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UC-602

# Lower Granite GIS Data Description and Collection Guidelines

J. L. Gordon
B. J. Evans
E. M. Perry

December 1995

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

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Pacific Northwest Laboratory
Richland, Washington 99352

# Acronyms

| | |
|---|---|
| CERL | Construction Engineering Research Laboratory |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| GRASS | Geographic Resources Analysis Support System |
| NOAA | National Oceanic and Atmospheric Administration |
| PNL | Pacific Northwest Laboratory |
| QA | quality assurance |
| USCOE | U.S. Army Corps of Engineers |
| USGS | U.S. Geological Survey |
| UTM | Universal Transverse Mercator |

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# 1.0 Data History

## 1.1 System Overview

The Lower Granite Geographic Information System (GIS) was developed jointly by the U.S. Army Corps of Engineers (USCOE) Walla Walla District, and the Pacific Northwest Laboratory (PNL).[a] The study area encompasses that portion of the Snake River extending from Illia (river mile 100.5) to the confluence of the Clearwater River (river mile 142). The goal of the project is to use GIS technology to analyze impacts of the drawdown mitigation option on the physical and biological environment of the Lower Granite Reservoir. The drawdown mitigation option is based on the hypothesis that faster juvenile salmon travel to the ocean would result in higher juvenile survival and greater smolt-to-adult return ratios; to accomplish this, reservoir elevations would be lowered to increase channel velocities. Altering the elevation of the reservoirs on the Snake River is expected to have a variety of impacts to the physical environment including changes to water velocity, temperature, dissolved gases, and turbidity. The GIS was developed to evaluate these changes and the resulting impacts on the anadromous and resident fish of the Snake River, as well as other aquatic organisms and terrestrial wildlife residing in the adjacent riparian areas.

The Lower Granite GIS was developed using commercial hardware and software (Intergraph Corp., Huntsville, Alabama), and is supported by a commercial relational database (ORACLE Corp., San Francisco, California). Much of the initial system development involved collecting and incorporating data describing the river channel characteristics, hydrologic properties, and aquatic ecology. Potentially meaningful data for the Lower Granite GIS were identified and an extensive data search was performed; however, approximately half of the data inventoried was not usable. Data in both digital and text formats were obtained from scientists across the Pacific Northwest who are analyzing the habitats, limnology, and hydrology of the Snake River. The next six sections of this document describe the bathymetry, fish abundance, substrate, sediment chemistry, and channel hydrology data. Recommendations for future sampling campaigns and a data dictionary follow the data description.

## 1.2 Bathymetry

### 1.2.1 Overview

The first task in the Lower Granite GIS was to create a digital model of the bathymetry of the Lower Granite Reservoir. An extensive search for bathymetry data revealed a lack of existing digital contour data, so PNL created the bathymetric model using the most recent data available. There were two versions of the bathymetry created. The first version used National Oceanic and Atmospheric Administration (NOAA) navigational charts, and 1989 hydroacoustic soundings of river cross-sections taken in 0.5 to 1 mile intervals from Illia to the Clearwater confluence. When additional data became available, a second version was created by modifying the first version with additional data: 1) 1992 hydroacoustic sounding data, 2) detailed sounding data of Schultz Bar and the deep-dredge disposal site

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(river mile 120.5), and 3) 1 ft bathymetry contour lines of the Snake-Clearwater River confluence that were digitized from aerial photographs taken during the 1992 drawdown study. References and detailed descriptions for these procedures follow.

The database tables related to bathymetry are bath_aspect_cent, bath_elev_cent, bath_slope_d_cent, bath_slope_p_cent, depth_cent, and photic_cent.

### 1.2.2 Version One

The first version was based on U.S. Geological Survey (USGS) Navigational Charts. All of the point depths available on the charts were digitized. The contour line representing 738 ft above mean sea level, and contour lines representing underwater depths of 3, 6, 12, 18, and 30 ft were also digitized. Water depth contours were converted to elevations above mean sea level to prepare the data for input to PV-WAVE (Visual Numerics, Boulder Colorado); the PV-WAVE script is shown in Appendix A. In addition to the NOAA charts, hydroacoustic soundings collected in 1989 were provided by the USCOE, Walla Walla District. The cross-sections were taken in 0.5 to 1 mile intervals from Illia to the Clearwater confluence, but did not contain georeferenced coordinates in latitude and longitude. The program read_hec_2xy.f was used to read these data, convert shoreline monolith information to latitude and longitude coordinates, and perform initial interpolation of the cross-section. This program can be found in Appendix B along with an example of the profile data in Appendix C. The Lower Granite Reservoir area had to be divided into eight sub-regions to allow PV-WAVE interpolation of the data. This was done using the program MAKE_WAVE.f (Appendix E), and the sub-region coordinates can be found in Appendix D. Once the interpolation was complete, the eight files were merged using the GRASS (Geographic Resources Analysis Support System; USCOE, Construction Engineering Research Laboratory [CERL]) software. Because interpolation programs do not preserve the anisotropy of river data, the interpolation program created discontinuous "deep holes" in the bathymetry at each digitized point. To avoid these erroneous interpolation results, three channel centerlines were digitized based on the NOAA charts. Channel centerline elevations were interpolated from a subset of the bathymetry points, contour lines, and cross-section data that were located in proximity of the channel centerline using the program tgridgen_xypts.f (Appendix F). The resulting contour file was used as input for the program XYZ_TO_GRPTS, which creates a GRASS sites file for display (see Appendix G). Another interpolation was performed with the improved channel bathymetry, after converting the gridpoints for use by PV-WAVE using MAKE_WAVE.f. The grid data from the final PV-WAVE interpolation were converted to vectors using GRASS software.

### 1.2.3 Version Two

For the second version, three additional data sets were merged into the existing model: 1) 1992 hydroacoustic Doppler soundings, 2) detailed soundings of Schultz Bar and the deep water dredge disposal site at river mile 120.5, and 3) 1 ft bathymetry contours created from aerial photography taken during the 1992 drawdown. All of these data were provided by the USCOE, Walla Walla District. Where there were data overlap, the 1992 hydroacoustic sounding data replaced the 1989 sounding data. The recent detailed soundings of Schultz Bar and the dredge disposal site replaced the older data; the data replacement programs can be found in Appendices H and J. The 1 ft bathymetry contour lines in the Snake-Clearwater confluence were digitized by the USCOE. Because of extreme noise in the 1 ft contour lines, only the 5 ft contour lines were used for the interpolation. To remove noise from the 5 ft contour lines, the data were imported into Arc/Info (ESRI, Redlands, California), gridded and resampled to 20 ft contours, and exported to DXF format. This DXF file was later merged with the second version of the bathymetry file. Once the bathymetric model had been generated, the surface modeling features of Intergraph were used to create aspect, elevation, degrees of slope, and percent of slope layers. The tables linked to these layers are bath_aspect_cent, bath_elev_cent, bath_slope_d_cent, and bath_slope_p_cent.

## 1.3 Substrate

Substrate data were collected as part of the 1992 drawdown study (Curet 1993). Much of the data has not been published, but was provided by Curet. The substrate information collected included substrate type, degree of embeddedness, and the amount of cover from predation.

To incorporate this data in the GIS, sampling areas were represented by polygons 0.5 miles long and 30 ft wide; these polygon covered elevations 708 to 738 ft, and ranged from river mile 107 to 139, along both shorelines. The polygons centroids were then linked to the substrate database tables by river mile and shore direction. Within each polygon, the data reported are substrate type, embedded quartile, and cover quartile. Substrate type is divided into 9 classes: 1) fines (<2 mm), 2) small gravel (2 to 25 mm), 3) medium gravel (25 to 50 mm), 4) large gravel (50 to 75 mm), 5) small cobble (75 to 150 mm), 6) medium cobble (150 to 225 mm), 7) large cobble (225 to 300 mm), 8) small boulder (300 to 600 mm), and 9) large boulder (>600 mm). The substrate degree of embeddedness is expressed as quartiles (0 to 25%, 25 to 50%, 50 to 75%, and 75 to 100%). Cover quartile describes the percent of area with cover from predation. The data resides in the database tables curet_substrat_stn and curet_substrate. In addition to the tabular substrate information for each sampling point, a video frame that characterized the habitat was captured and stored for each of the polygons. Instructions on how to retrieve videos can be found in the Intergraph I/RAS C User's Guide.

## 1.4 Fish Abundance and Habitat

As part of a sediment dredging and in-water disposal study, physical and biological data were collected to determine the impacts on fish habitat in the Lower Granite Reservoir; these data were published as a series of USCOE reports (Bennett and Shrier 1986; Bennett et al. 1988; Bennett et al. 1990; Bennett et al. 1991; Bennett et al. 1993). Physical data on the water velocity, dissolved oxygen, temperature, turbidity, and substrate were collected at a series of fish sampling stations extending from river mile 110 to river mile 128. In addition to the water physical properties, fish catch data for approximately 30 fish species were recorded for these sampling stations. The fish sampling techniques used included beach seine, electrofish, and gill net. The age of the fish (yearling or subyearling) was indicated as well as stock-type (wild or hatchery). Fish passage counts from the Lower Granite Dam from 1987 to 1992 were also included in the database.

All of the fish abundance and physical data were obtained from Bennett (University of Idaho) in computer spreadsheet form, and loaded into the relational database. Fish sampling stations were determined from maps contained within the published reports, and were represented in the GIS as a point sample (Figure 1). The fish catch data were normalized using 'catch per unit effort;' see the description in the Data Dictionary, 'bennett_stn_counts.'

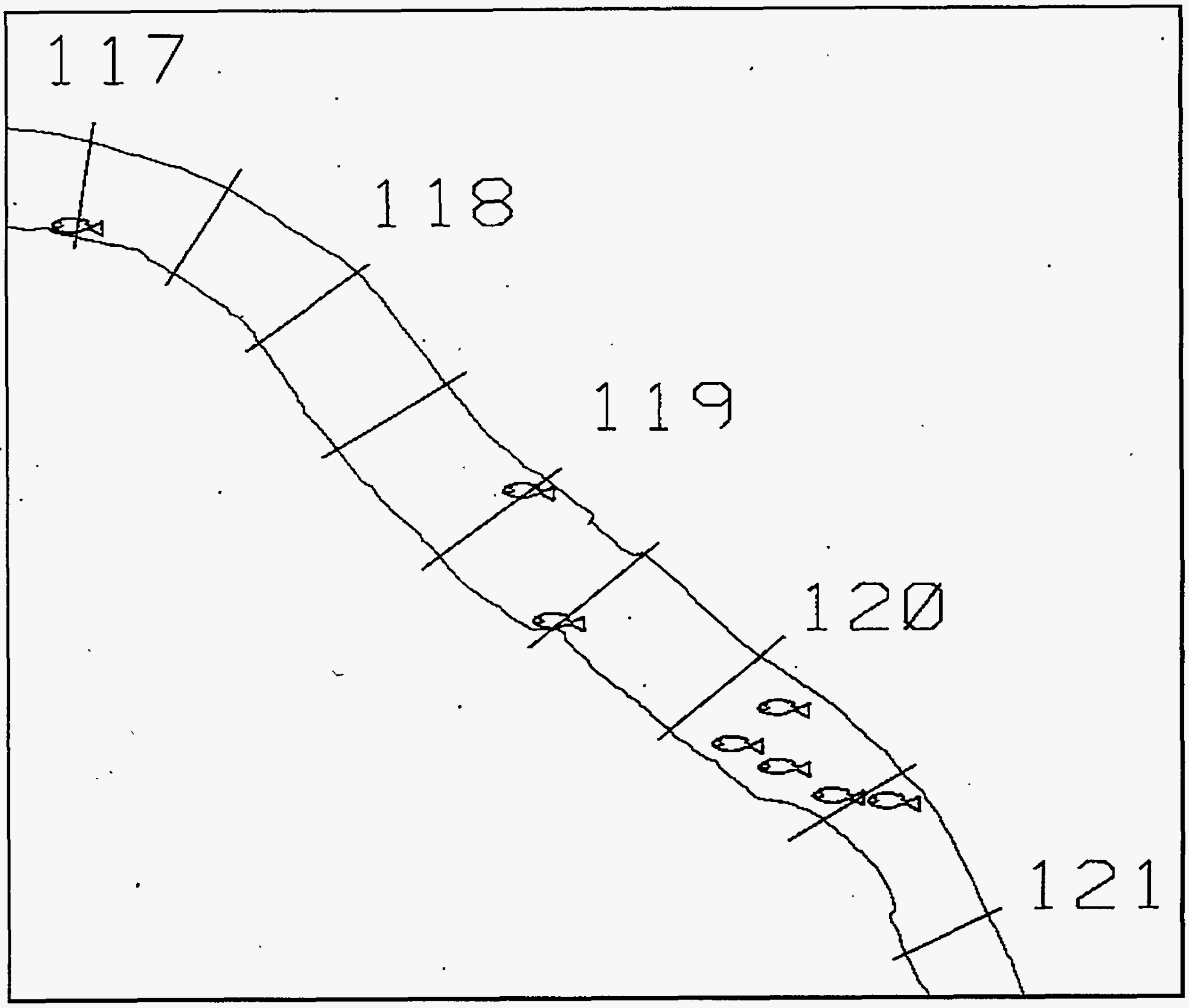


**Figure 1.** Location of Bennett's Fish Sample Stations (1988 to 1991)

The fish sample stations in the GIS are linked to the database by station numbers. Sample dates may be queried by month, year, or julian day (day of year 1 to 365). Species may be queried by the species code; these codes are included in Appendix I. The database tables that store the fish distribution and habitat data are bennett_stn_prop, bennett_survey_stn, bennett_stn_counts, fish_passage, and fish_pass_counts.

## 1.5 Sediment Analysis

### 1.5.1 Overview

In support of the 1992 drawdown study, the USCOE requested PNL to analyze potential water quality impacts on dredge areas in the Snake and Columbia Rivers, and the effects of resuspension of sediments in the Snake River as a result of drawdown. Sampling and analysis of sediments along key Ports of Authority on the Columbia and Snake rivers was performed by the Battelle Marine Sciences Laboratory in Sequim, Washington (Pinza et al. 1992). Data included in the Lower Granite database range from below the dam (river mile 104) to the confluence of the Clearwater River (river mile 139). Most of the sampling occurred in August 1991; analysis of river mile 119.56 was performed on a composite of archived core samples collected in October 1990.

Sediment chemistry data were extracted from the published PNL report and loaded into the relational database; the sample sites were linked to graphical representations of the sample area boundaries by sample station numbers. The locations of sample stations were provided by Tom Miller, USCOE, Walla Walla District. All river mile numbers were reported in statute miles, for consistency with the Lower Granite database. Some samples were composited before analysis; these samples were represented as a polygon in the map layer (Figure 2). The uncomposited sample stations were represented by circles approximately 0.25 mile in diameter.

The chemical analyses reported in the database include:

- Conventionals (percentage of total volatile solids, total organic carbon, ammonia, phosphate, and sulfides)
- Oil and grease, and total petroleum hydrocarbons
- Metals (As, Cd, Cr, Cu, Pb, Hg, Zn)
- Polynuclear aromatic hydrocarbons
- Chlorinated pesticides and polychlorinated biphenyls.

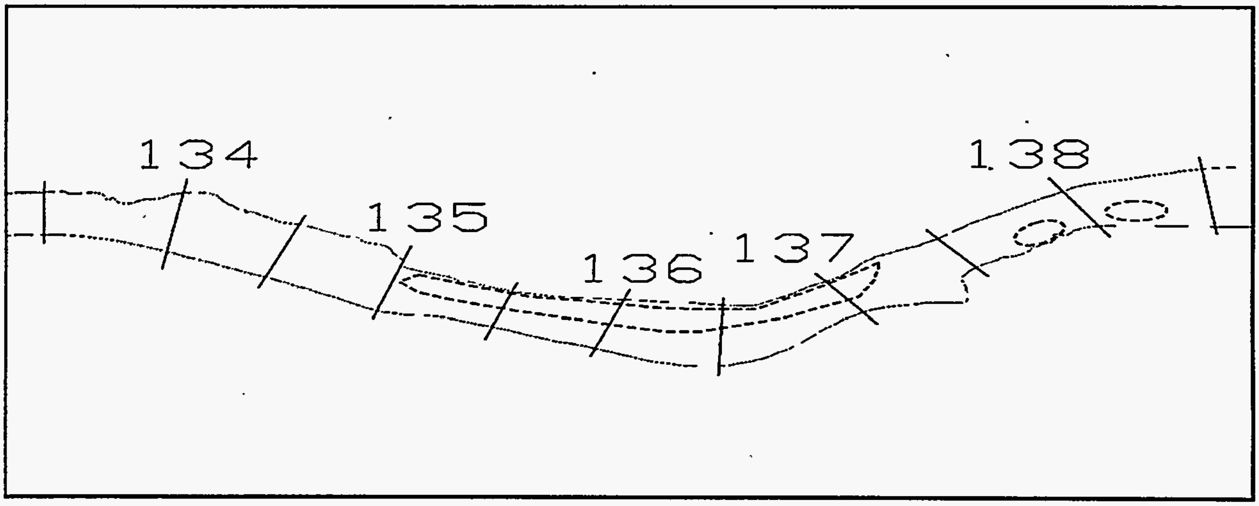


**Figure 2.** Example of Sediment Survey Locations Showing Single (Ellipse) and Composite (Polygon) Sample Stations

Note that the quality assurance (QA) records are NOT included in the database, but each of the concentrations reported include a QA code. These codes refer to the table conc_qual_code that describes the concentration qualifier. The reference for the sediment chemistry data is recorded in the Data Reference table. Related database tables are sed_analy_tab_1, sed_chemistry, sed_survey_stn, conc_qual_code, and chem_qa.

## 1.6 Hydrology

To analyze the effects of the various drawdown options, a number of different types of hydrologic data were created for the Lower Granite GIS. For each of three discharge rates, 30,000, 60,000, and 140,000 cfs, six different operable pool options, 738, 733, 700, 690, 681, and 623 ft were examined. Each of these flow rate/operable pools constituted a drawdown scenario. For each drawdown scenario, a number of different data were generated. The surface of the river was determined by initializing HEC-2 (USCOE 1990) for that scenario, and given the river elevations calculated by HEC-2, interpolating throughout the channel based on 1 ft contours of the bathymetry model. These polygons that represent the HEC-2 surface water profiles begin at river mile 107.5 and extend to river mile 139.5; individual polygons range from 0.25 to 2 miles in length. Travel times, velocity, pool elevations, and surface area are stored for each polygon. Related database tables are hec2_point, hec2_vel, and op_pool_cent.

While the surface water profiles derived from modelling were not as smooth as the natural river, it was a fast way to approximate the river surface within the GIS' vertical accuracy range. These river surfaces were then subtracted from the bathymetry to produce an isopach surface showing the depth of the reservoir for each drawdown scenario. These models were used to generate habitat (photic zone) change maps, bottom area calculations, and reservoir volume calculations. An example photic zone map for the Centennial Island reach is shown in Figure 3.

## 1.7 Future System Recommendations

### 1.7.1 Bathymetry

Through merging of the most recent data, we believe we have created the most accurate bathymetric data for the Lower Granite Reservoir. The creation of the bathymetry model was slow and tedious because of different data formats and the development of programs to manipulate the data. To increase the accuracy and reduce the cost of updating, we recommend that the following modifications be made to the sampling procedures:

1. Record each transect starting and ending point in latitude and longitude using Global Positioning System (GPS) technology. Latitude and longitude were not available for each of the cross-section points collected for the surface water modelling (HEC-2). Calculations were performed using known positions of shoreline monoliths; however, it was tedious and possibly not as accurate.

2. Decrease the amount of data collected with hydroacoustic soundings. Sounding files existed that would have been beneficial to incorporate into the bathymetric data; however, they were

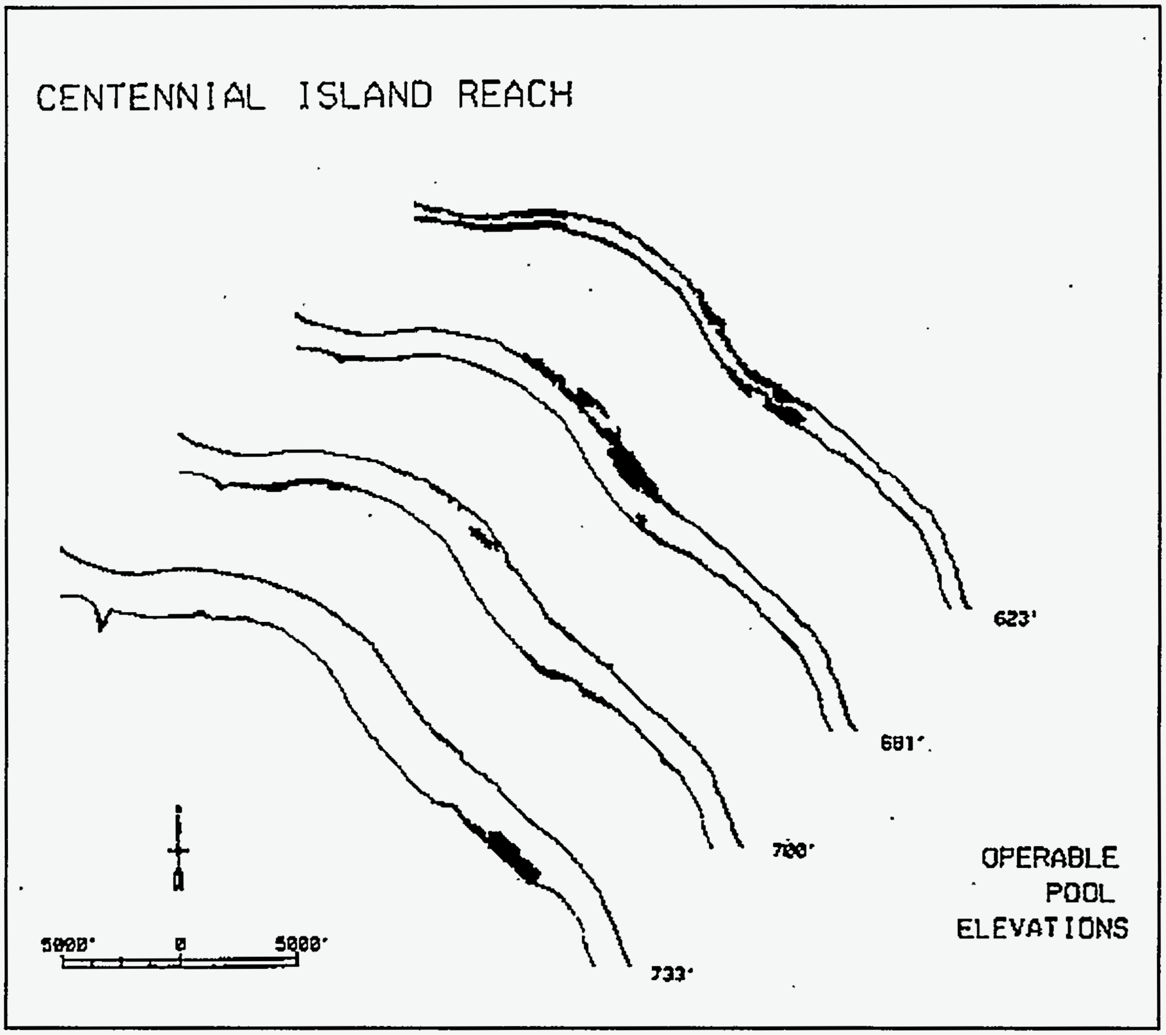


**Figure 3**. Photic Zones for the Centennial Island Reach, Based on the Lower Granite Bathymetry and Elevation from HEC-2 Simulations

excluded because the volume of data exceeded software limits and time constraints. This could have been avoided by decreasing the frequency of data capture during the sounding: these files captured approximately 60 soundings per second, and the capture rate could have been reduced by half without significantly affecting accuracy.

3. Explore technological advances for obtaining bathymetry. This includes aerial flights equipped with sonar and software packages like GeoLink (GeoLink Corp., Missoula, Montana) and BioSonics (BioSonics, Seattle, Washington) that will interface with GIS and hydroacoustic equipment.

### 1.7.2 Substrate

Substrate data were collected by Tom Curet (USCOE) and Dr. David Bennett (University of Idaho). The data were scattered point samples, and large portions of the river were unsampled.

