7-9-96 *cu*

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 100 K East Area Water Purification Pools Fish-Rearing Program

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Document Title: Feasibility Study 100K East Area Water Purification
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Release Date: 7/3/96

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WHC Information Release Administration Specialist:

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7/3/96

Feasibility Study

100 K East Area Water Purification Pools Fish-Rearing Program

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

**Westinghouse
Hanford Company** Richland, Washington

Management and Operations Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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Feasibility Study

100 K East Area Water Purification Pools Fish-Rearing Program

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Date Published
July 1996

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Feasibility Study

100 K East Area Water Purification Pools Fish-Rearing Program

Design Study of Sand Filters and Related Structures

I. Introduction

As part of the feasibility study, a design analysis was conducted to determine the usefulness of the existing sand filters and associated media for reuse. The sand filters which were studied for potential reuse are located on the northern end of the 100-K East Area water filtration plant on the Hanford Site. This plant is located about one-half mile from the Columbia River. The sand filters were originally part of a system which was used to provide cooling water to the nearby plutonium production K Reactors. This Cold War operation took place until 1971, at which time the K Reactors were closed for eventual decontamination and decommissioning.

Recently, it was decided to study the concept of putting the sand filter structures back into use for fish-rearing purposes. Because the water that circulated through the water purification pools (K Pools) and associated sand filters was clean river water, there is little chance of the structures being radioactively contaminated. To date, separate K Pools have been used for raising a variety of cold water fish species, including white sturgeon and fall chinook salmon, as well as for providing potable water to the 100 K Area of the Hanford Site for fire and service water purposes.

II. Proposal

A conceptual project consists of placing eight 8-ft diameter tanks and two 20-ft diameter tanks on the floor of an empty K Pool. The smaller tanks will be used to rear various warm-water fish, such as channel catfish, walleye, large mouth bass, small mouth bass, crappie, and blue gill. The tank volume for each of these tanks is 100 cubic feet. The larger tanks will rear white sturgeon. The tank volume for each of these tanks is 1250 cubic feet. Because all fish species to be used for this project are warm-water species, the water will need to be maintained between 60 and 80 degrees Fahrenheit year round.

The water flow pattern for this project is envisioned as follows (See Figure 1): River water is initially pumped up two 5-ft diameter pipes from the Columbia River. This water travels through the center of the KE filtration plant until it reaches the south end, where each of the pipes branch into three smaller ones. The smaller pipes carry the water to one of six K Pools via a distribution flume. As water fills a K Pool, it overflows the weir wall at the north end of the pool and flows into the K Pool discharge flume. By valve control, water is either directed into the effluent outfall or the nearest gullet (a holding tank). As the gullet fills, the water flows into troughs and onto the sand filter.

The concept being investigated is to use a sand filter as a header pool, where water will be heated before being circulated to the fish-rearing tanks located on the floor of an adjacent empty K Pool. After the water flows to the rearing tanks by the force of gravity, it will then be pumped back to the sand filter volume for treatment and then reheated.

III. Existing Structures and Possible Modifications

The structures in question consist of the K Pools, the sand filters, the flumes connecting the two, and the gulleys. Each K Pool is constructed of unlined concrete, and is 351 ft. long and 127 ft. wide. A K Pool can hold about 6.5 million gallons of water. The K Pool used to fill the sand-filter header volume should have the seams caulked before filling, and accumulated dirt and debris will need to be cleared. The flume from a K Pool to a sand filter, which runs in a west-to-east direction, is 4 ft. 4 inches high and 3 ft. 9 inches wide. This flume opens by valve action into another flume below it, which empties into the gulleys. The latter flume is called the filter distribution flume and is 5 ft. high and 6 ft. 6 inches wide. The gullet is located between sand filters and has the function of settling the water before it flows onto the sand filter material. This prevents the filter layers from being disrupted. The gullet measures 49 ft long, 11 ft. wide, and 14 ft. 8 inches deep, with a water volume of approximately 7977 cubic feet. A sand filter measures 50 ft. long, 25 ft. wide, and 8 ft. 7 inches deep, with a water volume of approximately 10,875 cubic feet. The total sand-filter header volume is thus 18,853 cubic feet or about 141,000 gal.

All of the valves in these structures are believed to be in working condition, but may need maintenance before they can be reused. Some modifications within the sand filter may be needed for this project. Because the sand filter was not originally designed as a water-holding volume, some valves may need to be added to prevent flow into the clearwell, a storage system that holds water for use at the 100-K Area that cannot be contaminated with fish water. The backwash pipe located near the bottom of the sand filter provides access to the clearwell for the filtration plant. Therefore, a blind flange can be inserted into the backwash pipe to ensure that contamination of the clearwell does not take place.

Other modifications that may be needed to carry out the conceptual project are the addition of pumps and piping to create a closed circulation pathway to the fish-rearing tanks and back. The water will flow from the sand filter volume to the individual fish-rearing tanks by gravity flow. Recommended piping will likely consist of 3 to 4 inch diameter PVC pipe. The water will then be circulated through the tanks and pumped back to the filter volume for reheating and cleaning. The recommended pump for this step will likely be a 12 psi 5 horsepower centrifugal pump. This pump will circulate 600 gallons/minute, which will be more than enough for required purposes.

The only potential challenge for this concept is the possible need to backwash the sand filter medium. Although there are no current plans for this procedure, it should be recognized that backwashing the filter may require extensive modifications to the system. The original backwash lines have been capped and the pumps removed, so it will be impossible to complete the procedure as the system currently exists. Another issue regarding this potential challenge of backwashing may be disposal of the backwash discharge

water. Regulations prohibit discharging backwash into the Columbia River, so additional piping and pumps will have to be constructed to route the water to a settling basin. Such modifications could be extremely costly. Therefore, alternative cleanup methods may have to be explored.

