 1993, III

15. REGULATORY INFORMATION

EPA SARA 311/312 (Title III Hazard Categories):

Acute Health:	Yes
Chronic Health:	Yes
Fire Hazard:	Yes
Pressure Hazard:	No
Reactive Hazard:	No

SARA 313 and 40 CFR 372:
This material contains the following chemicals subject to the reporting requirements of SARA 313 and 40 CFR 372:

Component	CAS Number	Weight %
-- None known --		

California Proposition 65:
Warning: This material contains the following chemicals which are known to the state of California to cause cancer, birth defects or other reproductive harm, and are subject to the requirements of California Proposition 65 (CA Health & Safety Code Section 25249.5):

Component	Effect
Benzene	Cancer, Developmental and Reproductive Toxicant
Toluene	Developmental Toxicant

Diesel engine exhaust, while not a component of this material, is on the Proposition 65 list of chemicals known to the State of California to cause cancer.

Carcinogen Identification:
This material has not been identified as a carcinogen by NTP, IARC, or OSHA. See Section 11 for carcinogenicity information of individual components, if any. Diesel exhaust is a probable cancer hazard based on tests in laboratory animals. It has been identified as carcinogen by IARC.

EPA (CERCLA Reportable Quantity: None

16. OTHER INFORMATION

Issue Date: 01/01/02
Previous Issue Date: 05/15/01
Product Code: Multiple
Revised Sections: None
Previous Product Code: Multiple
MSDS Number: 0041

Disclaimer of Expressed and Implied Warranties:

The information presented in this Material Data Safety Sheet is based on data believed to be accurate as of the date this Material Data Sheet was prepared. HOWEVER, NO WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY IS EXPRESSED OR IS TO BE IMPLIED REGARDING THE ACCURACY OR COMPLETENESS OF THE INFORMATION PROVIDED ABOVE, THE RESULTS TO BE OBTAINED FROM THE USE OF THIS INFORMATION OR THE PRODUCT, THE SAFETY OF THE PRODUCT, OR THE HAZARDS RELATED TO ITS USE. No responsibility is assumed for any damage or injury resulting from abnormal use or from any failure to adhere to recommended practices. The information provided above, and the product, are furnished on the condition that the person receiving them shall make their own determination as to the suitability of the product for their particular purpose and on the condition that they assume the risk of their use. In addition, no authorization is given nor implied to practice any patented invention without a license.

Tosco Refining Company ***Ferndale Refinery***

UltraLow Sulfur Diesel Product Specification

Ferndale Product Code:34380xx (5) Product Code: ULSD2

(COMETS)

Specification	Unit	Limit	Test Procedure	Typical
Appearance				
Water & Sediment	Vol %	0.05 Max	D 2709	
Color	Number	3.0 Max	D 1500	
Haze Rating	Rating	2 Max	D 4176	
Composition				
Carbon Residue (Ramsbottom)	Wt %	0.35 Max	D 524, D 189	
Volatility				
90% Recovered	Deg; F	540 Min	D 86	
	Deg; F	640 Min	D 86	
Flash Point	Deg; F	125 Min (1)	D 93	130 F
Gravity	API	30 Min	D 287, D4052	
Fluidity				
Pour Point	Deg; F	See Season Table (6)	D 97	
Cloud Point	Deg; F	See Season Table (6)	D 2500	10 F
Viscosity @ 104F	cSt	1.9 Min	D 445	
	cSt	4.1 Max	D 445	
Lubricity, SLBOCLE	grams	3100 Min	D 6078	3300gm
Lubricity, HFRR	mm	.45	D 6079	
Combustion				
Cetane Index or Cetane Number (3,4)	Number	40.0 Min	D 976, D613	47.0
Corrosion				
Copper Strip, 3hr @ 50 deg C	Number	3 Max (2)	D 130	
Aromatics (4)	Vol %	35 Max	D 1319	25 %
Contaminants				
Total Sulfur	PPM	30 Max	D 2622, D4294	15-20ppm
Water & Sediment	Vol %	0.05 Max	D 1796	
Ash	Wt %	0.01 Max	D 482	
Additives				
Cetane Improver	Lb/MBbl	675 Max		
Dye		Undyed		

1. Minimum release specification is 125 deg. F. The refinery should target 135 deg. F.
2. Test result reported as a number and letter (e.g. 1a). Any letter is allowable as long as the number meets the spec shown.
3. Either specification must be met.
4. Either cetane index minimum or aromatics maximum must be met.
5. Winter cloud and pour specifications may be relaxed to the summer specifications by agreement with the customer.
6. Season Table

Month	Product Code	Pour Point	Cloud Point
Jan, Feb, Nov, Dec	WI	0 max (5)	14 max (5)
Mar - Oct	SU	15 max	24 max

MSDS Number: **F1080** * * * * * *Effective Date:* ***11/21/08*** * * * * * *Supercedes:* ***02/16/06***

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

J.T.Baker®

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300
National Response in Canada
CANUTEC: 613-996-6666
Outside U.S. And Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

Ferric Chloride Solution

1. Product Identification

Synonyms: Iron (III) Chloride Solution
CAS No.: 7705-08-0
Molecular Weight: Not applicable to mixtures.
Chemical Formula: FeCl3 in H2O
Product Codes: 5251

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Ferric Chloride	7705-08-0	35 - 45%	Yes
Water	7732-18-5	55 - 65%	No

3. Hazards Identification

Emergency Overview

DANGER! CORROSIVE. CAUSES BURNS TO ANY AREA OF CONTACT. HARMFUL IF SWALLOWED OR INHALED. AFFECTS THE LIVER.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 3 - Severe (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:
Extremely destructive to tissues of the mucous membranes and upper respiratory tract. Symptoms may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea and vomiting.
Ingestion:
Corrosive. Swallowing can cause severe burns of the mouth, throat, and stomach. Can cause sore throat, vomiting, diarrhea. Low systemic toxicity in small quantities but larger doses may cause systemic effects. Pink urine discoloration is a strong indicator of iron poisoning. Liver damage, coma and death may follow, sometimes delayed as long as three days.
Skin Contact:
Corrosive. Symptoms of redness, pain, and severe burn can occur.
Eye Contact:
Corrosive. Contact can cause blurred vision, redness, pain and severe tissue burns.
Chronic Exposure:
Repeated ingestion may cause liver damage. Prolonged exposure of the eyes may cause discoloration.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Ingestion:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard. Irritating hydrogen chloride fumes may form in fire.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Water, dry chemical, foam or carbon dioxide. Do not allow water runoff to enter sewers or waterways.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Containers of this material are hazardous when empty since they retain product residues; observe all warnings for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-ACGIH Threshold Limit Value (TLV):
1 mg/m3 (TWA) soluble iron salt as Fe
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a full facepiece particulate respirator (NIOSH type N100 filters) may be worn for up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids. glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Orange to brown liquid.
Odor:
Acid odor.
Solubility:
Complete (100%)
Specific Gravity:
1.40
pH:
No information found.
% Volatiles by volume @ 21C (70F):
55-65
Boiling Point:

230C (446F)
Melting Point:
No information found.
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
May produce hydrogen chloride.
Hazardous Polymerization:
This substance does not polymerize.
Incompatibilities:
Metals, allyl chloride, sodium, potassium.
Conditions to Avoid:
Incompatibles.

11. Toxicological Information

Oral rat LD50: 316 mg/kg (anhydrous); investigated as a mutagen, reproductive effector.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Ferric Chloride (7705-08-0)	No	No	None
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Ferric Chloride (7705-08-0)	Yes	Yes	Yes	Yes
Water (7732-18-5)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\----------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Ferric Chloride (7705-08-0)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Ferric Chloride (7705-08-0)	No	No	No	No

```
  Water (7732-18-5)                          No    No      No         No

  --------\Federal, State & International Regulations - Part 2\----------------
                                                          -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  ----------------------------------------   ------     ------    ------
  Ferric Chloride (7705-08-0)                1000       No         No
  Water (7732-18-5)                          No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Mixture / Liquid)
```

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
DANGER! CORROSIVE. CAUSES BURNS TO ANY AREA OF CONTACT. HARMFUL IF SWALLOWED OR INHALED. AFFECTS THE LIVER.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe mist.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. In all cases get medical attention immediately.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 3.
Disclaimer:
****
Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.
****
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910 1200. Standard must be consulted for specific requirements.

U.S. Department of Labor

Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(as Used on Label and List)*

HYDRATED LIME

Note: Blank spaces are not permitted. If any item is not applicable or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's name CHENEY LIME & CEMENT COMPANY	Emergency Telephone Number 205-625-3031
Address *(Number, Street, City, State and ZIP Code)* 478 GRAYSTONE ROAD	Telephone Number for Information 205-625-3031
ALLGOOD, ALABAMA 35013	Date Prepared
	Signature of Preparer *(optional)*

Section II—Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
CALCIUM HYDROXIDE (EPA #A349-3522)	10 mg/M^3	5 mg/M^3		
$Ca(OH)_2$				

Section III—Physical/Chemical Characteristics

Boiling Point	5162°F (CaO)	Specific Gravity (H_20 = 1) TRUE	2.3 – 2.6
Vapor Pressure (mm Hg)	NA	Melting Point DEHYDRATES TO CaO AT 580°C (1076°F) AT 1 ATM.	
Vapor Density (AIR = 1)	NA	Evaporation Rate (Butyl Acetate = 1)	

Solubility in Water NEGLIGIBLE 0.185-0.070% AT 25°C

Appearance and Odor WHITE POWDER NO ODOR

Section IV—Fire and Explosion Hazard Data

Flash Point (Method Used) NA	Flammable Limits NA	LEL	UEL

Extinguishing Media NA

Special Fire Fighting Procedures

HYDRATED LIME IS INCOMBUSTIBLE AND, UNLIKE QUICKLIME, IT WILL NOT GENERATE HEAT WHEN IT COMES IN CONTACT WITH WATER.

Unusual Fire and Explosion Hazards

NA

(Reproduce locally) OSHA 174 Sept. 1985

Section V—Reactivity Data

Stability			Conditions to Avoid
	Unstable	YES	IF SUBJECTED TO CARBON DIOXIDE IN MOIST AIR AND ACIDS
	Stable	YES	IF CONFINED IN WATER-TIGHT CONTAINER.

Incompatibility *(Materials to Avoid)*

CONTACT WITH ACIDS.

Hazardous Decomposition or Byproducts NA

Hazardous Polymerization			Conditions to Avoid
	May Occur		NA
	Will Not Occur	X	

Section VI—Health Hazard Data

Route(s) of Entry Inhalation? X Skin? X Ingestion?

Health Hazards *(Acute and Chronic)* TLV 5mg/M^3

Carcinogenicity NA NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure UNDER DUSTY CONDITIONS IT CAN CAUSE EXCESSIVE DRYING OF SKIN AND POSSIBLE SKIN IRRITATION AND OPEN CUTS ARE PARTICULARLY VULNERABLE.

Medical Conditions
Generally Aggravated by Exposure OPEN CUTS

Emergency and First Aid Procedures

WASH OFF ALL LIME DUST FROM SKIN WITH CLEAN WATER; THEN OPTIONALLY RINSE SKIN WITH VINEGAR; APPLY BURN OINTMENT TO AFFECTED AREAS. FOR EYES FLUSH OUT IMMEDIATELY WITH WATER & SEE PHYSICIAN.

Section VII—Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled

CLEAN UP BY NORMAL PHYSICAL METHODS.

Waste Disposal Method

CAN BE SALVAGED FOR USE OR EMPTIED IN SEWER OR REMOVED TO DUMP.

Precautions to Be Taken in Handling and Storing

KEEP PRODUCT DRY AND AVOID DUSTING.

Other Precautions NONE

Section VII—Control Measures

Respiratory Protection *(Specify Type)* PROTECT (FILTER) MASK IN DUSTY ENVIRONMENT.

Ventilation				
	Local Exhaust	NA	Special	NA
	Mechanical *(General*	APPLY ADEQUATE VENTILATION TO KEEP DUST CONC. BELOW TLV.	Other	VENT DUST TO A COLLECTOR.

Protective Gloves	Eye Protection
WORK GLOVES IN MANUAL HANDLING	TIGHT FITTING SAFETY GOGGLES.

Other Protective Clothing or Equipment LONG SLEEVED SHIRT WITH BUTTONED COLLAR. LONG PANTS EXTENDING OVER WORK SHOES. PROTECTIVE CREAM MAY BE USED ON EXPOSED SKIN IF NEEDED

Work/Hygienic Practices HYDRATED LIME DUST SHOULD BE WASHED FROM SKIN & HAIR.

iSOC® Technology

Material Safety Data Sheet: Hydrogen

Product Name: Hydrogen	**CAS:** 1333-74-0
Hydrogen, Compressed (D.O.T); Water Gas	**DOT I.D No.:** UN 1049
Chemical Name and Synonyms: Hydrogen, Normal Hydrogen	**DOT Hazard Class:** Division 2.1
Formula: H_2	**Chemical Family:** Inorganic Flammable Gas

HEALTH HAZARD DATA

Time Weighted Average Exposure Limit:

Hydrogen is defined as a simple asphyxiant (ACGIH 1994-1995); OSHA 1993 PEL (8 Hr. TWA) = No Listing

Symptoms of Exposure:

Inhalation: High concentrations of hydrogen so as to exclude an adequate supply of oxygen to the lungs causes dizziness, deeper breathing due to air hunger, possible nausea and eventual unconsciousness.

Toxicological Properties:

- Hydrogen is inactive biologically and essentially nontoxic; therefore, the major property is the exclusion of an adequate supply of oxygen to the lungs.
- Hydrogen is not listed in the IARC, NTP or by OSHA as a carcinogen or potential carcinogen.
- Persons in ill health where such illness would be aggravated by exposure to hydrogen should not be allowed to work with or handle this product.

Hazardous Mixtures of other Liquids, Solids or Gases: Hydrogen is flammable over a very wide range in air.	
PHYSICAL DATA	
Boiling Point: -423°F (-252.8°C)	**Liquid Density at Boiling Point:** 4.43 lb/ft3 (70.96 kg/m3)
Vapor Pressure @ 70°F (21.1°C) = Above the critical temperature of 399.8°F (-239.9°C)	**Gas Density at 70°F. 1 atm** .0052
Solubility in Water: Very slightly	**Freezing Point:** -434.6°F (-259.2°C)
Evaporation Rate: N/A (Gas)	**Specific Gravity (AIR=1)** @ 70°F (21.1°C) = .069
Appearance and Odor: Colorless, odorless gas	

FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method used): N/A Gas	**Auto Ignition Temperature:** 1058°F (570°C)	**Flammable Limits % by Volume:** LEL 4 UEL 74.5
Extinguishing Media: Water, carbon dioxide, dry chemical		**Electrical Classification:** Class 1, Group B
Special Fire fighting Procedures: If possible, stop the flow of hydrogen. Cool surrounding containers with water spray. Hydrogen burns with an almost invisible flame of relatively low thermal radiation.		
Unusual Fire and Explosion Hazards: Hydrogen is very light and rises very rapidly in air. Should a hydrogen fire be extinguished and the flow of gas continue, increase ventilation to prevent an explosion hazard, particularly in the upper portions.		

REACTIVITY DATA

Stability: Stable

Incompatibility (Materials to Avoid): Oxidizers

Hazardous Decomposition Products: None

Hazardous Polymerization: Will not occur

Conditions to Avoid: None

SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled:

Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with an inert gas prior to attempting repairs. If leak is in container or container valve, contact your closest supplier location or call the emergency telephone number listed herein.

Waste disposal methods:

Do not attempt to dispose of waste or unused quantities. Return in the shipping container properly labeled, with any valve outlet plugs or caps secured and valve protection cap in place to your supplier. For emergency disposal assistance, contact your closest supplier location or call the emergency telephone number listed herein.

SPECIAL PROTECTION INFORMATION

Respiratory Protection (Specify type): Positive pressure air line with mask or self-contained breathing apparatus should be available for emergency use.

Ventilation: Hood with forced ventilation

Local Exhaust: To prevent accumulation above the LEL

Mechanical (Gen.): In accordance with electrical codes

Protective Gloves: Plastic or rubber

Eye Protection: Safety goggles or glasses

Other Protective Equipment: Safety shoes, safety shower

SPECIAL PRECAUTIONS

Special Labeling Information:

DOT Shipping Name: Hydrogen, Compressed
DOT Hazard Class: Division 2.1
DOT Shipping Label: Flammable Gas
I.D. No.: UN 1049

Special Handling Recommendation:

Use only in well-ventilated areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when connecting cylinder to lower pressure (<3,000 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder. For additional handling recommendations, consult Compressed Gas Association's Pamphlets G-5, P-1, P-14, and Safety Bulletin SB-2.

Special Storage Recommendations:

Protect cylinders from physical damage. Store in cool, dry, well-ventilated area of I noncombustible construction away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 125F (52C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a “first in -first out” inventory system to prevent full cylinders being stored for excessive periods of time. Post “No Smoking or Open Flames” signs in the storage or use area. There should be no sources of ignition in the storage or use area. For additional storage recommendations, consult Compressed Gas Association’s Pamphlets G-5, P-1, P-14, and Safety Bulletin SB-2.

Other Recommendations or Precautions:

Earth-ground and bond all lines and equipment associated with the hydrogen system. Electrical equipment should be non-sparking or explosion proof. Compressed gas cylinders should not be refilled except by qualified producers of compressed gases. Shipment of a compressed gas cylinder which has not been filled by the owner or with his (written) consent is a violation of Federal Law (49CFR).

Special Packaging Recommendations:

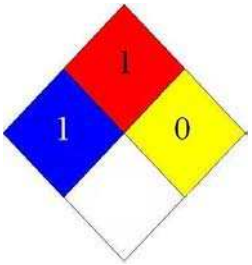
Hydrogen is non-corrosive and may be used with any common structural material.

MATERIAL SAFETY DATA SHEET

COPYRIGHT ITW Industrial Finishing
PRODUCT RELATED HEALTH DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: LUBRICATING OIL
Binks Part No. 17611-102
MSDS #: MSDS-22
REVISION #: 2.3
DATE REVISED: 03/14/2007 DATE PREPARED: 01/01/2003



ITW Industrial Finishing - Binks
195 Internationale Blvd.
Glendale Heights, IL 60139
Emergency Number - INFOTRAC
EMERGENCY PHONE (24 HOURS):
1-8OO-535-5053
630-237-5000
GENERAL USE: LUBRICATING OIL

2. COMPOSITION/INFORMATION ON INGREDIENTS

INGREDIENTS CAS REG NO.	WGT . %	ACGIH TLV	ACGIH STEL	OSHA PEL	OSHA STEL	UNITS
Oil Mist in Air (Not encountered in Normal Use)		5 mg/cubic meter	5 mg/cubic meter			

3. HAZARDS IDENTIFICATION

POTENTIAL HEALTH EFFECTS
PRIMARY EXPOSURE ROUTES: Skin – Eyes – Inhalation – Ingestion
ACUTE EFFECTS
Eye: Eye contact may result in irritation.
Skin: Prolonged or repeated skin contact may cause skin irritation.
Ingestion: Minute amounts aspirated into the lungs during ingestion may cause mild to severe pulmonary injury.
Inhalation: Vapor pressure is very low and inhalation at room temperature is not a problem. If overcome by vapor from a hot product mild to severe pulmonary injury may occur.
CHRONIC EFFECTS
Eye: No long-term adverse effects are known.
Skin: No long-term adverse effects are known.
Ingestion: This product has a low order of acute oral toxicity, but minute amounts aspirated into the lungs during ingestion may cause mild to severe pulmonary injury.
Inhalation: If overcome by vapor from a hot product mild to severe pulmonary injury may occur.
CARCINOGENICITY: Not listed as a carcinogen or potential carcinogen by the NTP, IARC, and OSHA.
TARGET ORGAN EFFECTS: None known.
MEDICAL CONDITIONS AGGRAVATED by LONG-TERM EXPOSURE: No known medical conditions are aggravated by exposure to solution.

MATERIAL SAFETY DATA SHEET

DURA LIFE TRANSFORMER OIL ALL GRADES

MSDS Number : **12038**
Version Date : 02/07/2007

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name : DURA LIFE TRANSFORMER OIL- ALL GRADES
Product Use : NA
Synonyms : NA

MANUFACTURER

American HiTech Petroleum & Chemicals, Inc.

810 WRIGHT AVE.
RICHMOND CA 94804, U.S.A.
Internet Address : www.amtecol.com

Medical Emergency : (866) 268 1888
Technical Assistance : (510) 235 7979
Customer Service : (510) 235 7979
Fax Number : (510) 232 4846

2. COMPONENT INFORMATION

Component	CAS No.	Weight Percent Range	Hazardous in Blend
- NAPHTHENIC MINERAL OIL	MIXTURE	< 90	No
- ADDITIVES	MIXTURE	< 10	No

This product is NOT HAZARDOUS according to OSHA 29 CFR 1910.1200.

3. HAZARDS IDENTIFICATION

IMMEDIATE HEALTH EFFECTS

EYE: Not expected to cause prolonged or significant eye irritation .
SKIN: Contact with the skin is not expected to cause prolonged or significant irritation. Not expected to be harmful to internal organs if absorbed through the skin .
INGESTION: Not expected to be harmful if swallowed .
INHALATION: This product is not expected to pose an inhalation hazard under conditions of normal use or forseeable misuse. This product has a low vapor pressure and is not expected to present an inhalation hazard at ambient conditions. Caution should be taken to prevent aerosolization or misting of this product. Acute and chronic overexposures generated under unusual conditions may be irritating to the respiratory tract .

4. FIRST AID INFORMATION

Eye Contact: Immediately flush eyes with large amounts of water and continue flushing until irritation subsides. If material is hot, treat for thermal burns and seek immediate medical attention.
Skin Contact: No treatment is necessary under ordinary circumstances. Remove contaminated clothing. Wash contaminated area throughly with soap and water. If material is hot, submerge injured area in cold water. If victim is severely burned, remove to a hospital immediately .
Inhalation: This material has a low vapor pressure and is not expected to present an inhalation exposure at ambient conditions. If vapor or mist is generated when the material is heated, and the victim experiences signs of respiratory tract irritation, remove to fresh air .
Ingestion: No treatment is necessary under ordinary circumstances. Do not induce vomiting. This material does not present any known ingestion hazard .

