Physics of Electrofishing
AiS Supercomputers Challenge Exposition Final Report

By:

Davin W. Richardson & Monte D. Topmiller
Advanced Placement Computers
Silver High School, Silver City, NM

March 8, 2002

Adventures in Supercomputing
Project Number 093
Teacher: Mrs. Peggy Larisch
Mentors: Mrs. Joy Garcia & Mr. Berry Estes

Acknowledgements

- Mrs. Joy Garcia----Physics, Chemistry, Biology, Physical Science Teacher at Silver High School and Biologists
- Mrs. Peggy Larisch----Advanced Computer Science Teacher at Silver High School
- Mr. Berry Estes----Retired Engineer from Sandia Laboratories
- Mr. Dennis Miller----Biologist, Herpetologist, and Professor at Western New Mexico University

Table of Contents

Executive Summary

Electrofishing is a process used by field biologists capture and study fish. This process electrically stuns the fish enabling the biologist to collect the fish for studying them. It is a very effective way, for performing this activity but is not totally reliable because the exact amount of electricity required to stun the fish is unknown, and it will remain this way until more money is spent on research. We found this out on a trip down the Gila River with Biologist Joy Garcia and Biologist Dennis Miller. We were fishing for Spiked Dace, a minnow, but were unsuccessful for the better part of the day. We were there to make a continuous study that the Western New Mexico University has been working on for several years. At first we were only catching a few Spiked Dace and thought it was because our electrofisher was not properly adjusted. We continued shocking and still had a lower fish count than was expected. After being unsuccessful here we tried another habitat and did better. This is where we decided that there was a problem. Were the fish already in that other habitat or did we scare them into that habitat trying to get the electrofisher set right? A computer program written in C ++ or Java Script (Java Script Is Phase IV of project) would have solved most of our problems. We would have known from the beginning that the fish simply moved habitats instead of being unsure.

After months of research (Phase I of project) we found that there are five factors that contribute to the effectiveness of shocking fish. Out of these five we found that we could use three to write a program that will make fish shocking safer and more reliable. These three factors are the water conductivity, the fish size, and the amount of substrate in the water. The other two factors are the water temperature and the fish conductivity. The water temperature is directly proportional to the water conductivity so we left it out of our program. Fish conductivity was left out because it is impossible to determine the amount of conductivity unless there are dead fish available.

Our program (Phase II of project) will ask the user for the water conductivity, the fish size, and the amount of substrate in the water. After analyzing this information the program will output an approximation of what the machine should be set at. From these settings it will ask the user to input the pulse length settings along with the frequency settings that the user would prefer. With all this information the program will output the amount of hertz and energy being used. This program will make electrofishing a much more effective means of catching fish for studies. After getting Phase II done we went back to the Gila River and had perfect success (Phase III of the project). Although the program worked, it probably could still be improved upon with additional studies and funds. What we have done is make a program that is good enough to get a biologist in the ballpark but not good enough to hit a homerun.

1.0 Introduction

1.1 -Purpose-

Electrofishing is the use of electricity generated by batteries, electric generators and other sources of electric power to kill, stupefy, disable or render unconscious fishery species. If it is done right, it is a simple and effective method for biologists to catch, study, and then release the fish back to the water unharmed. When using the Type VII Backpack Electrofisher, a great lightweight waterproof electrofisher, an electrode is put into the water sending out pulses of electricity to shock, which is to stun fish. We chose this subject because we enjoy fishing and do not want biologist to kill all of our fish while they are making studies. Our science teacher, Mrs. Joy Garcia, told us that when fish shocking, it is hard to get the machine set to the right settings so they either scare or kill the fish off without getting good and reliable data for their studies.

1.2 -Computer Program-

Our program, that we designed personally, utilizes our new skills for the C++ language. Learning most of the language in about a month and a half of school, we wrote the basics of the code for inputting data files using the matrices, if/else-if statements and other functions (see Appendix B and C for the code[s]). We wrote the program with our own knowledge, but used other programs for ideas of the code.