IV. Design Study Conclusions

This concept has the potential of being a highly successful one. Most of the existing structures needed for its implementation are in good working condition. With a well designed waste water treatment system, backwashing should not become a problem. Putting the proposed fish-rearing concept into use could be highly beneficial to the area's economy. In addition, it would also provide a purpose for these currently non-useful structures. Due to the success of previous fish-rearing projects similar in complexity to this one and the need for few major modifications, it can be concluded that the concept may be possible to implement with relative ease and should work well.

Baseline Energy Usage Required

Since this project is in design, there was no baseline information available in which to compare alternatives against. Therefore, liquid propane was used as the baseline which is the standard method used on the Hanford site. The baseline information included heating approximately 140,000 gallons of water in a header pool and maintaining the temperature between 60-80 degrees Fahrenheit for optimal fish growth. It was estimated that approximately 450,000 BTU's/hour would be required.

Area = LW

L = length

W = width

Volume = $7.5 \text{ gal/ft}^3 \times \text{Area} \times \text{Average Depth}$

1. Pool water capacity is 140,000 gallons
2. Desired heat pickup time 168 hours (1 week)
3. Desired pool temperature is 70 degrees F
4. Average pool water temperature of the coldest month is 37.2 degrees F
5. The sand filter is 1,250 ft²
6. Average yearly ambient temperature is 53.1 degrees F

$$q_1 = 8.33V(t_f - t_i)/-0-$$

where

q_1 = pool heat-up rate, Btu/h

8.33 = density of water, lb/gal

V = pool volume, gal

t_f = desired temperature

t_i = initial temperature of pool, degrees F

-0- = pool heat-up time, hours

$$\begin{aligned}
 q_1 &= (8.33)(140,000 \text{ gallons})(70 \text{ degrees F} - 37.2 \text{ degrees F})/168 \\
 &= (1,166,200)(32.8)/168 \\
 &= 227,686 \text{ Btu/h}
 \end{aligned}$$

$$\begin{aligned}
 q_2 &= 10.5A(t_p - t_a) \\
 q_2 &= (10.5)(1,250 \text{ ft}^2) (70 \text{ degrees F} - 53.1 \text{ degrees F}) \\
 &= (13,125)(16.9) \\
 &= 221,812 \text{ Btu/h}
 \end{aligned}$$

where

q_2 = heat loss from pool surface, Btu
 10.5 = surface heat transfer coefficient, Btu/h x ft² x degrees F
 A = pool surface area, ft²
 t_p = pool temperature, degrees F
 t_a = ambient temperature, degrees F

$$\begin{aligned}
 q_t &= q_1 + q_2 \\
 q_t &= 227,686 + 221,812 \\
 &= 449,498 \text{ Btu/h}
 \end{aligned}$$

Note: These heat losses assume a wind velocity of 3 to 5 mph.

Since the last equation ($q_t = q_1 + q_2$) applies to the coldest monthly temperatures, the calculated results may not be economical. Therefore, a value of 1/2 the surface loss plus the heat-up value yields a more viable heater output figure. The heater input then equals the output divided by the efficiency of the fuel source.

Study Method

Two analytical methods common to the Hanford site were utilized for identifying the most energy efficient opportunity available. The two methods used were the Pollution Prevention Opportunity Assessment (PPOA) model and the Building Life Cycle Cost (BLCC) program.

The PPOA model is an approved U.S. Department of Energy method for identifying inputs and outputs of a particular activity and determine opportunities for waste minimization and energy savings. The Assessment consists of five worksheets for analyzing various opportunities through a cost benefit analysis.

The information generated through the P20A process was used to input into the Building Life Cycle Cost computer program. The report generated a list of each opportunity indicating the opportunity with the lowest payback. Both models concluded with the same recommendation for implementation--reuse the

solar water heater from the 2750 roof.

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 1
TEAM AND ACTIVITY DESCRIPTION

Date 04/23/96

P2OA ID Code Energy-1

Facility K Basin Pools

Activity Water Heating Methods for Raising Warm Water Fish Species

Team Members (*Leader)

Telephone

MSIN

Mary Betsch

372-1627

B3-28

Dan Herborn

373-0087

H6-06

Steve Dunnivant

373-3279

G3-04

Bruce Anderson

373-0087

H6-06

Rick Huckfeldt

372-3212

R3-01

Michelle DiPiazza

372-0314

B3-28

Description of Activity to be Examined in this P2OA

Existing sand filters adjacent to the KE-Pools will be used as a self-insulated warm-water reservoir to rear fish species for a commercial market project. A conceptual project consists of placing eight 8-foot diameter (100 cubic ft) tanks and two 20-foot (1250 cubic ft) tanks on the floor of an existing, empty KE-Pool. The water must be maintained between 60 - 70 degrees fahrenheit for optimal fish growth.

The sand filter will be utilized as the header pool where water will be heated before being circulated to the fish-rearing tanks located on the floor of the KE-Pool. After the water flows to the rearing tanks via the force of gravity through 5-6 inch diameter insulated PVC pipe, it will be pumped back to the sand filter to be treated and reheated. The water will flow at 320 gallons per minute between the tanks.

The dimensions of the sand filter are 50 ft long, 25 ft wide, and 8 ft deep. Calculations will be based on a 20 year history of Columbia River water temperature and will be adjusted with approximately 20% more heat available to the system than is necessary to provide for possible loss.

The assessment process is to determine the most energy efficient method to heat approximately 140,000 gallons of water in the header pool to the required temperature range.