Because interpolation of the substrate data was not feasible due to the data distribution, these data were of limited use in characterizing habitat. Other available substrate data were not used because of incompatible classification techniques. Recommendations for improving substrate data are:

1. Take substrate measurements in 5 to 10 ft intervals in crucial areas. It may be possible to interpolate substrate information at these intervals using additional information such as water velocity. In certain areas, use aerial photography to digitize underwater features (e.g., sandbars) and derive substrate information.

2. Standardize methods of collecting substrate data. It is recommended that future substrate data be gathered using the HEC-6 Classifications of Sediment Properties and Transport Functions. These classifications can be found in Appendix K.

3. For video and other photographic data collection, include a field notebook or other object for scale. This is especially important when characterizing surface/subsurface properties (e.g., substrate, vegetation, etc.).

4. Record each frame (or time for video) and the location on a log sheet.

5. Use differential GPS (within 2.5 m accuracy) for locating data points whenever possible.

### 1.7.3 Fish Distribution and Abundance

Monthly count/effort data were calculated using Dr. Bennett's data stored in a Lotus 1-2-3 (Lotus Development Corporation) spreadsheet. These data required manipulation before being loaded into ORACLE. Several suggestions that would reduce the amount of time required for data preparation are listed below:

1. Standardize fish station numbers. When entering data into the spreadsheet, pay close attention to syntax and case.

2. Create a LOTUS macro that calculates monthly catch/effort. When Dr. Bennett provides updates, there would be no need to have the individual records for each fish sampling effort; only one record per month would be required; this would reduce the processing time, space requirements, and the possibility of errors.

The ability to interpolate fish counts beyond the sampling station was desired; however, the sparsity of the sampling stations precluded interpolation of the data or calculations of volumetric fish counts. Several suggestions that may make these abilities feasible:

1. Explore sampling techniques that sample fish volumetrically, such as water column sampling.

2. Position fish sampling stations closer together. If stations are approximately 100 ft apart, interpolation is feasible.

### 1.7.4 Sediment Analysis

Because of the methods that were used to collect the sediment samples and report the analyses, inclusion of the data in the database was made more difficult. In particular, digitizing the sample areas in the GIS was difficult because many of the sampling stations were composited. The following guidelines would improve the data quality and expedite incorporation into the database and GIS:

1. Don't composite samples unless absolutely necessary; analysis of individual samples may provide more information, and samples may still be composited after individual analysis.

2. Sample locations should be well-defined in advance, and increased accuracy of sample locations can be achieved using differential GPS.

3. Analyze the samples for particle size if possible; this would supplement substrate information in the database.

### 1.7.5 Hydrology

Hydrologic data such as velocity were desired. Transects of the river were, at times, many miles apart, which precluded interpolation of the data. Recommendations to improve hydrologic data include:

1. Run transects in spacing equal to the width of the river channel. Georeference the starting and ending position of the boat. A test case was done using transects 25 ft apart; this data was easily interpolated, but data at this resolution does not exist for the entire reservoir.

2 Include velocity measurements in all field sampling efforts if the collection of the data does not increase field time or cost.

# 2.0 Data Dictionary

## 2.1 Overview

ORACLE software comprises the relational database used for the Lower Granite GIS. All tables have been normalized for more efficient storage, retrieval, and updating.

The following section describes the database tables and fields. There are two types of tables that can exist in Intergraph: 1) tables with graphic elements linked to them, and 2) tables that do not have graphic elements linked to them. For the first case, Intergraph requires the fields mapid and mslink to be present. Mslink is always defined as an integer without nulls and mapid is defined as an integer with nulls allowed. More details on these fields can be found under the specific table entries following this overview. The second type of table is used for relational joins to retrieve information from other tables.

The format for dictionary entries is tablename, fieldname, data type, and either a "not null" notation or blank. "Not null" means the field is a key field and blanks are not allowed. If "not null" does not appear after the fieldname, blanks are acceptable for that field.

**NOTE**: All river mile distances are defined in statute miles, unless otherwise indicated. "Julian Day" is actually day of the year: 1 to 365 for non-leap years and 1 to 366 for leap years.

## 2.2 Data Dictionary

**TABLE: bath_aspect_cent**

Defines the minimum and maximum aspect of the bathymetry. Linked to a graphic centroid.

**FIELD**: **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

**FIELD**: **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

**FIELD**: **aspect_min (double)**
Minimum aspect (degrees) in polygon.

**FIELD**: **aspect_max (double)**
Maximum aspect (degrees) in polygon.

**TABLENAME: bath_elev_cent**

Defines the minimum and maximum elevation of the bathymetry. Linked to a graphic centroid.

**FIELD:** **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

**FIELD:** **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

**FIELD:** **elev_min (double)**
Minimum elevation in polygon.

**FIELD:** **elev_max (double)**
Maximum elevation in polygon.

**TABLENAME: bath_slope_d_cent**

Defines the minimum and maximum slope in degrees in the bathymetry. Linked to a graphic centroid.

**FIELD:** **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

**FIELD:** **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

**FIELD:** **slope_min (double)**
Minimum slope (degrees) in polygon.

**FIELD:** **slope_max (double)**
Maximum slope (degrees) in polygon.

**TABLENAME: bath_slope_p_cent**

Defines the minimum and maximum slope in percent in the bathymetry. Linked to a graphic centroid.

FIELD: **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

FIELD: **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

FIELD: **slope_min (double)**
Minimum slope (percent) in polygon.

FIELD: **slope_max (double)**
Maximum slope (percent) in polygon.

**TABLENAME: bennett_stn_counts**

Contains fish count information obtained from Dr. Bennett, University of Idaho.

FIELD: **fish_station_no ( small integer) - not null**
Sampling fish station number as reported from Dr. Bennett's surveys. Key field used to join bennett_stn_prop and bennett_survey_stn tables.

FIELD: **survey_month (small integer) - not null**
Month that sample was taken. Key field used to join bennett_stn_prop and bennett_survey_stn tables.

FIELD: **survey_year (small integer) - not null**
Year that sample was taken. Key field used to join bennett_stn_prop and bennett_survey_stn tables.

FIELD: **julian_day (small integer)**
The number of the day of the year.

FIELD: **sampling_method (char 15)**
Method used to count fish. May be beach seine, gillnet, electrofish, or all gear.

FIELD: **species (char 35)**
Three letter abbreviation for species sampled. Abbreviations may be found in Appendix J.

FIELD: **mo_catch_effort (double)**
Catch per unit effort was determined (for Dr. Bennett's data) based on sample method, as follows.

- Bottom trawling, surface trawling and purse seining (towing): expressed as number of fish per meter of distance trawled/towed

- Beach seining: expressed as number of fish per haul
- Electrofishing: number of fish per 5 minute pass
- Gill netting: number of fish per hour gill netting.

**TABLENAME: bennett_stn_prop**

Defines the hydrological and physical properties at the fish sampling station on the sample day. Data source is Dr. Bennett, University of Idaho.

**FIELD:** **fish_station_no (small integer) - not null**
Sampling fish station number as reported from Dr. Bennett's surveys. Key field used to join bennett_stn_counts and bennett_survey_stn tables.

**FIELD:** **survey_month (small integer) - not null**
Month that sample was taken. Key field used to join bennett_stn_counts and bennett_survey_stn tables.

**FIELD:** **survey_year (small integer) - not null**
Year that sample was taken. Key field used to join bennett_stn_counts and bennett_survey_stn tables.

**FIELD:** **substrate (char 25)**
Characterization of the dominant substrate type at the fish station on the sample day.

**FIELD:** **velocity (double)**
The speed at which the water is moving at the fish station on the sample day. If multiple samples were taken that month, velocity measurements were averaged.

**FIELD:** **dissolved_oxygen (double)**
The dissolved oxygen measurement at the fish station on the sample day. If multiple samples were taken that month, dissolved oxygen levels were averaged..

**FIELD:** **temperature (double)**
The temperature in degrees fahrenheit at the fish station on the sample day. If multiple samples were taken that month, temperatures were averaged.

**FIELD:** **turbidity (double)**
Measurement of turbidity at the fish station on the sample day. If multiple samples were taken that month, turbidity measurements were averaged.

**FIELD:** **julian_day (small integer)**
The number of days that have elapsed since January 1st (i.e., February 1st = 32nd day).

**TABLENAME: bennett_survey_stn**

Defines the physical location and properties of the Dr. Bennett's fish sampling station. Contains graphic link that identifies survey station location.

**FIELD:** **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

**FIELD:** **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

**FIELD:** **fish_station_no (small integer) - not null**
Sampling fish station number as reported from Dr. Bennett's surveys. Key field that links table to bennett_stn_prop and bennett_stn_counts.

**FIELD:** **river_mile (double)**
River mile of fish sampling station indicated in Dr. Bennett's surveys. If river mile was indicated as range, the mid-point was taken.

**FIELD:** **year_constructed (small integer)**
The year the fish sampling station was constructed, as indicated in Dr. Bennett's surveys.

**FIELD:** **northing (double)**
Universal Transverse Mercator (UTM) northing coordinate of fish sampling station obtained during field studies using a GPS unit.

**FIELD:** **easting (double)**
UTM easting coordinate of fish sampling station obtained during field studies using a GPS unit.

**FIELD:** **stn_description (char 150)**
Textual description of fish station location as found in Dr. Bennett's survey reports.

**FIELD:** **year_first_sampled (small integer)**
The year the fish station was first sampled.

**FIELD:** **latitude (double)**
The latitudinal position of the fish station.

**FIELD:** **longitude (double)**
The longitudinal position of the fish station.

**FIELD:** **naut_river_mile (double)**
1 nautical mile = 1.151 statute miles (Espenshade, Jr. and Morrison 1978).

**TABLENAME: birds**

Defines species and nest dates of birds and contains graphic link for identifying nest location.

**FIELD:** **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

**FIELD:** **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

**FIELD:** **species (char 30) not null**

**FIELD:** **nest_date (char 30)**

**TABLENAME: conc_qual_code**

**FIELD:** **qualifier (char 2) not null**
The concentration qualifier code which links the description below to the sediment analysis table (see sed_analy_tab_1).

**FIELD:** **qual_description (char 200)**
A description of the significance (data quality) of a reported chemical concentration.

**TABLENAME: curet_substrat_stn**

**FIELD:** **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

**FIELD:** **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

**FIELD:** **river_mile (real) not null**
The sediment sampling location in statute river miles.

FIELD: **shore_direction (char 2) not null**
This indicates whether the sampling location was on the north (N) or south (S) shore of the river.

FIELD: **naut_river_mile (real)**
The sediment sampling location in nautical river miles, determined as 1.151 times the statute river mile.

**TABLENAME: curet_substrate**

FIELD: **river_mile (real) not null**
The statute river mile of the sampling location; the river mile and shore direction (below) link the records in this table to the curet_substrat_stn table.

FIELD: **shore_direction (char 2) not null**
This indicates whether the sampling location was on the north (N) or south (S) shore of the river.

FIELD: **size_range (char 20)**
The particle size range (in mm) of the exposed gravel and sediments.

FIELD: **substrate_type (char 30)**
The particle type (fine grains, cobbles, etc.).

FIELD: **embedded quartile (small integer)**
The degree of embeddedness (large particles embedded in finegrains) expressed in terms of 0-25% (recorded as 1), 25-50% (2), etc.

FIELD: **cover_quartile (small integer)**
The amount of cover from predation (boulders, tree limbs, etc.) expressed in terms of 0-25% (recorded as 1), 25-50% (recorded as 2), etc.

FIELD: **area_of polygon (real)**
The area contained by the sampling area.

**TABLENAME: depth_cent**

FIELD: **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

FIELD: **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

FIELD: **oper_pool_elev (small integer)**
Operating pool elevation (in feet) of Lower Granite Dam.

FIELD: **flow_rate_kcfs (integer)**
Rate of flow of Lower Granite Dam in kcfs.

FIELD: **reservoir (small integer)**
????

FIELD: **depth_min (double)**
Minimum depth (feet) in polygon under flow rate and operating pool elevation indicated.

FIELD: **depth_max (double)**
Maximum depth (feet) in polygon under flow rate and operating pool elevation indicated.

**TABLENAME: fish_pass_counts**

Defines fish passage counts for Lower Granite Reservoir. Data source: USCOE.

FIELD: **passage_name (char 35) not null**
Name given to area that fish pass through to reach Lower Granite Reservoir and the Snake River. Key field used to link to table fish_passage.

FIELD: **julian_day (small integer) not null**
The number of days that have elapsed since January 1st (i.e., February 1st = 32nd day).

FIELD: **survey_year (small integer) not null**
Year that sample was taken.

FIELD: **species (char 35) not null**
3 letter abbreviation for species sampled. Abbreviations may be found in Appendix J.

FIELD: **stock_type (char 10)**
Describes stock type of fish being either wild or hatchery.

FIELD: **age (char 15)**
Describes age of fish being either yearling or subyearling.

FIELD: **fish_count (double)**
Number of fish counted at passage point within a specific year, day, and species.

FIELD: **flow (double)**
Flow rate in kcfs, of Lower Granite Dam on the day the specific count was taken.

FIELD: **temperature (double)**
Temperature at the passage on the day of the fish count.

FIELD: **turbidity (double)**
Turbidity at the passage on the day of the fish count.

**TABLENAME: fish_passage**

Table that contains the fish passage name and description and graphic link to identify fish station location. Data source: USCOE.

FIELD: **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

FIELD: **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

FIELD: **passage_name (char 35) not null**
Name given to area that fish pass through to reach Lower Granite Reservoir and the Snake River. Key field used to link table to fish_pass_counts.

FIELD: **passage_desc (char 35)**
Description of area that fish pass through to reach Lower Granite Reservoir and the Snake River.

**TABLENAME: half_mile_info**

A tables used to define half-mile markers along river.

FIELD: **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

FIELD: **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

FIELD: **naut_river_mile (double) not null**
Nautical river mile number. 1 nautical mile = 1.151 statute miles (Espenshade, Jr. and Morrison 1978). Used for labels in graphics.

FIELD: **stat_river_mile (double)**
Statute river mile number. Used for labels in graphics.

**TABLENAME: hec2_point**

FIELD: **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

FIELD: **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

FIELD: **statute_mile (double) not null**
Statute river mile number of graphic point. Used for reference in hydrological map layers.

FIELD: **naut_river_mile (double)**
One nautical mile = 1.151 statute miles (Espenshade, Jr. and Morrison 1978).

FIELD: **oper_pool_elev (small integer)**
Operating pool elevation (in feet) of Lower Granite Dam.

FIELD: **flow_rate_kcfs (integer)**
Rate of flow of Lower Granite Dam in kcfs.

**TABLENAME: hec2_vel**

Defines hydrological information from Hec-2 software.

FIELD: **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

FIELD: **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

FIELD: **statute_mile (double) not null**
Statute river mile number of graphic point. Used for reference in hydrological map layers.

**FIELD:** **oper_pool_elev (small integer)**
Operating pool elevation (in feet) of Lower Granite Dam.

**FIELD:** **naut_river_mile (double)**
Nautical river mile number. Used for reference in hydrological map layers. 1 nautical mile = 1.151 statute mile (Espenshade, Jr. and Morrison 1978).

**FIELD:** **flow_rate_kcfs (integer)**
Rate of flow in kcfs of Lower Granite Dam used for modelling the hec2 run.

**FIELD:** **river_mile**
The cross section river mile, in statute miles.

**FIELD:** **travel_time (double)**
Amount of time in hours that it takes to travel from river mile A to river mile B.

**FIELD:** **velocity (double)**
Average velocity in kcfs of the segment of river defined by the polygon.

**FIELD:** **surface_area (double)**
Surface area in acres of the segment of river defined by the polygon.

**FIELD:** **pool_elev (double)**
Average pool elevation of the segment of river defined by the polygon.

**FIELD:** **pct_chg_velocity (double)**
Percent of change in average velocity from river mile A to river mile B.

**FIELD:** **dist_btwn_hec_rm (double)**
The distance in miles between river mile A and river mile B. The Hec2 programs divide the river into varying lengths.

**FIELD:** **velo_difference (double)**
Difference in velocity in kcfs of river mile A and river mile B.

**FIELD:** **diff_div_dist (double)**
The velocity difference divided by the distance between HEC-2 river mile A and B.

**FIELD:** **area_of_polygon (double)**
Area in feet of specific polygon.

**TABLENAME: mammals**

Defines the mammal species and location.

FIELD: **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

FIELD: **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

FIELD: **species (char 30) not null**
The Genus and species name of the mammal.

| TABLENAME: op_pool_cent |
|---|

Defines operating pool and flow rate of Lower Granite Dam and contains graphical centroid.

FIELD: **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

FIELD: **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

FIELD: **oper_pool_elev (small integer) not null**
Operating pool elevation (in feet) of Lower Granite Dam.

FIELD: **flow_rate_kcfs (integer) not null**
Flow rate (kcfs) of Lower Granite Dam.

| TABLENAME: photic_cent |
|---|

Defines the photic zones under a certain operating pool elevation. Linked to a graphic centroid.

FIELD: **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

FIELD: **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

FIELD: **oper_pool_elev (small integer)**
Operating pool elevation (in feet) of Lower Granite Dam.

**TABLENAME: sed_analy_tab_1**

Contains detailed information on the sediment analysis results.

**FIELD:** **sampling_stn (char 25) not null**
The name of the sediment chemistry sampling station; this field links these records to the sed_survey_stn table.

**FIELD:** **chemical (char 50) not null**
The chemical being reported in this record; each chemical analysis for each sample is reported in a separate record.

**FIELD:** **sample_type (char 10)**
This field indicates whether the sample was a normal sample, or a type of QA record (such as trip blanks, field replicates, etc.).

**FIELD:** **concentration (real)**
The chemical concentration reported for this sample.

**FIELD:** **conc_units (char 25)**
The units of that the chemical concentration are reported in.

**FIELD:** **conc_qa (char 10)**
The QA code which describes the accuracy of the concentration; this code is linked to the conc_qual_code table.

**FIELD:** **comments (char 100)**
This field contains special notes, comments, etc.

**TABLENAME: sed_survey_stn**

Defines the location of the sediment chemistry sampling station.

**FIELD:** **mslink (integer) not null**
An Intergraph required field for tables that contain graphic elements. A unique value that links graphic elements to the database.

**FIELD:** **mapid (integer)**
An Intergraph required field for tables that contain graphic elements. Identifies the map (design file) that contains the graphic element associated with the database record.

**FIELD:** **sampling_stn (char 25) not null**
The name of the sediment chemistry sampling station; this field links these records to the sed_analy_tab_1 table.

**FIELD:** **river_mile (real) not null**
The statute river mile of the sediment chemistry sampling location.

**FIELD:** **northing (real)**
The Washington State Plane South zone Northing (in feet) of the sample station location.

**FIELD:** **easting (real)**
The Washington State Plane South zone Easting (in feet) of the sample station location.

**FIELD:** **stn_description (char 75)**
The description of the station location.

**FIELD:** **latitude (real)**
The latitude (in degrees) of the sample station location.

**FIELD:** **longitude (real)**
The longitude (in degrees) of the sample station location.

# 3.0 References

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Bennett, D. H., L. K. Dunsmoor, and J. A. Chandler. 1988. *Fish and Community Abundance at Proposed In-Water Disposal Sites, Lower Granite Reservoir (1987)*. Completion Report, with Addendum, prepared for the U.S. Army Corps of Engineers - Walla Walla District, Walla Walla, Washington.

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Pinza, M. R., J. Q. Word, E. S. Barrows, H. L. Mayhew, and D. R. Clark. 1992. *Snake and Columbia Rivers Sediment Sampling Project*. PNL-8479, prepared for the U.S. Army Corps of Engineers - Walla Walla District by Pacific Northwest Laboratory, Richland, Washington.

U.S. Army Corps of Engineers. 1990. *Water Surface Profiles Users' Manual*. USCOE Hydrologic Engineering Center, Davis, California.

# Appendix A

## Conversion of Water Depth Contours to Elevations for PV-WAVE

# Appendix A

## Conversion of Water Depth Contours to Elevations for PV-WAVE

```
LG_grid=intarr(3520,3170)
openr,1,'/files8/guy/tmp/bathymetry.739shore.V2'
readu,1,LG_grid
close,1

min_z = min(LG_grid)
max_z = max(LG_grid)

interval=[608,618,628,638,648,658,668,678,688,698,708,718,728,738]

contour,LG_grid,/follow,/spline,levels=interval,$
path='whole_river_contour.PVout'

pnl_contour_out_12,'whole_river_contour.PVout','whole_river_contour_data'
```