5. FIRE AND EXPLOSION INFORMATION

Flammable Properties

Flash Point : >284°F, >140°C
Test Method : ASTM D 92 (C.O.C.)
Flammable Limits in Air
Upper Percent : NA
Lower Percent : NA
Autoignition Temperature : NA
Test Method : NA
NFPA Ratings : Health : 0 Flammability : 1 Reactivity : 0
Extinguishing Media : Use dry chemical, foam, or carbon dioxide .
Fire Fighting Mesures
Special Fire Fighting Procedures and Equipment : Water may be ineffective but can be used to cool containers exposed to heat or flame to prevent vapor pressure builup and possible container rupture. Caution should be exercised when using water or foam as frothing may occur, especially if sprayed into containers of hot, burning liquid .
Unusual Fire and Explosion Conditions : Dense smoke may be generated while burning. Carbon monoxide, carbon dioxide, and other oxides may be generated as products of combustion .
Hazardous Combustion By-Products : None

6. ACCIDENTAL RELEASE MESURES

Emergency Number : 866 268 1888
Accidental Release Mesures : Stop the source of the leak or release. Clean up releases as soon as possible, observing precautions in Exposure Controls/Personal Protection. Contain liquid to prevent further contamination of soil, surface water or groundwater. Clean up small spills using appropriate techniques such as sorbent materials or pumping. Where feasible and appropriate , remove contaminated soil. Follow prescribed procedures for reporting and responding to larger releases .

7. HANDLING AND STORAGE INFORMATION

Handling : Fire extinguishers should be kept readily available. See NFPA 30 and OSHA 1910.106 - Flammable and Combustible Liquids .
Storage : Do not transfer to unmarked containers. Store in closed containers away from heat, sparks, open flame, or oxidizing materials. See also additional information section below .
Empty Container Warnings
Drums : Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner, or properly disposed. Empty containers retain product residue and can be dangerous .
Plastic : Do not reuse this container. Empty container may retain product residues .

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Limits and Guidelines : This product does not contain any components with OSHA or ACGIH exposure limits .
Personal Protective Equipment
Eye/Face Protection : No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields as good safety practice .
Skin Protection : No skin protection is required for single, short duration exposures. For prolonged or repeated exposures, use impervious clothing (boots, gloves, aprons, etc..) over parts of the body subject to exposure. If handling hot material, use insulated protective clothing (boots, gloves, aprons, etc..). Launder soiled clothes. Properly dispose of contaminated leather articles including
shoes, which cannot be decontaminated .
Respiratory Protection : Respiratory protection is not required under conditions of normal use. If vapor or mist is generated when the material is heated or handle, use an organic vapor respirator with a dust and mist filter. All respirators must be NIOSH certified. Do not use compressed oxygen in hydrocarbon atmospheres .
Personal Hygiene : Always wash hands and face with soap and water before eating, drinking, or smoking. Consumption of food and breverage should be avoided in work areas where this product is present .
Engineering Control/Work Practices : Use in a well-ventilated area. If user operations generate an oil mist, use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below the recommended mineral oil mist exposure limits .

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance : Bright Yellow Brown	Pour Point : < -22 °F (- 30 °C)
Odor : Petroleum - mild	Solubility in Water :Negligible in water
Physical State : Liquid	Vapor Pressure : < 0.1 mm Hg
Boiling Point : > 700 °F (371.1 °C)	Vapor Density (air=1) : NA
Melting Point : NA	pH : NA
Specific Gravity : < 1	Viscosity @ 100 oC : 13.0 - 17.0 cSt

10. STABILITY AND REACTIVITY INFORMATION

Chemical Stability : Stable
Condition to Avoid : High heat and open flames
Incompatible Materials to Avoid : May react with strong oxidizing agents

11. TOXICOLOGICAL INFORMATION

Primary Eye Irritation : NA
Primary Skin Irritation : NA
Acute Dermal Toxicity : NA
Subacute Dermal Toxicity : NA
Dermal Sensitization : NA
Inhalation Toxicity : NA
Oral Toxicity : NA
Mulagenicity : NA

Carcinogenicity : The International Agency for Research on Cancer (IARC) has concluded that there is inadequate data to evaluate the carcinogenicity to experimental animals of this class of product. IARC has concluded there is sufficient evidence that used gasoline-engine motor oils produce skin tumors in experimental animals. Also, IARC has determined this class of products belongs to Group 3 - "not classifiable as to its carcinogenicity to humans" .
Reproductive and Developmental Toxicity : NA
Teratogenicity : NA
Immunotoxicity : NA
Neurotoxicity : NA

12. ECOLOGICAL INFORMATION

Ecotoxicity : The toxicity of this material to aquatic organisms has not been evaluated. Consequently, this material should be kept out of sewage and drainage systems and all bodies of water .
Environmental Fate : This material is not expected to be readily biodegradable .

13. DISPOSAL INFORMATION

Regulatory Information : All disposals must comply with federal, state, and local regulations. The material, if spilled or discarded, may be a regulated waste. Refer to state and local regulations. Department of Transportation (DOT) regulations may apply for transporting this material when spilled .
Waste Disposal Methods : Waste material may be landfilled or incinerated at an approved facility. Materials should be recycled if possible .

14. TRANSPORTATION INFORMATION

U.S. Department of Transportation (DOT)
Highway / Rail (Bulk) : Not Regulated
Highway / Rail (Non-Bulk) : Not Regulated
The DOT description is provided to assist in the proper shipping classification of this product and may not be suitable for all shipping descriptions .
International Information
Vessel : IMDG Not Regulated
Air : ICAO Not Regulated

15. REGULATORY INFORMATION

Regulatory Lists Searched : The components listed in Section 2 of this MSDS were compared to substances that appear on the following regulatory lists. Each list is numerically identified. See Regulatory Search Results below .
Health & Safety : 10 - IARC carcinogen, 11 - NTP carcinogen, 12 - OSHA carcinogen, 15 - ACGIH TLV, 16 - OSHA PEL, 17 - NIOSH exposure limit, 20 - US DOT Appendix A, Hazardous substances, 22 - FDA 21 CFR Total food additives, 23 - NFPA 49 or 325 .
Environmental : 30 - CAA 1990 Hazardous air pollutants, 31 - CAA Ozone depletors, 33 - CAA HON rule, 34 - CAA Toxic substance for accidental release prevention, 35 - CAA Volatile organic compounds (VOC's) in SOCMI, 41 - CERCLA / SARA Section 302 extremely hazardous substances, 42 - CERCLA / SARA Section 313 emissions reporting, 43 - CWA Hazardous substances, 44 - CWA
Priority pollutants, 45 - CWA Toxic pollutants, 46 - EPA Proposed test rule for hazardous air pollutants, 47 - RCRA Basis for listing - Appendix VII, 48 - RCRA waste, 49 - SDWA - (S)MCLs .
International : 50 - Canada - WHMIS Classification of substance, 54 - Mexico - Drinking water - ecological criteria, 55 - Mexico - Wastewater discharges, 56 - US - TSCA Section (12)(b) - export notification .

State Lists : 60 - CA - Proposition 65, 61 - FL - Substances, 62 - MI - Critical materials, 63 - MA - RTK, 64 - MA - Extraordinarily hazardous substances, 65 - MN - Hazardous substances, 66 - PA -RTK, 67 - NJ - RTK, 68 - NJ - Environmental hazardous substances, 69 - NJ - Special harzardous substances .
Inventories : 80 - Canada - Domestic substances, 81 - European - EINECS, 82 - Japan - ENCS, 83 - Korea - Existing and evaluated chemical substances, 84 - US - TSCA, 85 - China Inventory .
Regulatory Search Results : No components appear on any of the regulatory lists searched .
U.S. TSCA Inventory : All components of this material are on the US TSCA Inventory .
SARA Section 313 : This product is not known to contain any SARA, Title III, Section 313 Reportable Chemicals at or greater than 1.0% (0.1% for carcinogens)
IARC : NA
SARA 311 / 312 Categories : Not Regulated
Canadian WHMIS Classification : Not a controlled substance under WHMIS

European Union Classification

Hazard Symbols : No classification recommended
Risk Phrases : No classification recommended
Safety Phrases : No classification recommended

16. OTHER INFORMATION

Health and Environmental Label Language

CAUTION : Contains Petroleum Lubricant. Repeated skin contact can cause skin disorders .
ATTENTION : Used motor oil is a possible skin cancer hazard based on animal data. Repeated exposure to oil mist in excess of the OSHA limit (5mg/m3) can result in accumulation of oil droplets in pulmonary tissue .
PRECAUTIONARY MEASURES : Avoid excessive & prolonged skin contact. Wash thoroughly after handling. Avoid generation and inhalation of oil mists .
INSTRUCTIONS IN CASE OF FIRE OR SPILL : In case of fire, use water spray, foam, dry chemical or carbon dioxide. Water spray may be ineffective, but can be used to cool containers. In case of spill, do not use water, soak up with absorbent material .
DON'T POLLUTE, CONSERVE RESOURCES, RETURN USED OIL TO COLLECTION CENTER .

Prepared by : American HiTech Petroleum & Chemicals, Inc.
810 WRIGHT AVE.
RICHMOND CA 94804, U.S.A.

Disclaimer of Warranty : The above information is based on the data of which we are aware and is believed to be correct as of the data hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made available subsequent to the date hereof may suggest modification of the information, we do not assume any responsibility for the results of its use. This information is furnished upon condition that the person receiving it shall make his own determination of the suitability of the material for his particular purpose .

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SIGMA-ALDRICH

SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006
Version 3.0 Revision Date 29.12.2008
Print Date 05.03.2009
GENERIC EU MSDS - NO COUNTRY SPECIFIC DATA - NO OEL DATA

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Product name	:	Magnesium nitrate hexahydrate
Product Number	:	63087
Brand	:	Sigma-Aldrich
Company	:	Sigma-Aldrich Chemie BV Stationsplein 4 3331 LL ZWIJNDRECHT NETHERLANDS
Telephone	:	+31 78-620-5411
Fax	:	+31 78-620-5421
Emergency Phone #	:	112
E-mail address	:	eurtechserv@sial.com

2. HAZARDS IDENTIFICATION

Risk advice to man and the environment
Contact with combustible material may cause fire. Irritating to eyes, respiratory system and skin.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Formula	:	$MgN_2O_6 \cdot 6H_2O$
Molecular Weight	:	256,41 g/mol

CAS-No.	EC-No.	Index-No.	Classification	Concentration
Magnesium nitrate hexahydrate				
13446-18-9	233-826-7	-	O, Xi, R 8 - R36/37/38	-

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled
If breathed in, move person into fresh air. If not breathing give artificial respiration Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for fire-fighters
Wear self contained breathing apparatus for fire fighting if necessary.

Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protective equipment. Avoid dust formation. Avoid breathing dust. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions
Do not let product enter drains.

Methods for cleaning up
Pick up and arrange disposal without creating dust. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE

Handling
Avoid contact with skin and eyes. Avoid formation of dust and aerosols.
Provide appropriate exhaust ventilation at places where dust is formed. Keep away from sources of ignition - No smoking. Keep away from combustible material.

Storage
Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

hygroscopic Store under inert gas.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Where risk assessment shows air-purifying respirators are appropriate use a dust mask type N95 (US) or type P1 (EN 143) respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it. Handle with gloves.

Eye protection
Safety glasses

Skin and body protection
Choose body protection according to the amount and concentration of the dangerous substance at the work place.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	solid

Safety data

pH	no data available

Melting point	89 °C
Boiling point	no data available
Flash point	not applicable
Ignition temperature	no data available
Lower explosion limit	no data available
Upper explosion limit	no data available
Density	1,636 g/cm3
Water solubility	no data available

10. STABILITY AND REACTIVITY

Storage stability
Stable under recommended storage conditions.

Materials to avoid
Strong reducing agents, Strong acids, Organic materials, Powdered metals, DimethylformamideStrong reducing agents, Strong acids, Organic materials, Powdered metals, Dimethylformamide

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - nitrogen oxides (NOx), Magnesium oxide

11. TOXICOLOGICAL INFORMATION

Acute toxicity

LD50 Oral - rat - 5.440 mg/kg

Irritation and corrosion

no data available

Sensitisation

no data available

Chronic exposure

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

Signs and Symptoms of Exposure

Absorption into the body leads to the formation of methemoglobin which in sufficient concentration causes cyanosis. Onset may be delayed 2 to 4 hours or longer., To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Potential Health Effects

Inhalation	May be harmful if inhaled. Causes respiratory tract irritation.
Skin	May be harmful if absorbed through skin. Causes skin irritation.
Eyes	Causes eye irritation.
Ingestion	May be harmful if swallowed.
Target Organs	Blood, Central nervous system,

Additional Information
RTECS: OM3756000

12. ECOLOGICAL INFORMATION

Elimination information (persistence and degradability)

no data available

Ecotoxicity effects

no data available

no data available

Further information on ecology

no data available

no data available

13. DISPOSAL CONSIDERATIONS

Product
Observe all federal, state, and local environmental regulations. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

ADR/RID
UN-Number: 1474 Class: 5.1 Packing group: III
Proper shipping name: MAGNESIUM NITRATE

IMDG
UN-Number: 1474 Class: 5.1 Packing group: III EMS-No: F-A, S-Q
Proper shipping name: MAGNESIUM NITRATE
Marine pollutant: No

IATA
UN-Number: 1474 Class: 5.1 Packing group: III
Proper shipping name: Magnesium nitrate

15. REGULATORY INFORMATION

Labelling according to EC Directives

Hazard symbols

O	Oxidising
Xi	Irritant

R-phrase(s)

R 8	Contact with combustible material may cause fire.
R36/37/38	Irritating to eyes, respiratory system and skin.

S-phrase(s)

S17	Keep away from combustible material.
S26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S36	Wear suitable protective clothing.

16. OTHER INFORMATION

Further information
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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Co., shall not be held liable for any damage resulting from handling or from contact with the above product. See reverse side of invoice or packing slip for additional terms and conditions of sale.

MATERIAL SAFETY DATA SHEET

Date Printed: 08/04/2006
Date Updated: 02/01/2006
Version 1.8

Section 1 - Product and Company Information

Product Name	POTASSIUM NITRATE
Product Number	60429
Brand	FLUKA
Company	Sigma-Aldrich
Address	3050 Spruce Street SAINT LOUIS MO 63103 US
Technical Phone:	800-325-5832
Fax:	800-325-5052
Emergency Phone:	314-776-6555

Section 2 - Composition/Information on Ingredient

Substance Name	CAS #	SARA 313
POTASSIUM NITRATE	7757-79-1	No

Formula	KNO3
Synonyms	Collo-Bo * Kaliumnitrat (German) * Niter * Nitre * Nitric acid, potassium salt * Saltpeter * Vicknite
RTECS Number:	TT3700000

Section 3 - Hazards Identification

EMERGENCY OVERVIEW
Oxidizing.
Contact with combustible material may cause fire.
Target organ(s): Blood. Central nervous system.

HMIS RATING
HEALTH: 0*
FLAMMABILITY: 0
REACTIVITY: 3
SPECIAL HAZARD(S): Oxidizer

NFPA RATING
HEALTH: 0
FLAMMABILITY: 0
REACTIVITY: 3
SPECIAL HAZARD(S): Oxidizer

*additional chronic hazards present.

For additional information on toxicity, please refer to Section 11.

Section 4 - First Aid Measures

ORAL EXPOSURE
If swallowed, wash out mouth with water provided person is conscious. Call a physician.

INHALATION EXPOSURE
If inhaled, remove to fresh air. If breathing becomes difficult, call a physician.

DERMAL EXPOSURE
In case of skin contact, flush with copious amounts of water for at least 15 minutes. Remove contaminated clothing and shoes. Call a physician.

EYE EXPOSURE
In case of contact with eyes, flush with copious amounts of water for at least 15 minutes. Assure adequate flushing by separating the eyelids with fingers. Call a physician.

Section 5 - Fire Fighting Measures

CONDITIONS OF FLAMMABILITY
Vigorously supports combustion.

AUTOIGNITION TEMP
N/A

FLAMMABILITY
N/A

EXTINGUISHING MEDIA
Suitable: Water spray.

FIREFIGHTING
Protective Equipment: Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and eyes.
Specific Hazard(s): Emits toxic fumes under fire conditions. Contact with other material may cause fire.

Section 6 - Accidental Release Measures

PROCEDURE TO BE FOLLOWED IN CASE OF LEAK OR SPILL
Evacuate area.

PROCEDURE(S) OF PERSONAL PRECAUTION(S)
Wear self-contained breathing apparatus, rubber boots, and heavy rubber gloves.

METHODS FOR CLEANING UP
Sweep up, place in a bag and hold for waste disposal. Ventilate area and wash spill site after material pickup is complete.

Section 7 - Handling and Storage

HANDLING
User Exposure: Do not breathe vapor. Do not get in eyes, on skin, on clothing. Avoid prolonged or repeated exposure.

STORAGE
Suitable: Keep tightly closed. Keep away from combustible materials, heat, sparks, and open flame.

SPECIAL REQUIREMENTS
Hygroscopic.

Section 8 - Exposure Controls / PPE

ENGINEERING CONTROLS
Use only in a chemical fume hood. Safety shower and eye bath.

PERSONAL PROTECTIVE EQUIPMENT
Respiratory: Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU). Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator.
Hand: Compatible chemical-resistant gloves.
Eye: Chemical safety goggles.

GENERAL HYGIENE MEASURES
Wash thoroughly after handling. Remove and wash contaminated clothing promptly.

Section 9 - Physical/Chemical Properties

Appearance	Physical State: Solid Color: White Form: Crystals	
Property	Value	At Temperature or Pressure
Molecular Weight	101.11 AMU	
pH	5.5 - 8.0	20 °C Concentration: 50 g/l
BP/BP Range	N/A	
MP/MP Range	400 °C	
Freezing Point	N/A	
Vapor Pressure	N/A	
Vapor Density	N/A	
Saturated Vapor Conc.	N/A	
SG/Density	2.109 g/cm3	
Bulk Density	800 kg/l	
Odor Threshold	N/A	
Volatile%	N/A	
VOC Content	N/A	
Water Content	N/A	
Solvent Content	N/A	
Evaporation Rate	N/A	
Viscosity	N/A	
Surface Tension	N/A	
Partition Coefficient	N/A	
Decomposition Temp.	N/A	
Explosion Limits	N/A	
Flammability	N/A	
Autoignition Temp	N/A	
Refractive Index	N/A	
Optical Rotation	N/A	
Miscellaneous Data	N/A	
Solubility	N/A	

N/A = not available

Section 10 - Stability and Reactivity

STABILITY
Stable: Stable.
Conditions to Avoid: Moisture.

Materials to Avoid: Strong reducing agents, Finely powdered metals, Strong acids, Organic materials.

HAZARDOUS DECOMPOSITION PRODUCTS
Hazardous Decomposition Products: Nitrogen oxides, Potassium oxides.

HAZARDOUS POLYMERIZATION
Hazardous Polymerization: Will not occur

Section 11 - Toxicological Information

ROUTE OF EXPOSURE
Skin Contact: May cause skin irritation.
Skin Absorption: May be harmful if absorbed through the skin.
Eye Contact: May cause eye irritation.
Inhalation: Material may be irritating to mucous membranes and upper respiratory tract. May be harmful if inhaled.
Ingestion: May be harmful if swallowed.

TARGET ORGAN(S) OR SYSTEM(S)
Central nervous system. Blood.

SIGNS AND SYMPTOMS OF EXPOSURE
Absorption into the body leads to the formation of methemoglobin which in sufficient concentration causes cyanosis. Onset may be delayed 2 to 4 hours or longer.

TOXICITY DATA

Oral
Rat
3750 mg/kg
LD50

Oral
Rabbit
1901 mg/kg
LD50

CHRONIC EXPOSURE - REPRODUCTIVE HAZARD

Species: Rat
Dose: 22 GM/KG
Route of Application: Oral
Exposure Time: (1-22D PREG)
Result: Effects on Fertility: Other measures of fertility

Species: Rat
Dose: 598 MG/KG
Route of Application: Oral
Exposure Time: (1-22D PREG/5D POST)
Result: Effects on Newborn: Behavioral.

Species: Rabbit
Dose: 6505 MG/KG
Route of Application: Oral
Exposure Time: (23-27D PREG)
Result: Effects on Fertility: Abortion.

Species: Guinea pig
Dose: 15 GM/KG

Route of Application: Oral
Exposure Time: (24W PRE)
Result: Effects on Newborn: Stillbirth.

Species: Guinea pig
Dose: 1670 GM/KG
Route of Application: Oral
Exposure Time: (29W PRE)
Result: Effects on Embryo or Fetus: Other effects to embryo.
Effects on Fertility: Female fertility index (e.g., # females pregnant per # sperm positive females; # females pregnant per # females mated).

Section 12 - Ecological Information

ACUTE ECOTOXICITY TESTS

Test Type: EC50 Daphnia
Species: Daphnia magna
Time: 72 h
Value: 226 mg/l

Section 13 - Disposal Considerations

APPROPRIATE METHOD OF DISPOSAL OF SUBSTANCE OR PREPARATION
Contact a licensed professional waste disposal service to dispose of this material. Observe all federal, state, and local environmental regulations.

Section 14 - Transport Information

DOT
Proper Shipping Name: Potassium nitrate
UN#: 1486
Class: 5.1
Packing Group: Packing Group III
Hazard Label: Oxidizer
PIH: Not PIH

IATA
Proper Shipping Name: Potassium nitrate
IATA UN Number: 1486
Hazard Class: 5.1
Packing Group: III

Section 15 - Regulatory Information

EU ADDITIONAL CLASSIFICATION
Symbol of Danger: O
Indication of Danger: Oxidizing.
R: 8
Risk Statements: Contact with combustible material may cause fire.

US CLASSIFICATION AND LABEL TEXT
Indication of Danger: Oxidizing.
Risk Statements: Contact with combustible material may cause fire.
Safety Statements: Keep away from combustible material. Avoid contact with skin and eyes.
US Statements: Target organ(s): Blood. Central nervous system.

UNITED STATES REGULATORY INFORMATION
SARA LISTED: No
TSCA INVENTORY ITEM: Yes

CANADA REGULATORY INFORMATION
WHMIS Classification: This product has been classified in accordance with the hazard criteria of the CPR, and the MSDS contains all the information required by the CPR.
DSL: Yes
NDSL: No

Section 16 - Other Information

DISCLAIMER
For R&D use only. Not for drug, household or other uses.