Doing the project, we split up and did the important things separate but came back to see if we both agreed with each other's work. Davin wrote the code for the C++ and JavaScript, with the help of Mrs. Peggy Larisch and the imputing ideas of Biologist Mrs. Joy Garcia, while Monte wrote the papers and prepared the data for the program(s).

2.0 Problem Statement

2.1 -Problem Statement-

If too much electricity is shot out, the fish that are wanted for studying will be electrocuted to death. When a fish has been shocked with too much electricity, muscle hemorrhage and spinal damage are caused by contractions on both sides of the fish. If too little electricity is used the fish will be unaffected and will swim off. Either way, the results of a shocking trip will be both unacceptable and unreliable. This is why it is important to have the electorfisher set on the proper settings and have an experienced user. Even with an experienced user there is a lot of time wasted because the biologist must start at a low level of electricity and gradually move to the right setting in order to not harm any fish. These settings still might not be the best that they can be and will destroy the reliability of studies. When a biologist does this, the lower amounts of electricity might not be able to shock the fish and instead will just scare them off and by the time the electrofisher is set on the proper settings there might not be any fish left. By not knowing that the fish are gone the biologist would probably keep moving the settings higher in to the deadly amounts. Most people would say that if this scares off fish, just start at a higher level of electricity. This is not a good way either because the shocked fish will not just be shocked they will be fried.

3.0 -Method of Solution-

3.1 -Mathematical Model-

A computer program that the user could input what they think the electrofisher should be set at and the computer would in return give information that would either support the decision or recommend another setting that would be better. The user also needs to input the fish size, water conductivity, and that amount of substrate. The outputted information would be the amount of energy being shot out and the frequency, and what we believe the settings should be. Other outputted information would be some basic information that would help in the final decision such as the high or low conductivity, big or little fish, temperature, etc. Biologists are not electricians therefore a solution to this problem would be an easy to use program that could be used on a laptop that explains the basics of fish shocking electricity. The program we believe to work best is shown in at the end of the report (Appendix A). This program will not only save time but would also increase the reliability of studies by allowing biologists to only shock an area once and to be sure the right amount of electricity is used. The program developed in this project calculates the standard pulses of the electrofisher. Special settings for non-standard applications did not have enough information and consequently could not be folded into the program. Once a fish has been shocked with the correct amount of electricity, using this program, it will either float to the top and be caught with dip nets or it will flow down stream into a seine for studies.

4.0-Results-

4.1-Calculations-

Most of our time spent on this project has dealt mostly with researching and finding information on: (1) the affect electricity has on fish, (2) the width and frequency of the pulses, and (3) which pulses are the best considering different variables. Among these variables are the conductivity of fish, the conductivity of water, the conductivity of lake or streambed, the size of the fish, and the temperature of the water. In (Phase I) it was found that temperature is directly proportional to the water conductivity, that is, as the temperature increases so does the water conductivity. We also learned from the research efforts that without a dead fish the conductivity of that fish cannot be determined. Therefore these two factors were not included in our program. In the next part, (Phase II) of this project, a C++ program was developed that calculates all this information and outputs recommended values for what the electrofisher should be set at. The ran program is shown in (Appendix A). After completing this phase, the team went out into the field and tested the program making sure it worked as it is supposed to (Phase III). We took a trip to the Gila River, a small river in Southwest New Mexico, and found that are program worked as we had planned. We confirmed our studies to be true by finding the water conductivity, fish size, and the amount of substrate to plug it into the program. After analyzing the data, the program suggested a range of settings. After using the programs suggestions to shock and catch the fish, we looked at the previous studies of the same area, and time of year. We found that we caught more fish with a less percentage of injuries and deaths. In (Phase IV) we plan to write the same program in Java Script and/or in HTML. In the HTML we are hoping to make graphs of what each shock would look like with different settings on the machine.