# Appendix B

# Conversion of Shoreline Monolith Data to Latitude, Longitude

# Appendix B

## Conversion of Shoreline Monolith Data to Latitude, Longitude

process_hec_2xy.f

Read HEC-2 data and convert coordinates to latitude and longitude. Interpolate HEC-2 data cross-sections.

```
      implicit none
      integer maxmon, maxsect, maxinsect, maxsectmon
      parameter         (maxmon=150, maxsect=150, maxinsect=700,
     +                   maxsectmon=8)
c
      character*40      fnmono, fn89, fnout
      character*80      buffer(maxsect), tembuf, xshead
      character*160     sectbuff
      integer           iunmn, iun89, oun, linecount, rivmile, rivindex,
     +                  nskip, i,j, ip
      real              rivermile(maxmon), xsrivermile, numstations,
     +                  station_elev(maxinsect), station(maxinsect),
     +                  start_station,end_station
      integer           monindex(maxmon),
     +                  numrecs, num_extra_stations,
     +                  station_index, ib,ie, xscount,
     +                  curr_index, ic, rm, ind1, ind2, old_rm
      real              monelev(maxsectmon), diff, maxdiff,
     +                  rivmaltb, noraltb, eastaltb, elevaltb, stationaltb
      character*3       rivshorealtb
      double precision  monx(maxsectmon), mony(maxsectmon),
     +                  monstation(maxsectmon), xstart,ystart,zstart,
     +                  xend,yend,zend, start_dist, xout, yout
      logical           endfile, found, same_rm, altformb
c
c read the file names and open the 1) monolith coordinate file, 2) the 1989 cross-sections file, and
c  3) the output file
c
      iunmn = 11
      iun89 = 13
      oun = 21
      write(*,*)' '
      write(*,*)' Enter File Names'
```

```
      write(*,*)' Enter Monolith Coordinate File Name'
      read(*,100) fnmono
      open(iunmn,file=fnmono,status='old')
C
      write(*,*)' Enter Cross-Section File Name'
      read(*,100) fn89
      open(iun89,file=fn89,status='old')
C
      write(*,*)' Enter output File Name'
      read(*,100) fnout
      open(oun,file=fnout,status='unknown')
C
      endfile = .false.
      linecount = 1
      altformb = .false.
      rivindex = 0
      write(*,*)' '
C
      write(*,*)' '
      write(*,*)' Read Monolith File'
      do 10 while(.not.endfile)
       read(iunmn,110,end=99) buffer(linecount)
       if(mod(linecount,100).eq.0) write(*,*)' At Monument File line # ',
     +          linecount
C
       tembuf = buffer(linecount)
C
       if(linecount.eq.1) then
        if(tembuf(1:2) .eq. 'RM') then
         write(*,*)' Alternative Monolith File Format B'
         altformb = .true.
        endif
       endif
C
       if(altformb) then
        read(tembuf(3:9),*) rivmaltb
        read(tembuf(10:12),511) rivshorealtb
        read(tembuf(12:49),*,err=999) noraltb, eastaltb, elevaltb
        read(tembuf(50:56),*,err=999) stationaltb
C
        rivmile = rivmaltb * 100.
        write(tembuf,500) noraltb, eastaltb, elevaltb, stationaltb
        write(tembuf(57:61),'(i5)') rivmile
        buffer(linecount) = tembuf
       else
        read(tembuf(57:61),*,err=999)  rivmile
       endif
```

```
C
      if(endfile) then
 999        continue
C           write(*,*)' Error reading rivermile from buffer!'
        rivmile = 0
      endif
C
      if(rivmile.gt.0) then
        rivindex = rivindex + 1
        rivermile(rivindex) = float(rivmile/100.)
        monindex(rivindex) = linecount
        if(rivindex.eq.1 .or. mod(rivindex,20).eq.0) then
                          write(*,*)' At Monument # ',rivindex
                          write(*,*)' Rivermile =    ',rivermile(rivindex)
                          write(*,*)' River Index = ',monindex(rivindex)
        endif
      endif
C
      linecount = linecount + 1
      if(endfile) then
  99        continue
        endfile = .true.
      endif
C
  10    continue
     close(iunmn)
     linecount = linecount - 1
     write(*,*)' '
     write(*,*)' ',linecount,' Monument lines Read In'
     write(*,*)' ',rivindex,' River Mile Monuments Counted'
     write(*,*)' '
C
C ******************************************************************
C  read in the cross-sections from the 1989 cross-sections file
C      the first nskip lines of the file are comments and HEC stuff
C
     nskip = 1
     read(iun89,110) tembuf
     do 20 while(tembuf(1:2).ne.'X1')
       read(iun89,110) tembuf
       nskip = nskip + 1
  20    continue
     write(*,*)' SKIP FIRST ',nskip-1,' Lines of the File'
C
     endfile = .false.
     xscount = 0
C
```

```
      write(*,*)' '
      write(*,*)' Read Cross-Sections File'
      xshead = tembuf
      do 30 while(.not. endfile)
 779      if(xscount.gt.0) read(iun89,110,end=98) xshead
        if(xshead(1:2).ne.'X1') then
          if(xshead(1:1).eq.'*') go to 779
          write(*,*)' At XSECTION = ',xscount + 1
          write(*,*)' Header line incorrect'
          write(*,*) xshead
          stop' CRASHH and BURN Babe!'
        endif
        read(xshead,300) xsrivermile, numstations, start_station,
     +            end_station
        xscount = xscount + 1
        if(xscount.eq.1 .or. mod(xscount,25).eq.0) then
                          write(*,*)' At Cross Section # ',xscount
                          write(*,*)' At Rivermile = ',xsrivermile
                          write(*,*)' Number of Stations in Xsect = ',numstations
        endif
C
C    the number of records to read for this cross section is the
C    total number of stations divided by 5 stations per line.
C    any extra stations are counted separately.
C
        numrecs = int(numstations / 5)
        num_extra_stations = numstations - (numrecs*5)
C
C   read in the values for the cross-section
C
        station_index = 1
        do 35 i=1,numrecs
 78          read(iun89,110) sectbuff(1:80)
          if(sectbuff(1:2).ne.'GR') go to 78
C
C   check for the B revision format of GR files with all
C       five coordinate pairs on one line (instead of 2 lines)
C
          if(sectbuff(80:80).eq.' ') then
            read(iun89,110) sectbuff(75:154)
          endif
          ib = station_index
          ie = ib + 5 - 1
          read(sectbuff(3:80),*) (station_elev(j),station(j),j=ib,ie)
          station_index = ie + 1
 35        continue
        station_index = station_index - 1
```

```
C
C  if extra stations in the next record, read them
C
      if(num_extra_stations.gt.0)then
        read(iun89,110) sectbuff(1:80)
        ib = station_index + 1
        ie = ib + num_extra_stations - 1
        read(sectbuff(3:80),*) (station_elev(j),station(j),j=ib,ie)
        station_index = ie
      endif
C
C         if(xscount.eq.1 .or. mod(xscount,25).eq.0) then
C           write(*,*)' numrecs, num_extra_stations = ',numrecs,
C    +           num_extra_stations
C           write(*,*)' Number of stations read = ',station_index
C           write(*,410) (station_elev(j),station(j),j=1,station_index)
C         endif
C
C  ***************************************************************
C  Translate the station numbers to State Plane Coordinates in Feet
C     for this cross-section
C     search through the rivermiles list read in for the monument
C     coordinates (through 'rivindex' points), find the matching coordinates
C     for the current cross section
C
      found = .false.
      curr_index = 0
      do 44 while(.not. found .and. curr_index.lt.rivindex)
        curr_index = curr_index + 1
        if(xsrivermile .eq. rivermile(curr_index)) then
          found = .true.
        endif
 44     continue
      if(.not. found) then
        write(*,*)' '
        write(*,*)' Cross Section River Mile ',xsrivermile,
     +            ' NOT Found'
        write(*,*)' NO Output generated for this Cross-Section'
      else
        write(*,*)' Found Cross-Section at RM ',xsrivermile
C
C  the index back to the monolith buffer array is monindex(curr_index).
C     this character array and the next 1-5 contain the XY Coordinates of the
C     monoliths used for the end points of the current cross-section
C
C     IF the Monolith elevation cannot be read, then you are in a new RM,
C     If you CAN read a Rivermile number and it is not the first record, then
```

```
C       you are at a new rivermile.  IP is the number of monolith entries for
C       this rivermile after the current index counter.
C  NOTE: Monitor file is Nothings THEN Eastings (Y,X)
C
        same_rm = .true.
        ic = monindex(curr_index)
        ip = 1
        do 55 while(same_rm)
          tembuf = buffer(ic)
          read(tembuf,500,err=598) mony(ip), monx(ip),
     +               monelev(ip), monstation(ip)
          if(monelev(ip).le.0.0) go to 598
          ip = ip + 1
          read(tembuf(57:61),*,err=599) rm
     write(*,*)' RM = ', rm
          if(ip.eq.1) then
                    old_rm = rm
          else if(rm.eq.old_rm) then
                    go to 599
          endif
          if(ip.ne.2) then
                    ip = ip - 1
                    same_rm = .false.
                    go to 599
          endif
C
          if(.not. same_rm) then
 598         continue
                    ip = ip - 1
                    same_rm = .false.
          endif
C
          if(.not. same_rm) then
 599         continue
          endif
C
          ic = ic + 1
 55       continue
C
     write(*,*)' ip = ',ip
     do 888 i=1,ip
       write(*,*)monx(i), mony(i), monelev(i),monstation(i)
 888  continue
C
C   *************************************************************
C     NOW we actually get to do some work on the data !
C
```

```
C       1) Determine which 2 of the IP monoliths are closest to the ones
C          used for this Cross-Section
C       2) Use these 2 monoliths to interpolate the XY locations of all the
C          points across the Cross-Section
C
        if(ip.gt.2) then
         maxdiff = 1.0e+8
         do 777 i=1,ip
                   diff = abs(start_station - monstation(i))
                   if(diff .lt. maxdiff) then
                    maxdiff = diff
                    ind1 = i
                   endif
 777      continue
C
         maxdiff = 1.0e+16
         do 778 i=1,ip
                   diff = abs(end_station - monstation(i))
                   if(diff .lt. maxdiff) then
                    maxdiff = diff
                    ind2 = i
                   endif
 778      continue
C
        else
C
C  if only two monolith points, assume are in correct order (?)
C
         ind1 = 1
         ind2 = 2
        endif
C
        xstart = monx(ind1)
        ystart = mony(ind1)
        zstart = monelev(ind1)
        start_dist = monstation(ind1)
        xend = monx(ind2)
        yend = mony(ind2)
        zend = monelev(ind2)
        if(xsrivermile.eq.103.57.or. xsrivermile.eq.104.26) then
     write(*,*)' xsrivermile = ',xsrivermile
     write(*,*)' ip, ind1, ind2 = ',ip,ind1, ind2
     write(*,*) 'xstart,ystart,zstart,start_dist = '
     +          ,xstart,ystart,zstart,start_dist
     write(*,*)' xend,yend,zend = ',xend,yend,zend
        endif
```

```
C   For each of the points of the Cross-Section, calculate the XY
C     position of the point.
C
         do 666 i=1,numstations
           call interp_xy(xstart,ystart,xend,yend,start_dist,
    +                   station(i),xout,yout)
           write(oun,600) xout,yout,station_elev(i),xsrivermile
 666       continue
C
       endif
C
       if(endfile) then
 98        continue
         endfile = .true.
       endif
C
 30    continue
C
     close(iun89)
     close(oun)
C
C ***************************
C Format Statements
C
 100   format(a40)
 110   format(a80)
 300   format(2x,f6.2,4x,f5.0,2f8.1)
 410   format(2x,5(f6.1,2x,f6.1,2x),/)
 500   format(f10.2,5x,f10.2,3x,f7.2,26x,f8.2)
 511   format(a3)
 515   format(f7.2)
 600   format(1x,2f12.2,f12.4,f12.4)
C
     stop
     end
C
C *****************************************************************
     subroutine interp_xy(x1,y1,x2,y2,d1, distin, xout,yout)
C
     implicit none
C
     double precision        x1,y1,x2,y2, d1, xout,yout
     real            distin
     real            line_dist, delx,dely, deldist, prop
C
     line_dist = distin - d1
     delx = x1 - x2
```

```
      dely = y1 - y2
      deldist = sqrt(delx**2 + dely**2)
      if(deldist.eq.0.0) then
        xout = x1
        yout = y1
        return
      endif
C
      prop = line_dist / deldist
C
      xout = x1 - (delx*prop)
      yout = y1 - (dely*prop)
C        write(*,*)' distin,line_dist, d1 = ',distin,line_dist, d1
C        write(*,*)' delx,dely,deldist,prop = ',
C     +           delx,dely,deldist,prop
C        write(*,*)' Xout,yout = ', Xout,yout
C
      return
      end
```

# Appendix C

# Example from USCOE HEC-2 Modeling Runs

# Appendix C

## Example from USCOE HEC-2 Modeling Runs

```
*    SNAKE RIVER SET UP FOR NATURAL CONDITIONS- DAMS NOT IN PLACE
*    SECTIONS FROM MOUTH TO ICE HARBOR SURVEYED
*    SECTIONS FROM ICE HARBOR TO RM 101 BASED ON 1935-57 RIVER SOUNDING
*    AND TOPOGRAPHY MAPS
*    SECTIONS FORM 101.87 TO LOWER GRANITE DAM FROM 1987 LITTLE GOOSE
SURV.
*    SECTIONS FROM LOWER GRANITE DAM UPSTREAM:  1989 HYDROGRAPHIC
SURVEYS.
T1    SNAKE RIVER FROM COLUMBIA-SNAKE CONFLUENCE TO SNAKE RIVER MILE
148.83
T2        21 JUNE 91
T3
J1   -10     2     0     0     0     0     0     0   337.0
0
J2   -1     0    -1

J3   38    43     1     2     3    11    12     8    42
39
J3    0    38    55    26    56    13    14    15    25

J5   -10    -10
QT    8  20000.  25000.  30000.  35000.  40000.  45000.  50000.  55000.

NC 0.040   0.040   0.028   0.10   0.30

NC              .028
X1   0.1     21    2690    5928    0000    0000    0000
GR 347.6    2666   340.4   2690   336.8   2962   330.3   3113   322.8
3200
GR 317.6    3400   317.1   3601   315.0   3779   292.5   4001   287.5
4200
GR 285.1    4399   288.3   4600   291.3   4800   299.4   5000   305.4
5200
GR 308.1    5400   307.6   5600   308.9   5775   321.3   5870   340.3
5928
GR 345.2    5936
X1 1.91     026    100    1582    9630    9630    9630
GR 340.0      0   336.0     20   337.4     22   336.5     60   334.3
```

100
GR 328.7 118 329.0 138 330.8 154 329.0 165 327.0
218
GR 318.2 380 316.2 550 317.0 700 318.0 800 317.3
946
GR 315.0 1000 305.0 1125 302.5 1184 301.5 1363 306.5
1406
GR 305.6 1427 321.2 1580 337.0 1582 340.0 1631 343.0
1640
GR 347.3 1690
X1 2.86 027 80 1815 5100 5500 5570
GR 351.2 0 349.0 10 341.3 20 335.2 80 324.0
100
GR 312.0 230 311.8 477 309.0 611 309.0 690 311.0
720
GR 324.8 830 324.8 848 322.1 880 322.2 912 327.5
1092
GR 327.2 1120 322.0 1157 322.6 1200 330.0 1322 326.0
1375
GR 329.0 1400 330.3 1437 325.7 1531 317.8 1604 317.2
1700
GR 323.2 1762 340.0 1815
X1 3.84 029 82 2822 5200 5400 5240
GR 344.4 0 336.0 40 325.0 82 317.7 243 321.0
375
GR 310.0 520 310.0 577 319.8 676 322.2 800 322.2
1000
GR 323.3 1088 335.4 1140 337.8 1192 336.0 1243 339.0
1308
GR 336.9 1380 332.0 1427 339.0 1578 335.8 1636 341.0
1705
GR 341.7 1848 343.4 1897 342.0 2206 335.2 2332 317.8
2632
GR 318.0 2762 319.9 2790 331.8 2822 338.5 2903
X1 5.09 21 292 1920 6700 7500 7190
GR 338.5 0 337.0 62 334.0 227 336.8 292 327.5
380
GR 321.8 575 326.0 620 321.4 730 320.0 792 322.0
802
GR 321.5 835 319.0 945 320.8 972 320.0 1021 329.0
1078
GR 327.8 1102 327.0 1343 328.5 1780 334.3 1857 345.8
1920
GR 356.7 1932
X1 5.84 27 67 1379 4200 4500 4370
GR 338.4 0 333.3 67 332.5 278 334 415 328.7
592

GR 329.2 641 328.7 662 329.8 680 323.4 690 318.6
703
GR 313.5 748 313.8 778 318.4 800 329.0 817 331.3
842
GR 326.9 867 332.0 912 330.0 930 332.2 1083 331.2
1097
GR 321.8 1109 320.8 1119 320.8 1177 320.0 1350 338.5
1379
GR 347.5 1427 352.5 1440
X1 6.15 16 0 1586 2350 2350 2350
GR 340.1 0 336.2 20 331.7 130 327.7 313 327.7
438
GR 330.0 600 333.3 878 333.5 1110 332.8 1195 322.0
1253
GR 322.8 1285 320.0 1453 323.2 1526 335.5 1547 340.3
1586
GR 355.9 1627
X1 6.79 31 0 1418 2790 2790 2770
GR 340.4 0 336.7 20 328.8 167 327.0 180 327.8
220
GR 331.8 233 330.0 305 331.9 355 331.2 380 330.0
500
GR 329.6 661 332.0 706 327.0 715 331.5 762 332.0
870
GR 325.8 887 326.0 915 329.0 922 329.0 932 326.7
937
GR 326.0 965 330.3 992 328.3 1087 322.4 1145 321.0
1360.
GR 323.0 1387 336.7 1405 338.0 1418 336.0 1425 349.0
1470
GR 361.0 1485
X1 7.17 18 720 2200 730 730 730
GR400.00 570.00 340.00 720.00 331.00 770.00 330.30 970.00 329.80
1170.00
GR329.10 1320.00 324.60 1420.00 322.20 1520.00 330.00 1800.00 328.00
1885.00
GR318.00 1912.00 318.20 1995.00 320.00 2012.00 323.00 2164.00 337.00
2190.00
GR342.00 2200.00 350.00 2320.00 360.00 3000.00
X1 7.27 24 670 2200 530 530 530
GR400.00 520.00 342.00 670.00 332.00 700.00 330.90 730.00 329.00
800.00
GR330.60 970.00 328.40 1070.00 329.70 1220.00 329.00 1270.00 325.80
1420.00
GR326.10 1470.00 326.10 1630.00 328.00 1720.00 330.00 1780.00 328.00
1885.00
GR318.00 1912.00 318.20 1995.00 320.00 2012.00 323.00 2164.00 337.00

2176.00
GR341.00 2190.00 342.00 2200.00 350.00 2320.00 360.00 3000.00
X1 7.46 19 670 2200 1000 1000 1000
GR400.00 520.00 342.00 670.00 332.00 700.00 330.90 730.00 329.00
800.00
GR335.10 1280.00 333.30 1380.00 331.00 1500.00 329.30 1650.00 330.00
1800.00
GR328.00 1885.00 318.00 1912.00 318.20 1995.00 320.00 2012.00 323.00
2164.00
GR337.00 2176.00 342.00 2200.00 350.00 2320.00 360.00 3000.00
X1 7.84 25 570 2170 2000 2000 2000
GR360.00 420.00 350.00 540.00 340.00 570.00 336.40 600.00 334.00
660.00
GR335.60 780.00 334.40 950.00 336.50 1100.00 334.00 1200.00 331.50
1300.00
GR335.00 1400.00 334.00 1600.00 336.00 1700.00 335.00 1770.00 330.00
1830.00
GR327.50 1862.00 315.50 1896.00 316.00 2019.00 317.00 2052.00 316.00
2150.00
GR330.00 2160.00 335.00 2170.00 340.00 2180.00 350.00 2200.00 400.00
2975.00
X1 8.03 27 580 2190 1000 1000 1000
GR400.00 380.00 342.00 580.00 335.00 600.00 330.00 610.00 329.20
700.00
GR330.00 770.00 335.00 810.00 342.00 860.00 348.50 1000.00 342.00
1110.00
GR336.20 1170.00 331.00 1270.00 331.80 1350.00 331.00 1460.00 332.00
1570.00
GR334.40 1660.00 333.40 1820.00 332.50 1852.00 315.20 1896.00 315.00
1950.00
GR316.50 1995.00 315.40 2054.00 316.20 2145.00 328.00 2166.00 342.00
2190.00
GR350.00 2220.00 400.00 2500.00
X1 8.41 21 1190 2200 2000 2000 2000
GR400.00 260.00 341.80 410.00 335.00 470.00 334.00 600.00 335.00
670.00
GR340.00 720.00 345.00 1000.00 340.00 1190.00 335.00 1410.00 330.00
1640.00
GR329.30 1700.00 331.90 1800.00 333.20 1831.00 318.40 1879.00 316.50
1935.00
GR318.00 2002.00 318.00 2162.00 333.00 2180.00 340.00 2200.00 350.00
2220.00
GR400.00 2500.00
X1 8.60 15 850 2184 1000 1000 1000
GR380.00 250.00 360.00 780.00 340.00 850.00 337.00 950.00 335.00
1150.00
GR334.30 1550.00 330.00 1700.00 328.00 1860.00 316.20 1884.00 318.30

1990.00
GR316.00 2068.00 318.00 2165.00 341.60 2184.00 350.00 2250.00 400.00
2500.00
X1 8.79 19 990 2240 1000 1000 1000
GR380.00 740.00 370.00 910.00 342.60 990.00 340.00 1010.00 330.00
1180.00
GR330.00 1270.00 335.00 1380.00 340.00 1470.00 343.00 1570.00 340.00
1670.00
GR335.00 1750.00 330.00 1810.00 330.00 1831.00 315.00 1883.00 318.90
2130.00
GR332.00 2164.00 335.00 2190.00 350.00 2240.00 400.00 2320.00
X1 8.97 18 1040 2260 1000 1000 1000
GR380.00 290.00 370.00 940.00 342.60 1040.00 340.00 1060.00 335.00
1150.00
GR330.00 1240.00 330.00 1320.00 335.00 1400.00 335.20 1650.00 332.00
1827.00
GR316.50 1892.00 316.60 2132.00 325.50 2152.00 330.00 2180.00 335.00
2200.00
GR342.80 2260.00 350.00 2300.00 400.00 2380.00
X1 9.16 17 930 2190 1000 1000 1000
GR380.00 280.00 370.00 830.00 342.60 930.00 339.10 1000.00 338.10
1050.00
GR337.30 1200.00 336.20 1350.00 335.00 1450.00 329.70 1600.00 328.40
1800.00
GR325.00 1866.00 317.60 1878.00 318.00 2114.00 326.00 2137.00 343.60
2190.00
GR350.00 2250.00 400.00 2380.00
X1 9.30 19 850 2230 200 700 700
GR380.00 350.00 370.00 750.00 343.30 850.00 340.00 910.00 337.80
980.00
GR337.60 1200.00 335.00 1360.00 330.00 1380.00 325.00 1400.00 323.00
1450.00
GR320.90 1530.00 322.70 1570.00 322.80 1730.00 320.00 1800.00 326.00
1900.00
GR325.00 2180.00 343.60 2230.00 350.00 2300.00 400.00 2500.00
X1 9.39 19 1020 1920 800 300 500
GR380.00 620.00 370.00 920.00 343.30 1020.00 340.00 1030.00 335.00
1170.00
GR330.00 1310.00 330.00 1370.00 325.00 1410.00 320.00 1450.00 315.00
1530.00
GR313.00 1550.00 313.60 1600.00 315.00 1700.00 320.00 1750.00 325.00
1780.00
GR325.10 1920.00 350.00 1930.00 350.00 2300.00 400.00 2500.00
X1 9.69 41 0 2430 1584 1584 1584
GR 425 0 400 60 395 83 390 105 385
120
GR 385 160 390 195 395 210 400 260 395

```
300
GR   390    325    385    338    380    358    375    382    360
420
GR   355    472    350    578    345    645    340    685   338.9
730
GR   340    770    340   1130   338.9   1145    333   1272    330
1400
GR 327.7   1590    330   1750    333   1780   338.9   1925    340
1960
GR   350   1975    375   2040    400   2100    405   2128    410
2200
GR   415   2250    420   2280    425   2320    430   2340    435
2372
GR   440   2430
*  ICE HARBOR DAM.   RM 9.7
X1   9.7     41      0   2430      1      1      1
GR   425      0    400     60    395     83    390    105    385
120
GR   385    160    390    195    395    210    400    260    395
300
GR   390    325    385    338    380    358    375    382    360
420
GR   355    472    350    578    345    645    340    685   338.9
730
GR   340    770    340   1130   338.9   1145    333   1272    330
1400
GR 327.7   1590    330   1750    333   1780   338.9   1925    340
1960
GR   350   1975    375   2040    400   2100    405   2128    410
2200
GR   415   2250    420   2280    425   2320    430   2340    435
2372
GR   440   2430
NC 0.029   0.029   0.029    0.1    0.3
X1 10.12     21      0   1560   2218   2218   2218
GR   425      0    400    100    375    170    350    190    345
195
GR   340    328    339    340    333    390    333    580    330
620
GR   329    680    327    750    330    790    333    805    333
925
GR   339   1315    340   1350    350   1370    375   1455    400
1520
GR   425   1560
X1 11.08     25      0   2208   5068   5068   5068
GR   425      0    400     37    375     75    355    105    350
130
```

```
GR   345    158   342.4    190   337.2    290   342.4    470    345
505
GR   345    815   342.4    890   340.2   1020   341.1   1130   333.7
1270
GR 342.4   1670    345    1700    350    1710    375    1785    400
1860
GR   425   1878    435    1890    440    1970    445    2060    450
2208
X1  11.9     34      0    1825   4330   4330   4330
GR   425      0    415      82    410    135    400    200    390
282
GR   380    352    375     375    370    408    365    430    360
470
GR   355    497    350     530    345    557    340    608    339
640
GR   335    698    334     724    335    755    336    810    337
880
GR   338   1020    339    1053   339.6   1200    339   1410    339
1490
GR   345   1608    350    1650    355   1670    360   1688    365
1695
GR   375   1718    400    1768    425   1808    440   1825
X1 13.04     51      0    3150   6019   6019   6019
GR   475      0    450      37    425     90    400    175    395
197
GR   390    280    390     415    395    469    400    490    405
515
GR   410    550    410     595    405    615    400    630    380
718
GR   375    778    375     853    375   1050    365   1065    360
1122
GR   355   1222    350    1260    350   1485    355   1510    360
1530
GR   365   1570    365    1600    360   1620    355   1728    350
1778
GR 347.8   2022   343.5   2070   347.8   2120    350   2140    350
2283
GR 347.8   2313   341.8   2408   338.8   2458   338.8   2573   341.8
2578
GR 347.8   2635    350    2741    355   2760    360   2812    375
2865
GR   400   2928    425    2983    430   3033    435   3084    445
3155
GR   450   3206
X1  14.1     43      0    3265   5597   5597   5597
GR   440      0    430      42    425     75    420    132    415
162
```

```
GR   400    188    390    210    380    238    375    252    370
390
GR   375    452    375    750    370    810    365    820    360
833
GR   355    843  353.8    890  353.8   1018  353.8   1135    350
1258
GR   345   1277    340   1340    339   1395    340   1590    345
1786
GR   350   1845  353.8   1930  354.6   2000  353.8   2047  351.6
2155
GR 353.8   2550    365   2602    375   2638    380   2665    395
2730
GR   395   2990    400   3058    410   3080    415   3122    420
3165
GR   425   3190    435   3240    440   3265
X1   15     32      0   1730   4750   4750   4750
GR   440      0    425     25    415     42    405     67    395
90
GR   385    110    375    122    370    130    365    216    360
248
GR   355    590  354.3    690    350    790    347   1052    347
1170
GR   350   1247  354.3   1465    355   1518    360   1540    365
1552
GR   370   1572    375   1588    385   1603    395   1620    400
1630
GR   405   1640    410   1653    420   1670    425   1680    430
1700
GR   435   1718    440   1730
X1  16.4    42      0   2770   7590   7590   7590
GR   435      0    425     10    420     25    400     42    395
55
GR   385     65    380     70    375    103    370    220    365
328
GR   360    390  355.7    418    355    428  354.3    460    355
470
GR 355.8    480    355    490  355.7    510    355    525  357.8
570
GR   355    610    350    780    350    847    355   1015  355.7
1096
GR   360   1334    365   1357    370   1405    375   1500    380
1623
GR   385   1658    390   1753    395   1850    400   1923    405
2003
GR   410   2122    415   2225    420   2340    425   2390    430
2450
GR   435   2483    440   2770
```