WORKSHEET 2

ACTIVITY FLOW DIAGRAM

Facility K Basin Pools

Activity Water Heating Methods for Raising Warm Water Fish Species

[illegible]

Material Inputs	
Name	Quantity
Blue Gill-2,000 ea	12 kg
Channel Catfish-2,000 ea	12 kg
Crappie-2,000 ea	12 kg
Large Mouth Bass-2,000 ea	12 kg
Small Mouth Bass-2,000 ea	12 kg
Sturgeon-389 ea	2,646.70 kg
Walleye-2,000 ea	12 kg
Raw Water-Cold	529.96 m ³

Energy Inputs	
Name	Quantity
Pump-5 hp	105.74 KJ

Activity
Activity Time Period: 1 Year

Outputs include:
Solid (s)
Liquid (l)
Air (a)

Product or Result Output	
Name	Quantity
Blue Gill-2,000/year	180 kg
Channel Catfish-2,000 ea	180 kg
Crappie-2,000 ea	180 kg
Large Mouth Bass-2,000 ea	180 kg
Small Mouth Bass 2,000 ea	180 kg
Sturgeon-389 ea	5,293.40 kg
Walleye-2,000 ea	180 kg
Raw Water-Warm	529.96 m ³

[illegible][illegible]

Radioactive Waste Output	
Name	Quantity

[illegible]

Other	
Name	Quantity
Algae	N/A
Ammonia	N/A
Nitrogen	189 kg
Pathogens	N/A
Phosphorus	31.50 kg
Solid Fish Feces	N/A

Total Input mass $\approx$ Total Output mass kg In $\approx$ kg Out

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3
POLLUTION PREVENTION OPPORTUNITY DESCRIPTION

Date 04/24/96

P2OA ID Code Energy-1

Facility K Basin Pools

Activity Water Heating Methods for Raising Warm Water Fish Species

P2O No. 1

P2O Title Cube Tumbleweeds and Noxious Weeds as Feed to a Small Biomass Boiler

Current Practice

Because this project is in design, there is no current practice. Therefore, Liquid Propane (LP) will be used as the current practice (baseline) to heat approximately 140,000 gallons of water in the header pool and maintain the temperature between 60-70 degrees Fahrenheit for optimal fish growth. It is estimated that approximately 449,498 BTU's/hour will be required.

Recommended Action

Shred and cube tumbleweeds, nuisance weeds (Tumble Mustard) and noxious weeds (Yellow Starthistle, Russian Knapweed). The cubes will be used as feed to a small biomass boiler which will in turn heat water to maintain the required temperature.

Noxious weeds include plant species specified at the Federal, State, or County level as noxious. Yellow Starthistle and Russian Knapweed are legal noxious weeds whereas Tumble Mustard and Tumbleweeds are simply nuisance weeds.

Tumbleweed Collection Process (Scott Angerman, ICF KH)

In an effort to keep tumbleweeds from blowing into radioactive zones, Hanford has established an aggressive tumbleweed pick up program for non-radioactive tumbleweeds. Tumbleweeds are collected from various locations onsite using a pitch fork and a garbage truck. The tumbleweeds are dumped into inert pits and left for decomposition. Additionally, tumbleweeds which accumulate along fence lines and barriers are routinely mulched and left in place using a tumbleweed mulching machine.

Shredding/Grinding Process (Colton Equipment, Inc. and Johnnie Young, ICF KH)

There are two possible alternatives to consider with regard to shredding the tumbleweed and noxious weeds prior to cubing. One scenario would be to bring the material to a central location and process through a stationary shredder. The other would be to use a mobile unit and shred the weeds in the field. The stationary system would include an in feed conveyor, shredder, discharge conveyor and controls. The mobile system would be comprised of a trailer mounted shredder equipment with diesel power and a discharge conveyor. Both of these types of shredders can usually be purchased in good used condition for a significant savings.

Additionally, there are two grinders available onsite which can be utilized 2-3 times per year. The grinders are available through ICF Kaiser, Johnnie Young. Utilizing the grinders available onsite is recommended.

Cubing System (Warren and Baerg Manufacturing, Inc.)

The fuel cubes produced have characteristics similar to those of coal or hog fuel and

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

can be used in most industrial boilers. Utilizing these materials not only reduces the volume of waste going to the landfills, it creates an on-going source of energy.

The fuel cubes can be 1-1/4" square, 1" square, or 1" round. They break off in lengths of 1" to 3". Feed stock (noxious weeds and tumbleweeds) need only be shredded to 1-1/2" - 2", reducing the horsepower demand for shredding equipment.

Warren and Baerg Manufacturing has successfully cubed agriculture waste such as Wheat Straw, Rice Straw, Oat Straw, Flax, Water Hyacinths, and Sudan Grass which have a moisture content between 8% and 18%, a bulk density between 25 and 34 pounds per cubic foot, and produce 4.5 to 12 tons per hour.

The cuber (Model 250 and Model 250W) has a 200 hp motor and can operate at 6 to 8 tons per hour. The cuber has 66 individual die blocks and one 22" diameter adjustable press wheel. There is no cutting device. Rather, a cub breaker continuously sizes the cubes and the length of the cube can be adjusted with the setting of the cube breaker. Materials enter the die chamber and are forced through the die at 7,500 to 10,000 PSI, the dwell time is 6 to 8 seconds.

The Basic 200 Cubing System manufactured by Warren and Baerg Manufacturing, Inc. includes a Metering Bin, Model 200 Cuber, and Conveying System all designed to the following specifications:

-Open Metering Bin

6' wide x 32' long

Two rake in doffer, each with 5 hp motor

.5 hp floor drive

Fines return auger

-Infeed Auger

16" Auger

10 hp electric motor and gear reducer

Auger flights are 1/4" thick

-Magnet and Transition Chute

At infeed auger to mixer auger

Industrial plate magnet

-Standard Mixer

22" x 12'

5 hp shaft mount reduction gearhead drive

Six 110 v solenoid on/off valves

-Model 200 Cuber

18" plate magnet in infeed chute

Heavy duty right hand end cap

Frame and trolley for die ring removal

One set of dies

Rexnord gearbox - Saturn

200 hp electric motor - TEPC, 1800 rpm, 460 v, 3 phase, 60 Hz

-Takeaway Conveyor

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

15" wide x 30' long
Electric motor and gear reducer

-Cyclone, Blower and Ducting

Two collection points (cuber and metering bin fines auger)
Includes ducting, fittings, hangers and hoses

It is important to note that most materials will not store as well over 12% moisture content.