5.0-Conclusion-

5.1-Computer Program/Results-

Since all of our efforts confirmed that we have a user-friendly C++ program (Appendix A) that will assist the user to make the right decisions, by knowing the amount of energy of each shock, and in the near future programs in Java Script and/or HTML. A biologist that is new to fish shocking will be able to shock without harming any fish and will still be able to make reliable studies using any of these program. Our C++ program is very affective but once we write a program in Java Script and/or in HTML it will be much more advanced and eiser to use. It will also have graphs to help the user to have a better understanding of what is going on.

References

1.*Type VII POW Backpack Manual,* 1993, Smith-Root, Inc.,
2.Couchman, Mat, *Electrofishing*, www.fisheriesmanagement.co.uk/electrofishing.html, 12/13/01
3.*Backpack Electrofishing Guidelines,*1998

Appendices

Appendix A -- Ran Program
Appendix B -- Written Program
Appendix C --Data File

Appendix A
Ran Program

Welcome to the Electrofishing Program

By Davin Richardson and Monte Topmiller.

This program was designed to go with the Type VII POW Electrofisher backpack. To begin shocking the fish, first you must know some basic information.

Measure conductivity and set voltage as follows:

-Conductivity (umhos/cm)-	-Voltage-
100 to 300	500 to 600
Greater than 300	200 to 400

Here is a list of what to do.

For:
(1.) Low Water Conductivity-
Use increased voltage or keep the resistance constant.

(2.) High Water Conductivity-
Use low voltage and high currents.

More information:
(3.) Fish Conductivity-
The fish will receive the maximum shock through its body when the water conductivity equals the conductivity of the flesh of fish.

(4.) Fish Size-
The larger fish always receives the greater shock than that of the smaller fish.

(5.) Temperature-
The higher the temperature is of the water, the higher the conductivity.

(6.) Substrate-
Certain bottom substrates will conduct electrical current. These weaken the electrical field in the water making fish capture less effective.

Now that you know a little more than what you did earlier. You can start the fishing.
Do you wish to continue this program? press (1 for yes or 2 for no) to continue or close.1

Now that you have chosen to stick with us, we need to find out more information. Please tell us if the fish is small, 1-6 inches (press 1), medium, 7-20 inches (press 2), or large, 21+ inches (press 3). 1

*For small sized fish, we recommend the settings on the Standard Pulse Setting Chart to be between K-P, but remember that by using this much electricity the bigger fish will be affected greater than the smaller fish.

Next we need to see if there is any Substrate in the area that you will be shocking. Please enter on a scale of 1-10 the amount of substrate in the water. (10 being the greatest)
1

Please use the Pulse Width settings between 0.1-2 ms.

Now we will display for you the Standard Pulse Setting table for your use.