X1 17 39 0 2958 2950 2950 2950
GR 440 0 435 22 430 30 425 60 420
72
GR 415 87 410 102 405 112 400 130 395
150
GR 390 180 385 205 380 248 375 358 370
400
GR 365 442 362.6 1120 360 1168 355 1280 360
1342
GR 362.6 1350 362.6 1497 362.6 1580 365 1879 370
1913
GR 375 1940 380 1965 385 1998 390 2005 395
2020
GR 400 2045 405 2518 410 2562 415 2608 420
2642
GR 425 2690 430 2735 435 2861 440 2958

X1 17.6 27 0 1912 2970 2970 2970
GR 440 0 435 20 430 50 425 85 420
155
GR 415 180 400 200 395 260 390 300 385
346
GR 380 382 375 462 370 520 366.5 672 365
740
GR 360 925 357 960 357 1090 360 1170 365
1470
GR 366.5 1615 366.5 1660 370 1783 375 1810 400
1850
GR 425 1887 440 1912
X1 18 52 0 3220 2270 2270 2270
GR 440 0 435 58 430 88 425 110 415
120
GR 415 178 400 210 375 255 370 278 368.7
342
GR 365 418 362.7 435 362.7 503 365 648 368.7
730
GR 370 765 375 795 375 820 370 835 370
970
GR 375 1015 370 1325 368.7 1380 365 1480 362.7
1525
GR 359.7 1580 358 1630 359.7 1710 362.7 1760 365
1794
GR 368.7 1835 370 1860 375 1888 380 1900 385
2170
GR 385 2268 385 2370 390 2430 390 2520 385
2560
GR 380 2618 375 2670 375 2760 380 2800 380

2880
GR 375 2975 370 2990 370 3040 375 3062 400
3138
GR 425 3170 440 3220

X1 18.3 39 0 4310 1777 1777 1777
GR 440 0 435 20 430 33 425 44 420
50
GR 415 60 410 80 405 95 400 105 390
120
GR 385 130 375 145 370 155 369.1 240 367
312
GR 367 470 369.1 585 370 608 375 750 375
1100
GR 369.1 1250 367 1280 365 1280 363 1292 363
1398
GR 365 1730 367 1855 369.1 1870 370 1885 375
1900
GR 385 1925 390 1943 395 1962 400 1972 410
1990
GR 415 2480 420 2870 425 3100 440 4310

X1 18.5 45 0 3540 1010 1010 1010
GR 440 0 435 35 430 68 425 112 420
150
GR 415 180 410 210 405 245 400 258 390
278
GR 380 300 375 310 370 345 369.3 390 367
440
GR 367 490 370 568 375 705 376 730 375
750
GR 370 828 367 895 365 1040 363 1100 363
1128
GR 365 1198 365 1221 365 1292 365 1342 363
1410
GR 361 1470 361 1518 363 1630 365 1650 367
1662
GR 369.3 1670 370 1695 375 1710 385 1738 395
1773
GR 400 1788 405 1852 410 1895 415 2375 420
3540
X1 19.5 38 0 1790 5112 5112 5112
GR 440 0 435 19 430 30 425 50 420
75
GR 415 92 410 120 405 178 400 186 395
193
GR 390 210 385 253 380 261 375 270 369.5

292
GR 365 425 360.5 489 360.5 503 360 549 360
665
GR 355 790 352 839 355 1105 360 1230 365
1280
GR 370 1300 375 1335 380 1350 385 1360 390
1430
GR 395 1520 400 1668 405 1700 410 1720 415
1740
GR 420 1760 430 1780 440 1790
X1 19.7 25 0 872 1265 1265 1265
GR 440 0 425 9 415 18 410 21 405
58
GR 400 62 375 93 370 110 365 120 360
123
GR 355 168 350 200 345 390 340 505 335
612
GR 335 657 360 680 365 703 370 732 375
768
GR 400 782 425 812 430 825 435 845 440
872
X1 20.52 24 0 715 3860 3860 3860
GR 440 0 425 15 415 22 410 25 405
52
GR 400 65 390 75 375 118 370 164 363.6
200
GR 360.6 213 355 223 328 250 320 340 321
435
GR 341 490 354 535 360.6 550 363.6 563 370
595
GR 375 620 400 672 425 690 440 715
X1 21.2 21 0 1010 3630 3630 3630
GR 440 0 425 20 400 55 375 94 370
115
GR 365 210 360 287 355 318 350 368 350
423
GR 355 502 360 662 365 768 370 827 375
858
GR 380 880 400 918 410 952 425 975 430
990
GR 440 1010
X1 21.4 19 0 1350 850 850 850
GR 440 0 425 15 400 45 390 52 375
80
GR 370 175 365 208 360 320 370 480 370
530
GR 367 620 359 726 360 935 365 1025 370

```
1165
GR  375   1205   400   1250   425   1305   440   1350
ET        9.1                               768
2783
X1  22.2   49   768   2783   4540   4540   4540
GR  440   0.1   425   40   400   98   390   120   390
405
GR  390   630   390   692   395   730   400   750   405
768
GR  405   790   400   805   395   1000   390   1085   385
1088
GR  380   1105   380   1160   385   1342   385   1520   380
1688
GR  375   1960   374.3   1980   370   2330   368.3   2370   366
2545
GR  366   2560   370   2655   375   2698   380   2713   385
2750
GR  390   2770   395   2783   395   3092   390   3195   390
3320
GR  395   3340   395   3590   390   3608   385   3620   385
3744
GR  390   3756   395   3768   400   3780   400   4450   380
4465
GR  380   4512   400   4595   425   4725   440   4775
X1  23.2   27   0   1768   5280   5280   5280
GR  440   .0   425   15   415   20   410   50   400
60
GR  380   85   375   .200   370   240   365.3   300   368.5
370
GR  370   482   370   502   365   585   365   675   370
700
GR  375   763   380   868   390   970   400   1050   405
1152
GR  410   1265   415   1360   420   1490   425   1590   430
1668
GR  435   1710   440   1768
X1  24.3   21   0   2380   5870   5870   5870
GR  440   0   435   142   430   275   425   425   420
505
GR  420   670   415   700   410   725   385   828   380
900
GR  377   1483   376   1590   376   1810   377   1920   377.7
2030
GR  380   2150   380   2168   375   2243   375   2310   380
2370
GR  440   2380
X1  24.9   22   0   1265   3120   3120   3120
```

GR 440 0 430 80 425 130 410 194 405
245
GR 400 302 385 498 381 608 375 700 370
850
GR 365 948 360 1020 355 1088 350 1098 350
1150
GR 355 1165 370 1190 375 1210 380 1230 400
1240
GR 425 1253 440 1265
X1 26 29 0 2460 5810 5810 5810
GR 440 0 430 12 425 18 420 42 410
70
GR 400 82 385 118 380 208 375 308 370
448
GR 369 475 370 530 375 630 380 820 385
950
GR 390 1038 390 1215 395 1282 400 1663 405
1675
GR 410 1686 415 1730 415 1890 415 2056 420
2210
GR 425 2331 430 2380 435 2418 440 2460
X1 26.9 33 0 2480 4810 4810 4810
GR 440 0 425 40 420 58 415 115 410
440
GR 405 457 405 495 410 500 420 530 420
550
GR 415 580 415 850 415 1030 410 1095 405
1135
GR 400 1170 395 1210 390 1258 385 1352 380
1482
GR 375 1610 374 1830 375 1940 380 2092 385
2160
GR 395 2248 400 2325 405 2348 410 2358 415
2382
GR 420 2410 425 2425 440 2480
X1 28 24 0 3100 5830 5830 5830
GR 440 0 425 1 420 110 420 148 420
1018
GR 420 1058 415 1380 420 1525 420 1700 415
1715
GR 410 1718 405 1745 400 1763 395 1850 386
2145
GR 385 2265 381 2475 385 2880 386 2960 390
3000
GR 395 3022 400 3030 425 3075 440 3100
X1 28.5 34 0 2560 2640 2640 2640
GR 440 0 425 25 420 35 415 65 410

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90
GR  410    115    420    120    420    160    415    170    415
230
GR  415    620    410    752    405    820    400    842    395
875
GR  390    970  389.9    972    389   1020    388   1070    388
1120
GR  389   1140    390   1185    391   1280  389.9   1320    389
1380
GR  388   1420    387   1550    387   1640    388   1700    389
1740
GR  390   1760    395   2350    400   2442    440   2560
X1  29.7    29      0   2870   6350   6350   6350
GR  440      0    435    100    430    240    425    245    400
290
GR  400    479    405    492    410    498    415    512    420
610
GR  420   1095    415   1210    410   1310    405   1388    400
1495
GR  395   1610    393   1710    390   1932    385   2202    390
2385
GR  393   2510    395   2568    400   2618    405   2670    410
2700
GR  415   2760    420   2795    425   2828    440   2870
X1  30.8    20      0   2080   5680   5680   5680
GR  440      0    425     29    415     50    410     72    405
80
GR  400    103    395    302  394.2    350    390    530  388.2
590
GR  386    665    386    753    390    858    395   1080    400
1340
GR  405   1595    410   1763    415   2048    425   2060    440
2080
X1 31.50    32.0     .0 2400.0 3720.0 3720.0 3720.0    .000    .000
.000
GR 440.0      .0  435.0     8.0  430.0    42.0  425.0    48.0  400.0
85.0
GR 397.4   120.0  391.4   202.0  387.1   270.0  388.4   330.0  391.4
390.0
GR 397.4   440.0  400.0   510.0  405.0   892.0  410.0  1030.0  415.0
1130.0
GR 415.0  1390.0  410.0  1490.0  405.0  1615.0  400.0  1735.0  397.4
1860.0
GR 395.6  1960.0  397.4  2005.0  400.0  2082.0  405.0  2155.0  410.0
2205.0
GR 415.0  2252.0  425.0  2272.0  435.0  2330.0  440.0  2400.0  445.0
2670.0
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GR 450.0 2785.0 475.0 2875.0
X1 32.00 46.0 .0 2297.0 2700.0 2700.0 2700.0 .000 .000
.000
GR 440.0 .0 435.0 6.0 430.0 12.0 430.0 22.0 430.0
45.0
GR 425.0 65.0 420.0 75.0 415.0 100.0 410.0 112.0 405.0
122.0
GR 400.0 160.0 405.0 325.0 410.0 348.0 415.0 370.0 420.0
500.0
GR 415.0 550.0 415.0 580.0 425.0 610.0 425.0 740.0 420.0
775.0
GR 415.0 825.0 410.0 1070.0 405.0 1125.0 400.0 1200.0 398.7
1240.0
GR 395.0 1325.0 390.0 1485.0 387.0 1580.0 386.6 1637.0 387.0
1690.0
GR 390.0 1790.0 395.0 1850.0 400.0 2048.0 405.0 2115.0 410.0
2142.0
GR 415.0 2190.0 425.0 2230.0 430.0 2265.0 440.0 2297.0 445.0
2310.0
GR 450.0 2365.0 455.0 2415.0 460.0 2445.0 465.0 2490.0 470.0
2535.0
GR 475.0 2645.0
X1 33.00 28.0 825.0 2700.0 5230.0 5230.0 5230.0 .000 .000
.000
GR 475.0 .0 470.0 40.0 465.0 80.0 460.0 200.0 460.0
380.0
GR 455.0 425.0 450.0 450.0 445.0 635.0 440.0 825.0 425.0
863.0
GR 420.0 882.0 415.0 912.0 415.0 1059.0 415.0 1351.0 410.0
1387.0
GR 405.0 1445.0 400.0 2157.0 395.0 2255.0 394.2 2277.0 393.0
2315.0
GR 393.0 2372.0 395.0 2435.0 395.0 2575.0 395.0 2613.0 400.2
2635.0
GR 405.0 2655.0 425.0 2685.0 440.0 2700.0
X1 34.70 19.0 .0 1390.0 9020.0 9020.0 9020.0 .000 .000
.000
GR 440.0 .0 435.0 28.0 430.0 53.0 425.0 86.0 420.0
105.0
GR 415.0 132.0 410.0 205.0 405.0 341.0 400.0 625.0 395.0
762.0
GR 394.0 798.0 395.0 810.0 400.0 907.0 405.0 962.0 410.0
1270.0
GR 415.0 1348.0 420.0 1360.0 425.0 1370.0 440.0 1390.0
X1 35.40 16.0 .0 1485.0 3680.0 3680.0 3680.0 .000 ..000
.000
GR 440.0 .0 430.0 29.0 425.0 75.0 420.0 152.0 415.0

225.0
GR 410.0 500.0 405.0 912.0 400.0 1248.0 395.0 1292.0 390.0
1332.0
GR 390.0 1409.0 395.0 1420.0 400.0 1432.0 410.0 1448.0 425.0
1472.0
GR 440.0 1485.0
X1 36.60 23.0 105.0 1555.0 6370.0 6370.0 6370.0 .000 .000
.000
GR 475.0 .0 460.0 15.0 460.0 75.0 450.0 85.0 440.0
105.0
GR 430.0 117.0 425.0 137.0 420.0 162.0 417.5 204.0 415.0
223.0
GR 410.0 495.0 408.0 530.0 410.0 803.0 411.5 975.0 415.0
1385.0
GR 420.0 1430.0 425.0 1487.0 430.0 1505.0 435.0 1535.0 440.0
1555.0
GR 445.0 1635.0 450.0 1700.0 475.0 1790.0
X1 37.40 27.0 140.0 1385.0 4120.0 4120.0 4120.0 .000 .000
.000
GR 475.0 .0 470.0 40.0 455.0 70.0 450.0 107.0 440.0
140.0
GR 435.0 148.0 430.0 186.0 425.0 227.0 420.0 252.0 418.3
302.0
GR 415.0 420.0 410.0 567.0 405.0 732.0 402.0 893.0 402.0
1002.0
GR 405.0 1032.0 410.0 1070.0 415.0 1155.0 418.3 1210.0 420.0
1235.0
GR 425.0 1265.0 430.0 1340.0 435.0 1370.0 440.0 1385.0 445.0
1540.0
GR 450.0 1655.0 475.0 1690.0
X1 38.50 26.0 70.0 1065.0 5820.0 5820.0 5820.0 .000 .000
.000
GR 475.0 .0 455.0 15.0 450.0 52.0 440.0 70.0 425.0
100.0
GR 420.0 125.0 415.0 150.0 410.0 160.0 405.0 190.0 400.0
220.0
GR 399.0 260.0 400.0 310.0 405.0 602.0 410.0 710.0 415.0
870.0
GR 420.0 935.0 425.0 1000.0 430.0 1035.0 440.0 1065.0 445.0
1075.0
GR 450.0 1170.0 455.0 1225.0 460.0 1300.0 465.0 1385.0 470.0
1430.0
GR 475.0 1495.0
X1 39.60 25.0 435.0 1710.0 5470.0 5470.0 5470.0 .000 .000
.000
GR 475.0 .0 470.0 45.0 465.0 110.0 460.0 185.0 455.0
225.0

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GR 455.0   265.0   450.0   290.0   445.0   325.0   440.0   435.0   435.0
473.0
GR 430.0   483.0   425.0   495.0   422.1   537.0   420.0   685.0   418.0
1035.0
GR 417.0  1183.0   416.0  1355.0   417.0  1470.0   418.0  1545.0   420.0
1607.0
GR 422.1  1645.0   425.0  1678.0   440.0  1710.0   450.0  1730.0   475.0
1775.0
X1 40.70    24.0    75.0  1285.0  5820.0  5820.0  5820.0    .000    .000
.000
GR 475.0      .0   465.0    11.0   460.0    28.0   450.0    53.0   440.0
75.0
GR 430.0    93.0   425.0   114.0   422.8   140.0   420.0   255.0   416.8
503.0
GR 415.0   603.0   414.0   623.0   415.0   785.0   416.8   835.0   420.0
965.0
GR 422.8  1156.0   425.0  1185.0   430.0  1213.0   435.0  1245.0   440.0
1285.0
GR 445.0  1300.0   450.0  1310.0   460.0  1335.0   475.0  1355.0
X1 41.50    21.0   220.0  1680.0  3700.0  3700.0  3700.0    .000    .000
.000
GR 475.0      .0   470.0    95.0   465.0   135.0   450.0   155.0   445.0
170.0
GR 440.0   220.0   435.0   240.0   430.0   250.0   425.8   420.0   425.0
500.0
GR 420.0   770.0   420.0   820.0   425.8   972.0   425.8  1395.0   425.0
1470.0
GR 425.8  1530.0   430.0  1645.0   435.0  1660.0   440.0  1680.0   455.0
1715.0
GR 475.0  1805.0
X1 41.59      31       0    2140     527     527     527
GR   500       0     475     130     470     170     465     210     450
235
GR   445     265     440     310     435     335     430     350     426
505
GR   420     700   418.7     810     420     890     426    1050     426
1262
GR 423.8    1350     426    1600     430    1680     435    1700     440
1708
GR   465    1800     470    1830     475    1898     480    1940     485
1965
GR   495    1970     495    1998     495    2038     500    2062     505
2080
GR   510    2140
*  LOWER MONUMENTAL DAM.  RM 41.6
X1  41.6      31       0    2140       1       1       1
GR   500       0     475     130     470     170     465     210     450
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235
GR 445 265 440 310 435 335 430 350 426
505
GR 420 700 418.7 810 420 890 426 1050 426
1262
GR 423.8 1350 426 1600 430 1680 435 1700 440
1708
GR 465 1800 470 1830 475 1898 480 1940 485
1965
GR 495 1970 495 1998 495 2038 500 2062 505
2080
GR 510 2140
X1 42 26 0 1785 2112 2112 2112
GR 500 0 475 18 465 29 460 55 450
68
GR 440 88 430 110 427.9 202 426 290 426
348
GR 427.9 493 430 650 430 1280 427.9 1340 426
1420
GR 426 1460 427.9 1500 430 1580 440 1612 450
1622
GR 460 1637 470 1655 475 1667 495 1705 500
1750
GR 525 1785
X1 42.5 29 0 2408 2640 2640 2640
GR 500 0 495 70 490 100 485 110 480
120
GR 475 140 465 145 460 178 450 195 445
213
GR 435 232 432 270 430 440 428 850 428
1200
GR 432 1390 435 1668 440 1700 445 1800 450
1825
GR 460 1900 465 1920 470 1940 475 1975 480
2070
GR 485 2175 490 2240 495 2316 500 2408
X1 43.3 24 0 1900 4200 4200 4200
GR 500 0 475 10 470 20 465 58 455
70
GR 450 80 445 90 440 110 435 145 433
162
GR 430 240 425 338 431 710 431 890 430
1085
GR 433 1320 435 1410 450 1460 475 1505 490
1545
GR 500 1605 505 1640 510 1850 515 1900
X1 43.9 34 0 2140 3212 3212 3212

GR 500 0 495 28 490 48 485 90 480
142
GR 475 164 470 208 465 248 465 320 465
360
GR 460 400 455 560 450 610 445 690 440
760
GR 435 955 430 1010 425 1100 428.2 1500 430
1590
GR 434.2 1735 434.2 1930 435 1950 440 1970 445
1982
GR 450 2000 460 2008 470 2028 475 2032 485
2050
GR 500 2068 510 2083 520 2110 525 2140
X1 44.65 21 0 1565 3940 3940 3940
GR 500 0 495 20 490 45 485 62 480
65
GR 475 75 470 105 450 200 445 220 440
250
GR 436 830 435 960 430 1015 425 1070 422
1140
GR 425 1200 430 1308 436 1510 440 1538 500
1550
GR 525 1565
X1 45.2 31 0 2100 2930 2930 2930
GR 560 0 540 200 520 320 500 400 495
420
GR 475 445 470 470 450 510 445 540 440
580
GR 438.8 620 435 700 430 790 427 875 425
980
GR 425 1035 430 1060 435 1130 438.8 1145 440
1835
GR 445 1852 450 1870 455 1915 460 1930 465
1948
GR 470 1960 475 1975 500 2000 505 2030 525
2060
GR 555 2100
X1 46 23 0 1615 4190 4190 4190
GR 500 0 495 20 475 55 470 80 450
110
GR 445 120 440 200 440 240 435 690 430
905
GR 428 912 430 928 435 1080 440 1235 445
1280
GR 450 1310 455 1340 460 1355 470 1380 475
1405
GR 500 1545 505 1580 525 1615

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X1   47    37    0   2320   5230   5230   5230
GR   525    0   500    40    495    83    490    100    480
120
GR   450   180   445   190   443   470   443   625   440
790
GR   438   890   435   1210   438   1230   440   1250   443
1320
GR   445   1330   450   1365   455   1420   460   1620   465
1707
GR   470   1728   475   1760   480   1795   485   1810   490
1860
GR   495   1900   500   1920   500   1950   495   1960   495
1990
GR   500   2000   505   2005   510   2010   515   2015   515
2195
GR   520   2245   525   2320
X1  47.5    21    0   1530   2640   2640   2640
GR   525    0   500    12   475    42   450   100   445
150
GR 443.6   225   440   270   435   380   435   440   440
810
GR 443.6   1132   445   1150   450   1190   455   1210   475
1265
GR   500   1315   505   1380   510   1385   515   1438   520
1480
GR   525   1530
X1   48    25    0   1580   2630   2630   2630
GR   525    0   500    20   480    33   475    68   450
100
GR   445   130   444   145   440   208   438   360   435
430
GR   435   455   438   570   440   635   444   1125   445
1162
GR   450   1200   475   1305   490   1355   495   1382   500
1395
GR   505   1458   510   1472   515   1500   520   1540   525
1580
X1   49    30    0   1770   5280   5280   5280
GR   525    0   500    10   480    42   475    50   450
105
GR   445   140   442   198   440   235   439   330   439
850
GR   440   885   442   915   445   950   450   1080   455
1135
GR   460   1200   465   1230   470   1258   475   1292   480
1345
GR   485   1350   490   1370   495   1438   500   1453   500
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1530
GR 505 1560 510 1600 515 1625 520 1705 525
1770
X1 50 32 0 2353 5280 5280 5280
GR 525 0 520 62 515 115 510 158 505
198
GR 500 235 495 345 490 410 485 640 480
685
GR 475 715 470 760 465 805 460 830 455
840
GR 450 1045 445 1275 442 1310 444 1680 445
1715
GR 450 1950 455 2034 475 2072 485 2097 495
2118
GR 500 2150 505 2200 505 2258 510 2290 515
2302
GR 520 2325 525 2353
X1 51 27 0 1490 5280 5280 5280
GR 525 0 520 98 515 102 510 111 505
174
GR 500 190 495 210 490 240 475 270 470
280
GR 465 315 460 355 455 418 450 695 445
760
GR 442 775 440 790 429 818 442 830 445
860
GR 450 905 455 1300 460 1335 475 1390 500
1440
GR 505 1480 525 1490
X1 52 30 0 1400 5280 5280 5280
GR 530 0 525 41 520 78 515 110 510
135
GR 505 170 500 190 475 248 470 268 465
307

GR 460 372 455 425 450 545 445 680 440
720
GR 435 760 433 820 435 870 440 950 445
1025
GR 450 1100 453 1150 455 1240 460 1265 465
1290
GR 470 1320 475 1330 500 1358 505 1385 525
1400
X1 53 29 0 1375 5280 5280 5280
GR 535 0 530 60 525 92 520 130 515
165
GR 510 205 505 225 500 275 475 338 470

365
GR 465 390 460 400 455 420 454 440 450
612
GR 448 655 446 880 448 1025 450 1120 454
1155
GR 455 1180 460 1230 465 1265 470 1283 475
1300
GR 500 1325 510 1335 525 1365 550 1375
X1 54 32 0 1725 5280 5280 5280
GR 535 0 530 40 525 85 520 110 515
125
GR 510 140 505 170 500 180 475 215 470
250
GR 465 280 460 300 458 545 455 625 452
680
GR 450 748 452 825 455 880 460 1220 465
1258
GR 470 1310 475 1312 480 1395 485 1450 495
1468
GR 500 1484 510 1500 515 1588 520 1620 525
1660
GR 530 1700 535 1725
X1 55 31 0 1680 5280 5280 5280
GR 535 0 530 20 525 38 505 65 500
95
GR 475 125 470 130 465 180 460 230 455
280
GR 452 500 455 635 460 920 465 990 470
1045
GR 475 1100 480 1142 485 1170 490 1255 495
1270
GR 490 1370 495 1395 500 1410 515 1430 515
1458
GR 515 1540 520 1570 525 1600 530 1625 535
1640
GR 540 1680
X1 56 35 0 1850 5280 5280 5280
GR 540 0 525 40 520 62 515 82 510
122
GR 500 135 500 160 505 165 505 185 500
200
GR 495 225 490 240 485 265 480 310 475
340
GR 470 397 465 450 460 610 457 665 455
755
GR 457 980 460 1040 465 1210 470 1320 475
1340