Boiler (Wellons)

The steam generating system consists of a Wellons' 10,000 PPH combination firetube/watertube steam boiler, model WF1C4.5, operating at 30 psig and saturated temperature. Steam from the boiler system is piped to a heat exchanger where energy is transferred to the water stream of the main process. The equipment includes:

- Metering surge bin
- One Wellons' cell
- I.D. & F.D. Fans
- Ash handling system
- Boiler pressure parts and casing
- Feedwater storage tank and pumps
- Boiler plant piping, valves, and associated equipment
- Computerized control system
- Process piping to and from the heat exchanger (100 linear ft.)
- Cell feed screw
- Insulation and refractory
- Multiple cone collector
- Air and gas ducting
- Boiler trim
- Decks and catwalks
- Motor control center
- Steam to process heat exchanger

The cyclo-blast furnace cell has water-cooled grates and alumina plastic refractory cell lining. The combustion air is provided by a forced draft fan. An induced draft fan pulls exhaust gases through the boiler section and multiple cone collector and exhausts into an uptake stack.

The feedwater system includes two motor driven feedwater pumps, one gratewater pump, water level controls, feedwater storage tank, and associated piping.

A multiple cone collector is provided in the boiler exhaust system for removal of particulate from exhaust gases. The multiple cone discharges automatically via a rotary air lock valve to the receiver. Ash deposits in the fuel cell and the boiler dropout are removed manually.

Potential exists to use a bottom feed boiler which would accept shredded feed stock from 1" - 3" in size. The bottom feed boiler is the same cost as the top feed model explained above.

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

Heat Exchanger (Brad Thompson at The Brad Thompson Company)

The VICARB heat exchanger consists of a plate pack of a calculated number of embossed plates with perimeter gaskets clamped securely between two thick carbon steel plates by means of tie rods. The plates have openings at corners to direct process and service fluid flows through the passageways between plates. Fluids flow alternately between every other plate in order to achieve correct heat transfer almost always in true counter current condition.

Calculation of Waste Reduction and/or Energy Savings

Annual quantity of LP required = 5,256 gallons

The quantity of LP necessary to maintain the temperature required is approximately .6 gallons/hour running at 90% efficiency.

.6 gallons/hour x 24 hours/day x 365 days/year = 5,256 gallons/year

Annual quantity of tumbleweeds/noxious weeds necessary to heat water to desired temperature = 1,680 tons

Total Annual = 7 tons/hr x 240 hrs = 1,680 tons or 3,360,000 pounds.

TOTAL WASTE REDUCTION

5,256 gallons LP and 1,680 tons tumbleweeds/noxious weeds

Calculation of Annual Cost Savings

Costs:

Annual electricity cost to run boiler = \$319.46

The cost of electricity in the Tri-Cities is currently \$.03/Kwh. 10,000 PPH, operating at 30 psig and saturated temperature.

85 HP x 70% = 59.5 HP x .7457 Kw/hp = 44 Kwh x \$.03/Kwh x 240 hours = \$319.46

Annual electricity cost to run existing grinder onsite = \$62.42

The cost of electricity in the Tri-Cities is currently \$.03/Kwh. The grinder runs on 220 amp.

(.5HP + 10HP + 5HP) x 75% = 11.6HP x .7457 Kw/hp = 8.67 Kwh x \$.03 x 240 hours = \$62.42.

Annual electricity cost to run cuber = \$805.35

The cost of electricity in the Tri-Cities is currently \$.03/Kwh. The average load under normal operating conditions is 75% of the total 200 hp on the cuber. Costs are based on an operational throughput of 7 tons per hour.

200 hp x 75% = 150 hp x .7457 Kw = 112 Kwh x \$.03/Kwh x 240 = \$805.35

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

Annual labor cost to feed weeds through cuber = \$36,000

Based upon information provided by Warren and Baerg, at 85% efficiency, 7 tons of cubes are produced per hour.

2 operators x \$75 per hour = \$150/hour
\$150/hour x 6 hours/day = \$900/day
\$900/day x 5 days/week = \$4,500/week
\$4,500/week x 8 weeks/year = \$36,000/year

Benefits:

Annual tumbleweed disposal cost = \$0

The disposal costs are zero as the tumbleweeds are dumped in inert pits and left for decomposition. Tumbleweeds are no longer burned in the burn pits and therefore there is no air permit required.

Annual labor cost for collection of tumbleweeds = \$0

The annual labor cost is zero, the tumbleweeds are collected regardless of final disposition or use.

Annual noxious weed control spray cost = \$25,000

For fiscal year 1996, the "Noxious Weed" budget for Hanford is \$50,000 to control noxious weeds onsite which is considered a minimal maintenance program. It is estimated that 50% is for controlling Yellow Starthistle and Russian Knapp Weed.

50% divided by \$50,000 = \$25,000 annually

Annual Cost of a Liquid Propane (LP) = \$3,464

Natural gas is not available to the N Area where the K Basin pools are located. LP gas from AmeriGas is currently \$.659/gal.

An LP gas heater, running at approximately 90% efficiency, will consume about .6 gallons/hour of LP to produce 449,498 BTU's/hour.

\$.659/gal x .6 gallons/hour x 24 hours/day x 365 days/year = \$3,464/year

Cost of a LP Gas Tank and Heater = \$4,000 Amortized Annual Cost = \$880

AmeriGas LP tanks range from 5 gallon - 1,000 gallon tanks. The 124 gallon tank is \$450, the 500 gallon tank is \$950, and the 1,000 gallon tank is \$1,600. The 500 gallon tank is recommended. The cost of an LP gas heater is approximately \$3,000. Installation is an additional \$50.

Based upon a 20 year life cycle, the annual amortized cost including maintenance and repairs, for the LP gas tank and heater is \$440. An additional \$2,200 is expected every five years to replace the burner which is an additional \$440/year (\$2,200 divided by 5 = \$440).