WIDTH	100us	500us	1ms	2ms	3ms	4ms	5ms	6ms	7ms	8ms	9ms	10 ms
A	1Hz	1Hz	1Hz	1Hz	1Hz	1Hz	1Hz	1Hz	1Hz	1Hz	1Hz	1Hz
B	5Hz	5Hz	5Hz	5Hz	5Hz	5Hz	5Hz	5Hz	5Hz	5Hz	5Hz	5Hz
C	10Hz	10Hz	10 Hz	10 Hz	10 Hz	10 Hz	10 Hz	10 Hz	10 Hz	10 Hz	10 Hz	10 Hz
D	15Hz	15Hz	15 Hz	15 Hz	15 Hz	15 Hz	15 Hz	15 Hz	15 Hz	15 Hz	15 Hz	15 Hz
E	20Hz	20Hz	20 Hz	20 Hz	20 Hz	20 Hz	20 Hz	20 Hz	20 Hz	20 Hz	20 Hz	20 Hz
F	25Hz	25Hz	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz
G	30Hz	30Hz	30 Hz	30 Hz	30 Hz	30 Hz	30 Hz	30 Hz	30 Hz	30 Hz	30 Hz	30 Hz
H	40Hz	40Hz	40 Hz	40 Hz	40 Hz	40 Hz	40 Hz	40 Hz	40 Hz	35 Hz	35 Hz	35 Hz
I	50Hz	50Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	40 Hz	40 Hz	40 Hz
J	60Hz	60Hz	60 Hz	60 Hz	60 Hz	60 Hz	60 Hz	60 Hz	60 Hz	50 Hz	45 Hz	45 Hz
K	70Hz	70Hz	70 Hz	70 Hz	70 Hz	70 Hz	70 Hz	70 Hz	70 Hz	60 Hz	50 Hz	50 Hz
L	80Hz	80Hz	80 Hz	80 Hz	80 Hz	80 Hz	80 Hz	80 Hz	80 Hz	70 Hz	60 Hz	55 Hz
M	90Hz	90Hz	90 Hz	90 Hz	90 Hz	90 Hz	90 Hz	90 Hz	90 Hz	80 Hz	70 Hz	60 Hz
N	100Hz	100Hz	100 Hz	100 Hz	100 Hz	100 Hz	100 Hz	100 Hz	100 Hz	90 Hz	80 Hz	70 Hz

O	110Hz	110Hz	110 Hz	110 Hz	110 Hz	110 Hz	110 Hz	110 Hz	110 Hz	100 Hz	90 Hz	80 Hz
P	120Hz	120Hz	120 Hz	120 Hz	120 Hz	120 Hz	120 Hz	120 Hz	120 Hz	110 Hz	100 Hz	90 Hz

Please enter your desired Pulse Width settings in milliseconds (0.1, 0.5, or 1-10)
0.1 9
Please enter your desired Frequency (ALPHA) settings. Enter the Alpha settings as (a capital) A-P.
A

Your setting is 1Hz, just to let you know.

Please enter the water conductivity (Must be over 100).
102

The amount of energy in the shock is 10.2.

If you look at this chart again for the voltage settings;

-Conductivity (umhos/cm)-	-Voltage-
100 to 300	500 to 600
Greater than 300	200 to 400

You will see the voltage setting you need from the conductivity. Now that you have the settings for the backpack, go have some fun and don't kill the fish. If you have any other questions, please call Smith-Root, INC., at 1-360-573-0202 for customer information about the Type VII Backpack.

