uOttawa

L'Université canadienne
Canada's university

FACULTÉ DES ÉTUDES SUPÉRIEURES ET POSTDOCTORALES

uOttawa

L'Université canadienne
Canada's university

FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

Geoffrey Parker
AUTEUR DE LA THÈSE / AUTHOR OF THESIS

Ph.D. (Civil Engineering)
GRADE / DEGREE

Department of Civil Engineering
FACULTÉ, ÉCOLE, DÉPARTEMENT / FACULTY, SCHOOL, DEPARTMENT

Uncertainly Metrics for Coupled Watershed Models
TITRE DE LA THÈSE / TITLE OF THESIS

R. Droste
DIRECTEUR (DIRECTRICE) DE LA THÈSE / THESIS SUPERVISOR

C. Rennie
CO-DIRECTEUR (CO-DIRECTRICE) DE LA THÈSE / THESIS CO-SUPERVISOR

EXAMINATEURS (EXAMINATRICES) DE LA THÈSE / THESIS EXAMINERS

B. Daneshfar

E. McBean

O. Seidou

P. Van Geel

Gary W. Slater
Le Doyen de la Faculté des études supérieures et postdoctorales / Dean of the Faculty of Graduate and Postdoctoral Studies

UNCERTAINTY METRICS FOR COUPLED WATERSHED MODELS

by

Geoff Parker

A thesis
submitted under the supervision of
Dr. Ronald L. Droste

and

Dr. Colin D. Rennie

in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
in
Environmental Engineering

Department of Civil Engineering
University of Ottawa
Ottawa, Canada
K1N 6N5

May, 2009

Your file Votre référence
ISBN: 978-0-494-59479-7
Our file Notre référence
ISBN: 978-0-494-59479-7

NOTE AUX LECTEURS

Cette thèse contient plusieurs pages qui sont illisibles, à partir de l'***Appendix*** E.1, page 154- jusqu'à la fin.

NOTE TO READERS

This thesis has many unreadable pages, starting with Appendix E.1, page 154- till the end.

Appendix (en anglais dans le texte)

THE UNIVERSITY OF OTTAWA-FACULTY OF GRADUATE STUDIES

CERTIFICATE OF EXAMINATION

Examining Board

Advisors

The thesis by

Geoff Parker

entitled

'Uncertainty Metrics for Coupled Watershed Models'

is accepted in partial fulfillment

of the requirements of the degree of

Doctor of Philosophy (Environmental Engineering)

in the

Department of Civil Engineering

Date:

Chairperson of Examining Board

ACKNOWLEDGEMENTS

I would like to thank my supervisors, Dr. Ronald L. Droste and Dr. Colin D. Rennie, for their support, challenges and suggestions which have helped form and strengthen this thesis and the work presented herein. Also important were the members of my proposal review committee: Dr. Abhijit Sarkar (Carleton University) and Dr. Ousmane Seidou. I would like to acknowledge the Department of Civil Engineering at the University of Ottawa as a whole for their financial support in the form of a scholarship. Other members of the faculty, notably Drs. Kennedy, Narbaitz and Nistor have also provided stimulating conversation.

I am grateful to my friends and colleagues in graduate studies over the years, which have been equally supportive and helpful, in varied ways and forums. I would like to convey particular thanks to my office mates and the Water Resources Group members, at whose meetings this thesis has undoubtedly gotten better.

Above all I wish to acknowledge my family for their extraordinary help and unwavering encouragement during my graduate studies. I recognize in this work the influence of my father - the researcher; my mother - the scientist; and my brother - the inspired, though it can only hope to do them justice. I dedicate this thesis to them.

ABSTRACT

Predictions of river water quality models are subject to substantial uncertainties, which depend not only on parameterization and calibration strategies but also on the structure of the conceptual model itself. Equally, the uncertainty associated with a non-point source (NPS) model can also be attributed to both the parameterization and model structure. The work presented here evaluated the relative importance of these effects and the associated implications for coupled watershed/water quality models. Particular emphasis was placed on model application and interpretation for stochastic-type problems. Investigations were conducted using real-world data from the non-tidal Potomac basin in the Eastern United States for data analysis and case study purposes.

In the first sub-project, two commonly used conceptual representations of real-world water quality processes were used, and their simulation of dissolved oxygen (DO), biochemical oxygen demand (BOD) and ammonium (NH_4) components were scrutinized. A Generalized Likelihood Uncertainty Estimation (GLUE) approach to the inverse problem was then used to examine how uncertainty changed along the river network for each conceptual model. Differences were observed not only between deterministic instances of each conceptual model, but also between their response surfaces as a whole. In addition, response patterns showed substantial sensitivity to the selection of calibration data used. This methodology was able to identify surface response differences between two conceptual models, and could be used to identify or resolve conceptual model issues for specific applications and/or datasets. Of the two conceptual models examined, the simpler Mike11 model showed marginally better performance at the outlet in most respects, and substantially increased sensitivity to data proximity (i.e. location) throughout the watershed when compared with the more complex QUAL2E representation. Both'high-fitness' calibrations showed an aggregate coefficient of variation (ACV) of approximately $7. \times 10^{-2}$ near the outlet.

A second sub-project examined instead the suitability of deterministic calibration criteria for stochastic model calibration and uncertainty analysis. Here, the suitability, relative benefits and substantial disadvantages of 'deterministic-optimization' approaches in stochastic contexts were examined. Three alternate calibration strategies, suitable for water quality modeling under uncertainty, were proposed, and then demonstrated. The proposed strategies, based on absolute relative error (ARE) measures, place increased emphasis on lossless metrics and the inherent subjectivity of any calibration criteria. Calibration based on these criteria generally showed equal

or better performance for stochastic applications when contrasted to root mean square error (RMSE). The findings suggest opportunities for potential improvement in current calibration paradigms can be obtained by using ARE and related strategies..

The areal nature of NPS models and the implications associated with the direct relationship between model structure and parameterization sampling, were examined in a third sub-project. The approach was to find limitations in scale for use of a conceptual model, then examine the scales at which a suitable stochastic depiction of key parameter sets could be obtained. The overlapping regions for model scale are optimal (and possibly the only suitable regions) for conducting meaningful stochastic analysis with a given NPS model. The NPS model examined in this thesis, AnnAGNPS, demonstrated substantial limitations with respect to scale that seem to trump potential parameter uncertainty in many applications. A narrow range of discretizations (in the 4-8.5 km^2 scale range) suitable for conceptual model stability was identified. Response to parameter variations within this range was also examined and appears to be minimized within the structurally stable region, near discretizations of 8 km^2.

The final portion of this thesis was a holistic evaluation. Coupled hydrology and water quality models are today an important tool used in the understanding and management of surface water and watershed areas. Such problems are generally subject to substantial uncertainty in parameters, process understanding, and data. Component models, drawing on different data, different concepts, and different structures, are affected differently by each of these uncertain elements. The fourth, and final, subproject draws on the previous three sub-projects, and further proposes a framework wherein the response of component models to their respective uncertain elements can be quantified and assessed, using a hydrological model and water quality model as two exemplars. Appendix A of this thesis provides an overview of the proposed framework in the context of predictive watershed quality and quantity model construction. The resulting assessments can identify model coupling strategies that permit more appropriate use and calibration of individual models, as well as better coupled model construction and interpretation. The results of this portion showed that both QUAL2E and MIKE11 may couple well with the AnnAGNPS model uncertainty at relatively high fitness calibrations. Additionally, structural parameter uncertainty was shown to be at least as significant as parameter-based uncertainties.