GR 480 1350 500 1405 505 1440 510 1490 515
1530
GR 520 1555 525 1645 530 1710 535 1782 540
1850
X1 57 28 0 1150 5280 5280 5280
GR 540 0 535 28 530 50 525 70 520
88
GR 500 145 475 200 470 208 466 280 460
340
GR 455 400 450 450 445 550 442 555 445
580
GR 450 605 455 700 460 790 465 870 470
955
GR 475 975 480 995 485 1015 490 1040 500
1050
GR 520 1075 525 1113 550 1150
X1 58 33 0 1600 5280 5280 5280
GR 550 0 525 40 510 60 505 82 500
92
GR 495 108 485 125 480 145 475 165 470
230
GR 469 570 467 590 465 642 467 880 469
950
GR 470 1090 475 1160 480 1200 485 1230 490
1245
GR 495 1282 500 1290 520 1320 520 1350 515
1360
GR 515 1390 520 1420 525 1430 530 1475 535
1510
GR 540 1562 545 1580 550 1600
X1 59 36 0 1620 5280 5280 5280
GR 550 0 525 24 520 108 515 130 510
160
GR 500 180 495 183 490 208 485 245 480
275
GR 475 300 472 450 470 725 465 840 460
885
GR 455 925 454 950 455 1010 460 1075 465
1120
GR 470 1190 475 1215 480 1240 485 1275 490
1300
GR 495 1330 500 1375 505 1405 510 1450 525
1490
GR 530 1500 535 1516 535 1542 525 1560 525
1580
GR 550 1620
X1 60 30 0 1182 5280 5280 5280

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GR  565    0   550    13   525    38   515    60   500
87
GR  495   110   490   195   485   260   485   325   485
508
GR  480   550   475   570   470   580   465   590   450
595
GR  440   615   434   660   440   690   450   710   465
720
GR  470   735   475   750   480   980   485   1010   495
1025
GR  500   1040   525   1090   530   1110   530   1165   550
1182
X1  61   24   0   1380   5280   5280   5280
GR  565    0   550    20   525    55   520    58   515
82
GR  500   112   485   135   480   550   475   650   470
765
GR  464   790   470   820   475   830   480   835   485
940
GR  500   1005   515   1082   525   1160   530   1200   535
1300
GR  540   1335   545   1350   550   1360   565   1380
X1  62   25   0   1625   5280   5280   5280
GR  570    0   550    30   545    45   525    80   520
118
GR  510   142   505   212   500   245   495   270   490
290
GR  488   310   485   560   480   710   479   730   480
850
GR  485   1100   488   1200   490   1272   495   1310   500
1340
GR  525   1378   530   1390   535   1480   550   1525   565
1625
X1  63   20   0   1330   5280   5280   5280
GR  575    0   550    25   530    33   525    70   510
98
GR  505   120   500   140   495   150   490   580   485
730
GR  482   750   481   780   482   802   485   820   490
830
GR  495   1170   500   1180   525   1225   550   1290   565
1330
X1  64   29   0   1430   5280   5280   5280
GR  575    0   560    20   555    40   550    55   545
75
GR  540    87   535   110   525   120   515   140   510
160
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GR 505 190 500 200 495 285 490 450 485
535
GR 486 570 485 670 490 810 495 980 500
1060
GR 505 1150 510 1230 515 1275 520 1290 525
1300
GR 530 1310 535 1350 550 1385 575 1430
X1 65 25 0 1340 5280 5280 5280
GR 575 0 550 37 535 57 530 78 515
110
GR 510 130 505 178 500 232 495 355 490
438
GR 485 487 486 525 490 600 495 900 500
1045
GR 505 1090 510 1140 515 1170 520 1190 525
1207
GR 535 1240 540 1280 550 1290 570 1320 575
1340
X1 66 28 0 2555 5280 5280 5280
GR 575 0 570 20 565 90 560 165 555
200
GR 550 217 545 260 540 410 535 500 530
630
GR 525 680 520 710 515 750 510 820 505
930
GR 500 955 495 1020 500 1100 505 1140 509
1193
GR 510 2250 515 2450 525 2470 540 2498 545
2525
GR 550 2530 575 2550 585 2555
X1 66.5 31 0 3120 2630 2630 2630
GR 595 0 590 135 585 230 580 356 575
570
GR 570 690 565 928 560 1000 555 1250 550
1365
GR 545 1400 525 1458 520 1480 515 1500 510
1615
GR 505 1965 500 2092 500 2153 505 2290 510
2460
GR 510 2490 510 2880 515 2895 520 2900 525
2920
GR 545 2950 550 2990 565 3012 570 3090 575
3100
GR 585 3120
X1 67 43 0 2560 2630 2630 2630
GR 595 0 590 55 585 110 580 150 585
285

GR 585 305 580 360 575 375 555 405 555
430
GR 560 450 570 470 570 490 550 560 535
610
GR 530 650 525 690 520 715 515 800 510
980
GR 505 1025 500 1110 495 1240 492 1370 495
1390
GR 500 1590 505 1715 510 1790 515 1910 520
1925
GR 525 1930 545 1950 545 1980 540 1985 540
2035
GR 545 2095 550 2265 555 2340 560 2428 565
2495
GR 570 2518 575 2530 585 2560
X1 67.9 24 0 1770 4560 4560 4560
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1140
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1940
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1010
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1440
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2180
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1274.3
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669.5
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736.7
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802.6
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873.8
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945.3
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1015.2
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604.6
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2080.4
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2316.3
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GR781.50 499.80 727.40 649.20 678.80 728.70 646.30 773.70 641.30
812.50
GR634.90 844.00 627.60 884.80 627.40 913.10 628.30 957.20 628.90
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1173.30
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2187.50
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2353.00
GR617.90 2387.90 616.30 2418.80 632.10 2454.60 648.00 2495.20 651.00
2535.40
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2956.00
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3166.90
GR654.00 3207.70 653.00 3253.20 658.80 3295.40 666.80 3342.40 666.10
3385.60
GR673.00 3433.30 678.80 3487.30 690.10 3545.80 704.70 3603.40 719.20
3687.30
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* LOWER GRANITE DAM. RM 107.43
X1107.43 81. 499.8 3775.7 1 1 1 .00000 .00

GR781.50 499.80 727.40 649.20 678.80 728.70 646.30 773.70 641.30
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3166.90

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2000.70
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1038.00
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2137.00
GR623.70 2153.70 625.10 2176.90 627.40 2191.30 637.80 2215.60 645.30
2233.80
GR661.00 2256.10 669.70 2286.10 673.80 2318.10 688.10 2352.70 733.20
2450.70
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843.30
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1095.00
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1441.30
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1787.30
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1910.60
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2038.50
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2167.20
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2301.00
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2442.60
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2629.00
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1491.90
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2238.30
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2349.30
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2490.40
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2710.50
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755.70
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986.70
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1221.90

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1576.10
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1917.40
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2016.70
GR637.30 2035.80 636.30 2054.90 635.80 2073.70 634.80 2092.50 633.80
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1693.60
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1982.20
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654.50
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768.60
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955.30
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1736.10

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1898.90
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1654.40
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1775.10
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1958.30
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1393.30
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1476.80
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1571.00
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1667.00
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1861.00
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1965.50
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2103.80
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2301.00
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776.50
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1010.50
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1205.40
GR708.00 1240.50 703.50 1271.80 697.30 1300.30 691.60 1323.90 687.70
1347.70
GR686.90 1371.40 685.80 1395.30 684.80 1416.10 683.90 1435.90 682.50
1458.80
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1556.90
GR675.00 1578.80 674.10 1597.60 673.00 1614.20 671.80 1632.60 670.90
1652.10
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2315.50
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2454.80
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914.80
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1162.40
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1356.90
GR706.60 1390.10 702.70 1417.90 699.70 1439.40 695.80 1468.40 692.60
1490.60
GR690.50 1511.90 687.80 1531.20 684.90 1553.30 683.50 1570.30 679.50
1593.40
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1683.70
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1759.40
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1907.70
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1982.40
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2049.30
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2119.60
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2183.20
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2316.90
GR677.70 2330.10 690.10 2353.80 704.70 2381.60 709.70 2409.90 716.70
2449.40
GR744.80 2505.30
X1128.27 81. 610.0 2088.1 2800.0 3300.0 3110.0 .00000 .00

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815.30
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935.80
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1029.50
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1119.80

GR679.60 1137.60 678.60 1160.80 677.80 1172.40 676.90 1192.60 676.00
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1282.10
GR671.70 1299.80 671.10 1316.80 670.10 1330.70 668.80 1347.90 668.80
1359.80
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1431.30
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1501.10
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1572.10
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1639.50
GR660.90 1657.90 660.20 1666.50 659.30 1681.60 658.50 1693.60 658.10
1705.40
GR658.00 1719.10 657.40 1728.30 657.60 1745.60 657.70 1758.50 657.60
1771.40
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1834.90
GR662.00 1850.50 662.00 1865.30 662.30 1878.10 666.60 1895.90 674.50
1907.80
GR685.20 1925.80 691.70 1943.40 700.20 1967.00 713.90 1994.50 717.20
2036.30
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678.30
GR692.40 696.00 686.30 718.50 683.80 734.30 679.40 749.80 674.80
765.60
GR672.80 780.50 670.70 795.80 669.00 811.50 667.30 826.00 664.90
837.90
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898.80
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969.60
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1035.30
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1100.30
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1164.70
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1236.30
GR667.40 1251.00 668.00 1263.50 668.90 1275.50 669.10 1292.40 669.90
1309.40

GR670.20 1320.90 670.60 1332.40 671.30 1350.30 671.80 1368.30 672.20
1377.50
GR672.50 1394.70 671.80 1407.40 670.70 1422.60 672.20 1436.60 673.50
1449.80
GR675.00 1468.30 676.50 1484.00 677.60 1498.60 678.40 1515.90 678.40
1530.90
GR678.30 1548.20 679.40 1562.10 683.90 1581.80 686.70 1596.60 690.90
1619.10
GR694.40 1632.70 700.00 1653.00 706.30 1676.60 713.30 1706.60 712.00
1731.50
GR712.10 1761.60 715.60 1787.60 720.80 1823.00 720.80 1849.70 735.70
1884.30
GR738.20 1954.10
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718.30
GR698.90 747.50 696.70 766.10 693.00 789.00 691.70 807.30 690.80
824.60
GR688.80 849.10 687.10 873.50 686.40 886.70 685.10 907.70 683.80
922.50
GR683.50 942.90 681.60 959.20 679.70 975.50 678.10 993.40 676.60
1007.70
GR675.30 1028.10 674.20 1042.20 672.90 1058.80 671.30 1077.10 670.80
1090.90
GR670.20 1106.60 668.30 1121.70 664.30 1136.10 662.50 1150.30 660.70
1163.90
GR660.60 1179.00 660.40 1193.70 659.10 1206.70 658.20 1223.30 657.20
1232.80
GR655.20 1246.40 655.80 1258.40 656.60 1270.60 656.10 1286.60 656.90
1305.30
GR657.10 1312.30 658.30 1327.90 659.20 1339.40 660.00 1351.50 660.40
1366.40
GR661.00 1380.20 662.60 1395.20 664.60 1409.90 666.30 1424.40 668.00
1439.20
GR669.60 1453.30 671.50 1467.60 673.80 1484.80 675.70 1502.90 677.40
1517.20
GR679.40 1531.10 682.60 1551.90 685.20 1571.50 687.80 1589.80 690.40
1611.20
GR692.80 1628.60 696.60 1652.80 699.20 1675.20 702.90 1698.80 706.80
1724.20
GR710.30 1755.40 713.00 1780.10 716.10 1815.20 718.50 1846.40 720.40
1886.70
GR721.10 1920.90 721.50 1961.90 721.90 1996.30 722.40 2036.00 724.30
2077.30
GR725.60 2117.90 726.80 2163.80 728.40 2216.10 733.30 2261.20 738.90
2301.20

GR751.00 2464.50
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817.00
GR692.20 840.30 691.80 857.30 692.00 878.80 691.40 896.50 691.00
915.00
GR686.50 937.00 684.40 955.50 683.10 972.00 683.70 989.50 680.90
1006.00
GR678.60 1023.50 678.40 1037.30 677.50 1053.70 676.40 1071.00 676.50
1083.00
GR675.00 1101.00 674.00 1120.00 673.00 1131.10 671.00 1144.00 668.80
1159.00
GR666.30 1173.30 664.80 1186.80 663.50 1204.00 663.40 1214.30 663.50
1228.00
GR662.50 1239.50 661.30 1252.00 660.00 1265.60 659.90 1276.00 659.90
1290.30
GR660.20 1304.00 660.20 1316.50 660.20 1332.50 660.90 1341.30 661.90
1356.50
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1421.00
GR667.20 1434.30 667.70 1449.00 668.00 1464.50 668.30 1476.50 668.20
1488.00
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1563.00
GR673.50 1572.50 675.20 1593.00 677.40 1611.50 678.70 1622.50 680.60
1639.70
GR683.10 1657.50 685.10 1675.00 686.90 1692.00 688.90 1709.00 691.60
1730.80
GR693.30 1746.70 695.70 1773.00 700.10 1799.80 702.60 1820.30 706.30
1849.50
GR709.00 1873.50 711.10 1902.20 714.30 1936.00 716.40 1973.20 718.10
2009.00
GR721.90 2050.20 717.30 2091.00 719.60 2138.40 726.90 2175.00 729.20
2229.80
GR740.20 2327.50
X1130.44 81. 579.0 2488.3 2700.0 1850.0 2300.0 .00000 .00

GR745.40 579.00 718.40 638.80 717.70 686.80 717.60 723.10 718.20
762.70
GR717.80 803.40 714.30 841.80 706.00 871.80 704.40 900.50 703.50
930.10
GR702.50 956.10 701.60 981.90 700.20 1005.80 698.90 1034.30 698.00
1057.80
GR696.80 1080.40 695.10 1105.90 693.50 1129.00 692.20 1149.50 691.30
1170.30
GR691.30 1193.20 690.60 1217.00 687.40 1237.10 685.60 1258.40 685.40

1276.60
GR685.90 1294.10 686.20 1316.20 685.40 1340.70 686.50 1356.10 686.60
1377.70
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1473.40
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1657.40
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1746.30
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1832.30
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1927.00
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2023.70
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2144.00
GR698.50 2164.40 699.40 2184.90 700.70 2214.70 701.40 2238.30 702.00
2267.50
GR703.20 2299.00 703.50 2321.10 706.30 2352.80 712.80 2381.10 723.10
2429.40
GR745.00 2488.30
X1130.66 81. 659.0 3646.0 1450.0 950.0 1100.0 .00000 .00

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966.00
GR723.50 1025.30 723.20 1091.00 722.70 1152.70 722.40 1210.00 722.00
1269.40
GR721.80 1332.00 721.50 1390.20 720.70 1444.00 718.90 1500.60 718.10
1554.80
GR717.40 1603.60 716.00 1656.00 714.30 1705.80 714.30 1750.50 714.20
1800.90
GR714.40 1843.80 714.50 1890.90 715.20 1936.00 716.00 1987.80 714.30
2036.30
GR707.20 2080.70 706.40 2118.00 706.10 2154.80 703.80 2194.00 701.90
2229.60
GR701.20 2259.00 697.00 2292.50 693.00 2327.00 688.40 2355.60 683.50
2381.00
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2499.00
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2623.50
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2845.90
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3064.00
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3182.00
GR684.60 3208.00 686.00 3231.60 688.10 3262.00 689.70 3292.80 694.30
3317.50
GR713.50 3366.60 716.50 3399.00 719.40 3452.40 721.20 3507.00 721.20
3579.90
GR745.80 3646.00
X1130.93 81. 609.0 2093.0 2000.0 1550.0 1620.0 .96600 .00

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761.60
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847.80
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932.70
GR672.10 946.60 672.20 963.00 671.50 979.80 670.00 992.90 669.20
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1154.20
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1555.00
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1638.70
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1817.10
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1911.60
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2044.80
GR745.60 2093.00

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1385.40
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1655.50
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1949.90
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2176.50
GR687.90 2198.50 682.00 2220.00 678.30 2238.50 675.70 2257.00 674.20
2272.30
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2708.80
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2796.50
GR675.50 2814.50 676.30 2836.30 676.70 2849.80 677.00 2869.00 677.30
2885.00
GR678.00 2904.00 678.90 2920.50 679.30 2938.00 680.10 2957.80 680.80
2973.70
GR682.10 2997.00 683.10 3018.00 683.80 3035.50 684.00 3054.50 686.60
3076.40
GR698.20 3112.50 697.30 3121.30 700.00 3149.40 714.50 3179.00 725.00
3235.50
GR745.50 3293.00
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811.50
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1039.90
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1243.10
GR723.80 1279.60 722.50 1314.10 721.40 1352.50 720.40 1384.60 719.30
1413.40
GR714.30 1446.90 708.40 1472.80 704.80 1498.70 700.70 1524.90 698.20
1543.10

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1810.00
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1883.50
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1955.90
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2030.00
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2100.10
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2168.60
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2245.60
GR685.90 2263.50 688.00 2282.10 690.50 2300.10 693.90 2318.70 695.50
2340.00
GR703.90 2364.60 707.50 2384.30 709.10 2410.70 719.10 2439.60 721.00
2471.90
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723.00
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858.30
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1068.60
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1337.60
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1394.20
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1443.90
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1499.60

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1727.10
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762.70
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900.10
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1010.70
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1107.90
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1194.90
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1274.30
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1344.90
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1737.40
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1876.30
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1999.90
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782.70
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851.00
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915.00
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1099.30
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1157.50
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1286.30
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1356.30
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1611.30
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1770.50
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696.30
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768.30
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840.40
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912.40
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988.20
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1066.80

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1329.90
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1432.20
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1661.60
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1824.40
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2010.60
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2208.60
GR728.00 2251.00 729.20 2295.10 732.10 2323.70 733.80 2391.20 730.90
2440.10
GR753.20 2516.80
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680.50
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755.70
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825.30
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896.30
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965.70
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1120.10
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1200.90
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1276.30
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1361.90
GR690.20 1375.00 690.70 1393.70 691.30 1407.80 692.20 1425.80 693.10
1441.00
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1532.00

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1727.80
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1851.60
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2007.00
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893.00
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986.40
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1086.60
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1190.50
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1942.00
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726.20
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890.20
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2416.40
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2542.50
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719.80
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965.50
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1912.40
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ET 9.1 9.1 9.1 9.1 9.1 9.1 9.1 1440.
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2454.00
GR714.30 2484.30 717.00 2515.00 716.90 2549.60 716.80 2574.50 724.00
2614.70
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1017.90
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2015.40
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1814.80
GR712.90 1838.30 714.50 1855.10 717.90 1881.30 720.80 1901.60 726.00
1926.90
GR746.50 1979.40
X1138.07 81. 544.4 1994.7 680.0 680.0 710.0 .00000 .00

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664.90
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778.50
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873.40
GR710.90 890.50 710.90 916.70 711.40 935.50 711.00 957.20 710.90
979.90
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1066.40
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1148.50

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1246.20
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1343.00
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1587.00
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1660.30
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1729.40
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1794.40
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1857.10
GR687.20 1867.30 693.80 1885.20 704.10 1908.10 709.90 1919.00 726.30
1946.60
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797.00
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912.50
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1026.00
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1140.50
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1262.80
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1380.50
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1503.00
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1619.50
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1724.30
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1913.50
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1999.70

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2092.00
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2184.50
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2264.00
GR689.90 2282.00 694.10 2295.90 711.40 2327.50 715.30 2337.00 730.10
2366.50
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845.70
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989.20
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1115.80
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1360.60
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1481.20
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1711.60
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1830.50
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1941.90
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2037.80
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2139.00
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2245.10
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2362.40
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2484.70
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2617.90
GR744.00 2660.40
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954.50
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1104.00
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1225.50
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1346.50
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1461.50
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1573.80
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1697.00
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1818.00
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1929.00
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2045.00
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2166.00
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2293.80
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2414.00
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2520.80
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2630.00
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1046.00
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1193.80
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1323.00
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1435.70
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1544.80
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1889.80
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2013.50
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2363.30
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2614.80
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2788.00
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3057.90
GR747.00 3130.80
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1075.50
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1238.80
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1460.20
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1930.90
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2035.90
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2147.10
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2258.90
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2402.00
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2659.50
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2782.00
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1251.90
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1378.90
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1633.70
GR701.90 1659.60 701.40 1683.90 701.30 1714.80 701.90 1740.70 706.60
1765.10
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1914.30
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2062.50
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2396.30
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3138.80
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1309.40
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1361.10
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1407.40
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1685.60
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1765.20
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1846.80
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1931.40
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2019.60
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1008.90
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738.70
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649.80
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684.70
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781.50
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721.50
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898.20
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950.30
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1004.30
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1062.20
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1117.20
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1172.20
GR706.30 1181.00 709.20 1195.70 711.80 1205.50 714.80 1219.30 716.20
1232.10
GR716.00 1245.80 715.90 1258.60 715.60 1269.40 715.60 1279.20 715.10
1291.00
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1338.90
GR716.30 1348.50 716.40 1348.90 717.30 1353.80 720.30 1362.60 720.30
1362.70
GR731.70 1386.60 735.30 1394.30 743.80 1415.50
X1140.75 81. 689.5 1918.7 1400.0 1250.0 1350.0 .00000 .00

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777.90
GR716.20 797.50 715.10 811.10 712.40 831.30 710.20 842.90 708.20
859.40
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924.50
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986.50
GR704.80 1000.80 704.90 1014.90 705.60 1027.90 705.20 1041.10 705.50
1052.90
GR705.70 1064.80 706.00 1079.60 706.40 1088.40 706.20 1105.10 706.00
1117.30
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1184.30
GR705.70 1199.20 706.20 1210.50 706.80 1222.40 707.30 1237.10 707.60
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1322.80
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1395.70
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1469.20
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1542.40
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1618.00
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1694.10
GR715.90 1711.40 715.30 1729.30 715.40 1744.40 715.70 1765.70 715.30
1779.30
GR715.20 1796.10 715.70 1813.30 718.40 1836.70 722.50 1850.30 730.80
1878.90
GR743.80 1918.70
X1141,21 81. 578.8 2023.4 2550.0 2450.0 2550.0 .00000 .00

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690.80
GR717.70 709.70 716.90 732.00 713.50 749.50 712.70 768.00 709.80
789.00
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863.00
GR707.50 875.00 708.50 894.00 708.80 909.30 709.00 925.50 709.70
943.00
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1107.30
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1196.50
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1369.00
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1455.70
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1543.30
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1628.00
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1713.00
GR708.60 1727.30 708.60 1744.50 709.00 1761.30 709.40 1778.00 709.70
1794.00
GR710.30 1810.00 711.10 1826.00 711.70 1843.00 712.40 1861.00 713.00
1876.00
GR713.60 1897.00 715.20 1911.80 719.50 1936.30 723.70 1953.80 728.10

1979.10
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924.00
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1071.70
GR733.20 1101.10 730.40 1124.00 727.80 1148.00 726.50 1165.00 724.20
1186.80
GR724.60 1195.50 718.10 1222.10 715.30 1236.00 713.30 1250.50 711.80
1261.00
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1323.50
GR709.20 1336.00 708.30 1346.50 706.90 1357.00 706.20 1371.00 706.00
1379.50
GR705.90 1392.50 705.80 1400.00 705.90 1414.30 705.70 1422.00 706.60
1437.30
GR706.70 1444.50 706.10 1459.00 705.90 1466.50 707.10 1483.00 707.00
1494.00
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1551.00
GR707.40 1567.00 707.60 1574.40 707.50 1589.50 707.60 1597.50 708.00
1611.00
GR707.90 1620.40 707.80 1631.50 708.20 1643.20 708.20 1653.50 708.20
1667.30
GR708.30 1676.00 708.70 1690.40 708.80 1701.30 709.00 1714.10 709.40
1727.00
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1785.50
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1844.00
GR707.90 1855.00 710.70 1873.00 712.00 1880.40 713.20 1895.50 713.60
1906.50
GR714.10 1917.00 715.10 1932.10 718.70 1949.80 724.10 1964.30 733.00
1990.50
GR747.20 2023.80
X1142.40 87. 950.0 1947.8 3900.0 3750.0 3810.0 .00000 .00
GR750.00 950.00 746.20 957.40 745.70 969.50 735.80 1018.50 731.40
1030.60
GR730.40 1035.60 728.30 1041.50 725.90 1047.50 724.50 1055.50 724.00
1063.40
GR724.10 1073.40 723.40 1083.30 723.40 1094.30 723.50 1102.00 722.90
1112.10
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1194.50
GR722.40 1206.30 721.90 1214.70 722.00 1216.70 722.10 1226.60 721.60