Appendix B
Program

```
//Davin Richardson and Monte Topmiller
//AiS Challenge program
//Silver High School, team 93
//Started on January 08, 2002
//Electrofishing program

#include<iostream.h>                    //For cout and cin.
#include<fstream.h>                     //For inputing files.
#include<stdlib.h>                      //For the matricies.
#include<string>                        //For strings.
#include<math.h>                        //For computing math.

fstream InFile("standard.dat",ios::in | ios::out);      //Calls in the file(s).

int main()
{                                       //Start of main program.

      int array[12][16];
      char ALPHA;                       //Displaying Variables
      int x, a, xx, num_ALPHA, num_WIDTH;
      int water_cond, fish_size, substrate, voltage;
      double WIDTH;

      cout<<"Welcome to the Electrofishing Program"<<endl;
      cout<<endl;                       //Intro line of program.
      cout<<"By Davin Richardson and Monte Topmiller."<<endl;
      cout<<endl;                       //The authors!
      cout<<"   This program was designed to go with ";
      cout<<"the Type VII POW Electrofisher backpack."<<endl;
      cout<<"To begin shocking the fish, first you must know ";
      cout<<"some basic information."<<endl;
      cout<<endl;
      cout<<"Measure conductivity and set voltage as follows:"<<endl;
```

```
        cout<<"        -Conductivity(umhos/cm)-        -Voltage-"<<endl;
        cout<<"         100 to 300                    500 to 600"<<endl;
        cout<<"         Greater than 300               200 to 400"<<endl;
        cout<<endl;
        cout<<"Here is a list of what to do."<<endl;
        cout<<endl;
        cout<<"For:"<<endl;
        cout<<"(1.)Low Water Conductivity-"<<endl;
```



```
cout<<"   Use increased voltage or keep the resistance constant."<<endl;
        cout<<endl;
        cout<<"(2.)High Water Conductivity-"<<endl;
        cout<<"   Use low voltage and high currents."<<endl;
        cout<<endl;
        cout<<"More information:"<<endl;
        cout<<"(3.)Fish Conductivity-"<<endl;
        cout<<"   The fish will recieve the maximum shock threw its body ";
        cout<<"when the water condutivity equals the conductivity";
        cout<<" of the flesh of fish."<<endl;
        cout<<endl;
        cout<<"(4.)Fish Size-"<<endl;
        cout<<"   The larger fish always recives the greater shock than that ";
        cout<<"of the smaller fish."<<endl;
        cout<<endl;
        cout<<"(5.)Temperature-"<<endl;
        cout<<"   The higher the temperature is of the water, the higher the ";
        cout<<"conductivity is."<<endl;
        cout<<endl;
        cout<<"(6.)Substrate-"<<endl;
        cout<<"   Certain bottom substrates will conduct electrical ";
        cout<<"current. These weaken the electrical field in the water ";
        cout<<"making fish capture less effective."<<endl;
        cout<<endl;
        cout<<"*Now that you know a little more than what you did ";
        cout<<"earlier. You can start the fishing.*"<<endl;
        cout<<"Do you wish to continue this program? ";
        cout<<"press (1 for yes or 2 for no) to continue or close.";
        cin>> a;                        //Get question a from user.
                        //*Question A asks the user to continue.
        if (a == 1)
        {
        cout<<endl;
        cout<<"Now that you have chosen to stick with us, we need ";
        cout<<"to find out more information.";
        cout<<"Please tell us if the fish is small, 1-6 inches(press 1), ";
        cout<<"medium, 7-20 inches(press 2), or large, 21+ inches(press 3).";
```

```
	cin>>fish_size;			//Get fish size from user.

	if (fish_size==1)
	{
	cout<<endl;
	cout<<"*For small sized fish, we recomend the settings on the Standard Pulse
Setting Chart ";
	cout<<"to be between K-P, but remember that by using this much ";