The results of this work provide a reasonable, manageable, and widely applicable framework for the use of coupled deterministic models to assess uncertain systems. The suggested methodologies, with or without use of the specific codes and tools mentioned, can be readily employed to further understanding of the uncertainty issues, and uncertainty balance, surrounding contemporary, future, and legacy models.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

Abbreviations:

AGFLOW	Agricultural-Flow component of AnnAGNPS (Computer Code)
ANN	Artificial Neural Network
AnnAGNPS	Annualized Agricultural NPS Model (Computer Code)
ArcGIS	ESRI ArcGIS (Computer Code)
BASINS	Better Assessment Science Integrating Point and NPS (Computer Code)
DEM	Digital Elevation Model
DMset	Set of Delineated Models
EPA	Environmental Protection Agency
GA	Genetic Algorithm
GIS	Geographical Information System
GLUE	Generalized Likelihood Uncertainty Estimation
HRU	Hydrological Response Unit
HSPF	Hydrological Simulation Program Fortran (Computer Code)
HEC	Hydrologic Engineering Center
HEC-1	HEC [Program] 1 (Computer Code)
HEC-HMS	HEC Hydrology Modeling System (Computer Code)
WQPM	Water Quality Prototype Model
USGS	US Geological Survey
LCPM	Land Cover Prototype Model
LHS	Latin Hypercube Sampling
LU	Land Use
MRLC	Multi-Resolution Land Characteristics Consortium
NAWQA	National Water Quality Assessment
NED	National Elevation Dataset
NEXRAD	Next Generation Radar
NLCD	National Land Cover Data
NPS	Non-Point Source(s)
PRMS	Precipitation-Runoff Modeling System (Computer Code)
QUAL	Group of Computer Codes for Water Quality Modeling
REA	Representative Elementary Area
RORB	Runoff Routing [Burroughs] (Computer Code)

SCE	Shuffled Complex Evolution
SHE	Systeme Hydrologique European (Computer Code)
SODA	Simultaneous Optimization and Data Assimilation
SWM	Stanford Watershed Model
SWMM	Storm Water Management Model (Computer Code)
TIN	Triangular, Irregular Network
TOPAZ	Topographic Parameterization (Computer Code)
TOPMODEL	Topographic Watershed Model (Computer Code)
USDA	US Department of Agriculture
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WMO	World Meteorological Organization
WSR	Weather Surveillance Radar

Other Terms:

Equifinality	Describes the problem of a model calibration, that can be attained by many different modeling decisions (parameter sets, conceptual structure), which are equally plausible, given a calibration criteria or test of model fitness.
GLUE	A framework for identification of equally representative models to address the problem of structural, conceptual or parameter equifinality , as described above. (See also Abbreviations).
Likelihood	A likelihood function, describing a degree of belief in e.g. a parameter set, can be used to rank relative hypotheses based on e.g. suitability of model fit to calibration data. A group of representative models can thus be ranked by degree of belief.
Lossless Compression	Lossless data compression (as opposed to lossy data compression) is a compression of information into a format that allows for the original data to be retrieved exactly. Lossy data compression implies loss of information.
Stochastic Calibration	This is the calibration of models in a manner that acknowledges and allows for exploration of the model behaviour under uncertainty.
Stochastic Suitability	Describes the appropriateness of (typically deterministic) assumptions and approaches for modeling decisions that are subsequently subjected to uncertainty analysis.

Symbols:

‾ [overline]	Time Smoothed
^	Per Unit Mass
Δ	Slope of Saturation Vapor Pressure-Temperature Curve (kPa/°C)
γ	Psychrometric Constant (kPa/°C)
ρ	Fluid Density (M/L^3)
v	Mass Average Velocity (L/T)
t	Time (T)
τ	Viscous Stress Tensor (M/T^2L)
q	Energy Flux Relative to Mass Average Velocity (M/T^3)
g	Gravitational Acceleration (L/T^2)
p	Fluid Pressure (M/LT^2)
U	Internal Energy (ML^2/T^2)
W	Rate of Work on Surroundings (ML^2/T^3)
Ev	Rate of Viscous Dissipation of Mechanical Energy (ML^2/T^3)
CN	SCS Curve Number (-)
esat	Saturation vapor pressure (kPa)
e	Actual vapor pressure (kPa)
ETP	Potential evapotranspiration (mm)
Fc	Cloud Factor
Fa	Atmospheric Correction Factor
G	Soil heat flux (MJ/m^2)
Hv	Latent heat of vaporization (MJ/kg)
Q	Surface runoff [depth] (mm)
R	Net radiation (MJ/m^2)
REA	Representative elementary area
RSN	Net Shortwave Radiation (MJ/m^2)
RLN	Net Longwave Radiation (MJ/m^2)
RX	Extraterrestrial solar radiation (MJ/m^2)
S	SCS retention variable
S1	Wilting point value of S
S2	Halfway point value of S
S3	Field capacity point value of S
Sc	Solar Constant

St	Timestep value of S
uc	Uncertainty associated with conceptual model
ud	Uncertainty associated with data
ui	Uncertainty associated with model inputs
um	Uncertainty associated with model structure
un	Uncertainty associated with model discretization
up	Uncertainty associated with model parameterization
W	Wind function variable (-)
WI	Water input to the field area soil (mm)

CHAPTER 1

INTRODUCTION

1.1 PROBLEM DEFINITION

This research project explores a novel uncertainty-based approach for modeling of watershed hydrology and the related effects of NPS pollutants on water quality. In particular, the research focuses on incorporating uncertainty algorithms and metrics at an early stage of surface hydrology model construction.

Numerical models, including those used for environmental and watershed systems, have gradually arisen from a consistent progression of tools used to complement other techniques (including fieldwork and laboratory experimentation) and to test conceptual understanding of complex systems. As the usability and sophistication of these tools have grown, so too has the complexity involved. The need for healthy skepticism of simulation results and tools to quantify result quality is as pronounced as ever.

The use of stochastic models, which attempt to quantify uncertainty in model outputs, is today an often used method that attempts to manage the factor of model quality. Unfortunately, proper deployment of such systems is non-trivial, and requires a series of Pareto-optimization problems and assumptions. Results between two systems, two locations, two timeframes or even two modelers are often incompatible. Much attention has generally been paid to construction and calibration of models as well as data processing, while the issues surrounding model validation, error propagation, and analyses of uncertainty, risk, and reliability have not been as comprehensively examined.

This thesis draws on several approaches to the watershed modeling problem, and the incorporation and quantification of uncertainty components. The framework proposed is intended to address these and related issues surrounding the use of modern numerical models over varied spatial-temporal domains. While the focus here is on the use of coupled water-quality/hydrology models, the approach has potential for use in a wide variety of fields.

1.2 THESIS ORGANIZATION

This thesis is organized into a presentation of the key tasks required for the study. The novel work has been subdivided into four major project components, partitioned into documents of sufficient breadth and length to be suitable for dissemination and communication, but also of sufficient focus to be reviewed and discussed within a relatively narrower context. They are presented briefly here for the reader's reference. The major steps and objectives can be outlined as follows:

1) Review literature on topics relevant to the study

   A literature review was conducted on watershed-level models, their historical and conceptual basis, and the sources and methods commonly used to handle uncertainty therein.

2) Introduce an objective test of stochastic behaviour in riverine water quality models.

   Predictions of river water quality models are subject to substantial uncertainties, which depend not only on parameterization and calibration strategies but also on the structure of the conceptual model itself. To evaluate the importance of this effect and associated implications for stochastic models, investigations were conducted based on a segment of the Potomac River in the eastern US. Two commonly used conceptual representations of real-world processes were used (Mike11 and QUAL2E), and their simulation of dissolved oxygen (DO), biological oxygen demand (BOD) and ammonium (NH_4) components scrutinized. A Generalized Likelihood Uncertainty Estimation (GLUE) approach to the inverse problem was then used to examine how uncertainty changed along the river network for each conceptual model. Differences were observed not only between deterministic instances of each conceptual model, but also between their response surfaces as a whole. Uncertainties within the river network are substantially influenced by the selection of calibration data used, as well as the primary source of the constituent examined (areal vs. point). The suggested methodology can be used to test conceptual model validity for specific applications. The results of this study will help users select and assess models for varied problems, and refine appropriate data collection and monitoring schemes. A formal analysis of the stochastic suitability (and differing nature) of two 'out-of-the-box' deterministic models is novel, and especially relevant given the increasingly common (arguably misguided) 'stochastic' analyses done in this manner for water quality and related problems. The work also provides a novel pathway to the identifiability (equifinality) issue.