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

TOTAL ANNUAL COST SAVINGS

$\$25,000 + \$3,464 + \$880 - \$319.46 - \$62.42 - \$805.35 - \$36,000 = \$-7,843$ (No Cost Savings)

Calculation of Implementation Cost and Payback

Capital equipment cost of small biomass boiler = \$436,500

Capital equipment cost of cuber = \$127,915

Capital equipment cost of shredder (using the existing grinder onsite) = \$0

Capital equipment cost of heat exchanger = \$13,500

TOTAL IMPLEMENTATION COST

$\$436,500 + \$127,915 + \$13,500 = \$577,915$

PAYBACK

No Payback--a Negative Cost Savings

* See Building Life Cycle Cost analysis, "Attachment A" for Minimum Life Cycle Cost.

Notes:

This action would be best done in the summer months when weeds are the driest and the pellets can be stored for year-round use.

Vendor/Contact Information:

Heat Exchanger:

BradThompson
The Brad Thompson Company
3410 Carillon Point
Kirkland, WA 98033
Phone: (206) 828-3707 X306
Fax: (206) 827-2323

Cubing System:

John Scott
Colton Equipment, Inc.
7746 SW 141st Ave.
Beaverton, OR 97008-6151
Phone and Fax: (503) 641-5211

Shredder:

John Scott
Colton Equipment, Inc.

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

7746 SW 141st Ave.
Beaverton, OR 97008-6151
Phone and Fax: (503) 641-5211

Boiler:

Randy Paterson
Wellons
14440 SW Tualatin-Sherwood Road
P.O. Box 1030
Sherwood, OR 97140-1030
Phone: (503) 625-6131
Fax: (503) 625-5366

Hanford Noxious Weed Program:

Richard Roos
Westinghouse
(509) 373-7480

Hanford Grinder:

Johnnie Young
ICF Kaiser
(509) 373-6272

Hanford Tumbleweed Collection:

Rusty Knight
ICF Kaiser
(509) 376-6654

Scott Angerman

ICF Kaiser
(509) 376-3377

Jerry Maiuri

ICF Kaiser
376-3763

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3
POLLUTION PREVENTION OPPORTUNITY DESCRIPTION

Date 04/24/96

P2OA ID Code Energy-1

Facility K Basin Pools

Activity Water Heating Methods for Raising Warm Water Fish Species

P2O No. 2

P2O Title Utilize the Excess Solar Water Heater on the 2750 Roof

Current Practice

Because this project is in design, there is no current practice. Therefore, Liquid Propane (LP) will be used as the current practice to heat approximately 140,000 gallons of water in the header pool and maintain the temperature between 60 - 70 degrees Fahrenheit for optimal fish growth. It is estimated that approximately 449,498 BTU's/hour will be required.

Recommended Action

Utilize the excess solar water heater from the 2750-E for heating water at the K-Pools. The system (the Sunset by Rheem Manufacturing Company) consists of two tanks each with an 82 gallon capacity. The system (4' x 8') was in place approximately 15 years. The working pressure is 150 psi, the test pressure is 300 psi, and the voltage is 120 volts.

The solar system on building 2750-E has not been maintained due to control system failure since its installation in 1980. Now, the solar system has been disconnected and dismantled. The condition of the solar energy receiver surfaces, heat transfer fluid tubing and reflection/conduction insulating material inside every one of the four collector assemblies is in excellent condition. The condition of the visible tubing is appears to be good. However, there is one area of tubing which will require replacement. Foam insulation is missing from a few feet of tubing and connection. The condition of all the foam insulation is poor due to lack of a white latex protective coating not previously applied to protect the insulation from ultraviolet radiation. The condition of the solar collector housings and mounting braces is also in excellent condition. The plastic film window (cover) is completely gone on all four collectors.

Currently, the heaters are at the Westinghouse Excess yard and the tanks remain in the 2750-E Building.

The upgrades recommended by Rheem Engineering are as follows:

Flush the solar fluid heat transfer reservoir and system. Flush every two years thereafter or when litmus test indicates that contents have passed from neutral to acidic.

If the Thrush solar fluid circulation pump has failed, replace it with a Grundfos pump. One or two in series depending on the static head required to refill the system after draindown.

The plastic film cover as applied originally is no longer recommended by Rheem. Rather, reglaze with Sunlite II paneling.

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

Calculation of Waste Reduction and/or Energy Savings

Annual quantity of Liquid Propane (LP) required = 5,256 gallons

The quantity of LP necessary to maintain the temperature required is approximately .6 gallons/hour running at 90% efficiency.

.6 gallons/hour x 24 hours/day x 365 days/year = 5,256 gallons/year

TOTAL WASTE REDUCTION

5,256 gallons LP gas

Calculation of Annual Cost Savings

Benefits:

Annual Cost of a Liquid Propane (LP) = \$3,464

Natural gas is not available to the N Area where the K Basin pools are located. LP gas from AmeriGas is currently \$.659/gal.

An LP gas heater, running at approximately 90% efficiency, will consume about .6 gallons/hour of LP to produce 449,498 BTU's/hour.

\$.659/gal x .6 gallons/hour x 24 hours/day x 365 days/year = \$3,464/year

Cost of a LP Gas Tank and Heater = \$4,000 Amortized Annual Cost = \$880

AmeriGas LP tanks range from 5 gallon - 1,000 gallon tanks. The 124 gallon tank is \$450, the 500 gallon tank is \$950, and the 1,000 gallon tank is \$1,600. The 500 gallon tank is recommended. The cost of an LP gas heater is approximately \$3,000. Installation is an additional \$50.

Based upon a 20 year life cycle, the annual amortized cost including maintenance and repairs, for the LP gas tank and heater is \$440. An additional \$2,200 is expected every five years to replace the burner. The cost of an LP gas heater is approximately \$3,000.

TOTAL ANNUAL COST SAVINGS

\$3,464 + \$880 = \$4,344

Calculation of Implementation Cost and Payback

Implementation Cost of Removing and Reinstalling Solar Water Heater = \$4,000

Removing and reinstalling the solar water heater is estimated to cost approximately \$4,000.