WARRANTY
The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Inc., shall not be held liable for any damage resulting from handling or from contact with the above product. See reverse side of invoice or packing slip for additional terms and conditions of sale.
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SIGMA-ALDRICH

Material Safety Data Sheet

Version 3.2
Revision Date 07/14/2008
Print Date 03/12/2009

1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Sodium nitrate

Product Number : S5506
Brand : Sigma-Aldrich

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA
Telephone : +1 800-325-5832
Fax : +1 800-325-5052
Emergency Phone # : (314) 776-6555

2. COMPOSITION/INFORMATION ON INGREDIENTS

Formula : NaNO3
Molecular Weight : 84.99 g/mol

CAS-No.	EC-No.	Index-No.	Concentration
Sodium nitrate			
7631-99-4	231-554-3	-	-

3. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Oxidizer, Harmful by ingestion.

Target Organs
Blood, Central nervous system

HMIS Classification

Health Hazard: 1
Flammability: 0
Physical hazards: 1

NFPA Rating

Health Hazard: 1
Fire: 0
Reactivity Hazard: 1
Special hazard.: OX

Potential Health Effects

Inhalation May be harmful if inhaled. May cause respiratory tract irritation.
Skin May be harmful if absorbed through skin. May cause skin irritation.

Eyes	May cause eye irritation.
Ingestion	Harmful if swallowed.

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing give artificial respiration Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIRE-FIGHTING MEASURES

Flammable properties

Flash point	no data available
Ignition temperature	no data available

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for fire-fighters
Wear self contained breathing apparatus for fire fighting if necessary.

Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protective equipment. Avoid dust formation. Avoid breathing dust. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions
Do not let product enter drains.

Methods for cleaning up
Pick up and arrange disposal without creating dust. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE

Handling
Avoid contact with skin and eyes. Avoid formation of dust and aerosols.
Provide appropriate exhaust ventilation at places where dust is formed. Keep away from sources of ignition - No smoking. Keep away from combustible material.

Storage
Keep container tightly closed in a dry and well-ventilated place.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Contains no substances with occupational exposure limit values.

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Where risk assessment shows air-purifying respirators are appropriate use a dust mask type N95 (US) or type P1 (EN 143) respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. For prolonged or repeated contact use protective gloves.

Eye protection
Safety glasses

Skin and body protection
Choose body protection according to the amount and concentration of the dangerous substance at the work place.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	solid

Safety data

pH	9 at 100 g/l at 20 °C (68 °F)
Melting point	306 °C (583 °F)
Boiling point	380 °C (716 °F)
Flash point	no data available
Ignition temperature	no data available
Lower explosion limit	no data available
Upper explosion limit	no data available
Density	2.261 g/cm3
Water solubility	874 g/l at 20 °C (68 °F)
Partition coefficient: n-octanol/water	log Pow: -3.8 at 25 °C (77 °F)

10. STABILITY AND REACTIVITY

Storage stability
Stable under recommended storage conditions.

Conditions to avoid
Fusion of mixtures of metal cyanides, including lead thiocyanate, with metal chlorates, perchlorates, nitrates or nitrites causes a violent explosion. Addition of one solid component (even as a residue in small amount) to another molten component is also highly dangerous. Heat.

Materials to avoid
Strong acids, Strong reducing agents, Powdered metals, Organic materials, Alkali metals, Alkaline earth metals, Cyanides, thiocyanates

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Sodium oxides, nitrogen oxides (NOx)

11. TOXICOLOGICAL INFORMATION

Acute toxicity

LD50 Oral - rat - 1,267 mg/kg

LD50 Oral - rabbit - 2,680 mg/kg

LDLO Oral - Child - 22.5 mg/kg

LD50 Intravenous - mouse - 175 mg/kg

Irritation and corrosion

no data available

Sensitisation

no data available

Chronic exposure

Carcinogenicity - rat - Oral
Tumorigenic:Equivocal tumorigenic agent by RTECS criteria. Liver:Tumors.

Carcinogenicity - rat - Oral
Tumorigenic:Equivocal tumorigenic agent by RTECS criteria. Skin and Appendages: Other: Tumors. Tumorigenic Effects: Testicular tumors.

IARC:	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Genotoxicity in vitro - Hamster - fibroblast
Cytogenetic analysis

Genotoxicity in vitro - Hamster - Embryo
Host-mediated assay

Genotoxicity in vitro - Human - HeLa cell
Unscheduled DNA synthesis

Genotoxicity in vivo - mouse - Oral
Micronucleus test

Genotoxicity in vivo - mouse - Oral
Cytogenetic analysis

Genotoxicity in vivo - mouse - Oral
sperm

Reproductive toxicity - mouse - male - Oral
Paternal Effects: Spermatogenesis (including genetic material, sperm morphology,motility, and count).

Signs and Symptoms of Exposure

Absorption into the body leads to the formation of methemoglobin which in sufficient concentration causes cyanosis. Onset may be delayed 2 to 4 hours or longer.

Potential Health Effects

Inhalation	May be harmful if inhaled. May cause respiratory tract irritation.
Skin	May be harmful if absorbed through skin. May cause skin irritation.
Eyes	May cause eye irritation.
Ingestion	Harmful if swallowed.
Target Organs	Blood, Central nervous system,

Additional Information
RTECS: WC5600000

12. ECOLOGICAL INFORMATION

Elimination information (persistence and degradability)

no data available

Ecotoxicity effects

Toxicity to fish	static test LC50 - Gambusia affinis (Mosquito fish) - 6,650 mg/l - 96 h
Toxicity to daphnia and other aquatic invertebrates.	EC50 - Daphnia magna (Water flea) - 6,000 mg/l - 24 h

Further information on ecology

no data available

13. DISPOSAL CONSIDERATIONS

Product
Observe all federal, state, and local environmental regulations. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN-Number: 1498 Class: 5.1 Packing group: III
Proper shipping name: Sodium nitrate
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN-Number: 1498 Class: 5.1 Packing group: III EMS-No: F-A, S-Q
Proper shipping name: SODIUM NITRATE
Marine pollutant: No

IATA
UN-Number: 1498 Class: 5.1 Packing group: III
Proper shipping name: Sodium nitrate

15. REGULATORY INFORMATION

OSHA Hazards
Oxidizer, Harmful by ingestion.

DSL Status
All components of this product are on the Canadian DSL list.

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components

	CAS-No.	Revision Date
Sodium nitrate	7631-99-4	1991-07-01

SARA 311/312 Hazards
Reactivity Hazard, Acute Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Sodium nitrate	7631-99-4	1991-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Sodium nitrate	7631-99-4	1991-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Sodium nitrate	7631-99-4	1991-07-01

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth, or any other reproductive defects.

16. OTHER INFORMATION

Further information
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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Co., shall not be held liable for any damage resulting from handling or from contact with the above product. See reverse side of invoice or packing slip for additional terms and conditions of sale.

MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI, Canadian WHMIS Standards, Australian Worksfe and European EC Directive Standards

PART I *What is the material and what do I need to know in an emergency?*

1. PRODUCT IDENTIFICATION

TRADE NAME (AS LABELED):	**NITROGEN**
MANUFACTURER'S NAME:	**AMEREX CORPORATION**
ADDRESS:	P.O. BOX 81 Trussville, AL 35173-0081
EMERGENCY PHONE:	1-800-424-9300 (**CHEMTREC**)
BUSINESS PHONE:	(205) 655-3271
U.N. NUMBER:	1977
U.N. DANGEROUS GOODS CLASS/SUBSIDIARY RISK:	Class 2.2 (Non-Flammable Gas)
HAZCHEM CODE (AUSTRALIA):	2RE
POISONS SCHEDULE NUMBER (AUSTRALIA):	None Allocated
DATE OF PREPARATION:	June 12, 1995
DATE OF REVISION:	September 4, 2002

2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	EINECS #	%v/v	EXPOSURE LIMITS IN AIR					
				ACGIH-TLV		OSHA-PEL		NIOSH	OTHER
				TWA ppm	STEL ppm	TWA ppm	STEL ppm	IDLH ppm	ppm
Nitrogen	7727-37-9	231-783-9	100	There are no specific exposure limits for Nitrogen. Nitrogen is a simple asphyxiant (SA). Oxygen levels should be maintained above 19.5%.					

NE = Not Established. See Section 16 for Definitions of Terms Used.

NOTE (1): ALL WHMIS required information is included in appropriate sections based on the ANSI Z400.1-1998 format. This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR, EC Directives and WorkPlace Australia.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: This is a colorless, odorless. **Health Hazards:** The main health hazard associated with releases of this gas is asphyxiation, by displacement of oxygen. Contact with rapidly expanding gases may cause frostbite. **Flammability Hazard:** This gas is not flammable. **Reactivity Hazard:** This gas is not reactive. **Environmental Hazard:** This gas will not cause adverse effect if released in the environment other than frost from rapidly expanding gases in event of a release. **Emergency Response Considerations:** Emergency responders must wear personal protective equipment appropriate for the situation to which they are responding.

SYMPTOMS OF OVER-EXPOSURE BY ROUTE OF EXPOSURE: The most significant route of over-exposure for this gas is by inhalation.

INHALATION: High concentrations of this gas can cause an oxygen-deficient environment. Individuals breathing such an atmosphere may experience symptoms which include headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses. Under some circumstances of over-exposure, death may occur. The following effects associated with various levels of oxygen are as follows:

CONCENTRATION	**SYMPTOMS OF EXPOSURE**
12-16% Oxygen:	Breathing and pulse rate increased, muscular coordination slightly disturbed.
10-14% Oxygen:	Emotional upset, abnormal fatigue, disturbed respiration.
6-10% Oxygen:	Nausea and vomiting, collapse or loss of consciousness.
Below 6%:	Convulsive movements, possible respiratory collapse, and death.

3. HAZARD IDENTIFICATION (Continued)

INHALATION (continued): **WARNING: Exposure to atmospheres containing 8-10% or less oxygen will bring about unconsciousness without warning and so quickly that individuals cannot help or protect themselves. Lack of sufficient oxygen may cause serious injury or death.**

OTHER POTENTIAL HEALTH EFFECTS: Contact with rapidly expanding gases (which are released under high pressure) may cause frostbite. Symptoms of frostbite include change in skin color to white or grayish-yellow. The pain after contact with the rapidly expelled gas can quickly subside.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in **Lay Terms**. Over-exposure to this product may cause the following health effects:

ACUTE: The most significant hazard associated with this gas is inhalation of oxygen-deficient atmospheres. Symptoms of oxygen deficiency includes respiratory difficulty, ringing in ears, headaches, shortness of breath, wheezing, headache, dizziness, indigestion, nausea, and, at high concentrations, unconsciousness or death may occur. The skin of a victim of over-exposure may have a blue color. Contact with rapidly expanding gases may cause frostbite. Symptoms of frostbite include change in skin color to white or grayish-yellow.

CHRONIC: Chronic exposure to oxygen-deficient atmospheres (below 18% oxygen in air) may effect the heart and nervous system.

TARGET ORGANS: ACUTE: Respiratory system. CHRONIC: Heart, central nervous system.

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM

HEALTH HAZARD	(BLUE)	1
FLAMMABILITY HAZARD	(RED)	0
PHYSICAL HAZARD	(YELLOW)	0
PROTECTIVE EQUIPMENT		B

EYES	RESPIRATORY	HANDS	BODY
	See Section 8		See Section 8

For Routine Industrial Use and Handling Applications

See Section 16 for Definition of Ratings

PART II *What should I do if a hazardous situation occurs?*

4. FIRST-AID MEASURES

Remove victim(s) to a safe location. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. Victim(s) must be taken for medical attention. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to physician or other health professional with victim(s).

In case of frostbite, place the frostbitten part in warm water. DO NOT USE HOT WATER. If warm water is not available, or is impractical to use, wrap the affected parts gently in blankets. Alternatively, if the fingers or hands are frostbitten, place the affected area of the body in the armpit. Encourage victim to gently exercise the affected part while being warmed. Seek immediate medical attention.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: None known.

RECOMMENDATIONS TO PHYSICIANS: Treat symptoms and reduce over-exposure.

5. FIRE-FIGHTING MEASURES

FLASH POINT: Not applicable.

AUTOIGNITION TEMPERATURE: Not applicable.

FLAMMABLE LIMITS (in air by volume, %):

Lower (LEL): Not applicable.

Upper (UEL): Not applicable.

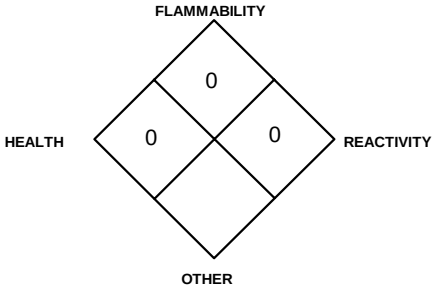
FIRE EXTINGUISHING MATERIALS: Non-flammable. Use extinguishing media appropriate for surrounding fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS: This gas does not burn; however, containers, when involved in fire, may rupture or burst in the heat of the fire.

Explosion Sensitivity to Mechanical Impact: Not Sensitive.

Explosion Sensitivity to Static Discharge: Not Sensitive.

NFPA RATING



See Section 16 for Definition of Ratings

SPECIAL FIRE-FIGHTING PROCEDURES: Structural fire-fighters must wear Self-Contained Breathing Apparatus and full protective equipment. In the event of fire, cool containers of this product with water to prevent failure. Use a water spray or fog to reduce or direct vapors. If cylinders are exposed to heat, the cylinder may rupture or burst and release the contents. It may be prudent to remove potentially heat-exposed cylinders from the area surrounding a fire, if it is safe for fire-fighters to do so.

6. ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a spill, clear the affected area, protect people, and respond with trained personnel. Minimum Personal Protective Equipment should be **Level B: protective clothing, mechanically-resistant gloves and Self-Contained Breathing Apparatus**. Locate and seal the source of the leaking gas. Allow the gas to dissipate. Monitor the surrounding area for oxygen levels. The atmosphere must have at least 19.5 percent oxygen before personnel can be allowed in the area without Self-Contained Breathing Apparatus. Attempt to close the main source valve prior to entering the area. If this does not stop the release (or if it is not possible to reach the valve), allow the gas to release in-place or remove it to a safe area and allow the gas to be released there.

PART III *How can I prevent hazardous situations from occurring?*

7. HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting this gas IN YOU. Do not eat or drink while handling chemicals. Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of this gas could occur without any significant warning symptoms.

STORAGE AND HANDLING PRACTICES: Cylinders should be stored in dry, well-ventilated areas away from sources of heat. Compressed gases can present significant safety hazards. Store containers away from heavily trafficked areas and emergency exits. Post “No Smoking or Open Flames” signs in storage or use areas.

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: Protect cylinders against physical damage. Store in cool, dry, well-ventilated, fireproof area, away from flammable materials and corrosive atmospheres. Store away from heat and ignition sources and out of direct sunlight. Do not store near elevators, corridors or loading docks. Do not allow area where cylinders are stored to exceed 52 °C (125 °F). Isolate from incompatible materials (see Section 10, Stability and Reactivity for more information). Do not store containers where they can come into contact with moisture. Cylinders should be stored upright and be firmly secured to prevent falling or being knocked over. Cylinders can be stored in the open, but in such cases, should be protected against extremes of weather and from the dampness of the ground to prevent rusting. Never tamper with pressure relief devices. The following rules are applicable to situations in which cylinders are being used:

Before Use: Move cylinders with a suitable hand-truck. Do not drag, slide or roll cylinders. Do not drop cylinders or permit them to strike each other. Secure cylinders firmly. Leave the valve protection cap in-place (if provided), until cylinder is ready for use.

During Use: Use designated CGA fittings and other support equipment. Do not use adapters. Do not heat cylinder by any means to increase the discharge rate of the gas from the cylinder. Use check valve or trap in discharge line to prevent hazardous backflow into the cylinder. Do not use oils or grease on gas-handling fittings or equipment.

After Use: Close main cylinder valve. Replace valve protection cap (if provided). Mark empty cylinders “EMPTY”.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain application equipment is locked and tagged-out safely. Purge gas handling equipment with inert gas (i.e. nitrogen) before attempting repairs. Always use gas in areas where adequate ventilation is provided.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation.

RESPIRATORY PROTECTION: Maintain oxygen levels above 19.5% in the workplace. If respiratory protection is needed, use only protection authorized in the U.S. Federal OSHA Standard (29 CFR 1910.134), applicable U.S. State regulations, or the Canadian CSA Standard Z94.4-93 and applicable standards of Canadian Provinces. Oxygen levels below 19.5% are considered IDLH by OSHA. In such atmospheres, use of a full-facepiece pressure/demand SCBA or a full facepiece, supplied air respirator with auxiliary self-contained air supply is required under OSHA’s Respiratory Protection Standard (1910.134-1998).

EYE PROTECTION: Splash goggles, face-shields or safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133, or Canadian Standards.

HAND PROTECTION: Wear mechanically-resistant gloves when handling cylinders of this gas. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada.

BODY PROTECTION: Use body protection appropriate for task. If a hazard of injury to the feet exists due to falling objects, rolling objects, where objects may pierce the soles of the feet or where employee’s feet may be exposed to electrical hazards, use foot protection, as described in U.S. OSHA 29 CFR.

9. PHYSICAL and CHEMICAL PROPERTIES

VAPOR DENSITY: 1.650 kg/m^3

SPECIFIC GRAVITY (air = 1): 1.380

SOLUBILITY IN WATER: 3.37% (v/v @ 20°C)

VAPOR PRESSURE: Not applicable.

EVAPORATION RATE (nBuAc = 1): Not applicable.

FREEZING POINT: -189.2°C (-308.9°F)

BOILING POINT (@ 1 atmos): -185.9°C (-302.6°F)

ODOR THRESHOLD: Not applicable.

9. PHYSICAL and CHEMICAL PROPERTIES (Continued)

EXPANSION RATIO: Not applicable. pH: Not applicable.
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable. SPECIFIC VOLUME (ft^3/lb): 9.7
APPEARANCE AND COLOR: Nitrogen is a colorless, odorless gas.
HOW TO DETECT THIS SUBSTANCE (warning properties): There are no unusual warning properties associated with a release of this product. In terms of leak detection, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation.

10. STABILITY and REACTIVITY

STABILITY: Normally stable in gaseous state.
DECOMPOSITION PRODUCTS: None.
MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: None. Nitrogen is inert.
HAZARDOUS POLYMERIZATION: Will not occur.
CONDITIONS TO AVOID: Cylinders exposed to high temperatures or direct flame can rupture or burst.

PART IV *Is there any other useful information about this material?*

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: There are no toxicity data for Nitrogen; Nitrogen is an inert gas.
SUSPECTED CANCER AGENT: Nitrogen is not found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, IARC; and therefore are not considered to be, nor suspected to be cancer-causing agents by these agencies
IRRITANCY OF PRODUCT: Contact with rapidly expanding gases can cause frostbite and damage to exposed skin and eyes.
SENSITIZATION OF PRODUCT: Nitrogen is not a skin or respiratory sensitizer.
REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of Nitrogen on the human reproductive system.

Mutagenicity: Nitrogen does not cause mutagenic effects in humans.
Embryotoxicity: Nitrogen does not cause embryotoxic effects in humans.
Teratogenicity: Nitrogen does not cause teratogenic effects in humans.
Reproductive Toxicity: Nitrogen does not cause adverse reproductive effects in humans.

A mutagen is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generation lines. An embryotoxin is a chemical which causes damage to a developing embryo (i.e. within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A teratogen is a chemical which causes damage to a developing fetus, but the damage does not propagate across generational lines. A reproductive toxin is any substance which interferes in any way with the reproductive process.
BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are not applicable for Nitrogen.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: This gas will be dissipated rapidly in well-ventilated areas. The components of the gas are stable in the environment.
EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on animals would be related to oxygen deficient environments. No adverse effect is anticipated to occur to plant-life, except for frost produced in the presence of rapidly expanding gases.
EFFECT OF CHEMICAL ON AQUATIC LIFE: No evidence is currently available on the effect of this gas on aquatic life.

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. Do not puncture or incinerate cylinder.
EPA WASTE NUMBER: Not applicable.

14. TRANSPORTATION INFORMATION

THIS GAS IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

PROPER SHIPPING NAME:	Nitrogen, compressed
HAZARD CLASS NUMBER and DESCRIPTION:	2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER:	UN 1066
PACKING GROUP:	Not Applicable
DOT LABEL(S) REQUIRED:	Non-Flammable Gas

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 121

MARINE POLLUTANT: Nitrogen is not classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B).

14. TRANSPORTATION INFORMATION (Continued)

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: This gas is considered as Dangerous Goods, per regulations of Transport Canada. The use of the above U.S. DOT information from the U.S. 49 CFR regulations is allowed for shipments that originate in the U.S. For shipments via ground vehicle or rail that originate in Canada, the following information is applicable.

PROPER SHIPPING NAME: Nitrogen, compressed
HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER: UN 1066
HAZARD LABEL(S) REQUIRED: Class 2.2 (Non-Flammable Gas)
SPECIAL PROVISIONS: None
EXPLOSIVE LIMIT & LIMITED QUANTITY INDEX: 0.12
ERAP INDEX: None
PASSENGER CARRYING SHIP INDEX: None
PASSENGER CARRYING ROAD OR RAIL VEHICLE INDEX: 75
MARINE POLLUTANT: Nitrogen is not designated by the TDG Act to be a Marine Pollutant.

INTERNATIONAL AIR TRANSPORT ASSOCIATION SHIPPING INFORMATION (IATA): This gas is considered as dangerous goods, per the International Air Transport Association.

PROPER SHIPPING NAME: Nitrogen, compressed
HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER: UN 1066
HAZARD LABEL(S) REQUIRED: Class 2.2 (Non-Flammable Gas)
PACKING GROUP: Not Applicable
ERG CODE: 2L

The following Packaging Information is applicable to this product:

PASSENGER AND CARGO AIRCRAFT				CARGO AIRCRAFT ONLY	
Limited Quantity		Packing Instruction	Max. Qty per Pkg	Packing Instruction	Max. Qty per Pkg
Packing Instruction	Max. Qty per Pkg				
//////	//////	200	75 kg	200	150 kg

INTERNATIONAL MARITIME ORGANIZATION SHIPPING INFORMATION (IMO): This gas is considered as dangerous goods, per the International Maritime Organization.

PROPER SHIPPING NAME: Nitrogen, compressed
HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER: UN 1066
HAZARD LABEL(S) REQUIRED: Class 2.2 (Non-Flammable Gas)
PACKING GROUP: Not Applicable
STOWAGE: Category A
MARINE POLLUTANT: Nitrogen is not designated by the IMO to be a Marine Pollutant.