3) Define procedures for stochastic calibration of riverine water quality models

Watershed-level modeling has become an essential tool in planning and managing environmental risks and the relationship between pollutant sources and water bodies. Water quality models are generally deployed in such cases to provide insight on source assessments and their impacts on water quality targets as well as the consequences of varied management scenarios (e.g., Parker et al. 2008a).

Typically, model parameters are adjusted to fit one or several years of reference data. It is well understood for deterministic models that the chosen 'calibrated' parameter set, and thus simulation results, depend on the reference data (often sparse) and the calibration strategy used. Since similar results are often achieved with different approaches, the issue of which parameter set should be used frequently arises. This phenomenon is known as model equifinality.

Stochastic models attempt to mitigate these issues to some degree by representing modeled phenomena as a distribution of possible outcomes. A common implementation is to perturb input parameters, through use of Monte-Carlo simulations for example, and assess likely outcomes from the results. Though commonly used, the suitability of well-accepted deterministic calibration criteria (e.g., Least Squared Error) for stochastic model calibration is not, however, clear.

The approach of this project is to illustrate the suitability, relative benefits and substantial disadvantages of these 'deterministic-optimization' approaches in stochastic contexts. Three alternate calibration strategies suitable for modeling water quality under uncertainty are proposed and then demonstrated.

A formal analysis of the stochastic suitability (and differing nature) of 'deterministic' calibration criteria for these models is novel. Like the previous project, it leads to a broader discussion of model complexity and suitability.

4) Determine suitable land use scales for NPS modeling under uncertainty

In a fashion analogous to the previous two projects, the uncertainty associated with a NPS model can be attributed to both the parameterization and model structure. An interesting implication of the areal nature of NPS models is the direct relationship between model structure (i.e., subwatershed size) and sample set for the parameterization of raw input data.

The approach of this project is to find limitations in scale for use of the conceptual model, then examine the scales at which a suitable stochastic depiction of key parameter sets can be generated. The overlapping regions are optimal (and possibly the only suitable regions) for conducting meaningful stochastic analysis can be conducted with a given NPS model.

An analysis of stochastic suitability and uncertainty associated with both the conceptual model and the parameter set is quite novel. Similar work (as discussed in Chapter 2) has been done to find an optimal scale for deterministic problems (where, in fact, calibration can be adjusted to compensate for sub-optimal scale selection), but here is provided an examination of the more interesting (and more relevant) case of managing data and structure uncertainty as stochastic components. The notion of a division strategy based primarily on areas of equal uncertainty (rather than e.g., equal critical source area or minimum channel length) is novel.

5) Construct a procedure for NPS and water quality model coupling under uncertainty

This project draws on the previous three and illustrates construction of coupled watershed models for several problems under uncertainty.

Most of the literature ignores either expressly or, more often, implicitly the model uncertainty associated with structure. These projects, and particularly this final one, emphasize throughout a more sound handling of both model parameter and model structure (since the two are related) components to the uncertainty problem.

In this component project, the author demonstrates how this revised paradigm can lead to improvements not only to individual component model (better model structure, better calibration) but also to better and more powerful ways of examining complex problems such as the use of coupled models. Two new model coupling techniques for stochastic investigation are presented: balanced-uncertainty or constant-uncertainty, with relative performance examined. Several metrics for stochastic watershed behaviour description are also presented, based on the new paradigm.

6) Discussion and Recommendations

A summary review of the overall project and major findings is presented, along with a discussion of potential implications for current and future work. Recommendations are also made, based on the results and analyses from prior steps. The recommendations focus on consequences of the work, as well as areas where potential improvements may be made.

1.3 GOALS

The primary goal of this work is to propose a framework for a quantitative algorithmic approach to coupled model construction. The belief is, firstly, that all such applications of models are subject to substantial uncertainties, be they explicitly acknowledged or otherwise. Further, it is demonstrated that incorporation of uncertainty principles and metrics at an early phase of a typical NPS study can be beneficial on several fronts.

This study provides a stepping stone towards more efficient numerical models, and particularly more efficient interpretation and structuring of such models. From a greater perspective, local and regional studies that include the types of quantitative uncertainty metrics proposed here should lead, in turn, to better tools for management and decision support, along with reduced duplication of effort.

CHAPTER 2

BACKGROUND KNOWLEDEGE

This study will draw on diverse approaches to the watershed modeling problem, and the incorporation of uncertainty components. Since its origins in the late nineteenth century, mathematical modeling of watershed hydrology has grown into a ubiquitous tool for addressing the gamut of environmental and water resources problems. Recent developments in the field include the emergence and incorporation of geographical information systems (GIS), remote sensing, and data acquisition, chemical tracers, topographic representation, up-scaling of hydrologic conservation equations, spatial variability of hydraulic roughness, infiltration and precipitation, spatial and temporal scaling, model calibration, and the linkage with water quality models.

2.1 MATHEMATICAL MODELING OF WATERSHED HYDROLOGY

2.1.1 INTRODUCTION

A watershed hydrology model is a system of mathematical descriptions of the component processes of the hydrologic cycle. The first hydrological models were developed in the nineteenth century for civil engineering design applications. In the twentieth century, substantial improvements in the underlying theories and conceptual models emerged, culminating in the development of the sophisticated numerical models in common use today.

2.1.2 EARLY HISTORY/COMPONENT MODELS

The origins of mathematical modeling for hydrological systems date back to the simple approaches developed in the nineteenth century by Mulvany and then Imbeau. In the 1910s Green and Ampt did some early work on a theory of infiltration, and derived a simplified physically-based formula for computing the infiltration rate. The 1930s saw Sherman suggest a unit hydrograph concept, linking runoff response to excess rainfall, while Horton contributed a theory of infiltration to estimate rainfall excess and improve hydrograph separation methods, as well as a semi-empirical equation for overland flow. Horton went on to model erosion and stream-flow generation by overland flow, and presented what would become commonly known as "Horton's (empirical) laws". The understanding of subsurface flows increased greatly over the same period, with important work from Hursh and others noting that subsurface flows constituted a significant component of storm flow hydrographs in some regions. This was expanded upon in subsequent years by work from Hewlett, Nielsen and Remson, amongst others, which revealed that unsaturated flow can generate stream-flow via streamside saturated zones. Together with Horton's theories, the research into subsurface flow mechanisms expanded into a more integrated picture of stream-flow generation. In these contributions, evaporation and other abstractions were treated using coefficients or indices.

More sophisticated attempts to quantify water losses emerged in the work of Richardson, and then Cummings, and their analysis of evaporation from lakes. Subsequent work by Thornthwaite and Penman focused instead on quantify evapotranspiration losses. Other work addressed abstractions such as interception, depression storage, and detention storage. In the 1950s, the US Soil Conservation Service developed its curve-number method to take abstractions into account in the computation of storm runoff. In the same period, substantial advances in the theoretical formulation of flow routing were also achieved, as Lighthill and Whitham developed the kinematic wave theory, furthering the earlier work of Keulegan.

The foundations of quantitative groundwater hydrology were investigations in the 1930s by Fair and Hatch, who derived a formula for computing the permeability of soil, and then Theis, who combined Darcy's law with the continuity equation. The following decade saw development of baseflow separation techniques, with work by Barnes and then Jacob. Work on incorporating linear system theory eventually led to the instantaneous unit hydrograph and generalized unit hydrograph theories, by Nash and Dooge, respectively.

2.2 NUMERICAL WATERSHED SIMULATION CODES

2.2.1 EMERGENCE OF HOLISTIC WATERSHED CODES

The emergence of transistor-based computers made possible the combination of multiple component models, describing the entire hydrologic cycle, as in the Stanford Watershed Model developed by Crawford and Linsley in 1966. This code was perhaps the first that attempted to model most processes involved in the watershed to a significant degree, and its descendents, including the Hydrological Simulation Program Fortran (HSPF), remain in common use today. Other early systems have also survived, for instance the code that became known as HEC-1. The 1970s saw continued proliferation of codes simulating watershed hydrology, from Metcalf and Eddy's SWMM to Beven and Kirkby's TOPMODEL. Later models included the 'Systeme Hydrologique Europeen' (SHE) by Abbott et al. in 1986. Many of the codes also remain in use today, though all have seen improvements. Development of new or revised models has continued since, with individual organizations or agencies frequently releasing their own codes or, at least as often, variants of previously developed models.