Upgrade Project Costs = \$1,205

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

One 50' x 48" x 0.040" Sunlight (HP) cover is \$445

One Grundfos pump is \$150

Two differential controllers are \$300

Four sensors are \$80

Insulation and latex paint is \$50

Eight tubes silicone type all-weather caulking is \$40

Four gallons anti-freeze with inhibitor and 10 gallons distilled water and flushing compound is \$140

The total upgrade project costs are $\$445 + \$150 + \$300 + \$80 + \$50 + \$40 + \$140 = \$1,205$

TOTAL IMPLEMENTATION COSTS

$\$4,000 + \$1,205 = \$5,205$

PAYBACK

$\$5,205$ divided by $\$4,344 = 1.2$ years

* See Building Life Cycle Cost analysis, "Attachment A" for minimum life cycle cost.

Vendor/Contact Information:

Solar tanks at 2750-E:

John Althaus
ICF Kaiser
(509) 373-4945

Heaters at Excess:

Jerry Brown
Westinghouse
(509) 376-0414

Sunlite II Paneling:

Pella Products, Inc.
P.O. Box 1088
Spokane, WA 99210
(509) 624-4281

Grundfos Pump:

W. W. Grainger, Inc.
3306 W. Marie St.
Pasco, WA 99301
(509) 545-5065

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3
POLLUTION PREVENTION OPPORTUNITY DESCRIPTION

Date 04/24/96

P2OA ID Code K Basin-1

Facility K Basin Pools

Activity Water Heating Methods for Raising Warm Water Fish Species

P2O No. 3

P2O Title Solar Water Heating Panels

Current Practice

Because this project is in design, there is no current practice. Therefore, Liquid Propane (LP) will be used as the current practice to heat approximately 140,000 gallons of water in the header pool and maintain the temperature between 60 - 70 degrees Fahrenheit for optimal fish growth. It is estimated that approximately 449,498 BTU's/hour will be required.

Recommended Action

Heliocol Solar Panels (Roger Eschenroeder, Heliocol Solar)

A Heliocol panel converts about 70% of the energy that falls on it to thermal energy for heating. For Eastern Washington, this represents an average daily energy delivery of about 856 BTU's per square foot of panel area. The Heliocol Solar Collector is a heat exchanger which can be used to collect thermal energy as well as to distribute thermal energy.

One Heliocol HC-50 collector (50 sq ft) will produce about 42,800 BTU's/day or about 15,622,000 BTU's/year. The HC-50 Collector data has the following characteristics:

Size 4' x 12'

Width 47"

Length 151.5"

Area (Sq. ft.) 48.7

Manifold Diameter 2"

Weight, Dry 22 lbs.

Volume Capacity 3.7 gal.

Max. Working Pressure 90 PSI

Burst Pressure 270 PSI

Recommended Flow 5 GPM

Heliocol collectors are manufactured using "over-molding" process whereby the headers and risers become one piece of plastic--there are no seams or welds. The "over-molded" construction provides 120 PSI operating pressure. This design virtually eliminates wind load and the collectors are certified to withstand 180 MPH winds. The individual tubes also enable the roof to "breathe" which prevents moisture from being trapped under the collector. Since each tube is able to expand and contract independently, cracks and leaks due to wear and tear of thermal expansion and contraction are eliminated. High head pressures are eliminated which protects the collector against clogging. Lower head pressure keeps pumping requirements to a minimum which helps maximize efficiency.

Heliocol collectors offer a twelve year warranty on panels and installation including freeze protection.

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

Calculation of Waste Reduction and/or Energy Savings

Annual quantity of Liquid Propane (LP) required = 5,256 gallons

The quantity of LP necessary to maintain the temperature required is approximately .6 gallons/hour running at 90% efficiency.

.6 gallons/hour x 24 hours/day x 365 days/year = 5,256 gallons/year

TOTAL ANNUAL WASTE REDUCTION

5,256 gallons LP gas

Calculation of Annual Cost Savings

Benefits:

Annual Cost of Liquid Propane (LP) = \$3,464

Natural gas is not available to the N Area where the K Basin pools are located. LP gas from AmeriGas is currently \$.659/gal.

An LP gas heater, running at approximately 90% efficiency, will consume about .6 gallons/hour of LP to produce 449,498 BTU's/hour.

\$.659/gal x .6 gallons/hour x 24 hours/day x 365 days/year = \$3,464/year

Cost of a LP Gas Tank and Heater = \$4,000 Amortized Annual Cost = \$880

AmeriGas LP tanks range from 5 gallon - 1,000 gallon tanks. The 124 gallon tank is \$450, the 500 gallon tank is \$950, and the 1,000 gallon tank is \$1,600. The 500 gallon tank is recommended. The cost of an LP gas heater is approximately \$3,000. Installation is an additional \$50.

Based upon a 20 year life cycle, the annual amortized cost including maintenance and repairs, for the LP gas tank and heater is \$440. An additional \$2,200 is expected every five years to replace the burner. The cost of an LP gas heater is approximately \$3,000.

Cost of a LP Gas Tank = \$950

AmeriGas LP tanks range from 5 gallon - 1,000 gallon tanks. The 124 gallon tank is \$450, the 500 gallon tank is \$950, and the 1,000 gallon tank is \$1,600. The 500 gallon tank is recommended.

TOTAL ANNUAL COST SAVINGS

\$3,464 + \$880 = \$4,344

Calculation of Implementation Cost and Payback

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

Capital Equipment Cost of Solar Panels = \$39,600

A Heliocol HC-50 costs about \$250.00 per collector. Approximately 120 HC-50's will be needed for a total capital cost of \$39,600 including installation costs.

TOTAL IMPLEMENTATION COST

\$39,000

PAYBACK

\$39,600 divided by \$4,344 = 9.1 years

* See Building Life Cycle Cost analysis, "Attachment A" for minimum life cycle cost.