```



```
cout<<"electricity the bigger fish will be effected greater than";
	cout<<" the smaller fish."<<endl;
	}

	if (fish_size==2)
	{
	cout<<endl;
	cout<<"*For medium sized fish, we recomend the settings on the Standard Pulse
Setting Chart ";
	cout<<"to be between E-J. Fishing for diversity will be best using these ";
	cout<<"settings."<<endl;
	}

	if (fish_size==3)
	{
	cout<<endl;
	cout<<"*For large sized fish, we recomend the settings on the Standard Pulse
Setting Chart ";
	cout<<"to be between A-D. If the fish is too small for this setting, ";
	cout<<"the shock will have little or no effect on the fish."<<endl;
	}

	cout<<endl;
	}

	else if (a == 2)
	{
	cout<<"Thank you. Have fun fishing without us!"<<endl;
	cout<<"!!BUT REMEMBER!! The size of the fish does matter!"<<endl;

	return(0);
	}

	cout<<"Next we need to see if there is any Substrate in the area that you will be
shocking. ";
	cout<<" Please enter on a scale of 1-10 the amount of substrate in the water. (10
being ";
```

```
        cout<<"the greatest)"<<endl;;
        cin>>substrate;                         //Get substrate from user.

        if ((substrate=1)&&(substrate<4))
        {
        cout<<endl;
        cout<<"Please use the Pulse Width settings between 0.1-2 ms.";
        cout<<endl;
```



```
}

        else if ((substrate=4)&&(substrate<8))
        {
        cout<<endl;
        cout<<"Please use the Pulse Width settings between 3-6 ms.";
        cout<<endl;
        }

        else if ((substrate=8)&&(substrate<10))
        {
        cout<<endl;
        cout<<"Please use the Pulse Width settings between 7-10 ms.";
        cout<<endl;
        }

        cout<<endl;
        cout<<"Now we will display for you  the Standard Pulse Setting table for your
use."<<endl;
        cout<<endl;

        for (int r=0; r<12; r++)
        {
                for(int c=0; c<16; c++)
                {
                InFile>> x;
                array[r][c]=x;
                }
        }                               //Prints out chart.

        cout<<"  0.1ms  0.5ms  1ms   2ms   3ms   4ms   5ms   6ms   7ms   8ms   9ms
10ms"<<endl;
        cout<<"A    ";
                for (int r=0; r<12; r++)
                {
                cout<< array[r][0]<<"Hz    ";
                }
```

```
cout<<endl;
cout<<"B   ";
      for (int r=0; r<12; r++)
      {
      cout<< array[r][1]<<"Hz   ";
      }
cout<<endl;
cout<<"C  ";
for (int r=0; r<12; r++0)                    14
      {
      cout<< array[r][2]<<"Hz  ";
      }
cout<<endl;
cout<<"D  ";
      for (int r=0; r<12; r++)
      {
      cout<< array[r][3]<<"Hz  ";
      }
cout<<endl;
cout<<"E  ";
      for (int r=0; r<12; r++)
      {
      cout<< array[r][4]<<"Hz  ";
      }
cout<<endl;
cout<<"F  ";
      for (int r=0; r<12; r++)
      {
      cout<< array[r][5]<<"Hz  ";
      }
cout<<endl;
cout<<"G  ";
      for (int r=0; r<12; r++)
      {
      cout<< array[r][6]<<"Hz  ";
      }
cout<<endl;
cout<<"H  ";
      for (int r=0; r<12; r++)
      {
      cout<< array[r][7]<<"Hz  ";
      }
cout<<endl;
cout<<"I  ";
      for (int r=0; r<12; r++)
      {
```

```
            cout<< array[r][8]<<"Hz  ";
            }
      cout<<endl;
      cout<<"J  ";
            for (int r=0; r<12; r++)
            {
            cout<< array[r][9]<<"Hz  ";
            }
```



```
cout<<endl;
      cout<<"K  ";
            for (int r=0; r<12; r++)
            {
            cout<< array[r][10]<<"Hz  ";
            }
      cout<<endl;
      cout<<"L  ";
            for (int r=0; r<12; r++)
            {
            cout<< array[r][11]<<"Hz  ";
            }
      cout<<endl;
      cout<<"M  ";
            for (int r=0; r<12; r++)
            {
            cout<< array[r][12]<<"Hz  ";
            }
      cout<<endl;
      cout<<"N ";
            for (int r=0; r<12; r++)
            {
            cout<< array[r][13]<<"Hz ";
            }
      cout<<endl;