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR): This gas is considered by the Economic Commission for Europe to be dangerous goods. Additional information is as follows:

UN NO.: 1066
NAME & DESCRIPTION: Nitrogen, compressed
CLASS: 2
CLASSIFICATION CODE: 1A
PACKING GROUP: Not Applicable
LABELS: 2.2
HAZARD IDENTIFICATION NUMBER: 20

AUSTRALIAN FEDERAL OFFICE OF ROAD SAFETY CODE FOR THE TRANSPORTATION OF DANGEROUS GOODS BY ROAD OR RAIL: This product is considered as Dangerous Goods, per regulations of the Australian Federal Office of Road Safety. Shipping information is a follows:

UN IDENTIFICATION NUMBER: UN 1066
PROPER SHIPPING NAME: Nitrogen, compressed
HAZARD CLASS NUMBER and DESCRIPTION: Class 2.2 (Non-Flammable Gas)
PACKING GROUP: Not Applicable
HAZCHEM CODE: 2[T]
SPECIAL PROVISIONS: None
PACKAGING METHOD: 3.8.2

15. REGULATORY INFORMATION

ADDITIONAL U.S. REGULATIONS:

U.S. SARA REPORTING REQUIREMENTS: Nitrogen is not subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act.

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for Nitrogen. The default Federal MSDS submission and inventory requirement filing threshold of 10,000 lb (4,540 kg) may apply, per 40 CFR 370.20.

U.S. TSCA INVENTORY STATUS: Nitrogen is listed on the TSCA Inventory.

U.S. CERCLA REPORTABLE QUANTITIES (RQ): Not applicable.

OTHER U.S. FEDERAL REGULATIONS: Not applicable.

U.S. STATE REGULATORY INFORMATION: Nitrogen is covered under the following specific State regulations:

Alaska - Designated Toxic and Hazardous Substances: Nitrogen.
California - Permissible Exposure Limits for Chemical Contaminants: Nitrogen.
Florida - Substance List: Nitrogen.
Illinois - Toxic Substance List: Nitrogen.
Kansas - Section 302/313 List: No.
Massachusetts - Substance List: Nitrogen.
Michigan - Critical Materials Register: No.
Minnesota - List of Hazardous Substances: Nitrogen.
Missouri - Employer Information/Toxic Substance List: Nitrogen.
New Jersey - Right to Know Hazardous Substance List: Nitrogen.
North Dakota - List of Hazardous Chemicals, Reportable Quantities: No.
Pennsylvania - Hazardous Substance List: Nitrogen.
Rhode Island - Hazardous Substance List: Nitrogen.
Texas - Hazardous Substance List: No.
West Virginia - Hazardous Substance List: No.
Wisconsin - Toxic and Hazardous Substances: No.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Nitrogen is not on the Proposition 65 Lists.

LABELING (For Compressed Gas):

CAUTION: HIGH PRESSURE GAS.
CAN CAUSE RAPID SUFFOCATION.
Store and use with adequate ventilation.
Use equipment rated for cylinder pressure.
Close valve after each use and when empty.
Use in accordance with the Material Safety Data Sheet.

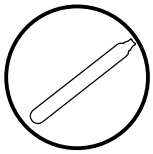
FIRST-AID: IF INHALED, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
DO NOT REMOVE THIS PRODUCT LABEL.

ADDITIONAL CANADIAN REGULATIONS:

CANADIAN DSL/NDSL INVENTORY STATUS: Nitrogen is listed on the DSL Inventory.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: Nitrogen is not on the CEPA Priorities Substances Lists.

CANADIAN WHMIS SYMBOLS: **Class A:** Compressed Gases



EUROPEAN ECONOMIC COMMUNITY REGULATIONS:

EC LABELING AND CLASSIFICATION: Nitrogen does not meet the definition of any hazard class as defined by the European Community Council Directive 67/548/EEC.

ADDITIONAL AUSTRALIAN INFORMATION FOR PRODUCT:

AUSTRALIAN INVENTORY OF CHEMICAL SUBSTANCES (AICS) STATUS: Nitrogen is listed on the AICS.

LIST OF DESIGNATED SUBSTANCES: Not applicable.

STANDARD FOR THE UNIFORM SCHEDULING OF DRUGS AND POISONS: Not applicable.

LABELING AND CLASSIFICATION: Currently, there is no NOHSC classification for Nitrogen [NOHSC: 10005 (1994)].

16. OTHER INFORMATION

PREPARED BY:

CHEMICAL SAFETY ASSOCIATES, Inc.
PO Box 3519, La Mesa, CA 91944-3519
619/670-0609

The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. AMEREX Corporation assumes no responsibility for injury to the vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, AMEREX Corporation assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in his use of the material.

DEFINITIONS OF TERMS

A large number of abbreviations and acronyms appear on a MSDS. Some of these which are commonly used include the following:

CAS #: This is the Chemical Abstract Service Number that uniquely identifies each constituent. **EXPOSURE LIMITS IN AIR:**

CEILING LEVEL: The concentration that shall not be exceeded during any part of the working exposure.

LOQ: Limit of Quantitation.

MAK: Federal Republic of Germany Maximum Concentration Values in the workplace.

NE: Not Established. When no exposure guidelines are established, an entry of NE is made for reference.

NIC: Notice of Intended Change.

NIOSH CEILING: The exposure that shall not be exceeded during any part of the workday. If instantaneous monitoring is not feasible, the ceiling shall be assumed as a 15-minute TWA exposure (unless otherwise specified) that shall not be exceeded at any time during a workday.

NIOSH RELs: NIOSH's Recommended Exposure Limits.

PEL-Permissible Exposure Limit: OSHA's Permissible Exposure Limits. This exposure value means exactly the same as a TLV, except that it is enforceable by OSHA. The OSHA Permissible Exposure Limits are based in the 1989 PELs and the June, 1993 Air Contaminants Rule (Federal Register: 58: 35338-35351 and 58: 40191). Both the current PELs and the vacated PELs are indicated. The phrase, "Vacated 1989 PEL," is placed next to the PEL that was vacated by Court Order.

SKIN: Used when a there is a danger of cutaneous absorption.

STEL-Short Term Exposure Limit: Short Term Exposure Limit, usually a 15-minute time-weighted average (TWA) exposure that should not be exceeded at any time during a workday, even if the 8-hr TWA is within the TLV-TWA, PEL-TWA or REL-TWA.

TLV-Threshold Limit Value: An airborne concentration of a substance that represents conditions under which it is generally believed that nearly all workers may be repeatedly exposed without adverse effect. The duration must be considered, including the 8-hour.

TWA-Time Weighted Average: Time Weighted Average exposure concentration for a conventional 8-hr (TLV, PEL) or up to a 10-hr (REL) workday and a 40-hr workweek.

IDLH-Immediately Dangerous to Life and Health: This level represents a concentration from which one can escape within 30-minutes without suffering escape-preventing or permanent injury.

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS: This rating system was developed by the National Paint and Coating Association and has been adopted by industry to identify the degree of chemical hazards.

HEALTH HAZARD:

0 (Minimal Hazard: No significant health risk, irritation of skin or eyes not anticipated. *Skin Irritation*: Essentially non-irritating. PII or Draize = "0". *Eye Irritation*: Essentially non-irritating, or minimal effects which clear in < 24 hours [e.g. mechanical irritation]. Draize = "0". *Oral Toxicity LD_{50} Rat*: < 5000 mg/kg. *Dermal Toxicity LD_{50}Rat or Rabbit*: < 2000 mg/kg. *Inhalation Toxicity 4-hrs LC_{50} Rat*: < 20 mg/L.); **1** (Slight Hazard: Minor reversible Injury may occur; slightly or mildly irritating. *Skin Irritation*: Slightly or mildly irritating. *Eye Irritation*: Slightly or mildly irritating. *Oral Toxicity LD_{50} Rat*: > 500-5000 mg/kg. *Dermal Toxicity LD_{50}Rat or Rabbit*: > 1000-2000 mg/kg. *Inhalation Toxicity LC_{50}* 4-hrs *Rat*: > 2-20 mg/L); **2** (Moderate Hazard: Temporary or transitory injury may occur. *Skin Irritation*: Moderately irritating; primary irritant; sensitizer. PII or Draize > 0, < 5. *Eye Irritation*: Moderately to severely irritating and/or corrosive; reversible corneal opacity; corneal involvement or irritation clearing in 8-21 days. Draize > 0, $\leq$ 25. *Oral Toxicity LD_{50} Rat*: > 50-500 mg/kg. *Dermal Toxicity LD_{50}Rat or Rabbit*: > 200-1000 mg/kg. *Inhalation Toxicity LC_{50} 4-hrs Rat*: > 0.5-2 mg/L.); **3** (Serious Hazard: Major injury likely unless prompt action is taken and medical treatment is given; high level of toxicity; corrosive. *Skin Irritation*: Severely irritating and/or corrosive; may destroy dermal tissue, cause skin burns, dermal necrosis. PII or Draize > 5-8 with destruction of tissue. *Eye Irritation*: Corrosive, irreversible destruction of ocular tissue; corneal involvement or irritation persisting for more than 21 days. Draize > 80 with effects irreversible in 21 days. *Oral Toxicity LD_{50} Rat*: > 1-50 mg/kg. *Dermal Toxicity LD_{50}Rat or Rabbit*: > 20-200 mg/kg. *Inhalation Toxicity LC_{50} 4-hrs Rat*: > 0.05-0.5 mg/L.); (continued in next column)

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

HEALTH HAZARD (continued):

4 (Severe Hazard: Life-threatening; major or permanent damage may result from single or repeated exposure. *Skin Irritation*: Not appropriate. Do not rate as a "4", based on skin irritation alone. *Eye Irritation*: Not appropriate. Do not rate as a "4", based on eye irritation alone. *Oral Toxicity LD_{50} Rat*: $\leq$ 1 mg/kg. *Dermal Toxicity LD_{50}Rat or Rabbit*: $\leq$ 20 mg/kg. *Inhalation Toxicity LC_{50} 4-hrs Rat*: $\leq$ 0.05 mg/L).

FLAMMABILITY HAZARD:

0 (Minimal Hazard-Materials that will not burn in air when exposure to a temperature of 815.5°C [1500°F] for a period of 5 minutes.); **1** (Slight Hazard-Materials that must be pre-heated before ignition can occur. Material require considerable pre-heating, under all ambient temperature conditions before ignition and combustion can occur, Including: Materials that will burn in air when exposed to a temperature of 815.5°C (1500°F) for a period of 5 minutes or less; Liquids, solids and semisolids having a flash point at or above 93.3°C [200°F] (e.g. OSHA Class IIIB, or; Most ordinary combustible materials [e.g. wood, paper, etc.]; **2** (Moderate Hazard-Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not, under normal conditions, form hazardous atmospheres in air, but under high ambient temperatures or moderate heating may release vapor in sufficient quantities to produce hazardous atmospheres in air, Including: Liquids having a flash-point at or above 37.8°C [100°F] Solid materials in the form of course dusts that may burn rapidly but that generally do not form explosive atmospheres; Solid materials in a fibrous or shredded form that may burn rapidly and create flash fire hazards (e.g. cotton, sisal, hemp; Solids and semisolids that readily give off flammable vapors.); **3** (Serious Hazard- Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures, or, unaffected by ambient temperature, are readily ignited under almost all conditions, including: Liquids having a flash point below 22.8°C [73°F] and having a boiling point at or above 38°C [100°F] and below 37.8°C [100°F] [e.g. OSHA Class IB and IC]; Materials that on account of their physical form or environmental conditions can form explosive mixtures with air and are readily dispersed in air [e.g., dusts of combustible solids, mists or droplets of flammable liquids]; Materials that burn extremely rapidly, usually by reason of self-contained oxygen [e.g. dry nitrocellulose and many organic peroxides]); **4** (Severe Hazard-Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air, and which will burn readily, including: Flammable gases; Flammable cryogenic materials; Any liquid or gaseous material that is liquid while under pressure and has a flash point below 22.8°C [73°F] and a boiling point below 37.8°C [100°F] [e.g. OSHA Class IA; Material that ignite spontaneously when exposed to air at a temperature of 54.4°C [130°F] or below [e.g. pyrophoric]).

PHYSICAL HAZARD:

0 (*Water Reactivity*: Materials that do not react with water. *Organic Peroxides*: Materials that are normally stable, even under fire conditions and will not react with water. *Explosives*: Substances that are Non-Explosive. Unstable *Compressed Gases*: No Rating. *Pyrophorics*: No Rating. *Oxidizers*: No "0" rating allowed. *Unstable Reactives*: Substances that will not polymerize, decompose, condense or self-react.); **1** (*Water Reactivity*: Materials that change or decompose upon exposure to moisture. *Organic Peroxides*: Materials that are normally stable, but can become unstable at high temperatures and pressures. These materials may react with water, but will not release energy. *Explosives*: Division 1.5 & 1.6 substances that are very insensitive explosives or that do not have a mass explosion hazard. *Compressed Gases*: Pressure below OSHA definition. *Pyrophorics*: No Rating. *Oxidizers*: Packaging Group III; Solids: any material that in either concentration tested, exhibits a mean burning time less than or equal to the mean burning time of a 3:7 potassium bromate/cellulose mixture and the criteria for Packing Group I and II are not met. Liquids: any material that exhibits a mean pressure rise time less than or equal to the pressure rise time of a 1:1 nitric acid (65%)/cellulose mixture and the criteria for Packing Group I and II are not met. (continued on next page)

DEFINITIONS OF TERMS (Continued)

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

PHYSICAL HAZARD (continued):

1 (continued): *Unstable Reactives*: Substances that may decompose, condense or self-react, but only under conditions of high temperature and/or pressure and have little or no potential to cause significant heat generation or explosive hazard. Substances that readily undergo hazardous polymerization in the absence of inhibitors.); **2** (*Water Reactivity*: Materials that may react violently with water. *Organic Peroxides*: Materials that, in themselves, are normally unstable and will readily undergo violent chemical change, but will not detonate. These materials may also react violently with water. *Explosives*: Division 1.4 – Explosive substances where the explosive effect are largely confined to the package and no projection of fragments of appreciable size or range are expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package. *Compressed Gases*: Pressurized and meet OSHA definition but < 514.7 psi absolute at 21.1°C (70°F) [500 psig]. *Pyrophorics*: No Rating. *Oxidizers*: Packing Group II Solids: any material that, either in concentration tested, exhibits a mean burning time of less than or equal to the mean burning time of a 2:3 potassium bromate/cellulose mixture and the criteria for Packing Group I are not met. Liquids: any material that exhibits a mean pressure rise time less than or equal to the pressure rise of a 1:1 aqueous sodium chlorate solution (40%)/cellulose mixture and the criteria for Packing Group I are not met. *Unstable Reactives*: Substances that may polymerize, decompose, condense, or self-react at ambient temperature and/or pressure, but have a low potential for significant heat generation or explosion. Substances that readily form peroxides upon exposure to air or oxygen at room temperature); **3** (*Water Reactivity*: Materials that may form explosive reactions with water. *Organic Peroxides*: Materials that are capable of detonation or explosive reaction, but require a strong initiating source, or must be heated under confinement before initiation; or materials that react explosively with water. *Explosives*: Division 1.2 – Explosive substances that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but do not have a mass explosion hazard. *Compressed Gases*: Pressure ≥ 514.7 psi absolute at 21.1°C (70°F) [500 psig]. *Pyrophorics*: No Rating. *Oxidizers*: Packing Group I Solids: any material that, in either concentration tested, exhibits a mean burning time less than the mean burning time of a 3.:2 potassium bromate/cellulose mixture. Liquids: Any material that spontaneously ignites when mixed with cellulose in a 1:1 ratio, or which exhibits a mean pressure rise time less than the pressure rise time of a 1:1 perchloric acid (50%)/cellulose mixture. *Unstable Reactives*: Substances that may polymerize, decompose, condense or self-react at ambient temperature and/or pressure and have a moderate potential to cause significant heat generation or explosion.); **4** (*Water Reactivity*: Materials that react explosively with water without requiring heat or confinement. *Organic Peroxides*: Materials that are readily capable of detonation or explosive decomposition at normal temperature and pressures. *Explosives*: Division 1.1 & 1.2-explosive substances that have a mass explosion hazard or have a projection hazard. A mass explosion is one that affects almost the entire load instantaneously. *Compressed Gases*: No Rating. *Pyrophorics*: Add to the definition of Flammability "4". *Oxidizers*: No "4" rating. *Unstable Reactives*: Substances that may polymerize, decompose, condense or self-react at ambient temperature and/or pressure and have a high potential to cause significant heat generation or explosion.). PPE Rating B: Hand and eye protection is required for routine chemical use. PPE Rating C: Hand, eye, and body protection may be required for routine chemical use.

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS:

HEALTH HAZARD: **0** (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials); **1** (materials that on exposure under fire conditions could cause irritation or minor residual injury); **2** (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury); **3** (materials that can on short exposure could cause serious temporary or residual injury); **4** (materials that under very short exposure could cause death or major residual injury).

FLAMMABILITY HAZARD AND REACTIVITY HAZARD: Refer to definitions for "Hazardous Materials Identification System".

FLAMMABILITY LIMITS IN AIR: Much of the information related to fire and explosion is derived from the **N**ational **F**ire **P**rotection **A**ssociation (**NFPA**). Flash Point - Minimum temperature at which a liquid gives off sufficient vapors to form an ignitable mixture with air. Autoignition Temperature: The minimum temperature required to initiate combustion in air with no other source of ignition. LEL - the lowest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source. UEL - the highest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source.

TOXICOLOGICAL INFORMATION:

Human and Animal Toxicology: Possible health hazards as derived from human data, animal studies, or from the results of studies with similar compounds are presented. Definitions of some terms used in this section are: **LD_{50}** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC_{50}** - Lethal Concentration (gases) which kills 50% of the exposed animals; **ppm** concentration expressed in parts of material per million parts of air or water; **mg/m^3** concentration expressed in weight of substance per volume of air; **mg/kg** quantity of material, by weight, administered to a test subject, based on their body weight in kg. Other measures of toxicity include **TDLo**, the lowest dose to cause a symptom and **TCLo** the lowest concentration to cause a symptom; **TDo**, **LDLo**, and **LDo**, or **TC**, **TCo**, **LCLo**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **Cancer Information:** The sources are: **IARC** - the International Agency for Research on Cancer; **NTP** - the National Toxicology Program, **RTECS** - the Registry of Toxic Effects of Chemical Substances, **OSHA** and **CAL/OSHA**. IARC and NTP rate chemicals on a scale of decreasing potential to cause human cancer with rankings from 1 to 4. Subrankings (2A, 2B, etc.) are also used. **Other Information: BEI** - ACGIH Biological Exposure Indices, represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV.

ECOLOGICAL INFORMATION:

EC is the effect concentration in water. **BCF** = Bioconcentration Factor, which is used to determine if a substance will concentrate in lifeforms which consume contaminated plant or animal matter. **TL_m** = median threshold limit; Coefficient of Oil/Water Distribution is represented by **log K_{ow}** or **log K_{oc}** and is used to assess a substance's behavior in the environment.

REGULATORY INFORMATION:

U.S. and CANADA:

This section explains the impact of various laws and regulations on the material. **ACGIH:** American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits. **EPA** is the U.S. Environmental Protection Agency. **NIOSH** is the National Institute of Occupational Safety and Health, which is the research arm of the U.S. **O**ccupational **S**afety and **H**ealth **A**dministration (**OSHA**). **WHMIS** is the Canadian Workplace Hazardous Materials Information System. **DOT** and **TC** are the U.S. Department of Transportation and the Transport Canada, respectively. Superfund Amendments and Reauthorization Act **(SARA)**; the Canadian Domestic/Non-Domestic Substances List **(DSL/NDSL)**; the U.S. Toxic Substance Control Act **(TSCA)**; Marine Pollutant status according to the **DOT**; the Comprehensive Environmental Response, Compensation, and Liability Act **(CERCLA or Superfund)**; and various state regulations. This section also includes information on the precautionary warnings which appear on the material's package label. **OSHA** - U.S. Occupational Safety and Health Administration.

EUROPEAN: EC is the European Community (formerly known as the **EEC,** European Economic Community). **EINECS:** This the European Inventory of Now-Existing Chemical Substances. The **ARD** is the European Agreement Concerning the International Carriage of Dangerous Goods by Road and the **RID** are the International Regulations Concerning the Carriage of Dangerous Goods by Rail.

AUSTRALIAN: AICS is the Australian Inventory of Chemical Substances. **NOHSC:** National Occupational Health & Safety Code.

MSDS Number: **P5950** * * * * * *Effective Date:* ***08/20/08*** * * * * * *Supercedes:* ***10/19/05***

MSDS *Material Safety Data Sheet*

From: **Mallinckrodt Baker, Inc.**
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

POTASSIUM NITRATE

1. Product Identification

Synonyms: Saltpeter; niter; Nitric acid, potassium salt
CAS No.: 7757-79-1
Molecular Weight: 101.1
Chemical Formula: KNO3
Product Codes:
J.T. Baker: 3190, 3192, 3193
Mallinckrodt: 3651, 6370, 6390, 6715, 7028

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Potassium Nitrate	7757-79-1	99 - 100%	Yes

3. Hazards Identification

Emergency Overview

DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)
Contact Rating: 2 - Moderate (Life)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: Yellow (Reactive)

Potential Health Effects

Inhalation:
Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath.
Ingestion:
Causes irritation to the gastrointestinal tract. Symptoms may include nausea, vomiting and diarrhea. May cause gastroenteritis and abdominal pains. Purging and diuresis can be expected. Rare cases of nitrates being converted to the more toxic nitrites have been reported, mostly with infants.
Skin Contact:
Causes irritation to skin. Symptoms include redness, itching, and pain.
Eye Contact:
Causes irritation, redness, and pain.
Chronic Exposure:
Under some circumstances methemoglobinemia occurs in individuals when the nitrate is converted by bacteria in the stomach to nitrite. Nausea, vomiting, dizziness, rapid heart beat, irregular breathing, convulsions, coma, and death can occur should this conversion take place. Chronic exposure to nitrites may cause anemia and adverse effects to kidney.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition.
Explosion:
Some nitrates may explode when shocked, exposed to heat or flame, or by spontaneous chemical reaction. Sealed containers may rupture when heated. Sensitive to mechanical impact.
Fire Extinguishing Media:
Dry chemical, carbon dioxide, Halon, water spray, or fog. If water is used, apply from as far a distance as possible. Water spray may be used to keep fire exposed containers cool. Do not allow water runoff to enter sewers or waterways.
Special Information:
Wear full protective clothing and breathing equipment for high-intensity fire or potential explosion conditions. This oxidizing material can increase the flammability of adjacent combustible materials.