Vendor/Contact Information:

Solar Panels:

Roger Eschenroeder
Heliocol Solar
13620 49th Street North
Clearwater, FL 34622
Phone: (813) 572-6655
Fax: (813) 572-7922

Liquid Propane Tank:

AmeriGas
204 N Fruitland
Kennewick, WA 99336
(509) 582-8888

Liquid Propane:

AmeriGas
204 N Fruitland
Kennewick, WA 99336
(509) 582-8888

Liquid Propane Gas Heater:

Jacobs and Rhodes
4825 W. Clearwater Avenue
Kennewick, WA 99336
(509) 783-3121

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3
POLLUTION PREVENTION OPPORTUNITY DESCRIPTION

Date 06/20/96

P2OA ID Code Energy-1

Facility K Basin Pools

Activity Water Heating Methods for Raising Warm Water Fish Species

P2O No. 4

P2O Title Water Source Heat Pump

Current Practice

Because this project is in design, there is no current practice. Therefore, Liquid Propane (LP) will be used as the current practice to heat approximately 140,000 gallons of water in the header pool and maintain the temperature between 60 - 70 degrees Fahrenheit for optimal fish growth. It is estimated that approximately 449,498 BTU's/hour will be required.

Recommended Action

Implement a water source heat pump which will pull Columbia River water into a heat exchanger and strip heat from the water and then discharge it back into the river at a reduced temperature. The approximate source water flow and load water flow is 36 GPM with water entering at an average temperature of 50 degrees Fahrenheit. Entering fluid temperatures below 45 degrees Fahrenheit requires an antifreeze solution. The recommended water source heat pump, Model WH/P158-3 available through Total Energy Management, Richland Washington has the following characteristics:

General Performance Data: -Source and load water pressure drop is 11.7 FOH

Cooling Performance Data: -Capacity is 157,563 BTUs/Hour
-Total watts are 7,283
-Energy efficiency ratio is 21.6
-Heat rejection is 182,433 BTUs/Hour
-Source leaving water temperature is 60.1 degrees Fahrenheit
-Load leaving water temperature is 46.2 degrees Fahrenheit

Heating Performance Data: -Capacity is 137,919 BTUs/Hour
-Total watts are 6,060
-Coefficient of performance is 6.7
-Heat absorption is 117,239 BTUs/Hour
-Source leaving water temperature is 43.5 degrees Fahrenheit
-Load leaving water temperature is 67.7 degrees Fahrenheit

Calculation of Waste Reduction and/or Energy Savings

Annual quantity of Liquid Propane (LP) required = 5,256 gallons

The quantity of LP necessary to maintain the temperature required is approximately .6 gallons/hour running at 90% efficiency.

.6 gallons/hour x 24 hours/day x 365 days/year = 5,256 gallons/year.

TOTAL ANNUAL WASTE REDUCTION

5,256 gallons LP gas

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3
POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

Calculation of Annual Cost Savings

Costs:

Electricity required to run water pump = \$978

Electrical requirements include a minimum circuit ampacity of 48.0 and a maximum fuse size or HACR circuit breaker of 60. This includes water pump amperage.

5hp x 0.745kW/hp x \$.03 kW/hr x 8760 hrs/yr = \$978

Benefits:

Annual Cost of Liquid Propane (LP) = \$3,464

Natural gas is not available to the N Area where the K Basin pools are located. LP gas from AmeriGas is currently \$.659/gal.

An LP gas heater, running at approximately 90% efficiency, will consume about .6 gallons/hour of LP to produce 449,498 BTU's/hour.

\$.659/gal x .6 gallons/hour x 24 hours/day x 365 days/year = \$3,464/year

Cost of a LP Gas Tank and Heater = \$4,000 Amortized Annual Cost = \$880

AmeriGas LP tanks range from 5 gallon - 1,000 gallon tanks. The 124 gallon tank is \$450, the 500 gallon tank is \$950, and the 1,000 gallon tank is \$1,600. The 500 gallon tank is recommended. The cost of an LP gas heater is approximately \$3,000. Installation is an additional \$50.

Based upon a 20 year life cycle, the annual amortized cost including maintenance and repairs, for the LP gas tank and heater is \$440. An additional \$2,200 is expected every five years to replace the burner. The cost of an LP gas heater is approximately \$3,000.

Cost of a LP Gas Tank = \$950

AmeriGas LP tanks range from 5 gallon - 1,000 gallon tanks. The 124 gallon tank is \$450, the 500 gallon tank is \$950, and the 1,000 gallon tank is \$1,600. The 500 gallon tank is recommended.

TOTAL ANNUAL COST SAVINGS

\$3,464 + \$880 - 978 = \$3,366

Calculation of Implementation Cost and Payback

Cost of water source heat pump = \$15,000

The capital equipment cost for the water source heat pump is approximately \$15,000 including installation.

TOTAL IMPLEMENTATION COST

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 3

POLLUTION PREVENTION OPPORTUNITY DESCRIPTION (Continued)

\$15,000

PAYBACK

\$15,000 divided by \$3,366 = 4.4 years

* See Building Life Cycle Cost analysis, "Attachment A" for minimum life cycle cost.

Vendor/Contact Information:

Water Source Heat Pump:
Aaron Dewitt
Total Energy Management Inc.
1975 Butler Loop
Richland, WA 99352
(509) 946-4500

WORKSHEET 4
POLLUTION PREVENTION OPPORTUNITIES SUMMARY

Facility K Basin Pools

Activity Water Heating Methods for Raising Warm Water Fish Species

[illegible]

Notes and Other Benefits

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

**WORKSHEET 5
FINAL SUMMARY**

Date 06/20/96

P2OA ID Code Energy-1

Facility K Basin Pools

Activity Water Heating Methods for Raising Warm Water Fish Species

Proposed Opportunities and Discussion

It has been previously demonstrated by the Yakama Indian Nation that large number of fish can be successfully raised in the Hanford 100-K Area water purification pools (K Pools), which are surplus to U.S. Department of Energy needs. Thus, suitable rearing facilities are in place and the Yakama Indian Nation possesses technical fish-rearing skills in the form of a large staff of experienced fish biologists, culturists, and technicians. Therefore, it is fully expected that a Hanford commercial aquaculture facility can significantly contribute to supplying warm-water species for sports fishing purposes and profitable seafood products for the West Coast fresh fish market.