As a diverse range of codes began to emerge, the World Meteorological Organization (WMO) sponsored several studies that compared the available alternatives. Their 1975, 1986 and 1992 studies dealt with models focused, in turn, on hydrologic forecasting, flow rate simulation and dynamic stream-flow forecasting. The majority of independent efforts since the WMO studies have been to compare a subset of watershed models, or models of a given component process. Additionally, developers of certain codes have offered comparisons of their programs with one or more other models.

Many current codes have essentially the same fundamental structure as the HSPF code of the 1970s, based largely on Freeze and Harlan's 1969 outline of a three-dimensional approach. At that time, the computational modeling of water quality drawing on hydrologic information was still just emerging, with models of dissolved oxygen in a reach of stream under continued development along with pollutant transport in streams and watersheds.

Major changes since these early models have largely been due to improvements in computer technology or data availability, along with the comparisons of newer conceptual model simulation results to experimental data. Many of the advances address better use of new or improved data sources, for instance the incorporation of digital elevation models (DEMs) and GIS. A related issue is the concept of sub-grid spatial variability and equation up-scaling. Other advances include the use of topographic indices and the ability to draw on sophisticated calibration measurements (e.g., chemical tracers.).

2.2.2 Code Classification

Much is oft made of the difference between 'lumped' and 'distributed' models. This distinction stems, originally, from the fact that, though the underlying equations in conceptual models are usually continuous, analytical solutions are not feasibly obtained beyond particularly simple cases, so most codes draw instead on numerical approaches.

In rigorous terms, "distributed" models consider spatial and temporal derivatives, while "lumped" models are those that ignore the spatial derivatives. In the former, the solutions are a function of time and space, while the latter only consider changes over time. Functionally however, most watersheds have limited data available, to an extent that does not allow for a fully distributed description (where all aspects must also be distributed, including parameters, geometry, boundary conditions, etc.). Some degree of lumping is therefore generally dictated, and most modern models comprise both distributed and lumped components. The distinction between approaches has become further blurred as modern computers and dataset handle input and simulation at ever-finer resolution. Today, many so-called 'distributed' models are nothing more than models lumped in a raster fashion.

Another distinction between codes is the selection of conceptual component models used to describe the hydrological cycle. The tradeoffs between empirical or physical models depend on the individual component examined and its importance for the designed purpose of the code, along with the data and numerical implications. Codes draw on a wide range of these models, and the choices are also affected by issues such as the topography and geographic region to which a code is likely to be applied.

Several attempts at formal classification of commonly available models have been made. Singh (1995, 2002) focused on hydrologic models and attempted to describe distinctions in scale and process description, while Wurbs (1998) focused on availability and the intended focus of codes available to water modelers.

2.3 State of the Art – Data Acquisition and Management

Hornsberger and Boyer (1995) along with others have, in their reviews, noted the use of GIS, remotely sensed data, and environmental tracers to be among the most important recent advances in watershed modeling. These data-acquisition advances have shifted, in many respects, the paradigm of data scarcity, by affording the opportunity to gather abundant quantities of data regarding spatial distribution of, for instance, topographical and surface cover data.

2.3.1 Topographical Data & Elevation Models

Prior to the 1980s, topographic data were most commonly sourced from contour maps. Modern data models, in conjunction with remote sensing techniques, have since provided the means to more accurately depict spatial changes in elevation for complex landscapes. In addition, digitized terrain and DEMs allow for rapid computation of basin and stream network geometry, slope, and flow direction.

There are several data models for treatment of DEM data in common use, ranging from triangular irregular networks (TIN) and raster schemes to vector and contour-based representations (Moore and Grayson 1991). The most widely used data structures are grid networks, or rasters. Many codes (e.g., Beasley et al. 1980, Abbott et al. 1986a, b) use a grid network as their basic structure. Though computationally efficient and useful for planning purposes, Mark (1978) and Moore and Grayson (1991) have discussed some of the limitations of grid structures as applied to hydrologic problems. Others (Moore et al 1988a, b, O'Loughlin 1986) have used contour-based DEMs for hydrologic and ecologic applications. A third approach has used a kinematic wave model for computing overland flow, based on a DEM representation (Vieux 1988, Goodrich and Woolhiser 1991). As the integration of remotely sensed, GIS, and DEM-based data in the model structure has become more sophisticated, more models have sought to take advantage of these developments. (e.g., Julien et al. 1995, Olivera and Maidment 1999, Fortin et al. 2001).

To incorporate topographical data, models themselves can conceive of watershed area as either a grid structure, similar to the rasterized elevation data, and other numerical methods (e.g., finite-element) themselves, or as some other, non-raster, network of elemental sections (Singh 1996). Sub-areas thus discretized can then be linked together through routing elements, forming the dendritic network and the watershed model.

2.3.2 Chemical Tracers

Radiological isotopes, chlorofluorocarbons and other chemical tracers have all been used to define, or calibrate, models of water flow (Adar and Neuman 1988, Dunkle et al. 1993, Robson et al. 1992). Such direct-experiment approaches can yield a wealth of information on flow sources and paths which are otherwise difficult to evaluate, supporting analysis and interpretation of additional remotely-sensed data.

2.3.3 Remote Sensing

Perhaps the most significant advances have been made in data collection with the advent and mainstreaming of new technologies, especially remote sensing, satellites, and radar. Their use has consequently become much more widespread over the last 20 years and continues to receive a great deal of attention. These technologies provide the ability to gather and geo-reference data regarding topography, soil, land-use, and meteorological parameters over a large area at a given point in time. As direct observation technology continues to progress, so too do the techniques and algorithms available for indirect measurement of parameters of interest.

Radar measurements provide a much truer spatial mapping of precipitation, as opposed to point measurements from older rain gauging techniques, which are particularly suited for use in distributed models. The resolution of newer implementations promises to determine precipitation data at high spatial and temporal resolution in real-time. The Next Generation [Weather] Radar (NEXRAD, also termed WSR-88) is a representative example of progress. Deployment for the WSR-88 Doppler systems began in 1988 (replacing the previous WSR-74 and WSR-54 deployments) and continued until 1997. Improvements to pieces of the NEXRAD network and similar systems continue, on aspects ranging from new and refined sensing technologies (Brewster et al. 2005, Scott et al. 2001) to data assimilation (Bocchiola 2007, Young et al. 2000).

Mapping and classification of land use and vegetation or snowpack cover data have also improved, due to projects (such as the Landsat Thematic Mapper, the Multispectral Scanner, and Systeme Probatoire de la Terre) that produce satellite imagery, which can be used alone or in conjunction with aerial photos and terrain data. Satellite-based remote sensing systems continue to progress in a fashion similar to land-based networks (such as NEXRAD). The Canadian Space Agency's RADAR-SAT2, launched in December 2007, began returning images in mid-January 2008, and will offer several new beam modes, with spatial resolution ranging from 3 to 100 meters and fully polarimetric C-band imagery (Kaya et al. 2004) In turn, land-cover classes can be used to obtain improved estimates of other parameters, as illustrated by Kite and Kouwen (1992) and Chen et al. (2005).

These new capabilities to observe and gather hydrologic data have stemmed entirely new applications of watershed models, which have found new uses, for instance, in real-time modeling applications. These applications, in turn, have stemmed new implications for management: Coskun (2008) has proposed an international 'Environmental Security' coalition for member states of the North Atlantic Treaty Organization (NATO). Flood and runoff forecasting, drought assessment/forecasting, mapping of groundwater potential, and management strategy assessment are but a few of the applications for which these approaches holds important potential (Coskun 2008, Goodrich et al. 1991).

2.3.4 Data Management Systems: GIS and Data

The augmented availability of these data types at higher resolutions, coupled with the drive to incorporate them into watershed models, has progressively led to a requirement for better data management and visualization systems. Non-raster based models, in particular, have seen a series of changes to translate a high volume of high resolution data into manageable digests for conceptual modeling tasks. This has resulted in the development of topographic parameterization and related terrain analysis techniques (e.g., Leavesley and Stannard 1990).