6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage and moisture. Isolate from any source of heat or ignition. Avoid storage on wood floors. Separate from incompatibles, combustibles, organic or other readily oxidizable materials. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
White crystals.
Odor:
Odorless.
Solubility:
36 gm/l00 ml water
Specific Gravity:
2.1
pH:
ca. 7
% Volatiles by volume @ 21C (70F):
0

Boiling Point:
400C (752F)
Melting Point:
333C (631F)
Vapor Density (Air=1):
3.00
Vapor Pressure (mm Hg):
Negligible @ 20C
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Oxides of nitrogen and toxic metal fumes may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Heavy metals, phosphites, organic compounds, carbonaceous materials, strong acids, and many other substances.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Oral rat LD50: 3750 mg/kg. Investigated as a mutagen, reproductive effector.

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--------\Cancer Lists\-----------------------------------------------------
                                      ---NTP Carcinogen---
Ingredient                            Known    Anticipated    IARC Category
------------------------------------  -----    -----------    -------------
Potassium Nitrate (7757-79-1)          No          No            None
```

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: POTASSIUM NITRATE
Hazard Class: 5.1
UN/NA: UN1486
Packing Group: III
Information reported for product/size: 50KG

International (Water, I.M.O.)

Proper Shipping Name: POTASSIUM NITRATE
Hazard Class: 5.1
UN/NA: UN1486
Packing Group: III
Information reported for product/size: 50KG

International (Air, I.C.A.O.)

Proper Shipping Name: POTASSIUM NITRATE
Hazard Class: 5.1
UN/NA: UN1486
Packing Group: III
Information reported for product/size: 50KG

15. Regulatory Information

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--------\Chemical Inventory Status - Part 1\--------------------------------
Ingredient                                    TSCA  EC   Japan  Australia
---------------------------------------------  ----  ---  -----  ---------
Potassium Nitrate (7757-79-1)                   Yes  Yes   Yes      Yes

--------\Chemical Inventory Status - Part 2\--------------------------------
                                                        --Canada--
Ingredient                                    Korea  DSL   NDSL  Phil.
---------------------------------------------  -----  ---   ----  -----
Potassium Nitrate (7757-79-1)                   Yes   Yes   No     Yes

--------\Federal, State & International Regulations - Part 1\----------------
                                            -SARA 302-    ------SARA 313------
Ingredient                                  RQ    TPQ     List  Chemical Catg.
----------------------------------------  ---   -----   ----  --------------
Potassium Nitrate (7757-79-1)               No    No      No    Nitrate Cmpd

--------\Federal, State & International Regulations - Part 2\----------------
                                                      -RCRA-    -TSCA-
Ingredient                                  CERCLA    261.33     8(d)
----------------------------------------  ------     ------    ------
Potassium Nitrate (7757-79-1)               No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: Yes Pressure: No
Reactivity: No          (Pure / Solid)
```
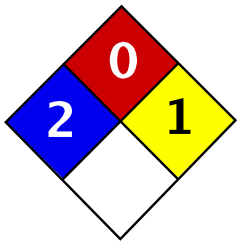

Australian Hazchem Code: 1[T]
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0** Other: **Oxidizer**
Label Hazard Warning:
DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.
Label Precautions:
Keep from contact with clothing and other combustible materials.
Store in a tightly closed container.
Do not store near combustible materials.
Remove and wash contaminated clothing promptly.
Avoid contact with eyes, skin and clothing.
Avoid breathing dust.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****
Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.
****
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)



Health	2
Fire	0
Reactivity	1
Personal Protection	E

Material Safety Data Sheet
Sodium carbonate MSDS

Section 1: Chemical Product and Company Identification

Product Name: Sodium carbonate

Catalog Codes: SLS3481, SLS1264, SLS4105, SLS1894, SLS3316

CAS#: 497-19-8

RTECS: VZ4050000

TSCA: TSCA 8(b) inventory: Sodium carbonate

CI#: Not available.

Synonym: Crystal Carbonate, Disodium Carbonate, Sal Soda, Soda Asha, Washing Soda

Chemical Name: Sodium Carbonate, Anhydrous

Chemical Formula: Na2-C-O3

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sodium carbonate	497-19-8	100

Toxicological Data on Ingredients: Sodium carbonate: ORAL (LD50): Acute: 4090 mg/kg [Rat]. 6600 mg/kg [Mouse]. DUST (LC50): Acute: 2300 mg/m 2 hours [Rat]. 1200 mg/m 2 hours [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects: Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation (lung irritant).

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer).
CARCINOGENIC EFFECTS: Not available.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance may be toxic to upper respiratory tract, skin, eyes.
Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Emits Na2O fumes when heated to decompositon.

Fire Hazards in Presence of Various Substances: Not applicable.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Sodium carbonate can ignite and burn fiercely in contact with fluoride.
Sodium Carbonate in contact with fluorine decomposed at ordinary temperature with incandescence.

Special Remarks on Explosion Hazards:
Reacts explosively with red-hot aluminum metal.
Sodium carbonate + ammonia in arabic gum solution will explode.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. If necessary: Neutralize

the residue with a dilute solution of acetic acid. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Neutralize the residue with a dilute solution of acetic acid. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Section 7: Handling and Storage

Precautions:
Do not ingest. Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as acids.

Storage:
Hygroscopic. Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 24°C (75.2°F). Hygroscopic

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Solid powder.)

Odor: Odorless.

Taste: Alkaline.

Molecular Weight: 105.99 g/mole

Color: White.

pH (1% soln/water): 11.5 [Basic.]

Boiling Point: Not available.

Melting Point: 851°C (1563.8°F)

Critical Temperature: Not available.

Specific Gravity: Density: 2.532 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility:
Soluble in hot water, glycerol.
Partially soluble in cold water.
Insoluble in acetone, alcohol.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials, moisture

Incompatibility with various substances:
Reactive with acids.
Slightly reactive to reactive with moisture.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Hygroscopic. Combines with water with evolution of heat.
Incompatible with phosphorus pentoxide, lithium, fluorine, fluoride, ammonia + silver nitrate, 2,4,6-trinitrotoluene, ammonia, acids, sodium sulfide + water, hydrogen peroxide, red hot alumium metal, sodium sulfide, zinc, calcium hydroxide.
Sodium Carbonate is decomposed by acids with effervescence.
Reacts violently with F2, Lithium, and 2,4,6-trinitrotoluene.
Sodium begins to decompose at 400 C to evolve CO2.

Special Remarks on Corrosivity: Hot concentrated solutions of sodium carbonate are mildly corrosive to steel.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals:
WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE.
Acute oral toxicity (LD50): 4090 mg/kg [Rat].
Acute toxicity of the dust (LC50): 1200 mg/m3 2 hours [Mouse].

Chronic Effects on Humans: May cause damage to the following organs: upper respiratory tract, skin, eyes.

Other Toxic Effects on Humans: Hazardous in case of skin contact (irritant), of ingestion, of inhalation (lung irritant).

Special Remarks on Toxicity to Animals: LDL (Lowest Published Lethal Dose) [Man] - Route: Oral; Dose: 714 mg/kg

Special Remarks on Chronic Effects on Humans: May cause adverse reproductive effects based on animal test data

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
Skin: Causes skin irritation with possible burns depending on the concentration, site (abraded or intact skin), and duration of exposure.
Eyes: Causes eye irritation and possible burns. Concentrated solutions may cause permanent corneal injury (permanent corneal opacity).
Ingestion: Sodium carbonate ingestion may cause irritation of the digestive tract resulting in nausea, vomiting, diarrhea, thirst, abdominal pain depending on concentration and amount ingested. May also affect the cardiovascular system .
Inhalation: Dust may cause respiratory tract and mucous membrane irritation with coughing and shortness of breath (dyspnea), pulmonary edema.
Chronic Potential Health Effects:
Chronic inhalation may result in decreased pulmonary function, nasal congestion, nosebleeds, perforation of the nasal septum. Other effects of chronic exposure are skin (dermatitis and ulceration), and gastrointestinal complaints. However, the effects of chronic exposure seem to be reversible if exposure is decreased.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations: TSCA 8(b) inventory: Sodium carbonate

Other Regulations: EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada): CLASS D-2B: Material causing other toxic effects (TOXIC).

DSCL (EEC):

R36/37/38- Irritating to eyes,
respiratory system and skin.
S22- Do not breathe dust.
S26- In case of contact with eyes, rinse
immediately with plenty of water and seek
medical advice.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 0

Reactivity: 1

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 0

Reactivity: 1

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Dust respirator. Be sure to use an
approved/certified respirator or
equivalent. Wear appropriate respirator
when ventilation is inadequate.
Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:26 PM

Last Updated: 11/06/2008 12:00 PM

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MATERIAL SAFETY DATA SHEET

Sodium Hydroxide 50% Solution

MSDS Ref. No.: 1310-73-2-3
Date Approved: 01/26/2004
Revision No.: 4

This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200; the Canada's Workplace Hazardous Materials Information System (WHMIS) and, the EC Directive, 2001/58/EC.

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME:	Sodium Hydroxide 50% Solution
SYNONYMS:	Caustic Soda Solution; Lye Solution; Sodium Hydrate Solution, White Caustic Solution
GENERAL USE:	pH Control
	This chemical is certified to ANSI/NSF Standard 60, Drinking Water Chemicals-Health Effects (as packaged in the original, unopened container). The maximum dosage level for this chemical is 200 mg/L

MANUFACTURER

FMC Wyoming Corporation
Alkali Chemicals Division
1735 Market Street
Philadelphia, PA 19103
(215) 299-6000 (General Information)

EMERGENCY TELEPHONE NUMBERS

(800) 424-9300 (CHEMTREC - U.S.)
(303) 595-9048 (Medical - Call Collect)

(307) 872-2452 (Plant - Green River, WY)

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

- Water white liquid with no appreciable odor.
- Solution is corrosive to body tissues and metallic materials.
- Product may react violently with acids.

POTENTIAL HEALTH EFFECTS: Solution is corrosive and severely irritating to the eyes and skin.

MEDICAL CONDITIONS AGGRAVATED: Skin and lung disorders may be affected adversely by this material; an individual's specific medical condition and circumstances of exposure determine the likelihood of an adverse effect.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Wt.%	EC No.	EC Class
Sodium Hydroxide	1310-73-2	50	215-185-5	C R35 /34; Xi R36/38
Water	7732-18-5	50	231-791-2	Not classified as hazardous

4. FIRST AID MEASURES

EYES: Immediately flush with water for at least 15 minutes, lifting the upper and lower eyelids intermittently. See a medical doctor or ophthalmologist immediately.

SKIN: Immediately flush with plenty of water while removing contaminated clothing and/or shoes, and thoroughly wash with soap and water. See a medical doctor immediately.

INGESTION: Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. See a medical doctor immediately.

INHALATION: Remove to fresh air. If breathing difficulty or discomfort occurs and persists, contact a medical doctor.

NOTES TO MEDICAL DOCTOR: Sodium hydroxide at this concentration is corrosive. Major burns to all surfaces may result. Prolonged dilution with water is required. Neutralization of eye burns is absolutely contraindicated; for skin, 2% acetic acid has been recommended, but washing with water is effective. Ingestion requires milk or water dilution, consideration of esphagoscopy and management for possible esophageal stricture.

5. FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA: Not applicable

FIRE / EXPLOSION HAZARDS: Non-combustible

FIRE FIGHTING PROCEDURES: Not applicable

FLAMMABLE LIMITS: Not applicable

HAZARDOUS COMBUSTION PRODUCTS: None

SENSITIVITY TO IMPACT: Not Sensitive

SENSITIVITY TO STATIC DISCHARGE: Not Sensitive

6. ACCIDENTAL RELEASE MEASURES

RELEASE NOTES: Wear personal protective equipment as recommended in Section 8, "Exposure Controls/Personal Protection" below.

Contain spill using absorbent material and place in an approved container.

Dispose of according to the method outlined in Section 13, "Disposal Considerations" below.

7. HANDLING AND STORAGE

HANDLING: During handling of liquid, prevent contact with skin and eyes by using adequate personal protective equipment (see Section 8, "Exposure Controls/Personal Protection" below). If the release of airborne material is likely, exhaust ventilation and/or respiratory protection may also be necessary.

STORAGE: Store in closed containers away from sources of heat.

COMMENTS: Use only in systems, processes and procedures in which effective ventilation has been provided to meet established exposure limits.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMITS

Chemical Name	ACGIH	OSHA	Supplier
Sodium Hydroxide	2 mg/m^3 (STEL) (Ceiling)	2 mg/m^3 (TWA) 2 mg/m^3 (PEL) (ceiling)	

ENGINEERING CONTROLS: Adequate engineering controls and/or personal protective equipment must be used to prevent contact with skin and eyes. Engineering controls and/or respirators may be necessary when the generation of airborne mists or fogs are possible.

PERSONAL PROTECTIVE EQUIPMENT

EYES AND FACE: Chemical goggles (and face shield if necessary) should be worn to prevent contact.

RESPIRATORY: When exposure above the established standard is likely, a respiratory protection program that complies with OSHA General Industry Standard 1910.134 should be implemented. Wear full face-piece respirators approved by MSHA / NIOSH if mists are expected.

PROTECTIVE CLOTHING: Rubber or vinyl apron. Rubber boots or rubber overshoes.

GLOVES: Impervious rubber or vinyl gloves with gauntlets. Thoroughly wash the outside of gloves with soap and water prior to removal. Inspect regularly for leaks.

COMMENTS:

The information noted above provides general guidance for handling this product. Specific work environments and material handling practices will dictate the selection and use of personal protection equipment (PPE).

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9. PHYSICAL AND CHEMICAL PROPERTIES

ODOR:	No appreciable odor
APPEARANCE:	Water white liquid
AUTOIGNITION TEMPERATURE:	Not applicable
BOILING POINT:	145 °C (293 °F)
COEFFICIENT OF OIL / WATER:	Not applicable
EVAPORATION RATE:	(butyl acetate = 1) Not available
FLASH POINT:	Non-combustible
FREEZING POINT:	4.4°C (40°F)
ODOR THRESHOLD:	Not applicable
OXIDIZING PROPERTIES:	Not available
PERCENT VOLATILE:	Not applicable
pH:	(as is) 13.7
SOLUBILITY IN WATER:	Infinite
SPECIFIC GRAVITY:	1.53 @ 15.5°C (60°F) (water = 1)
VAPOR DENSITY:	Not applicable
VAPOR PRESSURE:	6.33 mm Hg @ 40 °C (104 °F)

COMMENTS:

pH (1% solution): 13.0

10. STABILITY AND REACTIVITY

CONDITIONS TO AVOID:	Contact with acids, flammable liquids, organic halogen compounds, nitro compounds, and amphoteric metals, such as aluminum, magnesium and zinc.
STABILITY:	Slightly reactive
POLYMERIZATION:	Will not occur
INCOMPATIBLE MATERIALS:	Acids, flammable liquids, organic halogen compounds, nitro compounds, and amphoteric metals, such as aluminum, magnesium and zinc.
HAZARDOUS DECOMPOSITION PRODUCTS:	None

11. TOXICOLOGICAL INFORMATION

EYE EFFECTS: Severely irritating, corrosive (rabbit) [RTECS 1986, NIOSH 1975]

SKIN EFFECTS: Severely irritating, corrosive (rabbit) [RTECS 1986, PB 234-899 1974]

DERMAL LD_{50}: Corrosive

ORAL LD_{50}: 400 mg/kg (rabbit) LDLo [PB 234-899 1974]

INHALATION LC_{50}: Corrosive

TARGET ORGANS: Skin, eyes, mucous membranes

ACUTE EFFECTS FROM OVEREXPOSURE: Sodium hydroxide is corrosive and may produce severe eye, skin and respiratory tract irritation and upper gastrointestinal tract damage. Ingestion of concentrated solutions has caused death in animals and humans. [Gosselin, Smith & Hodge, 1984; PB 234-899 1974]

CHRONIC EFFECTS FROM OVEREXPOSURE: Sodium hydroxide may produce inflammation of the eyes, skin, and mucous membranes. Esophageal carcinoma at the site of a chronic lye stricture has been reported. [Gosselin , Smith & Hodge 1984]

CARCINOGENICITY:

NTP:	Not listed
IARC:	Not listed
OSHA:	Not listed
OTHER:	Not Listed (ACGIH)

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION: Bluegill sunfish: 48-hour LC_{50} = 99 mg/L
Mosquito fish: 96-hour LC_{50} = 125 mg/L
Brown shrimp (Crangon crangon): 48-hour LC_{50} = 30 - 100 mg/L

The damaging effects are mostly a consequence of the increase in pH. The upper pH limit tolerated by most freshwater fish is 8.4; the pH must generally be greater than 9 before the aqueous environment becomes lethal for fully developed fish. Freshwater algae are destroyed above pH 8.5. Concentrations of 20 to 100 mg/L have been reported to kill salmon, trout, carp and crayfish. [Ref. , Environment Canada, Environmental Protection Service, Sodium Hydroxide Environmental and Technical Information for Problem Spills. June 1984]

CHEMICAL FATE INFORMATION: The pH effect of sodium hydroxide in water is naturally reduced by the absorption of atmospheric carbon dioxide. This reduction is also effected by dilution with water and by the natural acidity of a given water body. There is no degradation of sodium hydroxide in waters, only loss by absorption or through chemical neutralization.

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: Dispose of in accordance with all local, state and federal environmental rules and regulations. Check the pH of the waste to be disposed, if it is greater than 12.5 it must be handled as a RCRA hazardous waste.

14. TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

PROPER SHIPPING NAME:	Sodium Hydroxide Solution
PRIMARY HAZARD CLASS / DIVISION:	8 (Corrosive)
UN/NA NUMBER:	UN 1824
PACKING GROUP:	II

LABEL(S):	Corrosive
PLACARD(S):	Corrosive
MARKING(S):	Sodium Hydroxide Solution
ADDITIONAL INFORMATION:	Hazardous Substance/RQ = 1000 lbs. (454 kg) 49 STCC Number: 4935240

INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)

PROPER SHIPPING NAME:	Sodium Hydroxide Solution

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) / INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

PROPER SHIPPING NAME:	Sodium Hydroxide Solution

OTHER INFORMATION:

Cool containers with water if exposed to fire or excessive heat conditions.

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15. REGULATORY INFORMATION

UNITED STATES

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A):
Not listed

SECTION 311 HAZARD CATEGORIES (40 CFR 370):
Immediate (Acute) Health Hazard

SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370):
The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs; however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.: None

SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372):
Not listed

CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)

CERCLA DESIGNATION & REPORTABLE QUANTITIES (RQ) (40 CFR 302.4):
Listed

Chemical Name	RQ	
Sodium Hydroxide	1,000 lb	Category C

TSCA (TOXIC SUBSTANCE CONTROL ACT)

TSCA INVENTORY STATUS (40 CFR 710):
Listed

U.S. STATES

U.S. State Regulation:
New Jersey - Special Health Hazard
Massachusetts - Substance List

CANADA

WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM):

Product Identification Number:	Not available
Hazard Classification / Division:	Class D, Div. 2, Subdiv. B (Toxic), E (Corrosive)
Ingredient Disclosure List:	Listed

EU EINECS NUMBERS:

sodium hydroxide 011-002-00-6

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16. OTHER INFORMATION

HAZARD, RISK AND SAFETY PHRASE DESCRIPTIONS:

Sodium hydroxide:

EC Symbols:	C	(Corrosive)
	Xi	(Irritant)
EC Risk Phrases:	R35/34	(Causes severe burns / causes burns)
	R36/38	(Irritating to eyes and skin.)
EC Safety Phrases:	S1/2	(Keep locked up and out of reach of children.)
	S26	(In case of contact with eyes, rinse immediately with plenty of water and seek medical advice)
	S37	(Wear suitable gloves.)
	S39	(Wear eye/face protection.)
	S45	(In case of accident or if you feel unwell, seek medical advice immediately - show the label where possible.)

HMIS

Health	3
Flammability	0
Physical Hazard	1
Personal Protection (PPE)	J

Protection = J (Safety goggles, gloves, apron & combination dust & vapor respirator)

HMIS = Hazardous Materials Identification System

Degree of Hazard Code:
4 = Severe
3 = Serious
2 = Moderate
1 = Slight
0 = Minimal

NFPA

Health	3
Flammability	0
Reactivity	1
Special	None

No special requirements

NFPA = National Fire Protection Association

Degree of Hazard Code:
4 = Extreme
3 = High
2 = Moderate
1 = Slight
0 = Insignificant

REVISION SUMMARY:
New Format, as well as text changes and/or updates to one or more Sections of this MSDS.

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MSDS Number: **S4442** * * * * * *Effective Date:* ***07/03/07*** * * * * * *Supercedes:* ***05/07/07***

MSDS *Material Safety Data Sheet*

From: **Mallinckrodt Baker, Inc.**
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

SODIUM NITRATE

1. Product Identification

Synonyms: Nitratine; nitric acid, sodium salt; sodium saltpeter; sodium nitrate, crystal
CAS No.: 7631-99-4
Molecular Weight: 84.99
Chemical Formula: NaNO3
Product Codes:
J.T. Baker: 3770, 3771, 4501
Mallinckrodt: 4484, 7709, 7793, 7796, 7808, 7811

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sodium Nitrate	7631-99-4	99 - 100%	Yes

3. Hazards Identification

Emergency Overview

DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: Yellow (Reactive)

Potential Health Effects

Inhalation:
Inhalation of dust irritates the respiratory tract. Symptoms may include coughing, shortness of breath.
Ingestion:
May cause gastroenteritis and abdominal pains. Other symptoms may include dizziness, bloody diarrhea, convulsions, and collapse. Purging and diuresis can be expected. Small repeated doses may cause headache and mental impairment. Rare cases of nitrates being converted to the more toxic nitrites have been reported, mostly with infants.
Skin Contact:
May cause irritation, symptoms including redness, itching, and pain.
Eye Contact:
May cause irritation, symptoms including redness, itching, and pain.
Chronic Exposure:
Under some circumstances methemoglobinemia occurs in individuals when the nitrate is converted by bacteria in the stomach to nitrite. Nausea, vomiting, dizziness, rapid heart beat, irregular breathing, convulsions, coma, and death can occur should this conversion take place.
Aggravation of Pre-existing Conditions:
Workers with a history of kidney or lung disease may be more susceptible to the effects of this substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Remove any contaminated clothing. Wipe off excess from skin. Wash skin with soap and water for at least 15 minutes. Get medical attention if irritation develops or persists.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

---

5. Fire Fighting Measures

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition.
Explosion:
Explosive with shock, heat or friction. Sodium Nitrate decomposes explosively when heated > 538C (1000F). Sensitive to mechanical impact.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire. Water spray may be used to keep fire exposed containers cool.
Special Information:
Wear full protective clothing and breathing equipment for high-intensity fire or potential explosion conditions. This oxidizing material can increase the flammability of adjacent combustible materials.