1236.60
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1289.30
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1384.60
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1448.60
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1500.30
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1550.00
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1607.80
GR700.60 1617.70 699.70 1629.70 698.90 1640.60 698.50 1650.60 698.20
1662.50
GR697.50 1672.40 696.80 1683.40 697.70 1695.30 697.10 1706.30 696.20
1717.20
GR696.70 1728.20 695.80 1739.10 694.70 1750.10 695.10 1760.00 696.60
1772.00
GR698.10 1781.90 699.80 1791.90 704.20 1814.80 707.50 1823.70 713.60
1844.60
GR716.20 1855.60 718.40 1866.50 723.80 1886.40 725.40 1893.40 726.00
1898.30
GR726.70 1902.30 728.80 1905.30 730.30 1913.30 732.20 1922.10 735.60
1931.80
GR737.20 1936.70 746.10 1947.80
X1142.57 74. 500.0 1958.5 400.0 1150.0 1000.0 .00000 .00

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646.70
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670.40
GR731.90 676.30 732.00 684.20 731.90 690.20 731.90 698.10 731.90
704.00
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739.50
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823.70
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938.10
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1032.30
GR718.30 1082.80 719.10 1113.10 719.40 1151.70 719.00 1210.60 719.10
1276.20
GR719.10 1283.80 719.00 1294.60 719.20 1301.50 717.90 1346.90 717.90
1365.40
GR716.50 1385.60 715.40 1420.90 713.90 1447.80 709.70 1513.40 707.70

1538.60
GR706.40 1574.00 706.60 1629.50 706.00 1674.90 705.40 1711.90 705.80
1722.30
GR706.50 1733.10 706.10 1747.00 708.30 1759.80 707.90 1772.60 708.80
1782.50
GR709.80 1792.40 710.90 1803.30 712.30 1812.20 714.10 1821.00 716.00
1827.00
GR716.50 1831.90 717.60 1832.90 720.40 1840.80 723.40 1846.70 732.20
1866.10
GR734.90 1872.90 743.60 1889.10 743.80 1948.90 748.90 1958.50

X1143.14 83. 611.1 1438.8 2800.0 2550.0 2680.0 .00000 .00

GR750.00 590.00 743.20 604.50 740.30 611.10 727.10 631.90 726.50
644.00
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701.30
GR717.20 710.50 715.20 723.10 713.70 730.00 712.00 738.50 711.20
747.80
GR710.40 758.30 709.60 765.10 708.50 774.70 708.10 780.30 707.30
789.50
GR706.90 795.70 707.00 804.40 707.00 811.10 707.50 818.30 708.40
827.00
GR708.90 833.20 709.20 843.20 709.60 849.50 710.10 859.50 710.50
869.80
GR710.90 876.30 711.30 886.70 711.70 893.60 711.90 902.60 712.00
911.30
GR712.40 922.50 712.60 928.80 713.00 938.30 713.40 945.70 714.10
953.20
GR714.50 964.40 714.60 973.00 714.90 982.50 715.20 994.80 715.30
1002.50
GR715.40 1010.70 715.50 1021.60 715.70 1031.50 716.00 1039.70 716.20
1047.90
GR716.20 1059.40 716.10 1070.30 716.30 1079.30 716.60 1091.60 716.60
1098.50
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1146.60
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1200.20
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1253.30
GR720.80 1265.60 721.10 1277.60 721.30 1286.50 721.60 1301.90 721.50
1309.70
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1375.80
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705.00
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766.50
GR717.10  782.10  716.30  790.00  716.10  805.00  716.40  813.50  716.50
827.30
GR716.10  836.00  716.00  848.80  715.80  860.00  715.50  872.00  715.60
883.50
GR715.30  893.50  714.60  907.50  714.20  914.90  713.30  928.00  712.70
934.80
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987.00
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1080.00
GR710.80 1090.00  710.80 1102.00  710.90 1109.40  711.20 1119.00  711.30
1129.00
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1229.10
GR713.90 1236.00  714.20 1250.30  714.50 1257.00  714.90 1271.00  715.40
1279.00
GR716.10 1293.00  716.70 1301.00  717.30 1315.00  717.50 1323.50  718.20
1339.00
GR719.20 1356.00  719.20 1362.30  719.90 1376.00  720.40 1386.00  722.20
1400.30
GR723.30 1413.00  723.30 1428.80  725.20 1441.00  728.50 1455.80  730.80
1471.60
GR732.00 1490.80  733.20 1509.90  733.60 1517.00  734.70 1551.80  741.30
1596.00
GR748.00 1610.60

X1143.69     80.   554.9   1705.0   1800.0   1350.0   1550.0   .00000     .00

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604.20
GR727.30  616.20  726.40  622.30  725.30  629.50  723.10  637.60  719.50
640.50
GR719.50  660.70  718.00  749.90  717.70  812.10  717.10  823.90  716.50
894.50
GR716.50  897.70  716.40  907.90  716.80  921.10  716.90  932.40  716.20
940.50
GR716.10  952.80  716.50  965.00  715.60  975.20  714.90  985.40  714.60

997.60
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1054.80
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1119.00
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1173.10
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1231.20
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1288.30
GR722.20 1298.50 722.30 1309.70 723.20 1319.90 723.30 1327.10 724.20
1334.20
GR724.60 1341.30 724.10 1348.50 725.20 1353.80 726.30 1358.80 727.50
1362.20
GR728.50 1365.50 728.30 1370.60 727.10 1387.40 727.10 1394.10 727.70
1402.60
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1429.50
GR730.10 1436.20 730.80 1448.00 730.80 1453.00 732.60 1469.00 735.30
1488.40
GR740.50 1523.00 741.20 1579.10 741.50 1632.80 743.20 1699.80 746.90
1705.40
X1144.73 83. 551.3 1604.7 5500.0 5100.0 5330.0 .00000 .00

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618.90
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681.00
GR717.20 690.40 717.20 701.30 716.30 711.30 715.50 719.50 715.40
727.70
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777.00
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826.30
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871.40
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921.40
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971.70
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1092.20
GR726.20 1106.30 726.30 1120.00 726.80 1135.60 727.00 1147.50 727.10
1159.40

GR727.40 1173.70 727.60 1188.30 727.90 1203.00 728.20 1217.20 728.40
1231.40
GR728.60 1244.80 728.60 1258.60 729.20 1277.60 729.10 1290.30 729.50
1308.50
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1382.30
GR731.20 1397.00 730.80 1416.20 730.50 1432.10 730.10 1447.60 730.00
1465.20
GR729.60 1477.70 729.60 1494.00 730.00 1509.00 732.70 1525.40 736.60
1544.50
GR740.90 1574.10 748.40 1604.70 754.90 1609.50

X1145.15 83. 539.6 1594.0 2350.0 1900.0 2160.0 .00000 .00

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630.10
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711.30
GR725.60 723.00 724.90 738.00 724.70 755.50 724.40 763.40 723.50
778.00
GR722.40 787.90 721.50 802.00 721.50 811.00 721.30 826.00 721.40
835.00
GR721.60 849.50 721.00 858.00 720.50 867.00 719.30 880.00 718.50
890.00
GR718.50 900.10 718.30 908.50 718.10 921.50 718.00 933.50 718.30
943.10
GR718.80 956.00 718.80 963.80 719.10 976.00 718.80 985.30 718.50
993.00
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1099.00
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GR723.30 1286.00 723.40 1296.00 723.80 1306.50 724.10 1320.40 724.70
1331.00
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1398.50
GR724.40 1411.00 723.60 1423.20 723.40 1434.00 725.00 1449.00 727.50
1462.00
GR728.60 1477.30 728.00 1494.90 730.10 1508.00 732.20 1519.80 735.00
1542.40
GR737.70 1570.70 748.90 1594.00 755.10 1619.60

X1145.22 83. 706.3 1872.6 360.0 350.0 360.0 .00000 .00

GR755.90 697.00 753.70 706.30 751.20 745.50 740.40 795.50 735.00
824.00
GR735.00 836.40 737.50 862.30 737.40 875.70 735.50 898.70 735.20
915.30
GR737.00 942.80 739.30 954.00 740.70 980.50 740.70 1002.50 740.40
1037.80
GR735.10 1050.30 728.90 1066.10 726.70 1081.00 726.60 1092.30 725.40
1107.60
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1176.00
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1227.50
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GR716.80 1291.50 716.50 1300.50 717.20 1313.00 718.00 1324.50 718.00
1334.50
GR717.70 1347.50 717.60 1357.10 717.60 1370.50 718.00 1378.50 717.40
1389.00
GR717.10 1399.10 717.00 1406.50 717.10 1421.00 717.90 1429.50 716.90
1442.00
GR716.40 1451.50 716.90 1462.60 716.90 1473.00 716.70 1484.00 716.30
1495.00
GR716.20 1505.50 716.30 1519.00 716.30 1526.30 716.90 1541.00 716.80
1547.80
GR716.50 1559.00 716.90 1568.30 717.20 1575.50 718.30 1590.00 718.60
1599.00
GR718.80 1611.00 719.30 1623.00 719.80 1634.00 720.50 1645.50 721.40
1656.90
GR722.20 1671.00 722.70 1681.50 723.30 1694.00 724.80 1706.50 727.70
1720.80
GR730.70 1735.50 731.80 1747.70 733.00 1768.10 735.20 1792.50 736.20
1804.90
GR737.80 1820.30 755.30 1872.60 760.00 1890.00

X1145.27 90. 577.0 1825.0 350.0 250.0 320.0 .00000 .00

GR756.50 577.00 753.70 587.30 752.50 640.70 747.90 666.60 741.70
695.40
GR738.50 710.40 736.10 721.40 734.00 733.40 731.60 781.20 732.10
814.80
GR735.80 855.10 736.90 871.40 738.10 895.20 739.00 930.40 739.60
965.50
GR738.70 975.10 739.70 983.50 739.40 1024.20 738.60 1052.10 736.90
1064.20
GR735.80 1074.40 734.10 1086.50 728.90 1103.00 727.80 1111.00 727.50

1121.00
GR727.10 1132.00 726.70 1142.00 726.00 1152.00 725.40 1162.00 725.00
1172.00
GR724.90 1184.00 723.70 1193.00 723.10 1204.00 722.60 1214.00 721.90
1224.00
GR721.30 1235.00 720.50 1247.00 719.40 1256.00 718.80 1267.00 717.90
1279.00
GR717.50 1288.00 717.10 1298.00 717.60 1310.00 717.30 1320.00 717.90
1329.00
GR717.30 1340.00 717.70 1350.00 716.90 1360.00 716.10 1369.00 716.60
1380.00
GR716.90 1390.00 716.40 1401.00 715.90 1410.00 715.10 1421.00 715.50
1434.00
GR716.90 1444.00 714.90 1454.00 714.80 1464.00 714.90 1474.00 715.60
1484.00
GR715.70 1493.00 715.40 1503.00 715.20 1515.00 715.80 1528.00 715.80
1537.00
GR716.60 1549.00 716.50 1559.00 716.60 1572.00 716.50 1584.00 716.50
1595.00
GR717.10 1606.00 718.20 1617.00 719.00 1627.00 719.40 1637.00 720.00
1647.00
GR720.60 1657.00 721.00 1664.00 722.40 1669.00 723.70 1675.00 725.40
1680.00
GR726.60 1683.00 727.50 1686.00 729.30 1694.00 730.90 1701.00 733.00
1712.80
GR735.70 1727.90 736.60 1740.90 740.50 1771.80 744.50 1791.10 755.00
1825.00
X1145.31 87. 801.6 1902.0 350.0 220.0 270.0 .00000 .00

GR756.00 749.00 753.10 763.40 750.10 777.80 746.30 793.40 746.10
801.60
GR746.60 838.80 744.40 882.70 743.40 912.00 742.50 942.10 741.60
988.30
GR741.60 993.70 741.50 1031.80 741.80 1045.60 741.40 1075.70 739.50
1095.70
GR738.10 1127.20 740.00 1139.30 736.20 1159.10 735.80 1175.00 734.70
1195.70
GR733.60 1208.60 732.40 1221.20 730.10 1238.30 729.50 1253.80 729.80
1265.00
GR729.30 1276.60 728.90 1290.70 729.10 1303.90 729.00 1316.10 729.20
1327.40
GR729.10 1341.30 727.70 1357.10 727.70 1365.10 727.20 1378.90 726.80
1389.40
GR726.60 1400.30 725.80 1411.80 725.00 1422.60 723.90 1433.40 724.30
1442.90
GR723.90 1455.50 723.20 1463.10 722.30 1476.30 722.00 1484.40 721.40
1495.40

GR720.60 1506.80 719.90 1515.40 718.90 1523.60 717.60 1533.50 716.90
1544.40
GR717.10 1550.00 716.30 1558.80 715.30 1566.80 715.50 1578.10 714.70
1584.00
GR715.20 1594.90 715.10 1599.40 714.90 1606.80 715.00 1615.70 714.80
1624.10
GR714.80 1632.60 715.40 1644.90 715.90 1648.90 715.10 1656.30 715.70
1664.50
GR715.80 1674.60 715.20 1681.30 715.10 1690.00 715.50 1697.50 716.60
1703.40
GR717.70 1714.50 718.10 1719.70 718.90 1732.40 719.30 1742.00 719.80
1751.10
GR720.40 1759.30 721.20 1770.20 721.80 1778.60 723.50 1789.50 726.70
1803.20
GR730.00 1814.10 735.00 1828.30 739.20 1846.80 739.60 1866.30 749.10
1902.00
GR751.80 1908.70 755.00 1925.00

X1145.38 83. 605.6 2074.3 300.0 240.0 280.0 .00000 .00

GR756.10 605.60 746.00 643.20 743.40 682.30 743.90 726.70 741.60
743.10
GR741.40 780.00 743.70 797.30 743.20 835.50 742.80 853.40 740.50
882.40
GR742.00 909.30 741.70 934.40 741.60 959.30 740.90 992.00 738.90
1012.10
GR739.70 1036.30 738.70 1060.90 740.40 1079.90 738.80 1107.70 738.60
1146.60
GR738.60 1155.80 738.50 1183.40 738.30 1200.30 738.10 1217.20 737.50
1243.30
GR737.10 1258.40 736.50 1286.30 736.40 1291.50 734.40 1326.90 733.80
1338.70
GR732.30 1364.70 730.90 1390.30 729.40 1401.00 728.60 1416.60 728.70
1433.00
GR728.60 1450.80 729.10 1465.30 728.70 1483.30 729.40 1498.00 728.80
1514.30
GR727.80 1529.00 725.00 1546.30 723.70 1559.30 721.80 1572.50 719.80
1585.00
GR717.70 1600.00 716.40 1609.50 715.30 1621.30 713.50 1631.80 712.80
1642.00
GR712.50 1654.00 712.20 1665.50 712.50 1674.00 712.50 1687.70 712.30
1696.60
GR711.90 1710.50 712.10 1716.80 712.40 1727.00 713.90 1739.50 714.00
1750.30
GR714.20 1761.30 715.00 1772.50 715.50 1783.80 715.90 1796.30 717.10
1807.00
GR718.90 1819.50 719.80 1830.00 720.50 1845.30 721.00 1857.00 721.50

1870.50
GR721.90 1881.50 722.40 1896.30 723.30 1909.00 725.50 1927.80 727.80
1938.00
GR730.30 1950.50 735.50 1973.30 739.40 1994.40 740.60 2022.10 742.30
2057.10
GR750.90 2074.30 750.90 2077.60 760.00 2095.00

X1145.61 85. 548.1 1616.2 1450.0 1200.0 1320.0 .00000 .00

GR756.80 500.00 753.20 521.10 751.90 529.00 748.90 548.10 741.60
587.80
GR737.80 610.60 735.20 629.30 733.00 645.70 731.30 662.80 730.40
673.50
GR729.40 688.60 728.90 700.70 728.60 711.30 728.60 726.00 728.70
737.20
GR729.10 751.60 729.70 766.00 730.00 778.70 729.60 790.90 729.60
806.60
GR729.70 824.30 729.80 833.30 729.60 847.00 729.30 858.50 729.00
869.20
GR728.50 884.50 728.30 900.10 728.30 911.60 727.90 926.60 727.50
937.00
GR727.30 947.80 727.10 961.30 727.10 969.40 726.80 983.90 726.80
995.10
GR726.60 1007.90 726.70 1024.50 726.50 1033.10 726.50 1048.60 726.50
1056.10
GR726.30 1073.20 726.30 1080.60 726.50 1096.30 726.30 1103.00 726.30
1116.40
GR726.20 1126.30 726.20 1137.60 726.20 1150.80 726.10 1166.10 726.00
1174.20
GR725.80 1190.20 725.70 1196.40 725.90 1210.40 726.10 1219.90 725.70
1232.40
GR725.30 1243.80 725.00 1257.10 724.90 1265.20 724.50 1276.30 724.40
1287.50
GR724.20 1298.80 723.70 1309.60 723.00 1325.40 722.80 1331.50 723.10
1342.60
GR723.40 1351.40 723.70 1360.80 724.00 1372.70 724.50 1388.40 725.20
1396.40
GR725.80 1412.90 726.30 1419.20 727.20 1436.60 727.60 1443.10 728.20
1457.10
GR729.50 1467.00 730.40 1480.60 730.30 1495.60 732.70 1516.40 734.40
1525.10
GR736.70 1537.40 739.20 1564.10 740.20 1578.60 744.20 1616.20 760.00
1660.00
X1146.33 76. 535.6 1459.0 3400.0 3500.0 3460.0 .00000 .00

GR750.80 535.60 747.30 569.60 746.90 605.70 738.10 635.40 736.80
650.40

GR735.10 666.40 734.50 680.40 734.50 724.50 734.00 805.70 732.30
834.20
GR732.20 840.90 731.90 846.70 731.10 857.00 731.10 864.00 731.00
871.00
GR730.90 880.00 730.50 890.00 730.20 901.00 729.40 912.00 728.90
923.00
GR728.30 933.00 728.20 943.00 727.70 951.00 726.90 961.00 726.70
971.00
GR726.50 980.00 726.20 990.00 726.10 1001.00 725.80 1011.00 725.30
1021.00
GR725.20 1030.00 725.00 1039.00 724.60 1048.00 724.30 1057.00 723.80
1067.00
GR723.50 1078.00 722.90 1088.00 722.10 1097.00 721.40 1106.00 721.10
1116.00
GR720.40 1124.00 719.40 1134.00 718.30 1143.00 717.60 1153.00 716.80
1163.00
GR716.00 1173.00 715.30 1182.00 714.50 1192.00 714.00 1202.00 714.00
1213.00
GR713.80 1224.00 714.10 1234.00 720.40 1254.00 719.60 1265.00 720.50
1275.00
GR721.10 1287.00 721.70 1299.00 723.80 1311.00 723.10 1323.00 724.90
1334.00
GR725.90 1345.00 726.30 1354.00 726.40 1363.00 727.00 1368.00 727.80
1375.00
GR729.30 1416.80 734.40 1441.30 737.00 1449.50 742.80 1459.00 743.30
1469.10
GR744.40 1477.50 748.20 1492.60 752.30 1509.40 754.10 1516.40 756.90
1527.80
GR760.00 1540.00

X1146.87 70. 525.6 1273.2 2700.0 3200.0 3000.0 .00000 .00

GR745.80 525.60 744.50 548.20 744.80 549.40 741.20 571.20 739.50
580.50
GR737.20 601.50 734.70 627.00 733.50 642.00 733.50 647.00 733.50
653.00
GR733.50 658.00 733.50 666.00 733.50 675.00 733.50 679.00 733.40
691.00
GR733.00 699.00 732.20 708.00 731.10 718.00 730.20 730.00 729.10
739.00
GR728.70 749.00 728.40 762.00 728.10 774.00 727.50 784.00 727.30
792.00
GR726.60 804.00 726.30 816.00 725.90 826.00 725.40 839.00 725.00
849.00
GR724.60 859.00 724.20 870.00 723.90 879.00 723.30 889.00 723.00
900.00
GR722.40 910.00 722.20 920.00 721.80 929.00 720.80 941.00 720.40

953.00
GR720.00 963.00 719.60 974.00 720.90 984.00 719.00 996.00 719.30
1007.00
GR720.90 1020.00 722.10 1030.00 721.70 1040.00 721.70 1051.00 722.10
1064.00
GR722.50 1077.00 722.50 1088.00 723.50 1100.00 723.80 1116.00 722.70
1127.00
GR723.40 1138.00 724.60 1148.00 724.40 1157.00 724.70 1165.00 724.70
1171.00
GR725.50 1175.00 725.50 1179.00 731.80 1203.00 737.20 1227.50 738.30
1236.30
GR741.80 1244.60 743.00 1254.60 745.80 1267.60 748.00 1273.10 748.90
1273.20
X1147.47 28. 500.0 1580.0 3100.0 3450.0 3280.0 .00000 .00

GR765.00 500.00 739.60 658.00 736.80 686.00 733.50 739.00 730.10
800.00
GR729.30 846.00 729.50 902.00 729.70 938.00 729.20 975.00 729.00
1021.00
GR728.80 1062.00 728.90 1096.00 728.80 1135.00 728.30 1176.00 728.20
1215.00
GR727.80 1265.00 729.40 1317.00 734.60 1363.00 737.40 1409.00 737.80
1444.00
GR739.60 1452.00 744.50 1482.00 745.10 1484.00 748.00 1516.00 750.50
1518.00
GR753.40 1541.00 759.00 1557.00 765.00 1580.00

X1148.09 20. 500.0 1520.0 3000.0 3050.0 3040.0 .00000 .00

GR765.00 500.00 747.10 611.00 737.10 686.00 728.80 721.00 726.80
773.00
GR726.20 820.00 725.70 851.00 726.90 896.00 727.60 930.00 729.00
973.00
GR730.10 1019.00 730.40 1051.00 730.70 1092.00 731.60 1152.00 733.30
1207.00
GR735.10 1262.00 736.30 1307.00 739.30 1356.00 741.10 1394.00 765.00
1520.00
X1148.83 26. 500.0 1545.0 3900.0 3300.0 3700.0 .00000 .00

GR767.40 500.00 749.60 595.00 740.60 639.00 739.30 655.00 739.90
696.00
GR739.80 788.00 739.40 828.00 738.50 863.00 737.00 900.00 735.40
930.00
GR733.50 958.00 732.60 988.00 732.00 1008.00 731.90 1030.00 731.90
1056.00
GR732.00 1088.00 732.00 1148.00 732.60 1198.00 733.40 1232.00 734.00
1279.00

GR735:20 1333.00 737.40 1385.00 741.60 1446.00 743.40 1456.00 752.80
1499.00
GR770.00 1545.00

# Appendix D

# Subregions of the Lower Granite Reservoir

# Appendix D

## Subregions of the Lower Granite Reservoir

Coordinates of the eight sub-regions of the Lower Granite Reservoir . Subsetting done as a result of software limitations of PV-WAVE. Sub-regions were merged together using GRASS.

| FILE NUMBER | NORTHSOUTHEASTWEST |
|---|---|
| 1 | 50100049200027850002770000 |
| 2 | 49302047700027930202780000 |
| 3 | 47810046670028059002786700 |
| 4 | 47192045590028199102804700 |
| 5 | 45690043110028252002815600 |
| 6 | 43211041720028318002819800 |
| 7 | 41970041160028630002840800 |
| 8 | 42082040540028767002862000 |
| 9 | 41830040924028419602825460 |