      cout<<"O ";
            for (int r=0; r<12; r++)
            {
            cout<< array[r][14]<<"Hz ";
            }
      cout<<endl;
      cout<<"P ";
            for (int r=0; r<12; r++)
            {
            cout<< array[r][15]<<"Hz ";
            }
      cout<<endl;
```

```
    cout<<endl;
    cout<<"Please enter your desired Pulse Width settings in milliseconds ";
    cout<<"(0.1, 0.5, or 1-10)"<<endl;
    cin>>WIDTH;                    //Get question B from user.

    if (WIDTH==0.1)
        num_WIDTH=0;
    if (WIDTH==0.5)
```



```
num_WIDTH=1;

    if (WIDTH==1)
        num_WIDTH=2;

    if (WIDTH==2)
        num_WIDTH=3;

    if (WIDTH==3)
        num_WIDTH=4;

    if (WIDTH==4)
        num_WIDTH=5;

    if (WIDTH==5)
        num_WIDTH=6;

    if (WIDTH==6)
        num_WIDTH=7;

    if (WIDTH==7)
        num_WIDTH=8;

    if (WIDTH==8)
        num_WIDTH=9;

    if (WIDTH==9)
        num_WIDTH=10;

    if (WIDTH==10)
        num_WIDTH=11;

    cout<<"Please enter your desired Frequency (ALPHA) settings. ";
    cout<<"Enter the Alpha settings as (a capital) A-P."<<endl;
    cin>>ALPHA;                    //Get question C from user.

    if (ALPHA=='A')
```

```
        num_ALPHA=0;

    if (ALPHA=='B')
        num_ALPHA=1;

    if (ALPHA=='C')
        num_ALPHA=2;
```



```
if (ALPHA=='D')
        num_ALPHA=3;

    if (ALPHA=='E')
        num_ALPHA=4;

    if (ALPHA=='F')
        num_ALPHA=5;

    if (ALPHA=='G')
        num_ALPHA=6;

    if (ALPHA=='H')
        num_ALPHA=7;

    if (ALPHA=='I')
        num_ALPHA=8;

    if (ALPHA=='J')
        num_ALPHA=9;

    if (ALPHA=='K')
        num_ALPHA=10;

    if (ALPHA=='L')
        num_ALPHA=11;

    if (ALPHA=='M')
        num_ALPHA=12;

    if (ALPHA=='N')
        num_ALPHA=13;

    if (ALPHA=='O')
        num_ALPHA=14;

    if (ALPHA=='P')
```

```
            num_ALPHA=15;

      cout<<" "<<endl;
            array[num_WIDTH][num_ALPHA];
            xx=array[num_WIDTH][num_ALPHA];

      cout<<"Your setting is "<<xx<<"Hz, just to let you know. "<<endl;
      cout<<"Please enter the water conductivity (Must be over 100)."<<endl;
```



```
cin>>water_cond;                    //Get water conductivity from user.

      if (water_cond>101)
      {
      cout<<"The amount of energy in the shock is
"<<(water_cond*WIDTH)<<"."<<endl;
      }

      else if (water_cond<100)
      {
      cout<<"A different (or more recent) electrofisher is needed to perform what you
want."<<endl;
      return(0);
      }

      cout<<"If you look at this chart again for the voltage settings; ";
      cout<<endl;
      cout<<"        -Conductivity(umhos/cm)-        -Voltage-"<<endl;
      cout<<"         100 to 300                    500 to 600"<<endl;
      cout<<"         Greater than 300               200 to 400"<<endl;
      cout<<endl;
      cout<<"You will see the voltage setting you need from the conductivity. ";
      cout<<"Now that you have the settings for the backpack, go have some ";
      cout<<"fun and don't kill the fish. If you have any other questions, ";
      cout<<"please call Smith-Root, INC., at 1-360-573-0202 for customer ";
      cout<<"information about the Type VII Backpack."<<endl;

      return(0);
}                                   //End of main program.
```

Appendix C
Data File

1
5
10
15
20
25
30
40
50
60
70
80
90
100
110
120
1
5
10
15
20
25
30
40
50
60
70
80
90
100
110
120
1

5
10
15
20
25
30
40

20

50
60
70
80
90
100
110
120
1
5
10
15
20
25
30
40
50
60
70
80
90
100
110
120
1
5
10
15
20
25
30
40
50
60
70
80
90
100

110
120
1
5
10
15
20

25
30
40
50
60
70
80
90
100
110
120
1
5
10
15
20
25
30
40
50
60
70
80
90
100
110
120
1
5
10
15
20
25
30
40
50
60
70

80
90
100
110
120
1
5

10
15
20
25
30
40
50
60
70
80
90
100
110
120
1
5
10
15
20
25
30
35
40
50
60
70
80
090
100
110
1
5
10
15
20
25
30
35

40
45
50
60
70
080
090

100
1
5
10
15
20
25
30
35
40
45
50
55
60
070
080
090