2.4 STATE OF THE ART – RESOLUTION AND SCALE ISSUES

2.4.1 SCALING AND VARIABILITY

Scale is usually defined as either the discretization used for computational purposes, or the spatial coarseness (length in the spatial domain, and duration in the time domain) at which observations are made (Singh 2002). Spatial variability describes the change in description of data or processes across each dimension, and is thus closely tied to the scale itself. Seyfried and Wilcox (1995) explored the effect of variability on hydrological response over a range of scales, using several field processes as examples.

Many hydrologic models employ point-scale equations based on conservation of mass, momentum, and energy. In such cases, the computations require data at a scale much finer than is readily available. This means that the point-scale equations must be up-scaled in order to conserve mass, momentum, and energy and to ensure compatibility between the scales of observed data and governing equations. It is important, however, to understand that excessive process description at one scale is effectively lost through the processes of integration in time and space and through averaging, justifying lumping and conceptual model simplification in many cases. Morel-Seytoux (1988) showed how simplifications can be made so that straightforward scaling integration is accomplished in a physically based stochastic framework. Indeed, as shown by Kavvas (1999) when a larger scale hydrological process (or parameter) itself is formed by averaging a small-scale process, the high frequency components of the smaller scale process are eliminated by averaging, and this leads to considerable simplification of the average hydrologic conservation equations.

2.4.2 SPATIAL RESOLUTION

With these issues outlined, it becomes clear that selection of the spatial scale to be used must also affect selection of a model. Loague (1988) and Chen (1994) have both demonstrated this, as has subsequent work.

The finest spatial scale which can acceptably characterize spatial heterogeneity in a hydrological model has been examined by Bathurst (1986), who suggested dividing the watershed into elements no larger than 1% of the total area to ensure that each element was more or less homogeneous, Wood et al. (1988), who proposed the notion of a representative elementary area (REA), and several others. Wood et al. defined the REA as the 'smallest discernible point which is representative of the continuum'. This suggests a preferable temporal and spatial scale over which the process representations can remain simple, and distributed catchment behaviour represented without the complexity of local heterogeneity (see Figure 2.1). The concept is analogous to the representative elemental volume concept of Hubbert (1956). Blösch et al. (1995) reasoned it is difficult, in practice, to determine the REA because it is strongly controlled by environmental characteristics.

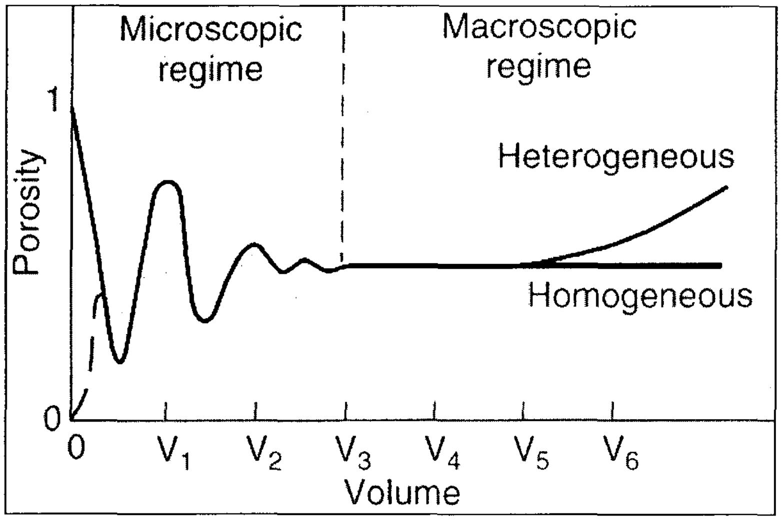


Figure 2.1: Representative Elementary Volume Determination (adapted from Hubbert 1956).

Zhang and Montgomery (1994) concluded that a grid size smaller than the hill-slope length was necessary to adequately simulate the processes controlled by land form, while Molnar and Julien (2000) found that coarser (0.835 vs. 0.016 km^2) grid-cell resolutions can be used for runoff simulations as long as parameters are appropriately calibrated, and suggested the primary effect of increasing grid-cell size on simulation parameters is to require an increase in overland and channel roughness parameters. Song and James (1992) proposed a stochastic method to find an optimal scale for model application.

2.4.3 Temporal Resolution

The issue of different timescales for individual hydrologic components remains an important issue. Common approaches generally apply conceptual models for fixed (e.g. daily) intervals, which can be viewed, in some ways, as analogous to rasterized approaches to spatial issues. Alternatively, event based (e.g., prior to, during and after precipitation events) discretization are perhaps more analogous to coarser, or hydrological lumping. Hughes (1993) suggested incorporation of variable time intervals in deterministic models. Conceptual disaggregation of rainfall into simple, constant and triangular distributions has been shown to cause significant distortion in peak runoff rates (Woolhiser and Goodrich 1988). Additionally, the timescale of problem considered substantially influences the type of the conceptual model and data considered.

2.5 STATE-OF-THE-ART – CALIBRATION, SENSITIVITY AND ANALYSIS

2.5.1 MODEL CALIBRATION

With increasing model complexity and increasing calibration and input data requirements, model calibration has become an increasingly challenging step in the model construction process. Significant advances have followed, as outlined by Gupta et al. (1998). Several optimization methods have been developed for parameter estimation (both local and global), as discussed by Sorooshan and Gupta (1995). Typically, these methods are comprised of four components: the objective function, the optimization algorithm, a termination criterion, and calibration data. Clarke (1973) suggested basing the objective function on the stochastic properties of the errors in the model and the data.

Common problems with the prevalent optimization strategies today include the lack of a unique 'best' solution and the ability to handle ever larger data sets. Monte-Carlo membership, the prediction uncertainty method, and GLUE are some attempts to address these problems (van Staten and Keesman 1991, Klepper et al. 1991, Freer et al. 1996). More recently, Gupta et al. (1998) proposed a multi-objective paradigm that could include some handling of model error. Vrugt et al. (2005) developed a method they termed "simultaneous optimization and data assimilation" (SODA), combining aspects of Shuffled Complex Evolution (SCE) parameter search, as described in Section 2.6.5, with an ensemble Kalman filter . This combination aims to account for both parameter and non-parameter uncertainty (including input, output and structural sources) even in cases where optimal model parameters are unknown.

2.5.2 MACHINE LEARNING TECHNIQUES

The use of Artificial Neural Networks (ANNs) is another alternative to parameter estimation problems, particularly suited for nonlinear systems such as rainfall-runoff forecasting [e.g., Lorrai and Sechi (1995)]. The key feature, but also reproach, was accurately identified by Hsu et al. (1995): ANNs do not require modeling the internal structure of the watershed, and can therefore be useful alternatives, but are not adequate replacements for conceptual watershed modeling. Genetic Algorithms (GAs) have also found applications in the field. Applications have ranged from calibration of conceptual models (e.g., Wang 1991) to more recent approaches incorporating evolution of the expression or algorithm itself (e.g., Savic et al. 1999). Gashing et al. (1981) developed a knowledge-based expert system based on SWM for water resource problems, a concept which has continued to receive attention (e.g., Liu et al. 2007, Simanovic 1990), though the potential application of artificial intelligence has largely not (see, for instance, Liao 2005).

2.5.3 Impact and Water Quality Analysis

The linking of hydrologic models with those of geochemistry, environmental biology, meteorology, and climatology has grown to be increasingly common since the 1980s, facilitated largely by new data technologies, coupled with an increased understanding of the issues surrounding spatial variability.

Several watershed hydrology models have moved towards direct incorporation of water-quality components into their structure. The demand for these tools is likely to continue to grow with the increasing need and applications of better, more integrated, environmental management systems.

t= 0	0	0	0	ε	0	0	0
t= 1	0	0	ε	-2ε	ε	0	0
t= 2	0	ε	-4ε	6ε	-4ε	ε	0
t= 3	ε	-6ε	15ε	-20ε	15ε	-6ε	ε
t= 4	-8ε	28ε	-46ε	70ε	-46ε	28ε	-8ε
t= 5	45ε	-10ε	190ε	-232ε	190ε	-110ε	45ε
t= 6	-210ε	455ε	-722ε	844ε	-722ε	455ε	-210ε

Figure 2.2: Error propagation effects in a forward-difference scheme

2.5.4 Error Analysis

One of the major limitations of current watershed models is the lack of error analysis in most applications. Indeed, it is often not clear from the user perspective what the model errors are or how errors are propagating through components and parameters. Figure 2.2 illustrates the effects of error propagation in a forward-difference scheme, where ε represents an error that propagates in space (columns) and time (rows).