Solar technology is safe, clean and efficient. It makes sense, then to heat at least in part with solar heating. Reuse of the existing solar water heater from the 2750 Building provides the greatest payback in close to 1 year. The upgrades to the unit and the associated costs are minimal.

The obvious disadvantage to solar energy is that during cold weather, no matter how big the system is, it won't produce energy. In the winter months, it may be necessary to supplement the solar technology with liquid propane during inclement or very cold weather. Since a constant water temperature is not critical, it may be possible to let the temperature drop some during the 3-4 month period of extremely cold weather. The implementation cost of a liquid propane tank and heater is less than \$4,000 and the cost for liquid propane is minimal.

Cubing tumbleweeds and noxious weeds is not a viable solution due to the high cost of capital equipment and labor charges. Additionally, National Environmental Policy Act (NEPA) documentation would be required as farming this waste source is potentially a major federal action significantly affecting the quality of the human environment. The NEPA documentation is an added expense not calculated in the payback.

The Heliocol solar panel system has a payback of over 9 years as the initial cost is \$36,000. A less expensive solar system might be viable—one such as simple as coiled black plastic tubing could provide enough solar energy to heat the water.

A water source heat pump, could provide a good water heating method as the temperature of the Columbia river water is ideal for this type of setup. However, the capital equipment cost and installation are considerably high.

Recommendations and Schedule for Implementation

Obtaining the excess solar heater and associated equipment should be done immediately as the heaters are already at the Westinghouse Excess yard for deployment to another DOE site, another government agency, or the general public. The tanks to the solar heater still remain at the 2750 Building but should also be moved as soon as possible to avoid excess to another organization or possible disposal.

It is further recommended to wait until the fall months to purchase the liquid propane system. During the summer months actual energy consumption data can be calculated to determine if a liquid propane system is necessary. The systems are readily available

POLLUTION PREVENTION OPPORTUNITY ASSESSMENT

WORKSHEET 5
FINAL SUMMARY (Continued)

from AmeriGas and therefore do not require a long lead time for delivery.

Building Life Cycle Cost Analysis

QI filename = FISHP20A.QI
 Analysis type = Federal Analysis--Energy Conservation Projects
 Project name = K-Basin Fish P20A
 Base Date of Study = 1996
 Service Date = 1996
 Study Period = 20 years
 Discount rate = 4.1%
 Inflation rate = 0.00%
 Cap replacements and residual values (if any) included as investment costs.
 Residual values automatically calculated for capital components.
 Residual values automatically calculated for capital replacements.

Common energy data	#1	#2	#3	#4
Energy type:	LPG	Electric	Other	
Units:	(gallon)	(kWh)	(pound)	
Price per unit:	\$0.659	\$0.030	\$0.006	
Escalation type code:	2	2	2	

Data for DOE escalation rates:
 DOE Escalation Rate File = ENCOST96
 Rate Schedule Type = 3
 State Abbreviation = WA

DOE Price escalation rates for LPG					
Year	Rate(%)	Year	Rate(%)	Year	Rate(%)
1996	-1.2059	2006	3.3990		
1997	-0.8780	2007	3.8633		
1998	0.6993	2008	0.9196		
1999	1.7638	2009	-1.2243		
2000	3.2349	2010	0.3396		
2001	6.1672	2011	0.6780		
2002	7.5102	2012	0.6734		
2003	7.9182	2013	0.6689		
2004	6.6602	2014	0.6645		
2005	4.7310	2015	0.7697		

DOE Price escalation rates for Electric					
Year	Rate(%)	Year	Rate(%)	Year	Rate(%)
1996	-0.7178	2006	1.5645		
1997	0.2645	2007	1.1905		
1998	0.6902	2008	1.2561		
1999	0.6566	2009	0.9024		
2000	0.7454	2010	0.0573		
2001	1.3883	2011	0.2868		
2002	2.2190	2012	0.2860		
2003	2.0659	2013	0.2567		
2004	0.5811	2014	0.2559		
2005	0.6958	2015	0.2837		

DOE Price escalation rates for Other

Year	Rate(%)	Year	Rate(%)	Year	Rate(%)	Year	Rate(%)	Year	Rate(%)
1996	-0.7178	2006	1.5645						
1997	0.2645	2007	1.1905						
1998	0.6902	2008	1.2561						
1999	0.6566	2009	0.9024						
2000	0.7454	2010	0.0573						
2001	1.3883	2011	0.2868						
2002	2.2190	2012	0.2860						
2003	2.0659	2013	0.2567						
2004	0.5811	2014	0.2559						
2005	0.6958	2015	0.2837						

Number of alternatives in file = 5

Number of groups in file = 1

ALT #	ALTERNATIVE NAME	GROUP CODE	LIFE (Y/M)	INITIAL COST(\$)	CAPITAL REPLACEMENTS		ANNUAL OM&R COST(\$)	NON-ANNUAL OM&R	
					FREQ*	COST(\$)		FREQ*	COST(\$)
1	Baseline-LP		20/0	4000	20/0	0	440	5/0	2200
2	Biomass Heat		20/0	578000	20/0	0	37000	5/0	4400
3	Solar-New		20/0	40000	20/0	0	440	10/0	2200
4	Solar-Reuse		20/0	4000	20/0	0	440	2/0	1000
5	Heat Pump-Wr		20/0	15000	20/0	0	440	5/0	2200

*FREQ = Frequency of occurrence (in years/months)

ALT #	ALTERNATIVE NAME	GROUP CODE	ANNUAL ENERGY USE			AN. ELEC. DEMAND CHARGE(\$)
			LPG (gallon)	Electric (kWh)	Other (pound)	
1	Baseline-LP		230	0	0	0
2	Biomass Heat		0	36700	3360000	0
3	Solar-New		0	0	0	0
4	Solar-Reuse		0	0	0	0
5	Heat Pump-Wr		0	2044	0	0

Figure 1

The K Basin Warm Water Fish Rearing Program Conceptual Design