# Appendix E

# Conversion of GRASS Raster Files to PV-WAVE Input

# Appendix E

## Conversion of GRASS Raster Files to PV-WAVE Input

grassras_to_PV-WAVE.f

generate a PV-WAVE input file with latitude and longitude coordinates from a GRASS raster file.

```
C     input the raster files NW Corner Coordinates and the pixel
C     resolution
C
C     If the input value is equal to the 'ZOT' value, it is assumed to
C     be masked into the value of ZERO.
C
      implicit none
C
      integer         maxlin
      parameter       (maxlin=4096)
C
      byte            buffb(maxlin), bval
      integer*2       buffi(maxlin), Zshort(2), bint
      integer*4       buffi4(maxlin)
      character*40    fnin, fnout
      double precision        North, west, X,Y,Z, zot
      real            pixres
      integer         form, colms, lines, inrec, iln, ic, ipts_out,i, Ztem
C
      equivalence     (Ztem,Zshort(1))
C
      zot = 666.0
C
      write(*,*)' '
      write(*,*)' Enter GRASS Raster file name'
      read(*,100) fnin
      write(*,*)' Enter number of columns and lines'
      read(*,*) colms, lines
   78 write(*,*)' Choose Format: 1) byte, 2) Integer*2, 4) I*4'
      read(*,*) form
      if(form.lt.1 .or. form.gt.4 .or. form.eq.3) go to 78
C
```

```
      write(*,*)' Enter NW Corner Coordinates (west,north)'
      read(*,*) west,north
      write(*,*)' Enter Pixel Resolution (Coordinate Units)'
      read(*,*) pixres
C
      write(*,*)' '
      write(*,*)' Enter Output file name'
      read(*,100) fnout
C
      inrec = colms*form
      open(11,file=fnin,status='old',access='direct',
     +    form='unformatted',recl=inrec)
      open(21,file=fnout,status='unknown')
C
      ipts_out = 0
      Y = north
C
      do 10 iln=1,lines
       X = west
       if(form.eq.1) then
        call read_byte_dbin(buffb,colms,11,iln)
       else if(form.eq.2) then
        call read_i2_dbin(buffi,colms,11,iln)
       else if(form.eq.4) then
        call read_i4_dbin(buffi4,colms,11,iln)
       endif
C
       do 12 ic=1,colms
        if(form.eq.1) then
         if(buffb(ic).ne.0) then
                    bval = buffb(ic)
                    bint = bval + 256
                    Z = float(bint)
                    if(Z.eq.zot) Z = 0.0
                    write(21,*) X,Y,Z
                    ipts_out = ipts_out + 1
                    if(mod(ipts_out,200).eq.0)
     +        write(*,*)' At output point ',ipts_out,' X,Y,Z = ',X,Y,Z
         endif
        else if(form.eq.2) then
         if(buffi(ic).ne.0) then
                    Z = float(buffi(ic))
                    if(Z.eq.zot) Z = 0.0
                    write(21,*) X,Y,Z
                    ipts_out = ipts_out + 1
                    if(mod(ipts_out,200).eq.0)
     +        write(*,*)' At output point ',ipts_out,' X,Y,Z = ',X,Y,Z
```

```
          endif
        else if(form.eq.4) then
          if(buffi4(ic).ne.0) then
                    Z = real(buffi4(ic))
                    if(Z.lt.0.0) then
                      Ztem = buffi4(ic)
                      Z = -dble(Zshort(2))
                    endif
                    if(Z.lt.-32760) then
                      write(*,*)' at iln = ',iln
                      write(*,*) (buffi4(i),i=1,colms)
                      write(*,*)' buffi4(ic) = ',buffi4(ic)
                      write(*,*)' Z          = ',Z
                      stop 'AARRGGFHH!!'
                    endif
                    if(Z.eq.zot) Z = 0.0
                    write(21,*) X,Y,Z
                    ipts_out = ipts_out + 1
                    if(mod(ipts_out,200).eq.0)
     +   write(*,*)' At output point ',ipts_out,' X,Y,Z = ',X,Y,Z
          endif
        endif
        X = X + pixres
 12     continue
C
      Y = Y - pixres
 10   continue
C
      write(*,*)' Number of points output = ',ipts_out
C
 100  format(a40)
C
      stop
      end
```

# Appendix F

# Interpolation of Depth Values for Channel Centerline

# Appendix F

## Interpolation of Depth Values for Channel Centerline

This appendix contains the source code and an example log from tgridgen_xypts, the program used to interpolate depth values along the river channel line. Interpolates a regular grid from irregular latitude/longitude coordinates and their depths.

I. Source

```
C     program: tgridgen_xypts
C     function: interpolation of general surface from irregularly
C     spaced point
C     MODIFIED by LGM Mar 5, 1993 to interpret XY input points
C     from the input data file of XYZ data
C
      implicit none
      integer             npoints, nx, ny, nz
      parameter (npoints=10000, nx=200, ny=200, nz=200)
C
      real                ttab(3,npoints)
      integer*4           indary(nx,ny,nz),head(50)
      integer*4           ntmx, ip, nstr, ntot, maxpoints, ind
      character*40        nam1, namout, namxy
      logical             endfile
      real                zthresh
C
      integer             inxmx,inymx,inmx,rdmx, ncolq,nlinq, ic,
      +                   icol,ilin, ncol,nlin, nsmp0, ift, nn, ipr,
      +                   i,j,k, ix,iy, nncol,nnlin, nsum, ixi,
      +                   iyi, iib,iie, ijb,ije, npt, ix_mn,ix_mx,iy_mn,
      +                   iy_mx, max_srad, iun, oun, count
      real                sizeq,dxq,dyq,xdimq,ydimq,bpln,tmax,
      +                   x00q,y00q,years, zbias, gispc, xidm,yidm, x0i,
      +                   y0i, xodm,yodm, x00,y00, radin,pwr,
      +                   xmin,xmax,ymin,ymax,zmin,zmax, x,y,z, tmax,
      +                   rdsch, wtsum, tsum, xt,yt,tp,dxt,dyt,rt,wt, twt, Z,
      +                   input_zmax, input_zmin
      logical             endfile, found
C
      common /bk/ ncolq,nlinq,sizeq,dxq,dyq,xdimq,ydimq,bpln,tmax
      1                   ,x00q,y00q,years
```

```
C
      equivalence (head,ncolq)
C
      ntmx =npoints
      inxmx =nx
      inymx =ny
      inmx = nz - 1
      rdmx = 1200
C
      write(*,*)' '
      write(*,*)' max number of input points = ',ntmx
      write(*,*)' max size of index array    = ',inxmx,inymx,inmx
      write(*,*)' max initial search radius  = ',rdmx
C
 1    write(*,*)' '
      write(*,*)'(1) - specify input x,y,z file'
      write(*,*)'(2) - specify index array'
      write(*,*)'(3) - specify input XY Coordinate file and Output file'
      write(*,*)'(4) - set interpolation parameters'
      write(*,*)'(5) - read XYZ point data file'
      write(*,*)'(6) - generate output XYZ file'
      write(*,*)'(7) - stop'
      read(*,*) ic
      if(ic.eq.1) then
        write(*,*)'enter x-y-z data input file name'
        read(*,100) nam1
        open(unit=1,name=nam1,type='old',form='formatted')
        write(*,*)' enter z bias value,(Add to Input Z Values)'
        read(*,*) zbias
        write(*,*)' Enter Minimum and Maximum Z value to be used in Interp'
        read(*,*) input_zmin, input_zmax
Cic
      else if(ic.eq.2) then
        write(*,*)'enter index grid spacing '
        read(*,*) gispc
        write(*,*)'enter x-dim , y-dim for index grid '
        read(*,*) xidm,yidm
        icol =int(xidm/gispc +.5)
        ilin =int(yidm/gispc +.5)
        icol =min(icol,inxmx)
        ilin =min(ilin,inymx)
        write(*,*)'icol =',icol,'  ilin =',ilin
        write(*,*)' Enter Minimum X Coordinate'
        read(*,*) x0i
        write(*,*)' Enter Maximum Y coordinate'
        read(*,*) y0i
C       x0i = 0
```

```
C     y0i = yidm
Cic
      else if(ic.eq.3) then
        write(*,*)' '
        write(*,*)' Enter XY Input file of points to interpolate'
        read(*,100) namxy
        iun = 20
        open(iun,file=namxy,status='unknown')
        write(*,*)' Enter Output File Name'
        read(*,100) namout
        oun = 31
        open(oun,file=namout,status='unknown')
Cic
      else if(ic.eq.4) then
        write(*,*)'enter initial search radius (XY Input Units)'
        read(*,*) radin
        write(*,*)' Enter MAX search radius factor'
        write(*,*)'  (multiply by initial search radius)'
        read(*,*) max_srad
        write(*,*)'enter min sample count'
        read(*,*) nsmp0
        write(*,*)'enter pwr in weight function: 1/r**pwr'
        read(*,*) pwr
          write(*,*)' enter minumum z threshold value'
          read(*,*) zthresh
Cic
      else if(ic.eq.5) then
        endfile = .false.
        ip = 0
        xmin = 1.0e+24
        xmax = -xmin
        ymin = xmin
        ymax = xmax
        zmin = xmin
        zmax = xmax
        write(*,*)' enter max number points to read (-1=all)'
        read(*,*) maxpoints
        if(maxpoints.eq.-1) maxpoints = npoints
        write(*,*)' '
        do 450 while(.not. endfile)
          if(ip.ge.maxpoints) go to 99
          read(1,*,end=99) x,y,z
          if(z.le.input_zmax .and. z.ge.input_zmin) then
            ip = ip + 1
            if(mod(ip,500).eq.0) write(*,700) ip
            ttab(1,ip) =x
            ttab(2,ip) =y
```

```
        ttab(3,ip) =z + zbias
        xmin = amin1(ttab(1,ip),xmin)
        xmax = amax1(ttab(1,ip),xmax)
        ymin = amin1(ttab(2,ip),ymin)
        ymax = amax1(ttab(2,ip),ymax)
        zmin = amin1(ttab(3,ip),zmin)
        zmax = amax1(ttab(3,ip),zmax)
        if(endfile) then
 99       continue
          endfile = .true.
        endif
      endif
 450                 continue
C
    close(unit=1)
    ntot = ip
    write(*,*)'total samples =',ntot
    write(*,*)' x range = ',xmin,xmax
    write(*,*)' y range = ',ymin,ymax
    write(*,*)' z range = ',zmin,zmax
C
C
C                   fill index file
C
    write(*,*)' '
    write(*,*)' initialize index array'
    do 451 i =1,inxmx
      do 451 j =1,inymx
        indary(i,j,1) = 0
 451                 continue
C
    write(*,*)' transfer data to the index array'
    write(*,*)' '
    nstr =0
    do 452 ip =1,ntot
      if(mod(ip,500).eq.0) write(*,701) ip
      x =ttab(1,ip)
      y =ttab(2,ip)
      ix =(x -x0i)/gispc +1
      iy =(y0i -y)/gispc +1
      if(ix .ge. 1 .and. ix .le. inxmx) then
        if(iy .ge. 1 .and. iy .le. inymx) then
          ind =indary(ix,iy,1)
          if(ind .lt. inmx) then
            ind =ind +1
            indary(ix,iy,1) =ind
            indary(ix,iy,ind+1) =ip
```

```
          nstr =nstr +1
        else
                   write(*,*)' Max # Pts in an Index Bin Exceeded'
                   write(*,*)' Dropping Input point in bin ',ix,',',iy
                  endif
       endif
      endif
452                continue
C
      write(*,*)' '
      write(*,*)' number entries into the index file = ',nstr
      write(*,*)'print index array ? (1=y,cr=n)'
      read(*,101) ipr
      if(ipr .eq. 1) then
        write(*,*)'ntot =',ntot,'  nstr =',nstr
        do 460 j =ilin,1,-1
          write(*,103) j,(indary(i,j,1),i =1,icol)
460                 continue
        do 462 j =ilin,1,-1
          do 462 i =1,icol
            nn =indary(i,j,1)
            if(nn .gt. 0) write(*,104) i,j,(indary(i,j,k),k =1,nn+1)
462                 continue
      endif
Cic
    else if(ic.eq.6) then
C
      tmax =0.
      nncol =ncol
      nnlin =nlin
      endfile = .false.
      count = 0
      do 471 while(.not. endfile)
         read(iun,*,end=777) x, y
         found = .true.
         count = count + 1
         if(mod(count,100).eq.0) write(*,*)' At Input Point # ',count
         ixi =(x -x0i)/gispc +1
         iyi =(y0i -y)/gispc +1
         rdsch =radin
         rdmx = max_srad*radin
         do 472 while(rdsch .lt. rdmx)
           nsum =0
           wtsum =0.
           tsum =0.
                   ix_mn = (x - x0i - rdsch) / gispc +1
                   ix_mx = (x - x0i + rdsch) / gispc +1
```

```
                    iy_mn = (y0i - y - rdsch) / gispc +1
                    iy_mx = (y0i - y + rdsch) / gispc +1
                    iib = max(ix_mn,1)
                    iie = min(ix_mx,icol)
                    ijb = max(iy_mn,1)
                    ije = min(iy_mx,ilin)
C  write(*,*)' ix,iy, x,y = ',ix,iy,x,y
C  write(*,*)' ixi,iyi, rdsch,rdmx = ',ixi,iyi, rdsch,rdmx
C  write(*,*)' ix_mn,ix_mx,iy_mn,iy_mx = ',ix_mn,ix_mx,iy_mn,iy_mx
C  write(*,*)' iib,iie,ijb,ije = ',iib,iie,ijb,ije
          do 474 i=iib,iie
           do 474 j=ijb,ije
            npt =indary(i,j,1)
            if(npt .ge. 1) then
C
C  write(*,*)' i,j,npt = ',i,j,npt
C
             do 476 k =1,npt
              ind =indary(i,j,k+1)
              xt =ttab(1,ind)
              yt =ttab(2,ind)
              tp =ttab(3,ind)
              dxt = x -xt
              dyt = y -yt
              rt =sqrt(dxt*dxt + dyt*dyt)
              if(rt .lt. 1) rt =1.
              if(rt .lt. rdsch) then
               wt =1./rt**pwr
               nsum =nsum +1
               wtsum =wtsum +wt
               tsum =tsum +wt*tp
                      endif
 476                  continue
C  write(*,*)' ind,xt,yt,tp,dxt,dyt = ',ind,xt,yt,tp,dxt,dyt
C  write(*,*)' rt,wt,nsum = ',rt,wt,nsum
C  write(*,*)' wtsum,tsum = ',wtsum,tsum
                    endif
 474              continue
C
          if(nsum .lt. nsmp0) then
                    rdsch =1.5*rdsch
          else
                    rdsch =rdmx
          endif
 472                 continue
C
```

```
        if(nsum .ge. nsmp0) then
                  twt =tsum/wtsum
        else
                  twt = zthresh
         write(*,*)' Minumum number of points not found for a point'
         found = .false.
        endif
        z = twt
        tmax =amax1(tmax,twt)
C   write(*,*)' twt, tmax = ', twt, tmax
C
C   write(*,*)' X, Y, Z = ',x,y,z
C   pause' hit C to Continue'
        if(found) write(oun,888) x, y, Z
        if(endfile) then
 777              endfile = .true.
        endif
.471               continue
C
       write(*,*)' ',count,' Input Points Interpolated'
       close(oun)
       close(iun)
Cc
C    write-file-discriptor
C ***********##################$$$$$$$$$$$$$$$$$$$$$$$$&&&&&&&&&&&&&
C
      write(*,107)
      if(ift.eq.1) then
       write(*,*)'file type: formatted'
       write(*,117) ncol,nlin
      else if(ift.eq.2) then
       write(*,*)'file type: binary'
       write(*,117) ncol,nlin
      endif
C
      write(*,109) x00,y00,xodm,yodm
C
      write(*,111)
      write(*,112) nam1
C
      write(*,113)
      write(*,114) radin,nsmp0,pwr
C
      write(*,115)
      write(*,116) gispc,xidm,yidm,icol,ilin,x0i,y0i
C
C ***********##################$$$$$$$$$$$$$$$$$$$$$$$$&&&&&&&&&&&&&
```

```
c
        else if(ic.eq.7) then
          stop 'tgridgen finished'
        endif
c
      go to 1
c
100                 format(a40)
101                 format(2i5)
102                 format(3i10,5x,10f5.1)
103                 format(i3,5x,20i5)
104                 format(1x,2i2,1x,i2,2x,30i4)
105                 format(1x,20f6.2)
106                 format(a2,i1)
107                 format(10x,'file discriptor data'//)
109                 format(
     1   1x,'lower left corner x(m) =',f8.2,' y(m) =',f8.2/
     1   1x,'array size : x-dim (m) =',f8.1,' y-dim (m) =',f8.1)
110                 format(1x,'disk blocks/line =',f6.0/1x,'file-q size =',f8.0)
111                 format(/10x,'input file data'/)
112                 format(1x,'input file name: ',28a1)
113                 format(/10x,'interpolation prameters'/)
114                 format(1x,'initial search radius (m) =',f6.1/
     1               1x,'minimum no. of samples =',i4/
     1               1x,'exponent in expression ( wt =1/r**exp) =',f6.2)
115                 format(/10x,'index array prameters'/)
116                 format(1x,'index columns =',i5/1x,'index lines =',i5/
     1               1x,'lower left corner : x0i(m) =',f8.2,' y0i(m) =',f8.2)
117                 format(1x,'output columns =',i5/1x,'output lines =',i5)
700                 format('+',' reading at line ',i7)
701                 format('+',' transferring at line ',i7)
888                 format(2x,2f16.5,2x,f12.4)
c
      end
```

II. Example Log

```
 enter x-y-z data input file name
bath_and_xsect.data
 enter z bias value,(Add to Input Z Values)
0
 Enter Maximum Z value to be used in Interp
500,638

index grid spacing
600
```

```
enter x-dim , y-dim for index grid
105600,95100
 Enter Minimum X Coordinate
2770500
 Enter Maximum Y coordinate
500500
3

 Enter XY Input file of points to interpolate
channel_90.asc
 Enter Output File Name
channel_90.xyzinterp.BS638
4
enter initial search radius (XY Input Units)
600
 Enter MAX search radius factor
  (multiply by initial search radius)
20
enter min sample count
5
enter pwr in weight function: 1/r**pwr
2
 enter minumum z threshold value
0
*************************************
total samples =  227
 x range =     2.77132E+06    2.82341E+06
 y range =     430386.    498765.
 z range =     609.000    648.000

 initialize index array
 transfer data to the index array


 number entries into the index file =   227

*************************************
    INCLUDE CROSS-SECTIONS

total samples =  380
 x range =     2.77132E+06    2.82318E+06
 y range =     430386.    498675.
 z range =     609.000    638.000

 initialize index array
 transfer data to the index array
```

number entries into the index file = 380

*****************************************************
CHANNEL_60ft

1
enter x-y-z data input file name
bath_and_xsect.data
enter z bias value,(Add to Input Z Values)
0
Enter Minimum and Maximum Z value to be used in Interp
648,678

2
enter index grid spacing
600
enter x-dim , y-dim for index grid
105600,95100
icol = 176 ilin = 159
Enter Minimum X Coordinate
2770500
Enter Maximum Y coordinate
500500

3

Enter XY Input file of points to interpolate
channel_60ftEN
Enter Output File Name
channel_60ftEN.xyzinterp

4
enter initial search radius (XY Input Units)
600
Enter MAX search radius factor
(multiply by initial search radius)
5
enter min sample count
5
enter pwr in weight function: 1/r**pwr
2
enter minumum z threshold value
0

5
enter max number points to read (-1=all)

```
-1

+ reading at line     500
+ reading at line    1000
total samples =  1255
 x range =     2.77206E+06   2.85373E+06
 y range =     413473.    499627.
 z range =     648.000    678.000

 initialize index array
 transfer data to the index array

+ transferring at line     500
+ transferring at line    1000

 number entries into the index file =    1255

************************************************************
channel_30ft

1
enter x-y-z data input file name
bath_and_xsect.data
 enter z bias value,(Add to Input Z Values)
0
 Enter Minimum and Maximum Z value to be used in Interp
678,708

2
enter index grid spacing
600
enter x-dim , y-dim for index grid
105600,95100
icol =  176  ilin =  159
 Enter Minimum X Coordinate
2770500
 Enter Maximum Y coordinate
500500

3
 Enter XY Input file of points to interpolate
channel_30ftEN
 Enter Output File Name
channel_30ftEN.xyzinterp

4
enter initial search radius (XY Input Units)
```

```
600
 Enter MAX search radius factor
  (multiply by initial search radius)
5
enter min sample count
5
enter pwr in weight function: 1/r**pwr
2
 enter minumum z threshold value
0

+ reading at line     500
+ reading at line    1000
+ reading at line    1500
+ reading at line    2000
+ reading at line    2500
+ reading at line    3000
+ reading at line    3500
total samples =  3686
 x range =     2.77197E+06   2.87432E+06
 y range =     397974.    499503.
 z range =     678.000    708.000

 initialize index array
 transfer data to the index array

+ transferring at line     500
+ transferring at line    1000
+ transferring at line    1500
+ transferring at line    2000
+ transferring at line    2500
+ transferring at line    3000
+ transferring at line    3500

 number entries into the index file =   3686
```

# Appendix G

## Conversion of Centerline Countours to GRASS Sites File

# Appendix G

## Conversion of Centerline Countours to GRASS Sites File

```
C
C xyz_to_grpts
C
C  make an XYZ file into a GRASS points file, with Z value tresholds
C
   implicit none
C
   character*40       fnin, fnout
   double precision   x,y,z, zmin,zmax
   integer            count, inun, oun, cout
   logical            endfile
C
   write(*,*)' '
   write(*,*)' Enter Input File name'
   read(*,100) fnin
   inun=11
   open(inun,file=fnin,status='old')
C
     write(*,*)' '
     write(*,*)' Enter Output File name'
     read(*,100) fnout
     oun=21
     open(oun,file=fnout,status='unknown')
C
   write(*,*)' '
   write(*,*)' Enter Min and Max Z value to be output'
   read(*,*) zmin, zmax
C
   count = 0
   count = 0
   endfile = .false.
C
   do 10 while(.not. endfile)
     read(inun,*,end=99) x,y,z
     count = count + 1
     if(mod(count,200).eq.0) write(*,*)' At Input Line = ',count
C
```

```
      if(z.ge.zmin .and. z.le.zmax) then
        count = count + 1
        write(oun,200) x,y,z
      endif
C
      if(endfile) then
 99                   continue
        endfile = .true.
      endif
 10                   continue
C
    write(*,*)' Number lines read = ',count
    write(*,*)' Number of lines output = ',cout
C
    close(inun)
    close(oun)
C
C ****************************
C Format Statements
C
100                   format(a40)
200                   format(2x,2f16.6,2x,f12.5)
C
    stop
    end
```

# Appendix H

## Replacement of 1989 Sounding Data Using 1992 Hydroacoustic Data for Schultz Bar and the Dredge Disposal Site, Creation of xyz Coordinates from Soundings