Even in such a relatively simple scenario, the significance of temporal and spatial propagation of error quickly becomes apparent. This adds ambiguity, and results in additional challenges for model selection and comprehension tasks.

2.6 State-of-the-Art - Error and Uncertainty in Environmental Systems

2.6.1 Terminology Overview

It is useful at this point to distinguish several terms, often used interchangeably. Error refers to the disagreement between a measurement and the true or accepted value. Precision refers to the tolerance or repeatability of a measurement, and is independent of the true value. Accuracy relates to the quality of a result (low error), and is distinguished from precision, which relates to the quality of the operation by which the result is obtained. Uncertainty of a measured value is an interval around that value such that any repetition of the measurement will produce a new result that lies within this interval. Uncertainty, rather than error, is the important term in most applications, and it is of particular importance to planners and modelers. The emphasis in this thesis, however, is focused in particular on the uncertainty associated with model estimates.

2.6.2 Error

As mentioned above, the error of a measurement is the discrepancy between the 'true' value and the value observed. All measurements have an inherent amount of error associated with them, and the act of observation itself affects the measured value to some degree. The task of modeling environmental processes at the catchment-scale involves varied measurement types and quality – including relatively invasive measurements that can significantly perturb the value being measured (but are generally more precise), and more non-invasive techniques which are also subject to significant error (and are generally less precise).

2.6.3 Uncertainty

With respect to the modeling task, the impact of data error can be assessed quantitatively by considering inputs as subject to measurement uncertainty. Other sources of error and uncertainty also exist and propagate through the modeling process. Wainwright and Mulligan (2004) distinguish computational, procedural, propagation and specification error, while Zimmerman (2000) identifies lack and abundance of information, conflicting evidence, ambiguity, measurement uncertainty and belief as causes of uncertainty in model application. While both approaches are enlightening, there is much overlap in these definitions, and in complex systems such distinctions quickly become cumbersome.

For the purpose of convenience, it is often more practical to differentiate sources on a functional basis. Thus, for the task at hand three distinct levels of uncertainty that filter through to quantitative model predictions were identified.

The uncertainty associated with the raw data, termed here u_d, incorporates such factors as measurement error and bad (or missing) data. The uncertainty associated with the model parameters is defined as u_p, and reflects the uncertainty introduced during the conversion and interpretation of raw data to suitable input forms for the numerical model, as well as components surrounding calibration parameters. Together, these two sources form the uncertainty associated with model inputs, or u_i. The other component, u_m, is the uncertainty associated with the model structure itself. This part of the uncertainty evolves from inadequate conceptualization (u_c) of processes being simulated as well as the connectivity and numerical discretization (u_n) of model components (see Equation 2-1, where u_t is the total uncertainty of model predictions).

$$u_t = f(u_i, u_m) = f(u_d, u_p, u_c, u_n) \quad (2\text{-}1)$$

2.6.4 Reducing Uncertainty

With this framework defined, the question of reducing the uncertainty of the model outputs (and thus the data, parameter and model components) naturally arises. The data problem is especially prevalent in relatively uncontrolled settings with sparse record points, and thus of particular importance in environmental contexts such as watershed modeling. Coupled with this is the reduced ability to reset or remeasure conditions at a given spatial-temporal point. One approach to bettering data issues is to reduce the impact of relatively infrequent aberrations in the data model. A spatially distributed stochastic precipitation model, for instance, can be assembled from precipitation measuring stations within a given catchment. Such a strategy further reduces the relative statistical significance of outliers (or input errors) which are less likely to occur simultaneously at several locations. A statistical description of several stations considered together may therefore help identify and/or mitigate those outliers due to data problems alone than is possible when considering a single temporal series at a given location alone.

The other source of input uncertainty, described above, involves the parameterization of the initial data model to match the model conceptualization and structure. It is thus closely tied to both the data and particular model structures, and can also be considered as the uncertainty inherent to linkage. This is the input component that typically demands the most of the user, both in terms of the inference from spatial data sources and model comprehension, and is the focus of the calibration process. Typically, models are calibrated by testing and optimizing their predictive accuracy, gauged against historical records with similar condition-spaces to the model's intended use. Specific optimization techniques range from straightforward numerical methods to procedures involving artificial intelligence and evolutionary algorithms. A detailed exploration of these procedures would be prohibitively long here, but it will suffice to say that they are plentiful and varied. It is well understood for deterministic models that the chosen 'calibrated' parameter set, and thus simulation results, depend on the reference data and calibration strategy used. Since similar results are often achieved with different approaches, the issue of which parameter set should be used frequently arises. This phenomenon is known as model equifinality.

The final uncertainty component (u_m) is essentially a fixed component once a given model conceptualization (e.g., code, although some codes offer alternate component models) and structure (e.g., discretization) have been defined. Additionally, since the structure and component models involved are typically buried in source and technical manuals, it is something of a 'blind' term and is occasionally neglected.

The process of uncertainty reduction is not straightforward, but can be broadly conceptualized as a Pareto optimization problem. In catchments with large discretized components for example, conceptual models tend to be more reflective of processes and overall patterns at the expense of heterogeneity in parameter values. Conversely, smaller discretizations tend to reduce the range of parameter values, but conceptual models may become invalid, even for relatively simple processes such as flow routing (see Figure 2.3). Scaling (and the associated change of parameter with scale) is thus an important consideration when addressing model uncertainty.

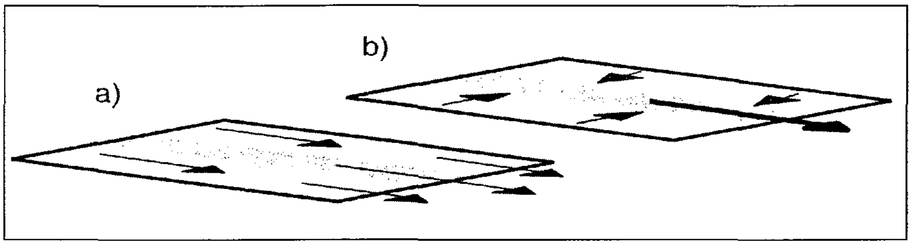


Figure 2.3: Two different conceptual models of flow within an element containing a channel (from Grayson and Blöschl 2001)

2.6.5 QUANTIFYING UNCERTAINTY

A variety of techniques for quantitative evaluation of uncertainty are available. Error-propagation and interval arithmetic type calculations can be used in comparatively simple models to compute the effects of input uncertainty. In more complex systems and modern codes, alternate analysis techniques are almost always required.

One of the most commonly used approaches for estimating model uncertainty is the Monte Carlo method. In this technique, multiple realizations of model input and parameter sets are generated based on distribution functions which are used to perturb the initial values. From the results of a sufficient number of realizations, probability estimates and error bands can be made to give ranges of possible outputs and confidence intervals (see, for instance De Roo et al. 1992, Häkanson 1996, and Phillips and Marks 1996). When contrasted with analytical methods, Monte Carlo analysis offers the advantage of being able to simulate variations in spatially distributed parameters, along with more complex interactions of uncertainty in component model outputs and intermediary variables. Nevertheless, implementation of the approach to large parameter sets can involve implementation of sampling designs and sensitivity analyses in addition to requiring hundreds or thousands of simulations for reliable results (see Heuvelink 1992, Klepper 1997, and Parysow et al. 2000).

In the random sampling case of parameter distributions, Monte Carlo analysis necessitates large numbers of simulations in order to accurately portray the parameter space. In many cases this approach becomes unwieldy, but this can be mitigated through use of strategic sampling techniques. One such approach is the Latin-Hypercube Sampling strategy (LHS) which is a stratified sampling method commonly used to reduce the number of Monte Carlo runs required.