---

6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container. Small amounts of residue may be flushed to sewer with plenty of water.

---

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage and moisture. Isolate from any source of heat or ignition. Avoid storage on wood floors. Separate from incompatibles, combustibles, organic or other readily oxidizable materials. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:
White crystals.
Odor:
Odorless.
Solubility:
81.5 g/100 g water @ 15C (59F)
Specific Gravity:
2.26
pH:
Aqueous solution is neutral.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
380C (716F)

Melting Point:
308C (586F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Emits nitrous oxides when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Reacts with acids to emit toxic fumes of nitrogen dioxide. Contact with the following may cause an explosion: barium rhodanide, boron phosphide, cyanides, sodium thiosulfate, sodium hypophosphite, sulfur plus charcoal, powdered aluminum and aluminum oxide. Fibrous organic material such as jute, wood, and similar cellulosic materials can become highly combustible by nitrate impregnation.
Conditions to Avoid:
Heat, flame, ignition sources, shock, friction, incompatibles.

11. Toxicological Information

Oral rat LD50: 1267 mg/kg. Investigated as a tumorigen, mutagen, reproductive effector.

```
--------\Cancer Lists\-----------------------------------------------------
                                      ---NTP Carcinogen---
Ingredient                            Known    Anticipated    IARC Category
------------------------------------  -----    -----------    -------------
Sodium Nitrate (7631-99-4)             No          No            None
```

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: SODIUM NITRATE
Hazard Class: 5.1
UN/NA: UN1498
Packing Group: III
Information reported for product/size: 100LB

International (Water, I.M.O.)

Proper Shipping Name: SODIUM NITRATE
Hazard Class: 5.1
UN/NA: UN1498
Packing Group: III
Information reported for product/size: 100LB

15. Regulatory Information

```
--------\Chemical Inventory Status - Part 1\---------------------------------
Ingredient                                      TSCA  EC   Japan  Australia
-----------------------------------------------  ----  ---  -----  ---------
```

```
  Sodium Nitrate (7631-99-4)                        Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\--------------------------------
                                                          --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  ----------------------------------------------  -----  ---   ----  -----
  Sodium Nitrate (7631-99-4)                        Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\----------------
                                              -SARA 302-    ------SARA 313------
  Ingredient                                  RQ    TPQ     List  Chemical Catg.
  ----------------------------------------  ---   -----   ----  --------------
  Sodium Nitrate (7631-99-4)                  No    No      No    Nitrate Cmpd

  --------\Federal, State & International Regulations - Part 2\----------------
                                                        -RCRA-    -TSCA-
  Ingredient                                  CERCLA    261.33     8(d)
  ----------------------------------------  ------    ------    ------
  Sodium Nitrate (7631-99-4)                  No        No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: No   Fire: No  Pressure: No
Reactivity: Yes         (Pure / Solid)
```

Australian Hazchem Code: 1[T]
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **1** Other: **Oxidizer**
Label Hazard Warning:
DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.
Label Precautions:
Keep from contact with clothing and other combustible materials.
Store in a tightly closed container.
Remove and wash contaminated clothing promptly.
Avoid breathing dust.
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 3.
Disclaimer:
****
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****
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

BOC GASES

MATERIAL SAFETY DATA SHEET

PRODUCT NAME: SULFUR HEXAFLUORIDE

1. Chemical Product and Company Identification

BOC Gases,
Division of
The BOC Group, Inc.
575 Mountain Avenue
Murray Hill, NJ 07974

TELEPHONE NUMBER: (908) 464-8100
24-HOUR EMERGENCY TELEPHONE NUMBER:
CHEMTREC (800) 424-9300

BOC Gases
Division of
BOC Canada Limited
5975 Falbourne Street, Unit 2
Mississauga, Ontario L5R 3W6

TELEPHONE NUMBER: (905) 501-1700
24-HOUR EMERGENCY TELEPHONE NUMBER:
(905) 501-0802
EMERGENCY RESPONSE PLAN NO: 20101

PRODUCT NAME: SULFUR HEXAFLUORIDE
CHEMICAL NAME: Sulfur hexafluoride
COMMON NAMES/SYNONYMS: None
TDG (Canada) CLASSIFICATION: 2.2
WHMIS CLASSIFICATION: A

PREPARED BY: Loss Control (908)464-8100/(905)501-1700
PREPARATION DATE: 6/1/95
REVIEW DATES: 6/7/96

2. Composition, Information on Ingredients

INGREDIENT	% VOLUME	PEL-OSHA[1]	TLV-ACGIH[2]	LD_{50} or LC_{50} Route/Species
Sulfur hexafluoride FORMULA: SFl_6 CAS: 2551-62-4 RTECS #: WS4900000	99.8-99.99	1000 ppm TWA	1000 ppm TWA	LD_{50} 5790 mg/kg; intravenous; (Rabbit)

[1] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)
[2] As stated in the ACGIH 1994-95 Threshold Limit Values for Chemical Substances and Physical Agents

3. Hazards Identification

EMERGENCY OVERVIEW

Simple Asphyxiant - This product does not contain oxygen and may cause asphyxia if released in a confined area. Maintain oxygen levels above 19.5%. Nonflammable. Decomposes to toxic fluoride compounds at temperatures above 400 ^{o}F (204 ^{o}C).

ROUTE OF ENTRY:

Skin Contact	Skin Absorption	Eye Contact	Inhalation	Ingestion
No	No	No	Yes	No

HEALTH EFFECTS:

Exposure Limits	Irritant	Sensitization
Yes	Yes	No
Teratogen	Reproductive Hazard	Mutagen
No	No	No
Synergistic Effects None reported		

Carcinogenicity: -- NTP: No IARC: No OSHA: No

EYE EFFECTS:
None known.

SKIN EFFECTS:
None known.

INGESTION EFFECTS:
None known. Ingestion is unlikely as product is gas at room temperature.

INHALATION EFFECTS:
Effects of oxygen deficiency resulting from simple asphyxiants may include: rapid breathing, diminished mental alertness, impaired muscular coordination, faulty judgement, depression of all sensations, emotional instability, and fatigue. As asphyxiation progresses, nausea, vomiting, prostration, and loss of consciousness may result, eventually leading to convulsions, coma, and death.

Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

NFPA HAZARD CODES	HMIS HAZARD CODES	RATINGS SYSTEM
Health*: 2	Health: 0	0 = No Hazard
Flammability: 0	Flammability: 0	1 = Slight Hazard
Reactivity: 0	Reactivity: 0	2 = Moderate Hazard
		3 = Serious Hazard
* Under fire conditions		4 = Severe Hazard

4. First Aid Measures

EYES:
None required.

SKIN:
None required.

INGESTION:
None required.

INHALATION:
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Victims should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, and if breathing has stopped, administer artificial resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

5. Fire Fighting Measures

Conditions of Flammability: Nonflammable		
Flash point: None	Method: Not Applicable	Autoignition Temperature: None
LEL(%): None	UEL(%): None	
Hazardous combustion products: None		
Sensitivity to mechanical shock: None		
Sensitivity to static discharge: None		

FIRE AND EXPLOSION HAZARDS:
Nonflammable. Decomposes to toxic fluoride compounds under fire conditions.

EXTINGUISHING MEDIA:
None required. Use as appropriate for surrounding materials.

6. Accidental Release Measures

Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with inert gas prior to attempting repairs. If leak is in container or container valve, contact the appropriate emergency telephone number listed in Section 1 or call your closest BOC location.

7. Handling and Storage

Electrical classification:
Non-hazardous.

This gas mixture is noncorrosive and may be used with all common structural materials.

Aluminum, stainless steel, copper, brasses or silver recommended for temperatures above 400 ^{o}F (204 ^{o}C) to prevent decompositon to toxic fluoride compounds.

Use only in well-ventilated areas. Valve protection caps must remain in place unless container is secured with valve protection outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when connecting cylinder to lower pressure (<3000 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder. Protect cylinders from physical damage. Store in cool, dry, well-ventilated area of non-combustible construction away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are

stored to exceed 125 ^{o}F (52 ^{o}C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Use a "first in-first out" inventory system to prevent full cylinders being stored for excessive periods of time.

For additional recommendations, consult Compressed Gas Association Pamphlets P-1, P-14, P-9, and Safety Bulletin SB-2.

Never carry a compressed gas cylinder or a container of a gas in cryogenic liquid form in an enclosed space such as a car trunk, van or station wagon. A leak can result in a fire, explosion, asphyxiation or a toxic exposure.

8. Exposure Controls, Personal Protection

EXPOSURE LIMITS[1]:

INGREDIENT	% VOLUME	PEL-OSHA[2]	TLV-ACGIH[3]	LD_{50} or LC_{50} Route/Species
Sulfur hexafluoride FORMULA: SFl_6 CAS: 2551-62-4 RTECS #: WS4900000	99.8 to 99.99	1000 ppm TWA	1000 ppm TWA	LD_{50} 5790 mg/kg; Intravenous; (Rabbit)

[1] Refer to individual state of provincial regulations, as applicable, for limits which may be more stringent than those listed here.
[2] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)
[3] As stated in the ACGIH 1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents.

ENGINEERING CONTROLS:
Local exhaust to prevent accumulation of high concentrations so as to reduce the oxygen level in the air to less than 19.5%.

EYE/FACE PROTECTION:
Safety goggles or glasses as appropriate for the job.

SKIN PROTECTION:
Protective gloves of material appropriate for the job.

RESPIRATORY PROTECTION:
Positive pressure air line with full-face mask and escape bottle or self-contained breathing apparatus should be available for emergency use.

OTHER/GENERAL PROTECTION:
Safety shoes or other footwear as appropriate for the job.

9. Physical and Chemical Properties

PARAMETER	VALUE	UNITS
Physical state (gas, liquid, solid)	: Gas	
Vapor pressure	: 319.1	psia
Vapor density (Air = 1)	: 5.13	
Evaporation point	: Not Available	
Boiling point	: -82.8	^{o}F
	: -63.8	^{o}C
Freezing point	: -59.4	^{o}F
	: -50.8	^{o}C
pH	: Not Applicable	
Specific gravity	: Not Available	
Oil/water partition coefficient	: Not Available	
Solubility (H20)	: Negligible	
Odor threshold	: Not Applicable	
Odor and appearance	: Colorless, odorless gas	

10. Stability and Reactivity

STABILITY:
Stable below 400 ^{o}F (204 ^{o}C).

INCOMPATIBLE MATERIALS:
Reported to explode in contact with disilane. Oxygen and certain metals cause slow decomposition to toxic fluorides.

HAZARDOUS DECOMPOSITON PRODUCTS:
Thionyl fluoride compounds including SF2, SF4, S2F2 and S2F10.

HAZARDOUS POLYMERIZATION:
Does not occur.

11. Toxicological Information

Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

No data given in the Registry of Toxic Effects of Chemical Substances (RTECS) or Sax, Dangerous Properties of Industrial Materials, 7th ed.

12. Ecological Information

No data given.

13. Disposal Considerations

Do not attempt to dispose of residual waste or unused quantities. Return in the shipping container PROPERLY LABELED, WITH ANY VALVE OUTLET PLUGS OR CAPS SECURED AND VALVE PROTECTION CAP IN PLACE to BOC Gases or authorized distributor for proper disposal.

14. Transport Information

PARAMETER	United States DOT	Canada TDG
PROPER SHIPPING NAME:	Sulfur Hexafluoride	Sulfur Hexafluoride
HAZARD CLASS:	2.2	2.2
IDENTIFICATION NUMBER:	UN 1080	UN 1080
SHIPPING LABEL:	NONFLAMMABLE GAS	NONFLAMMABLE GAS

15. Regulatory Information

SARA TITLE III NOTIFICATIONS AND INFORMATION

SARA TITLE III - HAZARD CLASSES:
Sudden Release of Pressure Hazard

16. Other Information

Compressed gas cylinders shall not be refilled without the express written permission of the owner. Shipment of a compressed gas cylinder which has not been filled by the owner or with his/her (written) consent is a violation of transportation regulations.

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES:
Although reasonable care has been taken in the preparation of this document, we extend no warranties and make no representations as to the accuracy or completeness of the information contained herein, and assume no responsibility regarding the suitability of this information for the user's intended purposes or for the consequences of its use. Each individual should make a determination as to the suitability of the information for their particular purpose(s).

Material Safety Data Sheet

Science Stuff, Inc.
1104 Newport Ave
Austin, TX 78753

Phone (512) 837-6020
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	C2795
Product Name:	Sulfuric Acid 30% v/v Aqueous Solution
Trade/Chemical Synonyms	
Formula:	N/A
RTECS:	None
C.A.S	See Below

Health:	3
Flammability	0
Reactivity	0

Hazard Rating:

Least	Slight	Moderate	High	Extreme
0	1	2	3	4

NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☐	Water, Deionized ASTM Type II	CAS# 7732-18-5	Balance	V/V	None Established
☑	Sulfuric Acid	CAS# 7664-93-9	30%	V/V	OSHA TWA 1 mg/mƒ, ACGIH STEL 3 ppm

Section 3 Hazard Identification (Also see section 11)

Causes severe irritation and burns. May Be harmful if swallowed. Avoid breathing vapor or dust. Use with adequate ventilation. Avoid contact with eyes, skin, and clothes. Wash thoroughly after handling. Keep container closed.

Section 4 First Aid Measures

Causes severe irritation and burns. May Be harmful if swallowed. Avoid breathing vapor or dust. Use with adequate ventilation. Avoid contact with eyes, skin, and clothes. Wash thoroughly after handling. Keep container closed.

FIRST AID: CALL A PHYSICIAN. SKIN: In case of contact, immediately flush skin with water for at least 15 minutes while removing contaminated clothing and shoes. Thoroughly clean clothing and shoes before reuse.

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: Give several glasses of milk or water. Vomiting may occur spontaneously, but DO NOT INDUCE! Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Fire Extinguisher Type:	Carbon Dioxide, dry chemical powder or appropriate foam
Fire/Explosion Hazards:	None
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Section 6 Accidental Release Measures

Absorb spill with inert material, then place in a chemical waste container. Neutralize with a weak base.

Section 7 Handling and Storage

Wash thoroughly after handling. Remove contaminated clothes and wash before reuse. Use with adequate ventilation.

Section 8 Exposure Controls & Personal Protection

Respiratory Protection: Acid vapor mask

Ventilation:	Mechanical: ☐	Hand Protection:	NIOSH Approved Gloves
	Local Exhaust: ☑	Eye Protection:	Goggles and Face Shield

Other Protective Equipment: Wear appropriate clothing to prevent skin exposure

Section 9 Physical and Chemical Properties

Melting Point:	Information not available	Specific Gravity	~1.3
Boiling Point:	Information not available	Percent Volatile by Volume:	~70%
Vapor Pressure:	Information not available	Evaporation Rate:	Information not available
Vapor Density:	Information not available	Evaporation Standard:	
Solubility in Water:	Soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:	Clear, colorless, odorless liquid	Lower Flamm. Limit in Air:	Not applicable
Flash Point:	Not flammable	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Stability: Stable

Conditions to Avoid: Avoid contact with incompatible materials.

Materials to Avoid:
Oxidizing agents, metals, bases, amines.

Hazardous Decomposition Products:
Oxides of sulfur, hydrogen (in presence of metals)

Hazardous Polymerization: Will Not Occur

Condition to Avoid: None known

Section 11 Additional Information

Conditions aggravated/target organs: Persons with pre-existing skin, respiratory and eye disorders are more susceptible. Corrosive! Acute: Severe irritation and burns to skin, eyes, lungs, and GI tract. Chronic: Dermatitis, eye damage. Strong inorganic acid mists of sulfuric acid can cause cancer of the

larynx.

DOT Classification: Sulfuric Acid Solution, 8, UN2796, PG II

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0	Date Entered: 9/1/2006	Approved by: WPF

The information contained herein is believed to be accurate and is offered in good faith for the user's consideration and investigation. No warranty is expressed or implied regarding the completeness or accuracy of this information, whether originating from Science Stuff, Inc. or from an alternate source. Users of this material should satisfy themselves by independent investigation of current scientific and medical information that this material may be safely handled.

MSDS Number: **S8234** * * * * * *Effective Date:* ***11/09/07*** * * * * * *Supercedes:* ***02/04/05***

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

SULFURIC ACID, 52 - 100 %

1. Product Identification

Synonyms: Oil of vitriol; Babcock acid; sulphuric acid
CAS No.: 7664-93-9
Molecular Weight: 98.08
Chemical Formula: H2SO4 in H2O
Product Codes:
J.T. Baker: 5030, 5137, 5374, 5802, 5815, 5858, 5859, 5868, 5889, 5897, 5961, 5971, 5997, 6163, 6902, 9671, 9673, 9674, 9675, 9676, 9679, 9680, 9681, 9682, 9684, 9687, 9691, 9693, 9694
Mallinckrodt: 21201, 2468, 2876, 2878, 2900, 2904, 3780, 4222, 5524, 555 7, H644, H850, H976, H996, V651, XL003

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sulfuric Acid	7664-93-9	52 - 100%	Yes
Water	7732-18-5	0 - 48%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR CONTACTED WITH SKIN. HARMFUL IF INHALED. AFFECTS TEETH. WATER REACTIVE. CANCER HAZARD. STRONG INORGANIC ACID MISTS CONTAINING SULFURIC ACID CAN CAUSE CANCER. Risk of cancer depends on duration and level of exposure.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Poison)

Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:
Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. May cause lung edema, a medical emergency.
Ingestion:
Corrosive. Swallowing can cause severe burns of the mouth, throat, and stomach, leading to death. Can cause sore throat, vomiting, diarrhea. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow ingestion or skin contact. Circulatory shock is often the immediate cause of death.
Skin Contact:
Corrosive. Symptoms of redness, pain, and severe burn can occur. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow skin contact or ingestion. Circulatory shock is often the immediate cause of death.
Eye Contact:
Corrosive. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
Chronic Exposure:
Long-term exposure to mist or vapors may cause damage to teeth. Chronic exposure to mists containing sulfuric acid is a cancer hazard.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician immediately.
Ingestion:
DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Call a physician immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Excess acid on skin can be neutralized with a 2% solution of bicarbonate of soda. Call a physician immediately.
Eye Contact:
Immediately flush eyes with gentle but large stream of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Call a physician immediately.

5. Fire Fighting Measures

Fire:
Concentrated material is a strong dehydrating agent. Reacts with organic materials and may cause ignition of finely divided materials on contact.
Explosion:
Contact with most metals causes formation of flammable and explosive hydrogen gas.
Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide. Do not use water on material. However, water spray may be used to keep

fire exposed containers cool.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Structural firefighter's protective clothing is ineffective for fires involving this material. Stay away from sealed containers.

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6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® acid neutralizers are recommended for spills of this product.

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7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, always add the acid to water; never add water to the acid. When opening metal containers, use non-sparking tools because of the possibility of hydrogen gas being present. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

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8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For Sulfuric Acid:
- OSHA Permissible Exposure Limit (PEL) -
1 mg/m3 (TWA)
- ACGIH Threshold Limit Value (TLV) -
0.2 mg/m3(T) (TWA) for sulfuric acid - A2 Suspected Human Carcinogen for sulfuric acid contained in strong inorganic mists.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a full facepiece respirator with an acid gas cartridge and particulate filter (NIOSH type N100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P particulate filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres. Where respirators are required, you must have a written program covering the basic requirements in the OSHA respirator standard. These include training, fit testing, medical approval, cleaning, maintenance, cartridge change schedules, etc. See 29CFR1910.134 for details.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to

prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
Clear oily liquid.
Odor:
Odorless.
Solubility:
Miscible with water, liberates much heat.
Specific Gravity:
1.84 (98%), 1.40 (50%), 1.07 (10%)
pH:
1 N solution (ca. 5% w/w) = 0.3; 0.1 N solution (ca. 0.5% w/w) = 1.2; 0.01 N solution (ca. 0.05% w/w) = 2.1.
% Volatiles by volume @ 21C (70F):
No information found.
Boiling Point:
ca. 290C (ca. 554F) (decomposes at 340C)
Melting Point:
3C (100%), -32C (93%), -38C (78%), -64C (65%).
Vapor Density (Air=1):
3.4
Vapor Pressure (mm Hg):
1 @ 145.8C (295F)
Evaporation Rate (BuAc=1):
No information found.

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10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Concentrated solutions react violently with water, spattering and liberating heat.
Hazardous Decomposition Products:
Toxic fumes of oxides of sulfur when heated to decomposition. Will react with water or steam to produce toxic and corrosive fumes. Reacts with carbonates to generate carbon dioxide gas, and with cyanides and sulfides to form poisonous hydrogen cyanide and hydrogen sulfide respectively.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Water, potassium chlorate, potassium perchlorate, potassium permanganate, sodium, lithium, bases, organic material, halogens, metal acetylides, oxides and hydrides, metals (yields hydrogen gas), strong oxidizing and reducing agents and many other reactive substances.
Conditions to Avoid:
Heat, moisture, incompatibles.

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11. Toxicological Information

Toxicological Data:
Oral rat LD50: 2140 mg/kg; inhalation rat LC50: 510 mg/m3/2H; standard Draize, eye rabbit, 250 ug (severe); investigated as a tumorigen, mutagen, reproductive effector.
Carcinogenicity:

Cancer Status: The International Agency for Research on Cancer (IARC) has classified "strong inorganic acid mists containing sulfuric acid" as a known human carcinogen, (IARC category 1). This classification applies only to mists containing sulfuric acid and not to sulfuric acid or sulfuric acid solutions.

```
--------\Cancer Lists\-------------------------------------------------------
                                        ---NTP Carcinogen---
Ingredient                              Known    Anticipated    IARC Category
------------------------------------    -----    -----------    -------------
Sulfuric Acid (7664-93-9)                No          No            None
Water (7732-18-5)                        No          No            None
```

12. Ecological Information

Environmental Fate:
When released into the soil, this material may leach into groundwater. When released into the air, this material may be removed from the atmosphere to a moderate extent by wet deposition. When released into the air, this material may be removed from the atmosphere to a moderate extent by dry deposition.
Environmental Toxicity:
LC50 Flounder 100 to 330 mg/l/48 hr aerated water/Conditions of bioassay not specified; LC50 Shrimp 80 to 90 mg/l/48 hr aerated water /Conditions of bioassay not specified; LC50 Prawn 42.5 ppm/48 hr salt water /Conditions of bioassay not specified.
This material may be toxic to aquatic life.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: SULFURIC ACID (WITH MORE THAN 51% ACID)
Hazard Class: 8
UN/NA: UN1830
Packing Group: II
Information reported for product/size: 440LB

International (Water, I.M.O.)