# Appendix H

## Replacement of 1989 Sounding Data Using 1992 Hydroacoustic Data for Schultz Bar and the Dredge Disposal Site, Creation of xyz Coordinates from Soundings

```
/* This program will read two different formats of dredge line depth soundings files.
 * The program pulls the data from the input files only if the data exists in the
 * current section of the river defined by station numbers.  The program requires the
 * input of two points with associated Eastings, Northings, and station numbers, for
 * defining the control line of the river.  The output of this program is the xyz
 * coordinates of all points in the defined sections, and a grass-readable vector
 * file which must have a header added to the beginning of the file first through.
 * Currently, the two formats readable are GR format and fix format. */
/* Date: 4-30-93  Output format added: Arc-info xyz format: one xy file and one z file. */

#include <stdio.h>
#include <math.h>

FILE *infile, *outfile, *outfile2;
int center_mask = 0;
int cen_base1, cen_base2;
float cen_offset1, cen_offset2;
double nor1, nor2, eas1, eas2;

get_center_data()
{
   char cenbuf[256];

   printf ("\nEnter center line data.");
   printf ("\nEnter station number for point 1: ");
   gets (cenbuf, "%s");
   sscanf (cenbuf, "%d+%f", &cen_base1, &cen_offset1);
   printf ("\nEnter Northing for station %d+%f: ", cen_base1, cen_offset1);
   gets (cenbuf, "%s");
   sscanf (cenbuf, "%lf", &nor1);
   printf ("\nEnter Easting for station %d+%f: ", cen_base1, cen_offset1);
   gets (cenbuf, "%s");
   sscanf (cenbuf, "%lf", &eas1);
   printf ("\nEnter station number for point 2: ");
```

```
    gets (cenbuf, "%s");
    sscanf (cenbuf, "%d+%f", &cen_base2, &cen_offset2);
    printf ("\nEnter Northing for station %d+%f: ", cen_base2, cen_offset2);
    gets (cenbuf, "%s");
    sscanf (cenbuf, "%lf", &nor2);
    printf ("\nEnter Easting for station %d+%f: ", cen_base2, cen_offset2);
    gets (cenbuf, "%s");
    sscanf (cenbuf, "%lf", &eas2);
    center_mask = 1;
    fprintf (outfile2, "L  2\n");
    fprintf (outfile2, "    %lf    %lf\n", nor1, eas1);
    fprintf (outfile2, "    %lf    %lf\n", nor2, eas2);
}

write_GR_format(start_sta, end_sta)
    float start_sta, end_sta;
{
    FILE *grfile;
    char inbuf[256], y_n, *grname[80], dum1, dum2, lft_to_rgt;
    float stat1, stat2, cur_stat, cur_z, dist;
    double nor_start, eas_start, nor_end, eas_end, cur_x, cur_y, hypot, displ_e, displ_n, cur_e, cur_n;
    int togo, i, line_val, j;

/*    printf (" %f  %f\n", start_sta, end_sta);*/
    if (center_mask) {
     printf ("Use same center line data <y/n>?");
     gets (inbuf, "%s");
     sscanf (inbuf, "%c", &y_n);
     if ((y_n == 'N') || (y_n == 'n')) {
        get_center_data();
    }
    }
    else
     get_center_data();
    printf ("\nEnter the offset of the center line in feet(usually 1000 or 2000):");
    gets (inbuf, "%s");
    sscanf (inbuf, "%d", &line_val);
    printf ("\nDoes the data run left to right looking downriver <y/n>?");
    gets (inbuf, "%s");
    sscanf (inbuf, "%c", &lft_to_rgt);
    stat1 = cen_base1 + (cen_offset1 / 100.0);
    stat2 = cen_base2 + (cen_offset2 / 100.0);
    nor_start = nor1 - (((start_sta - stat1)/(stat2 - stat1))*(nor1 - nor2));
    eas_start = eas1 - (((start_sta - stat1)/(stat2 - stat1))*(eas1 - eas2));
    nor_end = nor1 - (((end_sta - stat1)/(stat2 - stat1))*(nor1 - nor2));
    eas_end = eas1 - (((end_sta - stat1)/(stat2 - stat1))*(eas1 - eas2));
    hypot = sqrt (pow ((eas_end - eas_start),2.0) + pow ((nor_end - nor_start),2.0));
```

```
/*   printf ("\n%lf %lf %lf %lf %lf\n", nor_start, eas_start, nor_end, eas_end, hypot);*/
   printf ("\nEnter the GR format input filename: ");
   gets (inbuf, "%s");
   sscanf (inbuf, "%s", grname);
   while ((grfile = fopen(grname, "r")) == NULL) {
    printf ("Unable to open %s\n", grname);
    printf ("\nEnter the GR format input filename: ");
    gets (inbuf, "%s");
    sscanf (inbuf, "%s", grname);
   }
   while (fgets (inbuf, 256, grfile)) {
/*  printf ("Inbuf: %s¦\n", inbuf);*/
    sscanf (inbuf, "%c%c %f %d", &dum1, &dum2, &cur_stat, &togo);
    while (dum1 == 'C') {
       fgets (inbuf, 256, grfile);
       sscanf (inbuf, "%c%c %f %d", &dum1, &dum2, &cur_stat, &togo);
    }
/*  printf ("Header: %f %d\n", cur_stat, togo);*/
    if ((cur_stat >= start_sta) && (cur_stat <= end_sta)) {
       cur_y = nor_start - (((cur_stat - start_sta)/(end_sta - start_sta))*(nor_start - nor_end));
       cur_x = eas_start - (((cur_stat - start_sta)/(end_sta - start_sta))*(eas_start - eas_end));
       fprintf (outfile2, "L %d\n", togo);
       i = 0;
       while (i < togo) {
          fgets (inbuf, 20, grfile);
                    sscanf (inbuf, "%c%c %f %f", &dum1, &dum2, &cur_z, &dist);
/*                  printf ("%f %f\n", cur_z, dist);*/
                    displ_e = (line_val - dist)*(nor_end - nor_start)/hypot;
                    displ_n = (line_val - dist)*(eas_end - eas_start)/hypot;
                    if ((lft_to_rgt == 'N') || (lft_to_rgt == 'n')) {
                       cur_e = cur_x + displ_e;
                       cur_n = cur_y - displ_n;
                    }
                    else {
                       cur_e = cur_x - displ_e;
                       cur_n = cur_y + displ_n;
                    }
            fprintf (outfile, "%18.8lf   %18.8lf  %6.1f\n", cur_e, cur_n, cur_z);
                    fprintf (outfile2, "   %18.8lf   %18.8lf\n", cur_n, cur_e);
                    i++;
                    j = 0;
                    while ((j < 4) && (i < togo)) {
             fgets (inbuf, 17, grfile);
               sscanf (inbuf, " %f %f", &cur_z, &dist);
/*               printf ("%f %f\n", cur_z, dist);*/
               displ_e = (line_val - dist)*(nor_end - nor_start)/hypot;
               displ_n = (line_val - dist)*(eas_end - eas_start)/hypot;
```

```
                    if ((lft_to_rgt == 'N') || (lft_to_rgt == 'n')) {
                cur_e = cur_x + displ_e;
                cur_n = cur_y - displ_n;
            }
            else {
                cur_e = cur_x - displ_e;
                cur_n = cur_y + displ_n;
            }
            fprintf (outfile, "%18.8lf   %18.8lf  %6.1f\n", cur_e, cur_n, cur_z);
            fprintf (outfile2, "    %18.8lf   %18.8lf\n", cur_n, cur_e);
                    i++;
                    j++;
                }
        }
        printf ("%d points added at station number %f\n", togo, cur_stat);
    }
    else {
        printf ("Not adding station %f\n", cur_stat);
          i = 0;
          while (i < togo) {
             fgets (inbuf, 20, grfile);
             i++;
             j = 0;
             while ((j < 4) && (i < togo)) {
                fgets (inbuf, 17, grfile);
                i++;
                j++;
             }
          }
    }
  }
  fclose (grfile);
}

write_fix_format(start_sta, end_sta)
  float start_sta, end_sta;
{
  FILE *fixfile;
  char inbuf[256], y_n, *fixname[80], ch;
  float stat1, stat2, cur_z, val_st, val_en;
  double nor_start, eas_start, nor_end, eas_end, b_start, b_end, cur_nor, cur_eas;
  int togo, pnts_read, und, add, i;
  double hold_n[1000], hold_e[1000];

/*    printf (" %f  %f\n", start_sta, end_sta);*/
  if (center_mask) {
   printf ("Use same center line data <y/n>?");
```

```
    gets (inbuf, "%s");
    sscanf (inbuf, "%c", &y_n);
    if ((y_n == 'N') || (y_n == 'n')) {
        get_center_data();
    }
   }
   else
    get_center_data();
   stat1 = cen_base1 + (cen_offset1 / 100.0);
   stat2 = cen_base2 + (cen_offset2 / 100.0);
   nor_start = nor1 - (((start_sta - stat1)/(stat2 - stat1))*(nor1 - nor2));
   eas_start = eas1 - (((start_sta - stat1)/(stat2 - stat1))*(eas1 - eas2));
   nor_end = nor1 - (((end_sta - stat1)/(stat2 - stat1))*(nor1 - nor2));
   eas_end = eas1 - (((end_sta - stat1)/(stat2 - stat1))*(eas1 - eas2));
/*    printf ("\n%lf %lf %lf %lf\n", nor_start, eas_start, nor_end, eas_end);*/
   if (nor2 == nor1) {
    und = 1;
   }
   else {
    und = 0;
    b_start = nor_start - ((eas1 - eas2)/(nor2 - nor1))*(eas_start);
    b_end = nor_end - ((eas1 - eas2)/(nor2 - nor1))*(eas_end);
/*  printf ("%lf %lf\n", b_start, b_end);*/
   }
   printf ("\nEnter the fix format input filename: ");
   gets (inbuf, "%s");
   sscanf (inbuf, "%s", fixname);
   while ((fixfile = fopen(fixname, "r")) == NULL) {
    printf ("Unable to open %s\n", fixname);
    printf ("\nEnter the fix format input filename: ");
    gets (inbuf, "%s");
    sscanf (inbuf, "%s", fixname);
   }
   pnts_read = 0;
   while (fgets (inbuf, 128, fixfile)) {
    sscanf (inbuf, "%d,%lf,%lf,%f,%c", &togo, &cur_nor, &cur_eas, &cur_z, &ch);
    add = 0;
    if ((ch == 'f') || (ch == 'S') || (ch == 'E')) {
        if (und) {
                    if (((cur_eas >= eas1) && (cur_eas <= eas2)) || ((cur_eas >= eas2) &&
(cur_eas <= eas1))) {
                        add = 1;
                    }
        }
        else {
                    val_st = ((eas1 - eas2)/(nor2 - nor1))*(cur_eas) + b_start;
                    val_en = ((eas1 - eas2)/(nor2 - nor1))*(cur_eas) + b_end;
```

```
                if (b_start > b_end) {
                   if ((cur_nor <= val_st) && (cur_nor >= val_en)) {
                add = 1;
                   }
        }
                else
                   if ((cur_nor <= val_en) && (cur_nor >= val_st)) {
                add = 1;
                   }
      }
    }
    if (add) {
       hold_n[pnts_read] = cur_nor;
       hold_e[pnts_read] = cur_eas;
         pnts_read++;
         fprintf (outfile, "%18.8lf   %18.8lf  %6.1f\n", cur_eas, cur_nor, cur_z);
    }
      if (ch == 'E') {
       printf ("%d points added to file\n", pnts_read);
       if (pnts_read < 1001) {
       i = 0;
       fprintf (outfile2, "L %d\n", pnts_read);
       while (i < pnts_read) {
                fprintf (outfile2, "   %18.8lf   %18.8lf\n", hold_n[i], hold_e[i]);
                i++;
       }
       }
       pnts_read = 0;
      }
   }
   fclose (fixfile);
}

write_arc_info_format()
{
   FILE *arcfilexy, *arcfilez;
   char *arcnamxy[80], *arcnamz[80];

}

main (argc, argv)
   int argc;
   char *argv[];
{
   char *outname[80], buf[256], *outname2[80];
   char cont = 'Y';
   int cur_sect = 1;
```

```
    int base1, base2, choice;
    float offset1, offset2;

    printf ("Enter the output filename: ");
    gets (buf, "%s");
    sscanf (buf, "%s", outname);
    while ((outfile = fopen(outname, "w")) == NULL) {
       printf ("Unable to open %s\n", outname);
       printf ("Enter the output filename: ");
       gets (buf, "%s");
       sscanf (buf, "%s", outname);
    }
    sprintf (outname2, "%s.asc", outname);
    outfile2 = fopen (outname2, "w");
    printf ("\nEnter the Base Line Station start number for section # %d:", cur_sect);
    gets (buf, "%s");
    sscanf (buf, "%d+%f", &base1, &offset1);
/*   printf ("%d  %f\n", base1, offset1);*/
    while ((cont == 'y') || (cont == 'Y')) {
     printf ("\nEnter the Base Line Station end number for section # %d:", cur_sect);
     gets (buf, "%s");
     sscanf (buf, "%d+%f", &base2, &offset2);
/*   printf ("%d  %f\n", base2, offset2);*/
     while ((base2 < base1) || ((base2 == base1) && (offset1 >= offset2))) {
        printf ("End point must be farther down river than start point!\n");
        printf ("Enter the Base Line Station end number for section # %d", cur_sect);
        gets (buf, "%s");
        sscanf (buf, "%d+%f", &base2, &offset2);
/*      printf ("%d  %f\n", base2, offset2);*/
     }
     printf ("\nSelect format of input file for section # %d\n", cur_sect);
     printf ("\n    1) GR format: X1  0.00     118\n");
     printf ("                    GR 667.5   1014.   666.4   1021.   664.2   1031.   662.4   1041.   660.9
1051.\n");
     printf ("\n");
     printf ("    2) fix format:     1,464350.200,2811270.000,600.000,REF    20.00   1000.00\n");
     printf ("                    591,466242.34130022,2809494.57349555,664.8,STARL 20.00 fix 518
11:44:04\n");
     printf ("                    590,466235.84130022,2809498.57349555,664.8,fix 517 11:44:03\n");
     printf ("\n");
     printf ("Number:");
     gets (buf, "%s");
     sscanf (buf, "%d", &choice);
     while ((choice < 1) || (choice > 2)) {
        printf ("\nNot a valid choice.\n");
          printf ("Select format of input file for section # %d\n", cur_sect);
          printf ("\n    1) GR format: X1  0.00     118\n");
```

```
        printf ("                GR 667.5   1014.   666.4   1021.   664.2   1031.   662.4   1041.   660.9
1051.\n");
      printf ("\n");
        printf ("   2) fix format:     1,464350.200,2811270.000,600.000,REF    20.00    1000.00\n");
        printf ("                591,466242.34130022,2809494.57349555,664.8,STARL 20.00 fix 518
11:44:04\n");
        printf ("                590,466235.84130022,2809498.57349555,664.8,fix 517 11:44:03\n");
      printf ("\n");
        printf ("Number:");
        gets (buf, "%s");
        sscanf ( buf, "%d", choice);
    }
    if (choice == 1) {
      write_GR_format((base1 + (offset1 / 100.0)), (base2 + (offset2 / 100.0)));
    }
    else
      write_fix_format((base1 + (offset1 / 100.0)), (base2 + (offset2 / 100.0)));
    printf ("\nContinue with another section <y/n>? ");
    gets (buf, "%s");
    sscanf (buf, "%c", &cont);
    cur_sect++;
    base1 = base2;
    offset1 = offset2;
  }
  fclose (outfile);
  fclose (outfile2);
}
```

# Appendix I

## Replacement of 1989 Sounding Data Using 1992 Hydroacoustic Data for Schultz Bar and the Dredge Disposal Site, Creation of Higher Resolution File

# Appendix I

## Replacement of 1989 Sounding Data Using 1992 Hydroacoustic Data for Schultz Bar and the Dredge Disposal Site, Creation of Higher Resolution File

```
/* This program will take points out of a given low resolution xyz file given a file
 * of higher resolution points and a threshold around those points. The program
 * prompts for the elevation of the shore line and keeps those points automatically.
 * The output is a file with all of the higher resolution points, shoreline points and
 * low resolution points outside the threshold of the higher resolution points. Two
 * optional output files may be produced. One will contain the lower resolution points
 * taken out and the other will contain the lower resolution points kept. The optional
 * files will have the extensions .low.out and .low.in, respectively.*/
#include <stdio.h>
#include <math.h>

typedef struct {
   double x;
   double y;
   float z;
   int flag;
} XYZLIST;

FILE *infile, *outfile, *outfile2;
int num, trans;
XYZLIST old_vals[100000];
int in_out = 0;

load_low_res (pool_ele)
   float pool_ele;
{
   char inbuf[128];
   double x_val, y_val;
   float z_val;

   num = 0;
   trans = 0;
   while (fgets (inbuf, 128, infile)) {
      sscanf (inbuf, "%lf %lf %f", &x_val, &y_val, &z_val);
```

```
        if (z_val >= pool_ele) {
           fprintf (outfile, "   %lf   %lf   %f\n", x_val, y_val, z_val);
           if (in_out) {
              fprintf (outfile2, "   %lf   %lf   %f\n", x_val, y_val, z_val);
           }
           trans++;
        }
        else {
           old_vals[num].x = x_val;
           old_vals[num].y = y_val;
           old_vals[num].z = z_val;
           old_vals[num].flag = 1;
           num++;
        }
     }
     num--;
}

float calc_dist (pnt1x, pnt1y, pnt2x, pnt2y)
     double pnt1x, pnt1y, pnt2x, pnt2y;
{
     float distance;

     distance = sqrt (pow ((pnt2x - pnt1x),2.0) + pow ((pnt2y - pnt1y),2.0));
     return (distance);
}

int find_by_binary (x_val, y_val, thr)
     double x_val, y_val;
     float thr;
{
     int index, high, low;
     float dist;

     high = num;
     low = 0;
     index = (high + low) / 2;
     while ((high >= low) && (((old_vals[index].x - x_val) > thr) || ((x_val - old_vals[index].x) >
thr))) {
       if (old_vals[index].x > x_val)
          high = index - 1;
       else if (old_vals[index].x < x_val)
          low = index + 1;
       else {
          thr = abs(old_vals[index].x - x_val) + 1;
          printf ("%f\n", thr);
       }
```

```
    index = (high + low) / 2;
    dist = calc_dist (x_val, y_val, old_vals[index].x, old_vals[index].y);
   }
   if (high < low)
    return (-1);
   else
    return (index);
}

go_backward (x_val, y_val, thr, spot)
   double x_val, y_val;
   float thr;
   int spot;
{
   float dist;

   while (spot >= 0) {
    dist = calc_dist (x_val, y_val, old_vals[spot].x, old_vals[spot].y);
    if (dist <= thr)
       old_vals[spot].flag = 0;
    else if ((x_val - old_vals[spot].x) > thr)
       spot = 0;
    spot--;
   }
}

go_forward (x_val, y_val, thr, spot)
   double x_val, y_val;
   float thr;
   int spot;
{
   float dist;

   while (spot <= num) {
    dist = calc_dist (x_val, y_val, old_vals[spot].x, old_vals[spot].y);
    if (dist <= thr)
       old_vals[spot].flag = 0;
    else if ((old_vals[spot].x - x_val) > thr)
       spot = num;
    spot++;
   }
}

main ()
{
   char *inname[80], *outname[80], *out2name[80], buf[256], *syscmd[128], ch;
   int pos, num_out;
```

```
double x_hi, y_hi;
float thres, z_hi, pool;

printf ("\nEnter the output filename: ");
gets (buf, "%s");
sscanf (buf, "%s", outname);
while ((outfile = fopen(outname, "w")) == NULL) {
   printf ("\nUnable to open %s\n", outname);
   printf ("Enter the output filename: ");
   gets (buf, "%s");
   sscanf (buf, "%s", outname);
}
printf ("\nGenerate low resolution files with kept and thrown away points<y/n>?");
gets (buf, "%s");
sscanf (buf, "%c", &ch);
if ((ch == 'Y') || (ch == 'y')) {
 in_out = 1;
 sprintf (out2name, "%s.low.in", outname);
 outfile2 = fopen (out2name, "w");
}
printf ("\nEnter the low resolution data filename: ");
gets (buf, "%s");
sscanf (buf, "%s", inname);
sprintf (syscmd, "sort %s > foo1", inname);
while ((system (syscmd)) == 127) {
   printf ("\nUnable to find %s\n", inname);
   printf ("Enter the low resolution data filename: ");
   gets (buf, "%s");
   sscanf (buf, "%s", inname);
 sprintf (syscmd, "sort %s > foo1", inname);
}
sprintf (inname, "foo1");
infile = fopen (inname, "r");
printf ("\nEnter the pool elevation in feet: ");
gets (buf, "%s");
sscanf (buf, "%f", &pool);
printf ("\nLoading low resolution file...");
load_low_res (pool);
printf ("\n%d points read in.\n", num + trans);
fclose (infile);
printf ("\nEnter the high resolution data filename: ");
gets (buf, "%s");
sscanf (buf, "%s", inname);
while ((infile = fopen (inname, "r")) == NULL) {
   printf ("\nUnable to find %s\n", inname);
   printf ("Enter the high resolution data filename: ");
```

```
      gets (buf, "%s");
      sscanf (buf, "%s", inname);
   }
   printf ("\nEnter the threshold in feet:");
   gets (buf, "%s");
   sscanf (buf, "%f", &thres);
   printf ("\nWorking...");
   trans = 0;
   while (fgets (buf, 128, infile)) {
      sscanf (buf, "%lf %lf %f", &x_hi, &y_hi, &z_hi);
    fprintf (outfile, "   %lf   %lf   %f\n", x_hi, y_hi, z_hi);
    trans++;
    pos = find_by_binary (x_hi, y_hi, thres);
    if (pos > 0) {
       go_backward (x_hi, y_hi, thres, pos - 1);
       go_forward (x_hi, y_hi, thres, pos);
    }
   }
   pos = 0;
   num_out = 0;
   while (pos <= num) {
    if (old_vals[pos].flag) {
       fprintf (outfile, "   %lf   %lf   %f\n", old_vals[pos].x, old_vals[pos].y, old_vals[pos].z);
    }
    else {
       num_out++;
    }
    pos++;
   }
   if (in_out) {
    fclose (outfile);
    sprintf (out2name, "%s.low.out", outname);
    outfile = fopen (out2name, "w");
    pos = 0;
    while (pos <= num) {
       if (old_vals[pos].flag) {
                    fprintf (outfile2, "   %lf   %lf   %f\n", old_vals[pos].x, old_vals[pos].y,
old_vals[pos].z);
        }
       else
                    fprintf (outfile, "   %lf   %lf   %f\n", old_vals[pos].x, old_vals[pos].y,
old_vals[pos].z);
       pos++;
    }
   }
   printf ("\n%d points taken out of low resolution file.", num_out);
   printf ("\n%d points added from high resolution file.", trans);
```

```
    printf ("\nDone\n");
    system ("rm foo1");
    fclose (outfile);
    fclose (outfile2);
}
```

# Appendix J

# Codes for Fish Species

# Appendix J

## Codes for Fish Species

List of common names, scientific names, and species codes for fishes in Lower Granite Reservoir, Idaho-Washington (Bennett et al. 1990).

| CODES | SCIENTIFIC NAME | COMMON NAME |
|---|---|---|
| LTR | *Lampetra trientatus* | pacific lamprey |
| ASA | *Alosa sapidissima* | american shad |
| ATR | *Acipenser transmontanus* | white sturgeon |
| ONE | *Oncorhyncus nerka* | sockeye salmon |
| OTS | *Oncorhyncus tshawytscha* | chinook salmon |
| PWI | *Prosoplum williamsoni* | mountain whitefish |
| OMY | *Oncorhyncus mykiss* | rainbow trout |
| AAL | *Acrocheilus alutaceus* | chiselmouth |
| CCA | *Cyprinus carpio* | carp |
| MCA | *Mylocheilus caurinus* | peamouth |
| POR | *Ptychoshellus oregonenisis* | northern squawfish |
| ROS | *Rhinichthys osculus* | specticled dace |
| RBA | *Richardsonius balteatus* | redside shiner |
| CCO | *Catostomus columbianus* | bridgelip sucker |
| CMA | *Catostomus macrocheilus* | largescale sucker |
| INA | *Ictalurus natalis* | yellow bullhead |
| INE | *Ictalurus nebulosus* | brown bullhead |
| IME | *Ictalurus melas* | black bullhead |
| IPU | *Ictalurus punctatus* | channel catfish |
| LGI | *Lepomis gibbosus* | pumpkinseed |
| LMA | *Lepomis macrochirus* | bluegill |
| LSP | *Lepomis spp.* | misc. juv. sunfish |
| PNI | *Pomaxis nigromaclatus* | black crappie |
| PAN | *Pomaxis annularis* | white crappie |
| PSP | *Pomaxis spp.* | misc. juv. crappie |
| MDO | *Micropterus dolomieui* | smallmouth bass |
| PFL | *Perca flavescens* | yellow perch |
| COT | *Cottus spp.* | sculpin |

# Appendix K

# HEC-6 Sediment Properties

# Appendix K

## HEC-6 Sediment Properties

HEC-6 description of sediment properties and transport functions.

| ID NUMBER | CLASSIFICATION | GRAIN SIZE (mm) | GEOMETRIC MEAN |
|---|---|---|---|
| 1 | Very Fine Sand | 0.062 - 0.125 | 0.088 |
| 2 | Fine Sand | 0.125 - 0.250 | 0.177 |
| 3 | Medium Sand | 0.250 - 0.500 | 0.354 |
| 4 | Coarse Sand | 0.500 - 1.000 | 0.707 |
| 5 | Very Coarse Sand | 1.000 - 2.000 | 1.414 |
| 6 | Very Fine Gravel | 2.000 - 4.000 | 2.828 |
| 7 | Fine Gravel | 4.000 - 8.000 | 5.657 |
| 8 | Medium Gravel | 8.000 - 16.000 | 11.314 |
| 9 | Coarse Gravel | 16.000 - 32.000 | 22.627 |
| 10 | Very Coarse Gravel | 32.000 - 64.000 | 45.255 |

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