Individual model parameters are sampled evenly from the cumulative distribution into groups (or bins). By selecting parameters for a run from each bin, the variable space can be sampled with significantly fewer runs.

In the SCE algorithm, developed in 1992 at the University of Arizona (hence the '–UA' suffix that is often attached), the parameter space is sampled into a 'population' of several points representing parameter sets (see Figure 2.4). These points are then partitioned into a number of 'complexes'. Essentially, the optimization algorithm is analogous to those found in classical genetic or evolutionary algorithms. The complexes are made to evolve in the direction of global improvement, using competitive evolution techniques. At periodic stages in the evolution, the entire set of points is shuffled and reassigned to new complexes to enable information sharing. Duan et al. (1992) outlined the specific fitness functions associated with the method in some detail. Improvements to the original algorithm have also been suggested and may be of particular value in certain applications (see for instance, SCEM-UA 2001). Other methods, such as SODA (discussed in Section 2.5.1) rely on a combination of approaches.

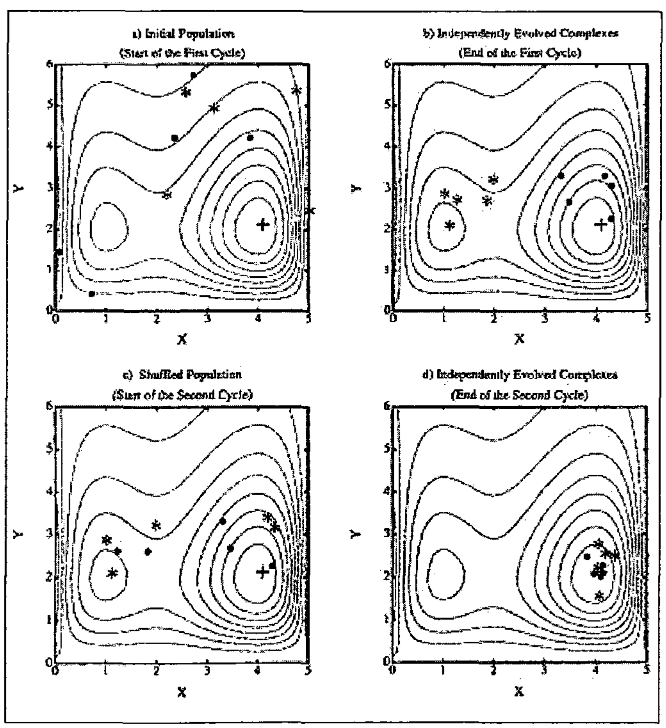


Figure 2.4: Sampling in the Shuffled Complex Evolution (SCE) method (from Duan et al. 1992)

In contrast to a search for an optimal parameter set, the GLUE procedure acknowledges the uncertainty associated with any representative set, and aims only to make an assessment of the likelihood of a set being an acceptable simulator of the watershed behaviour. In the GLUE algorithm, as developed by Beven and Binley (1992), many different model parameter sets are chosen for simulation. Evaluation measures are then used to reject some models (model structure/parameter set combinations) as nonbehavioural while all those considered as behavioural are retained in prediction. The predictions of the behavioural models are weighted by a likelihood measure based on past performance to form a cumulative weighted distribution of any predicted variable of interest.

The measures of likelihood are termed Bayesian estimators, and the parameter sets can be generated using a random (Monte Carlo) approach or subjectively based on, for instance, user experience. While LHS or similar techniques can also be used, one advantage of the GLUE algorithm is that it requires no assumptions to be made about the distribution function (see Beven 1993). The objective function chosen for the simulation is another significant factor in obtaining reliable results with the GLUE methodology (Legates and McCabe 1999, Wagener et al. 2003).

2.6.6 Qualitative Approaches

It should also be noted that there is a school of thought that holds such error-estimation techniques as inherently untenable in numerous instances. Hall and Anderson (2002) criticize objective-based error estimation techniques, noting the lack of sufficient data and detailed measurements in many cases. This argument frequently rejects the validity of probabilistic terms and favors instead discussion of possibilities.

2.7 References

Abbott, M.B., Bathurst, J.C., Cunge, J.A., O'Connell, P.E., and Rasmussen, J. (1986a) "An introduction to the European Hydrologic System-Systeme Hydrologique Europeen, SHE, 1: History and philosophy of a physically-based, distributed modeling system." J. Hydrol., 87, 45–59.

Abbott, M.B., Bathurst, J.C., Cunge, J. A., O'Connell, P.E., and Rasmussen, J. (1986b) "An introduction to the European Hydrologic System-Systeme Hydrologique Europeen, SHE, 2: Structure of a physically-based, distributed modeling system." J. Hydrol., 87, 61–77.

Adar, E.M. and Neuman, S.P. (1988) "Estimates of spatial recharge distribution using environmental isotopes and hydrochemical data, II. Application to Aravaipa Valley in Southern Arizona, USA." J. Hydrol., 97, 279–302.

Bathurst, J.C. (1986) "Sensitivity analysis of the Systeme Hydrologique European (SHE) for an upland catchment." J. Hydrol., 87, 103–123.

Beasley, D.B., Huggins, L.F., and Monke, E.J. (1980) "ANSWERS: a model for watershed planning." Trans. ASAE, 23, 938–944.

Beven, K. (1993) "Prophecy, reality and uncertainty in distributed hydrological modeling." Advance in Water Resources, 16, 41-51.

Beven, K. and Binley, A.M. (1992) "The future of distributed models: model calibration and predictive uncertainty." Hydrological Processes, 6, 279-298.

Blöschl, G., Grayson, R.B. and Sivapalan, M. (1995) "On the representative elementary area (REA) concept and its utility for distributed rainfall-runoff modeling." in J.D.Kalma and M. Sivapalan (eds), Scale Issues in Hydrological Modeling, John Wiley & Sons, Chichester, 71-88.

Blöschl, G. (2001), "Scaling in hydrology", Hydrological Processes 15: 709-711.

Borah, D. K. and Bera, M. (2003) "Watershed-Scale hydrologic and nonpoint-source pollution models: review of mathematical bases." Trans. of the ASAE. 46(6), 1553-1566.

Borah, D. K. and Bera, M. (2004) "Watershed-scale hydrologic and nonpoint-source pollution models: Review of applications." Trans. of the ASAE. 47(3), 789-803.

Bosh, D., Theurer, F., Binger, R., Felton, G., and Chaubey, I. (1998) "Evaluation of the AnnAGNPS water quality model." ASAE Paper No. 98-2195, St. Joseph, MI.

Bocchiola, D. (2007) "Use of scale recursive estimation for assimilation of precipitation data from TRMM (PR and TMI) and NEXRAD." Advances in Water Resour. 30(11), 2354-2372.

Brewster, K., White, L., Johnson, B. and Brotzge, J. (2005) "Selecting the sites for casa netrad, a collaborative radar network." 85th AMS Annual Meeting, Am. Meteorological Society - Combined Preprints, 3715-3722

Chen, J.M., Chen, X., Ju, W. and Geng, X. (2005) "Distributed hydrological model for mapping evapotranspiration using remote sensing input." J. of Hydrology 305(1-4), 15-39.

Chen, Z.Q., Govindaraju, R.S., and Kavvas, M.L. (1994a) "Spatial averaging of unsaturated flow equations under infiltration conditions over areally heterogeneous fields: 1. Development of models." Water Resour. Res., 30(2), 523–533.

Chen, Z.Q., Govindaraju, R.S., and Kavvas, M.L. (1994b) "Spatial averaging of unsaturated flow equations under infiltration conditions over areally heterogeneous fields: 2. Numerical simulations." Water Resour. Res., 30(2), 535–548.

Clarke, R.T. (1973) "A review of some mathematical models used in hydrology, with observations on their calibration and use." J. Hydrol., 19, 1–20.

Coskun, H.G. (2008) "An integrated approach for environmental security in the NATO countries based on remote sensing and gis technologies." NATO Security through Science Series C: Environmental Security, 3-15.

Cummings, N.W. (1935) "Evaporation from water surfaces: Status of present knowledge and need for further investigations." Trans. AmGeophys. Union, 16(2), 507–510.