Proper Shipping Name: SULFURIC ACID (WITH MORE THAN 51% ACID)
Hazard Class: 8
UN/NA: UN1830
Packing Group: II
Information reported for product/size: 440LB

15. Regulatory Information

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--------\Chemical Inventory Status - Part 1\----------------------------------
Ingredient                                        TSCA  EC   Japan  Australia
-------------------------------------------------  ----  ---  -----  ---------
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```
  Sulfuric Acid (7664-93-9)                          Yes  Yes   Yes      Yes
  Water (7732-18-5)                                  Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\---------------------------------
                                                          --Canada--
  Ingredient                                        Korea  DSL   NDSL  Phil.
  ----------------------------------------------    -----  ---   ----  -----
  Sulfuric Acid (7664-93-9)                          Yes   Yes   No     Yes
  Water (7732-18-5)                                  Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\----------------
                                              -SARA 302-    ------SARA 313------
  Ingredient                                  RQ    TPQ     List  Chemical Catg.
  ----------------------------------------    ---   -----   ----  --------------
  Sulfuric Acid (7664-93-9)                   1000  1000    Yes        No
  Water (7732-18-5)                           No    No      No         No

  --------\Federal, State & International Regulations - Part 2\----------------
                                                         -RCRA-    -TSCA-
  Ingredient                                  CERCLA     261.33     8(d)
  ----------------------------------------    ------     ------    ------
  Sulfuric Acid (7664-93-9)                   1000       No         No
  Water (7732-18-5)                           No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  Yes
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: Yes         (Pure / Liquid)
```

Australian Hazchem Code: 2P
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **2** Other: **Water reactive**
Label Hazard Warning:
POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR CONTACTED WITH SKIN. HARMFUL IF INHALED. AFFECTS TEETH. WATER REACTIVE. CANCER HAZARD. STRONG INORGANIC ACID MISTS CONTAINING SULFURIC ACID CAN CAUSE CANCER. Risk of cancer depends on duration and level of exposure.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe mist.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Do not contact with water.
Label First Aid:
In all cases call a physician immediately. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before re-use. Excess acid on skin can be neutralized with a 2% bicarbonate of soda solution. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:

********** **********

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

APPENDIX C
Conceptual Drainage Study

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Conceptual Drainage Study

Tonopah Solar Energy, LLC

Crescent Dunes Solar Energy Project

Nye County

Nevada

Prepared By:
WorleyParsons Group Inc.

May 15, 2009

PROFESSIONAL ENGINEER-STATE OF NEVADA
DAVID H. AKOLA
Exp: 12-31-2011
CIVIL
No. 7072

5/15/09

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Appendix C – Soil Classification
Appendix D – Pre Developed Conditions
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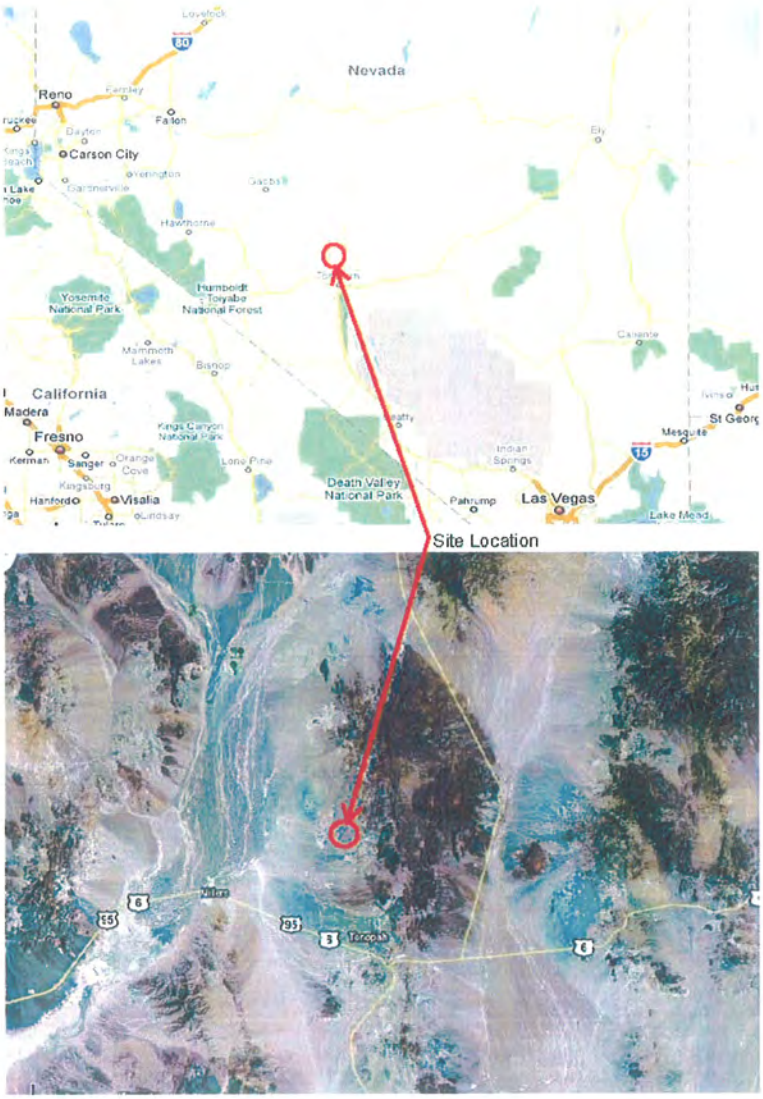
I. PROJECT LOCATION

The Tonopah Solar Energy Facility is a proposed Solar Thermal Power Generating Project to be built approximately 10 miles northwest of the town of Tonopah, NV in Nye County, State of Nevada (refer to **Figure 1**) by Tonopah Solar Energy, LLC. Images were provided by Google Earth maps. The Project Site ("Site") will be located on a 7,737 acre parcel of land ("Property") located north of US Route 6 and US Route 95. This Property is located along State Route 89.

The Site covers approximately 1,600 acres of land within the 7,737 acre private parcel of land.

The Property is situated within the Big Smokey Valley and has a very slight slope (less than 3% overall). The Site generally slopes from east to west with elevations of approximately 5336 to 4887 feet above mean sea level. The Property is comprised of low scrub vegetation.

The Property presently has no zoning ordinances or zoning map with the exception of Nye County Code Title 15.08 which regulates mobile homes, mobile home parks, nuisances, sanitary protection of water and food supplies and control of sewage disposal. Developments must comply with all other County/State/Federal and utility providers requirements applicable to the property.


Nevada
Reno
Carson City
Fallon
Yosemite National Park
Humboldt Toiyabe National Forest
Mammoth Lakes
Bishop
California
Madera
Fresno
Kerman
Sanger
Hanford
Visalia
Death Valley National Park
Pahrump
Las Vegas
Mesquite
St George
Site Location

PROJECT DESCRIPTION

The proposed solar power project is based on concentrating solar power (CSP) technology. The proposed CSP technology utilizes heliostats/reflecting mirrors to redirect sunlight on a receiver erected in the center of the solar field (the power tower or central receiver). A heat transfer fluid (HTF) is heated as it passes through the receiver and then circulated through a series of heat exchangers to generate high-pressure superheated steam. The steam is then used to power a conventional Rankine cycle steam turbine/generator, which produces electricity. The exhaust steam from the turbine is condensed and returned via feedwater pumps to the heat exchangers where the high-pressure superheated steam is generated again.

Both the central receiver and type of heat transfer fluid distinguish the technology used from other concentrating solar power technologies. With this technology, salt, which is melted to a liquid form, is circulated through the tubes in the central receiver, collecting the energy gathered from the sun. The heated salt is then routed to an insulated storage tank (hot thermal storage tank) where the energy can be stored with minimal energy losses. When electricity is to be generated, the hot salt is routed to the heat exchanger (or steam generator) and used to produce steam at high temperature. The steam is then used to power a conventional steam turbine, generating electricity. After exiting the steam generator, the salt is sent to a "cold" salt thermal storage tank and the cycle is repeated.

The salt is a combination of sodium and potassium nitrate, with a melting temperature of 460°F. In the liquid state, the salt has the viscosity and an appearance similar to water. Salt is a heat storage medium that retains thermal energy very effectively over time. Once the salt is melted to a liquid form during construction, it will remain heated and in a liquid state throughout the plant's operating life, being reused again and again in the cycle. The salt utilized is a technical grade salt similar to commercial fertilizer.

A primary advantage of the central receiver technology using salt is that the heat transfer medium can be heated to temperatures over 1000°F. Steam can be generated at utility-standard temperatures, allowing the use of highly efficient steam turbine cycles. While this technology is thus among the most efficient of solar technologies, one characteristic of the technology is a tall, central tower. The tall tower ensures that the large array of heliostats can focus the solar energy onto the receiver mounted on top of the tower.

Off-site storm water flows are sourced from an area east of the site draining off of the San Antonio Mountains.

Due to the type of terrain, the minor slopes, and the offsite flows being isolated, the storm water management dose not pose a significant concern.

Detail design of the roads will be included with the final drainage design.

All flows will sheet flow across the site to continue on their natural drainage course.

II. OBJECTIVE

The hydrologic and hydraulic conditions associated with the development of approximately 1,600 acres for the Tonopah Solar Energy Facility are conceptually addressed in this study. This conceptual drainage study addresses existing drainage patterns associated with pre-developed conditions and the future post development drainage flows through the Site. The objective of the study is to ensure the solar power plant development does not impact on the downstream drainage system and properties.

In order to accomplish this, hydrology calculations are performed using TR-55 (SCS Method) to determine the rate of pre and post development stormwater run-on and run-off in the watershed.

The USDA Natural Resources Conservation Service is used to classify soil characteristics, expected soil types and other design criteria necessary for use with the TR-55 calculations. Offsite flows are to be determined using the watershed boundaries from available state watershed information, contour intervals, and available soils mapping information. The watershed is then further broken down into basins as required to determine the flow from off site drainage locations as they approach the Site. Nodes shall be placed at appropriate locations to evaluate the pre and post development stormwater flows, and to ensure that the Site post-development discharge is kept at or below the pre-developed discharge.

III. DRAINAGE SUMMARY

Drainage modeling and calculations were performed using Bentley PondPack Ver. 10.1. The objective of not exceeding the pre-developed flows at the points of interest were accomplished (refer to **Table 1**). Detention basins shall be designed to ensure that the Site post-development discharge is kept at or below the pre-developed discharge.

Table 1: 100 year, 24 hour Pre Developed and Post Development Flows

BASIN 9		
	Pre Developed Flow (cfs)	**Post Developed Flow (cfs)**
Outlet	1217	1217

cfs = cubic feet per second

IV. HYDROLOGY

The hydrology analysis was performed and analyzed as set forth in the Nevada Department of Transportation Drainage Manual. USDA Natural Resources Conservation Service (NRCS formerly SCS) Technical release 55 (TR-55) is used to assign curve numbers (CN) in calculating runoff. TR-55 is also used to compute time of concentration. Time of concentration is based on sheet flow, shallow concentrate, and channel flow.

A. RAINFALL

In the 100 year, 24 hour storm event, 2.54 inches of rainfall shall fall (refer to **Appendix B**). Based on the Site location, the (NRCS/SCS) Type II rainfall distribution was used when performing calculations.

B. SOILS

Soil classification was made using data from USDA Natural Resources Conservation Service (refer to **Appendix C**). The soil type within the pre-developed watershed and post-developed watershed is listed in **Table 2**.

Table 2: Soil Types

Soil Type	On-site Watershed Areas (acres)
A	3902
B	218
D	6906
TOTAL	**11026**

The soil on site is classified as typical durorthids, loamy-skeletal mixed, hyperthermic and shallow, and typical torripsamments, mixed, hyperthermic. A soil list for the watershed is included in **Appendix C**.

C. HYDROLOGIC LOSSES

With the hydrologic soil group established, hydrologic losses can be computed using (NRCS/SCS) runoff curve numbers (CN) found by using TR-55 runoff curve numbers (refer to **Appendix C**). The sub-region and associated curve numbers are input into PondPack, which calculates a weighted CN for the total area to be used for the runoff computations. The hydrologic cover type was assumed to be desert shrub and allocated as "fair" for pre and post development.

D. PRE DEVELOPED CONDITIONS

The pre-developed drainage plans (refer to **Appendix D**) were prepared to estimate the runoff for all drainage areas at the Site. The total watershed area is 11,026 acres, of which 3,289 is off-site. The watershed consists of one basin. The area of the basin is shown in **Table 3**.

Table 3: Pre Developed Conditions, Basin Area

BASIN NUMBER	AREA (Acre)
1	11,026

Drainage was estimated using USGS quadrangle maps.

The calculations of the 100 year, 24 hour storm flows under pre-developed conditions for off-site and on-site areas are summarized in **Appendix D**. The 100 year, 24 hour storm flows were calculated using PondPack software. The software generates required runoff hydrographs for each of the drainage area separately, rainfall distribution used in this calculation is Type II 24 hour rainfall and the 100 year rainfall events were obtained from NOAA Atlas 2 Rainfall Depth – Duration – Frequency Maps reproduced for the Nye County, Nevada area (refer to **Appendix B**).

E. POST DEVELOPED CONDITIONS

The post-developed drainage plans are located in **Appendix E**. The total watershed area under post-developed conditions is approximately 11,026 acres.

The area for post developed conditions is shown in **Table 4**.

Table 4: Post Developed Conditions, Sub Basin Areas

BASIN NUMBER	AREA (Acre)
1	11,026

It has been assumed that each of the heliostats will freely drain onto the ground. The ground surface may be slightly more impervious in post developed conditions due to the footings of the heliostats.
The calculations of the 100 year, 24 hour storm event flows under post-developed conditions are summarized in **Appendix E**. The 100 year storm flows were calculated using PondPack software.

V. HYDRAULICS

A. SUMMARY

Channels were designed using open channel flow criteria.

B. DESIGN CONSIDERATIONS

1. DESIGN STORM FREQUENCY

100 year, 24 hour event.

2. DESIGN STORM DURATION

The goal in the storm drain design is to convey the maximum peak flow for a given design storm. This involves choosing a storm with the same duration as the time-of-concentration for the watershed (critical duration). As the storm is passed down the collection system, the time-of-concentration at each point downstream of the headwater sheds will increase according to shed minimum time-of-concentration plus travel time in structures.

3. MINOR LOSSES

No channels or dikes.

4. VEGETATION, CLEARING, AND GRUBBIING

The site's natural vegetation will remain in place an undisturbed throughout the Property, and will only be disturbed or removed within the limits of the Site. As discussed above, grading will be limited to that required to generate a smooth surface within the heliostat field. Vegetation will be removed, but root structures will be left in place where possible (i.e. no grading is required). A concerted effort will not be employed to "grub" the root system of the onsite vegetation.

5. GRADING, EXCAVATION, AND SLOPES:

The majority of the Site (the heliostat field) will be lightly graded to create a relatively smooth condition. High points (generally where wind blown sediment has accumulated to form 4" to 8" high ridges) will be leveled. Nominal grading will be required to elevate the roads and level the power island location. Slopes will be a maximum of 3H:1V, and will be flatter where possible to allow vehicle access from and to road shoulders. The site will not generate excess soil, nor require import. The site will be graded to balance by generation of needed material within the heliostat field or by very minor fills within the heliostat field.

C. CROSS SECTIONS

No channels or dikes provided. All drainage sheet flows across the site.

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APPENDICES

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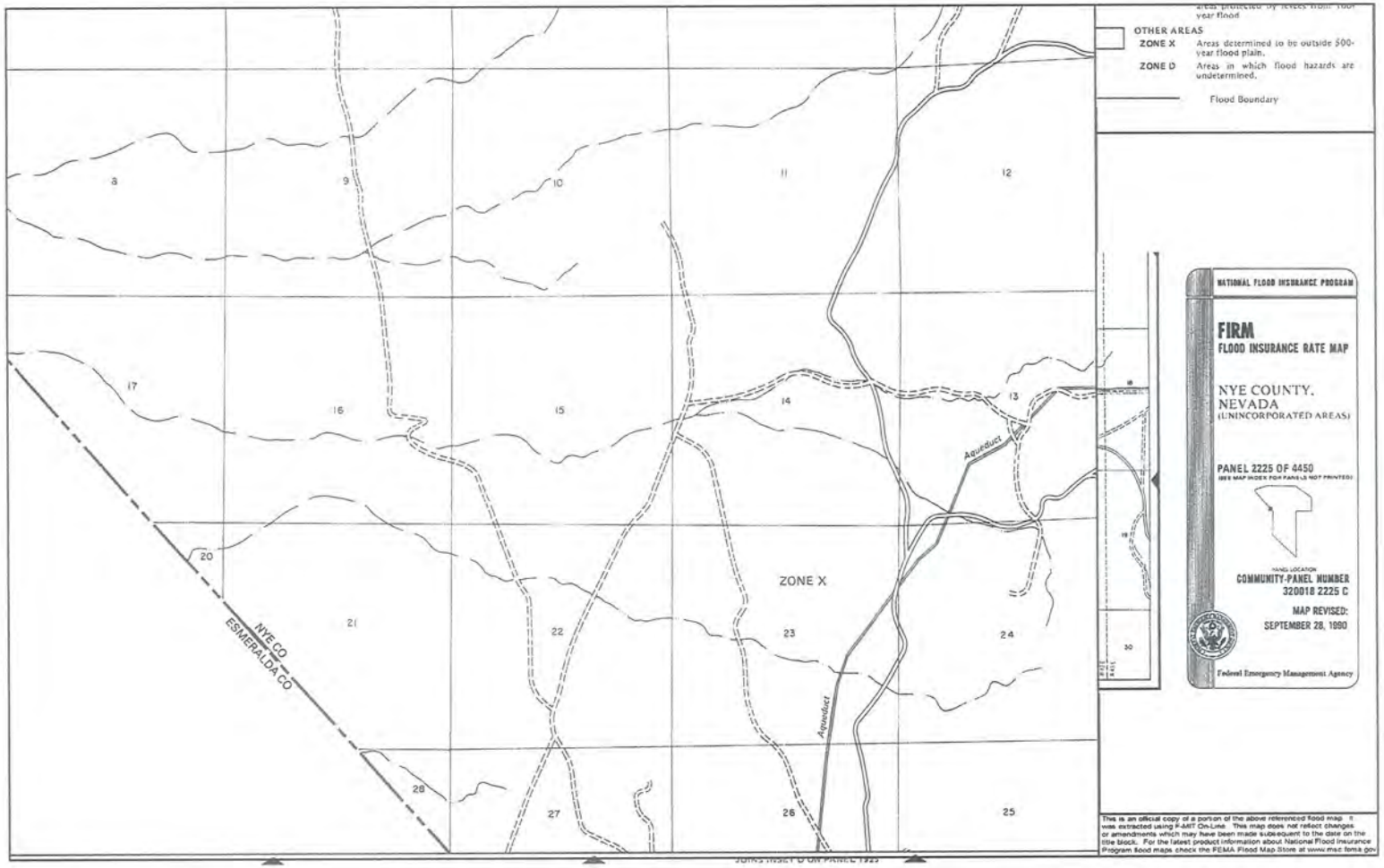
APPENDIX A – FLOOD MAP



APPENDIX B – RAINFALL PRECIPITATION

Figure 30
ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

Nevada 38.172557 N 117.234152 W 6377 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Tue Apr 21 2009

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Docs

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day
1	0.09	0.13	0.17	0.22	0.28	0.36	0.41	0.54	0.68	0.83	0.96	1.08	1.21	1.31	1.55	1.77	2.10
2	0.11	0.17	0.21	0.28	0.35	0.46	0.53	0.68	0.87	1.06	1.23	1.38	1.55	1.68	1.98	2.27	2.69
5	0.16	0.24	0.29	0.40	0.49	0.62	0.69	0.88	1.12	1.37	1.59	1.80	2.02	2.21	2.59	2.96	3.50
10	0.20	0.30	0.37	0.50	0.62	0.76	0.83	1.05	1.33	1.62	1.89	2.13	2.39	2.61	3.05	3.47	4.10
25	0.26	0.39	0.49	0.66	0.81	0.97	1.05	1.29	1.62	1.97	2.29	2.59	2.90	3.16	3.68	4.15	4.91
50	0.32	0.48	0.59	0.80	0.99	1.16	1.23	1.50	1.86	2.25	2.62	2.94	3.29	3.59	4.15	4.67	5.52
100	0.38	0.58	0.72	0.97	1.20	1.39	1.45	1.72	2.11	2.54	2.96	3.33	3.71	4.04	4.64	5.20	6.14
200	0.46	0.70	0.86	1.16	1.44	1.64	1.70	1.97	2.37	2.84	3.32	3.72	4.13	4.51	5.14	5.73	6.77
500	0.58	0.89	1.10	1.48	1.83	2.04	2.09	2.36	2.74	3.26	3.82	4.26	4.72	5.14	5.81	6.44	7.62
1000	0.69	1.06	1.31	1.76	2.19	2.39	2.44	2.69	3.07	3.59	4.22	4.70	5.18	5.64	6.33	6.99	8.28

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

*** Upper bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day
1	0.10	0.16	0.20	0.27	0.33	0.43	0.48	0.63	0.78	0.94	1.09	1.23	1.38	1.49	1.74	1.99	2.38
2	0.13	0.20	0.25	0.34	0.42	0.54	0.61	0.79	1.00	1.20	1.39	1.56	1.76	1.91	2.23	2.55	3.03
5	0.18	0.28	0.35	0.47	0.58	0.72	0.79	1.02	1.28	1.55	1.80	2.04	2.29	2.50	2.91	3.32	3.95
10	0.23	0.35	0.43	0.58	0.72	0.88	0.95	1.21	1.52	1.84	2.13	2.41	2.71	2.96	3.43	3.89	4.63
25	0.30	0.46	0.57	0.77	0.95	1.13	1.21	1.50	1.85	2.23	2.59	2.92	3.28	3.58	4.13	4.66	5.54
50	0.37	0.56	0.69	0.93	1.16	1.35	1.42	1.74	2.13	2.54	2.96	3.33	3.73	4.07	4.67	5.25	6.24
100	0.45	0.68	0.84	1.14	1.41	1.62	1.68	2.01	2.44	2.87	3.35	3.77	4.21	4.59	5.23	5.85	6.96
200	0.54	0.82	1.02	1.38	1.70	1.94	1.99	2.32	2.76	3.21	3.77	4.22	4.70	5.12	5.80	6.47	7.69
500	0.70	1.06	1.32	1.77	2.20	2.43	2.49	2.81	3.24	3.69	4.35	4.87	5.39	5.86	6.58	7.31	8.71
1000	0.85	1.29	1.60	2.15	2.67	2.90	2.94	3.25	3.66	4.09	4.83	5.39	5.95	6.46	7.20	7.97	9.51

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.

Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

APPENDIX C – SOIL CLASSIFICATION

Curve Number (CN) Determination

The SCS Curve Number Method uses a coil cover complex number (CN) for computing excess precipitation. The CN is related to hydrologic soil group (A, B, C, or D), land use, treatment class (cover), and antecedent moisture condition. The soil group is determined from published soil maps for the area (usually published by the NRCS (SCS))

The definitions of the hydrologic soil groups are:

> *Group A – Low run off potential. Soils having a high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well drained sands or gravels. These soils have a high rate of water transmission.*
>
> *Group B – Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained sandy-loam soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.*
>
> *Group D – High run off potential. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.*

The Hydrologic Soil Classifications were obtained from:

SSURGO – Soil Survey Geographic Data Base U.S. Department of Agriculture, Natural Resources Conservation Service.

Specific Soil taxonomy for the watershed is shown in the following maps.

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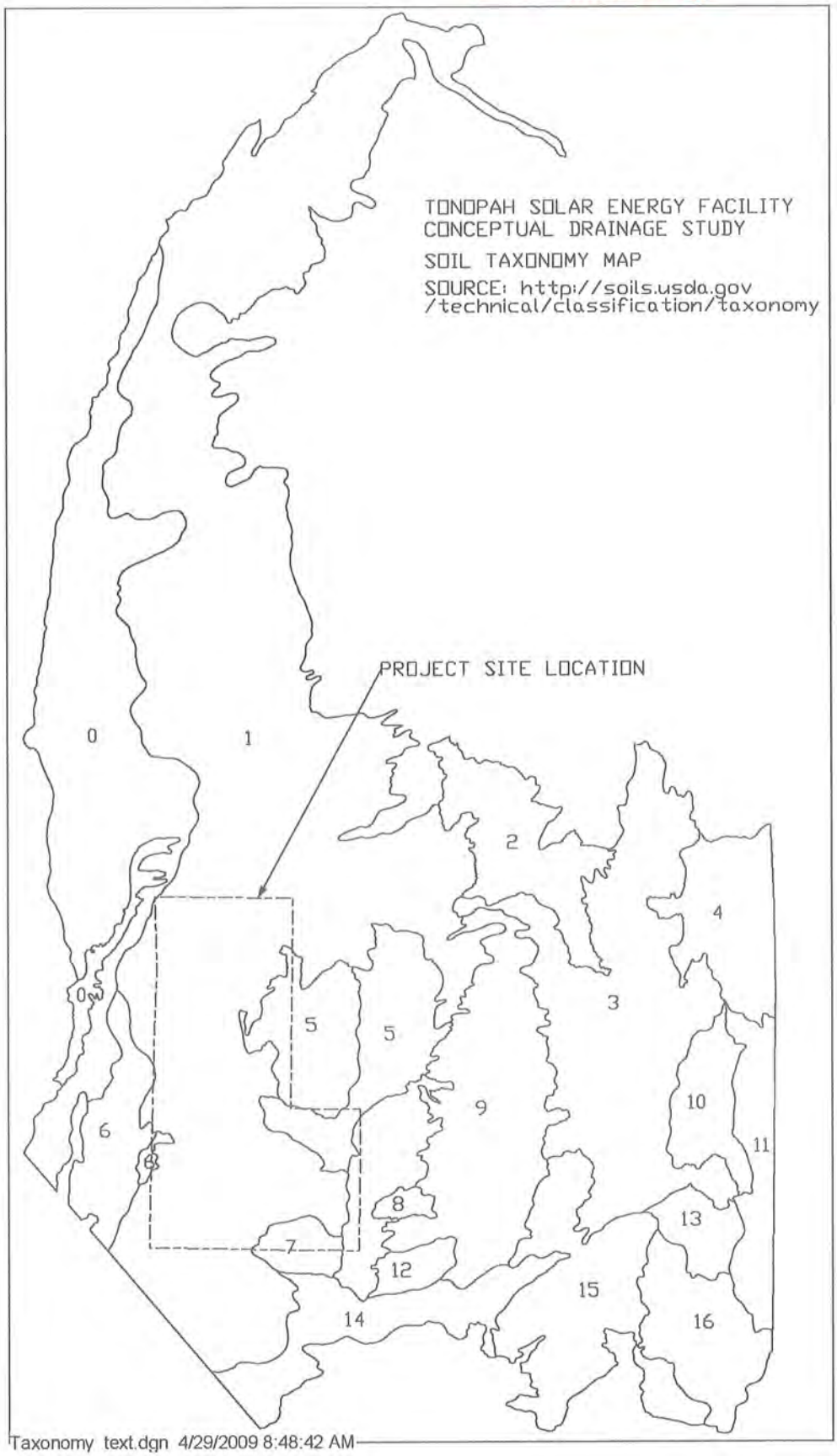

Taxonomy text.dgn 4/29/2009 8:48:42 AM

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Tonopah Solar Energy Facility
Conceptual Drainage Study

Soil Taxonomy List
Source:
http://soils.usda.gov/technical/classification/taxonomy/

ID. NAME,CLASS

0. LOAMY, MIXED, MESIC, SHALLOW ENTIC DURORTHIDS

1. MIXED, MESIC TYPIC TORRIPSAMMENTS

2. LOAMY –SKELETAL, MIXED, MESIC LITHIC XEROLLIC HAPLARGIDS

3. LOAMY-SKELETAL, MIXED, MESIC LITHIC XEROLLIC HAPLARGIDS

4. LOAMY-SKELETAL, MIXED, FRIGID, SHALLOW XEROLLIC DURARGIDS

5. MIXED, MESIC TYPIC TORRIPSAMMENTS

6. LOAMY, MIXED, MESIC, SHALLOW ENTIC DURORTHIDS

7. COARSE-LOAMY, MIXED, MESIC DURIC CAMBORTHIDS

8. LOAMY, MIXED, MESIC, SHALLOW ENTIC DURORTHIDS

9. LOAMY, MIXED, MESIC, SHALLOW TYPIC DURORTHIDS

10. LOAMY-SKELETAL, MIXED, MESIC LITHIC XEROLLIC HAPLARGIDS

11. LOAMY-SKELETAL, MIXED, FRIGID, SHALLOW XEROLLIC DURARGIDS

12. LOAMY, MIXED, MESIC, SHALLOW ENTIC DURORTHIDS

13. LOAMY-SKELETAL, CARBONATIC, MESIC LITHIC XERIC TORRIORTHENTS

14. COARSE-LOAMY, MIXED, MESIC TYPIC CAMBORTHIDS

15. LOAMY-SKELETAL, MIXED, MESIC TYPIC CAMBORTHIDS

16. LOAMY-SKELETAL, MIXED, MESIC LITHIC XEROLLIC HAPLARGIDS

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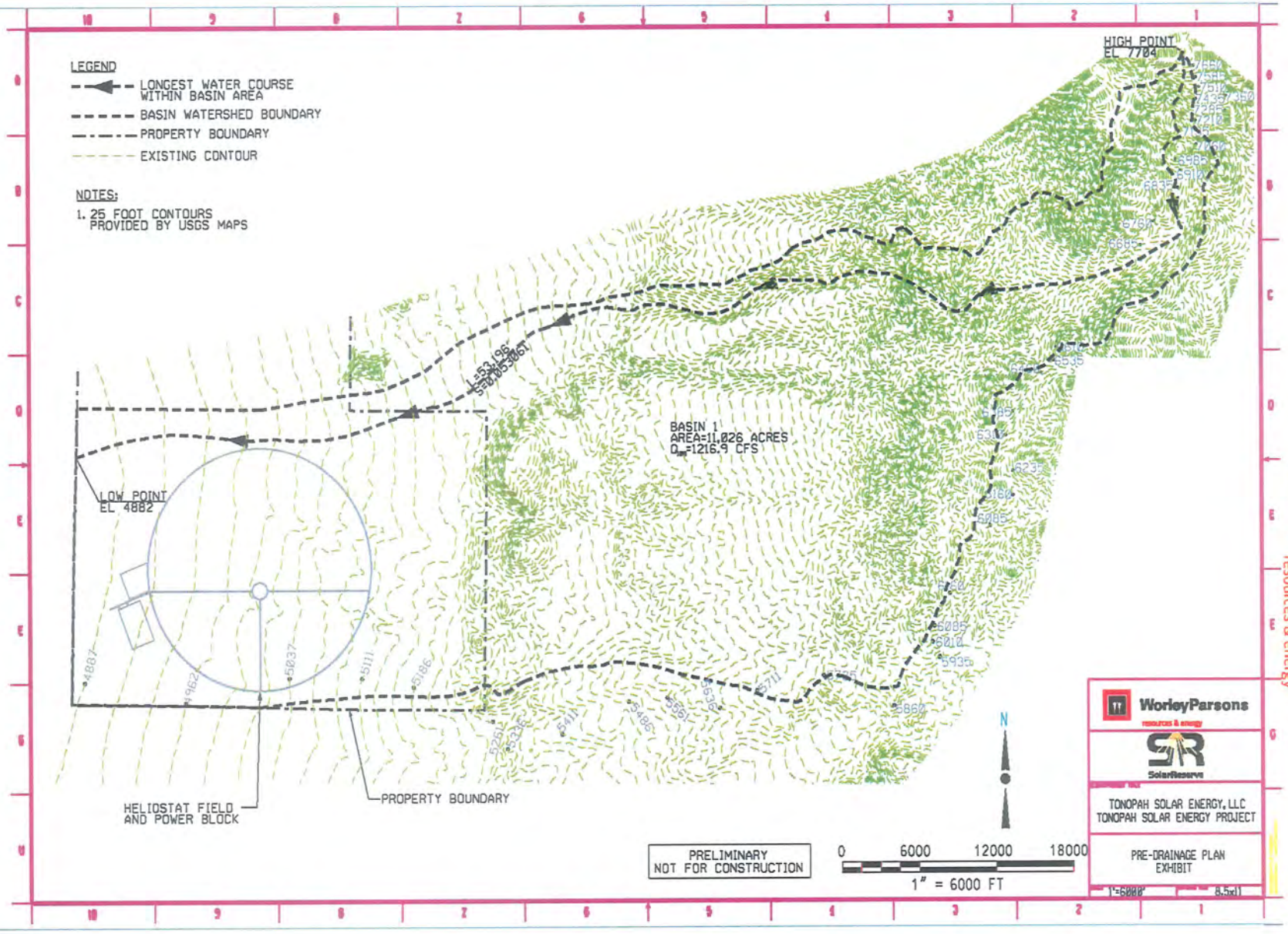
APPENDIX D – PRE-DEVELOPED CONDITIONS



Pre Drainage 8.5x11.dgn 5/7/2009 1:57:44 PM

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APPENDIX E – POST-DEVELOPED CONDITIONS

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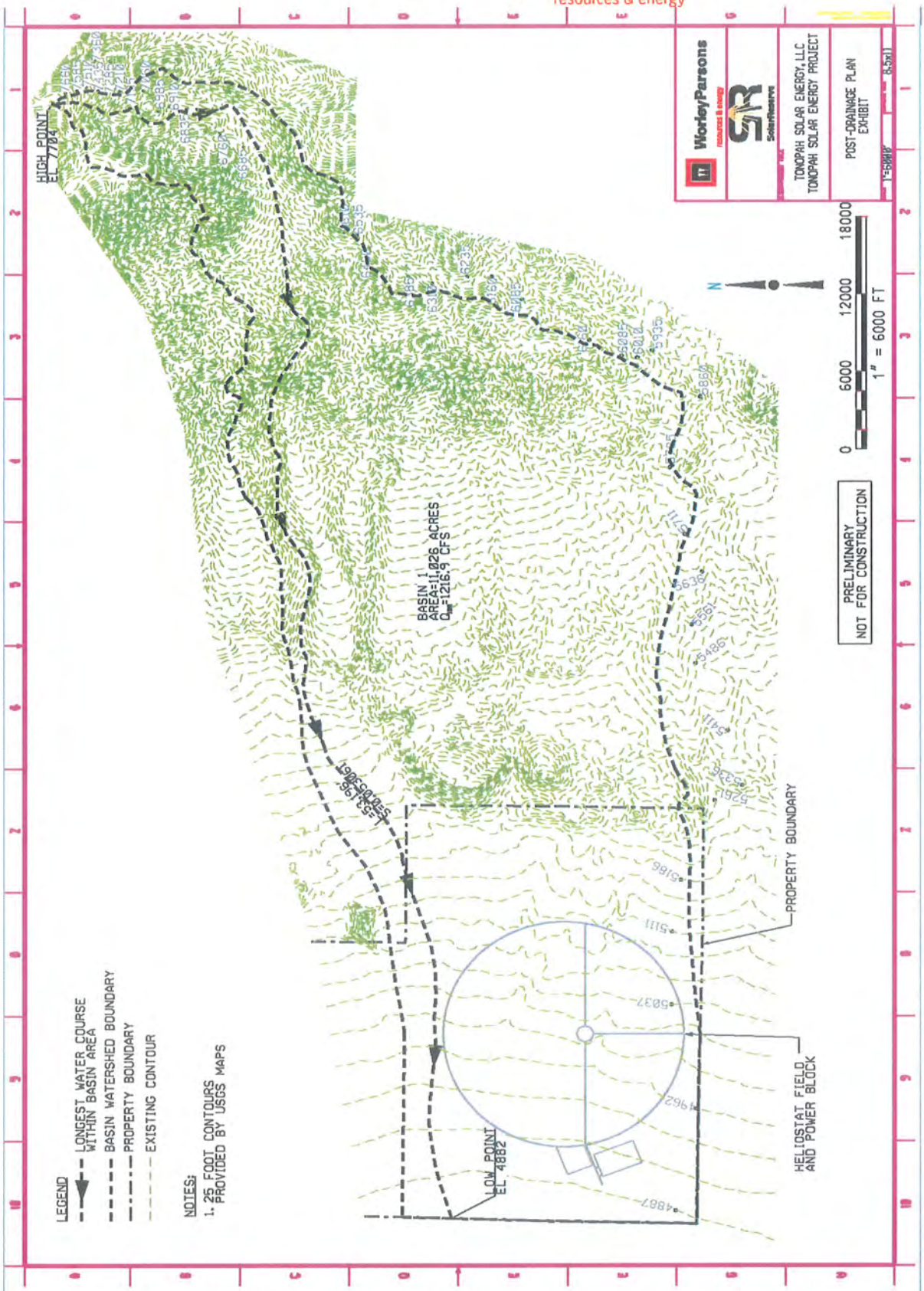

Post Drainage 8.5x11.dgn 5/7/2009 1:55:59 PM

APPENDIX D
GC WALLACE REPORT WITH COMMENTS

Tonopah Solar Energy, LLC - Crescent Dunes Solar Energy Project
(N-86292)
Plan of Development Review

Table 1. Schematic Design Review Comments

Page	Section/Table Figure	Comments	WorleyParsons Response
9	Purpose and Need	Discuss need for project in terms of total power demand, renewable demand (based on Nevada's laws).	This is now updated in section 2, Purpose and Need
12	Project Location, 1c3	The project build-out encumbers significantly less acreage than the Right of Way (ROW) to minimize encumbered property.	This is now updated in Section 4.1 and on updated maps and figures
		The project will also require an additional power line to deliver power to the Anaconda Substation. Include a legal description for this transmission line and a map clearly showing its location in the POD. Revise the Right of Way application accordingly.	This is now updated in Section 4.1 and on updated maps and figures
		If the offsite borrow pits are needed, BLM may require the pits to be included as part of this project. If so, the ROW application should include legal descriptions, or information regarding BLM ROW grants for the existing borrow pits.	This is now updated in Section 4.1 and on updated maps and figures
		Are the communication lines already in the area or would new fiber optic lines be needed? If new lines are needed, legal descriptions need to be included in the ROW application.	Communication lines are now addressed in 4.3.9
		Provide legal descriptions for the temporary and permanent facilities associated with this project.	These are now discussed in 4.1, and Figure 22 is now included to identify the disturbed areas of the Site.
		The BLM may require all of the ROW requests with legal descriptions to be included in one application. For NEPA purposes, all actions associated with a project (transmission line, plant site, communication lines, borrow sites) must be analyzed together as one project. Segmentation is not allowed under NEPA.	This statement is understood by Tonopah Solar Energy, LLC, and the permitting approach will consider the entire project and all it's impacts and features
57	6.1 Conceptual Schedule 1a2	The schedule for the project, as outlined in Table 5 and 6 is vague regarding the Local, State, and Federal permitting process. We suggest providing an updated schedule to BLM and including projected permit process start date(s) and/or prioritization of the permit schedule.	A more detailed schedule is included in Section 6.1
26	4.5.1 Access 2c	State SR89 is required for project access. A portion of SR 89 is in Esmeralda County. Is Nye submitting ROW for SR89 in Esmeralda? Is Nye maintaining the Esmeralda section?	This is now updated in Section 4.5.1
		Discuss traffic impacts, if any, to US 95 during construction and operation.	This is now updated in Section 4.5.1
		Discuss how the components will be shipped to the site.	This is now updated in Section 4.5.1
		Clarify - the proposed minimum road width for the perimeter road is 24 feet; however, Figure 10 shows the road as 20 feet wide with 2-foot shoulders on either side.	This is now updated in Section 4.5.1

Page	Section/Table Figure	Comments	WorleyParsons Response
10	3. Applicant Financial Capabilities 1e	Expand on the status of the financing for this project. What is the anticipated schedule for obtaining additional financing?	Additional information is now included in 3.0
		Expand on how the project will be financed.	Additional information is now included in 3.0
		Does estimate include transmission lines costs?	Refer to Section 3.0
38	4.7 Site Investigations and Data Needs 1c8	Discuss what, if any, known geotechnical issues the site has. Include what the proposed geotechnical studies scope of work will be and a timeline for when this detailed investigation will be conducted. The scope should include geologic hazards, seismic considerations, subsurface soil conditions, groundwater levels, suitable foundation type, allowable bearing pressures and estimated settlements, slope stability and/or retaining walls, corrosive soil conditions, anticipated excavatability of on-site soils, suitability of on-site material for structural fill material, and asphaltic pavement sections.	This is updated in Section 9.1.6.3
		The POD implies that the site is located in a seismically active area. Provide additional information in the text discussing these items and/or on the exhibits depicting the hazards.	This is updated in Section 9.1.6.3
41	4.8 Temporary Construction Facilities 1c7	Discuss how the temporary septic system and other temporary facilities will be abandoned and/or reclaimed.	Refer to updated Section 6.14
		Provide an exhibit depicting the anticipated temporary workspace location and temporary trailer park.	See 4.5.3, See also Figure 9, which is now explained further in 4.5.3
		For purposes of EIS, a decision will need to be made regarding an onsite concrete batch vs. commercial source delivery. The potential impacts would be very different.	Section 4.8 discusses an on-site batch plant
58	6.1 Construction Process and Conceptual Schedule 5a	When delineating and marking the boundaries of the construction zone, include tortoise fencing, if required.	The biological studies did not indicate a need for this. This feature/addition will be determined as part of the EIS process and will be a condition for the project if needed.
72	9.1.1 Biological Resources 5a- 1c	The statement that "…no channels or drainages appear to be present on the Site…" contradicts the statement in Section 4.5.6 that two gentle drainage paths are visible near the east end of the facility.	We do not believe this is a conflict. Some clarifying language has been added to 9.1.1
		Provide updated information regarding biological surveys. If they were conducted in the Spring of 2009 they are likely complete. If so, update the list of plants and animals that are actually present on the site and in the vicinity.	Refer to updated Section 9.1.1
		In the discussion of project design and mitigation features, include tortoise fencing, if required.	Refer to updated Section 9.1.1
82	9.1.6.3 Geologic Hazards and Soils 1c8	The second bullet implies that this Site is located in a seismically active area, but there is no discussion of these hazards in the POD text or on the Figures.	See updated Section 9.1.6.3
	Schematic Design Figures 6b - 6c	Provide location and size of potential Detention Basins.	See updated Section 4.5.6
		Provide typical grading for Heliostat area.	This is updated in Section 6.5
		Provide an exhibit showing permanently disturbed areas and the temporarily disturbed areas. Describe these areas in the POD.	Please see Figure 22, which has been added

Page	Section/Table Figure	Comments	WorleyParsons Response
	Figures 6d.	Provide a figure or update a figure to depict Geologic hazards and storm waters (flood zones), if any.	Please see the additional information provided in 9.1.6.3. This will also be further evaluated in the EIS process.
		Provide typical grading for Heliostat area.	Refer to updated Section 6.5
		Provide a map that clearly shows the transmission line and location of the substation.	Please see the updated information in 4.4.1, and Figures 7 and 23
		Although Figure 3 is referenced in the section, it does not clearly show the existing & proposed transmission lines or the substation location.	Please see the updated information in 4.4.1, and Figures 7 and 23

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DS	Drainage Study	Drainage Study (DS). The POD and site plan exhibits do not present sufficient information to evaluate how the site will be protected in a 10 and 100-year storm events. We suggest including a statement that building finish floor elevations must be set above the 100-year water surface elevation per local criteria and the International Building Code. Also, the power block area appears to be depressed on the east side. Depict how the power block is planned to be protected in a storm event.	See section 4.5.6 and revised figure 12
		Include a Note that the use of detention basins may require approval from the state Engineer's Office if the embankments are greater than 20 feet in height or impound over 20 acre-feet of water.	This is updated in Section 4.5.6
		For the detailed Design submittal, performance of a detailed technical drainage study (TDS) will be required to address the management of existing, interim, and ultimate storm water event runoff. This study will require approval by Nye County's Tonopah Public Works Office.	This is understood and will be undertaken during detailed design
		United States Army Corps of Engineers (USACE) Section 404 Screening and Permitting, Significant Nexus Analysis, Phase I Hazardous Materials Analysis, etc. may be required.	This is understood. Note that 9.1.1 was updated to include the status of the ACOE "Jurisdictional Determination Request"
		Clarify the two statements: The statement that "no channels or drainages appear to be present on the Site…" contradicts the statement in Section 4.5.6 that two gentle drainage paths are visible near the east end of the facility.	We do not believe this is a conflict. Some clarifying language has been added to 9.1.1

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36	54
3	96
6.3	0
16.3	26.5
61.6	176.5