De Roo, A.P.J., Hazelhoff, L., and Heuvelink, G.B.M. (1992) "The use of Monte Carlo simulations to estimate the effects of spatial variability of infiltration on the output of a distributed hydrological and erosion model." Hydrological Processes, 6, 127-143.

Dunkle, S.A., Plummer, L.N., Busenberg, E., Phillips, P.J., Denver, J.M., Hamilton, P.A., Michel, R.L., and Coplen, T.B. (1993) "Chloroflurocarbons (CC13F and CC12F2) as dating tools and hydrologic tracers in shallow groundwater of the Delmarva Peninsula, Atlantic Coastal Plain, United States." Water Resour. Res., 29, 3837–3860.

Duan, Q., Sorooshian, S., and Gupta, V. (1992) "Effective and efficient global optimization for conceptual rainfall-runoff models." Water Resour. Res., 26(4): 1015-31.

Fortin, J.P., Turcotte, R., Massicotte, S., Moussa, R., Fitzback, J., and Villeneuve, J.P. (2001a) "A distributed watershed model compatible with remote sensing and GIS data. I: Description of model." J. Hydrologic Eng., 6(2), 91–99.

Fortin, J.P., Turcotte, R., Massicotte, S., Moussa, R., Fitzback, J., and Villeneuve, J.P. (2001b) "A distributed watershed model compatible with remote sensing and GIS data II: Application to Chaudiere watershed." J. Hydrologic Eng., 6(2), 100–108.

Freer, J., Beven, A.M., and Ambroise, B. (1996) "Bayesian estimation of uncertainty in runoff prediction and the value of data: An application of the GLUE approach." Water Resour. Res., 32, 2161–2173.

Gashing, J., Reboh, R., and Rewiter, J. (1981) "Development of a knowledge-based expert system for water resource problems." Final Rep. Stanford Research Institute, Menlo Park, CA.

Gerhart, J.M., (1991) "National Water-Quality Assessment Program--The Potomac River Basin." US Geological Survey Open-File Report, 91-157.

Goodrich, D. and Woolhiser, D.A. (1991) "Catchment hydrology." Rev. Geophys., 29, 202–209.

Grayson, R.B. and Blöschl, G. (2001) "Spatial patterns in catchment hydrology: observations and modeling. Eds., Cambridge Univ. Press, Cambridge, UK, 404 pp.

Green, W.H. and Ampt, C.A. (1911) "Studies on soil physics: 1. Flow of water and air through soils." J. Agric. Sci., 4, 1–24.

Gupta, H.V., Sorooshian, S., and Yapo, P.O. (1998) "Toward improved calibration of hydrologic models: Multiple and noncommensurable measures of information." Water Resour. Res., 34(4), 751–763.

Häkanson, L. (1996) "A general method to define confidence limits for model predictions based on validations." Ecological Modeling, 91, 153-168.

Hall, J. and Anderson, M.G. (2002) "Handling uncertainty in extreme or unrepeatable hydrological processes – the need for an alternative paradigm." Hydrological Processes 16, 1867-1870.

Heuvelink, G.B.M. (1992) "Error Propagation in Quantitative Spatial Modeling: Applications in Geographical Information Systems." Netherlands Geographical Studies, Knag/Faculteit Ruimtelijke Wetenschappen Universiteit Utrecht, Utrecht.

Horton, R.E. (1919). "Rainfall interception." Monthly Weather Rev., 147, 603–623.

Horton, R.E. (1933) "The role of infiltration in the hydrologic cycle." Trans., Am. Geophys. Union, 145, 446–460.

Horton, R.E. (1935) "Surface runoff phenomena, Part 1—Analysis of hydrograph." Horton Hydrology Laboratory Publication No. 101, Voorheesville, NY.

Horton, R.E. (1939) "Analysis of runoff plot experiments with varying infiltration capacities." Trans. Am. Geophys. Union 20(IV), 683–694.

Horton, R.E. (1940) "An approach toward a physical interpretation of infiltration capacity." Soil Sci. Soc. Am. Proc., 5, 399–417.

Horton, R.E. (1945) "Erosional development of streams and their drainage basins: Hydrophysical approach to quantitative geomporphology." Bull. Geol. Soc. Am., 56, 275–370.

Hubbert, M.K. (1956) "Darcy's law and the field equations of the flow of underground fluids." Trans. of the Am. Institute of Mining, Metallurgical and Petroleum Engineers 207, 222-239.

Hughes, D.A. (1993) "Variable time intervals in deterministic hydrological models." J. Hydrol. 143, 217–232.

Hursh, C.R. (936) "Storm water and absorption." Trans., Am. Geophys. Union, 17(II), 301–302.

Hursh, C.R. (944). "Appendix B—Report of the subcommittee on subsurface flow." Trans. Am. Geophys. Union, 25, 743–746.

Hursh, C.R. and Brater, E.F. (1944) "Separating hydrographs into surface- and subsurface-flow." Trans. Am. Geophys. Union, 25, 863– 867.

Hsu, K. L., Gupta, H. V., and Sorooshian, S. (1995) "Artificial neural network modeling of the rainfall-runoff process." Water Resour. Res., 31(0), 2517–2531.

Julien, P.Y., Saghafian, B., and Ogden, F.L. (1995) "Raster-based hydrologic modeling of spatially varied surface runoff." Water Resour. Bull., 31(3), 523–536.

Kavvas, M.L. Chen, Z.-Q., Tan, L., Soong, S.-T., Terakawa, A., Yoshitani, J. and Fukami, K. (1998) "A regional scale land surface parameterization based on areally-averaged hydrological conservation equation." Hydrol. Sci. J., 43(4), 611–631.

Kavvas, M.L. (1999) "On the coarse-graining of hydrologic processes with increasing scales." J. Hydrol. 27, 191–202.

Kaya, S., Sokol, J. and Pultz, T.J. (2004) "Monitoring environmental indicators of vector-borne disease from space: a new opportunity for RADARSAT-2." Can. J. Remote Sensing, Vol. 30, No. 3, 560–565

Kite, G.W. and Kouwen, N. (1992) "Watershed modeling using land classification." Water Resour. Res., 28(2), 3193–3200.

Klepper, O., Scholten, H., and van de Kamer, J.P.G. (1991) "Prediction uncertainty in an ecological model of the Oosterschelde estuary." J. Forecast., 10, 191–209.

Klepper, O. (1997) "Multivariate aspects of model uncertainty analysis tools for sensitivity analysis and calibration." Ecological Modeling, 101, 1-13.

Kuczera, G. (1983a) "Improved parameter inference in catchment models.1: Evaluating parameter uncertainty." Water Resour. Res., 19, 1151–1162.

Kuczera, G. (1983b) "Improved parameter inference in catchment models. 2: Combining different kinds of hydrologic data and testing their compatibility." Water Resour. Res., 19, 1163–1172.

Leavesley, G.H., and Stannard, L.G. (1990) "Application of remotely sensed data in a distributed parameter watershed model." Proc., Workshop on Applications of Remote Sensing in Hydrology, National Hydrologic Research Center, Environment Canada, Saskatoon, SK.

Legates, D.R. and McCabe, Jr., G.J. (1999) "Evaluating the use of 'goodness-of-fit' measures in hydrologic and hydroclimatic model validation." Water Resour. Res., 35, 233-241.

Liao, S-H. (2005) "Expert system methodologies and applications—a decade review from 1995 to 2004." Expert Systems with Applications, 28(1) January 2005, 93-103.

Liu, Y., Guo, H., Zhang, Z., Wang, L., Dai, Y., and Fan, Y. (2007) "An optimization method based on scenario analysis for watershed management under uncertainty." Environmental Management 39(5), 678-690

Loague, K.M. (1988) "Impact of rainfall and soil hydraulic property information on runoff predictions at the hillslope scale." Water Resour. Res., 24(9), 1501–1510.

Lorrai, M. and Sechi, G.M. (1995) "Neural nets for modeling rainfall/runoff transformations." Water Resour. Manage., 9, 299–313.

Mark, D.M. (1978) "Concepts of 'data structure' for digital terrain models." Proc., Symposium on DTMs, American Society of Photogrammetry/American Congress of Surveying and Mapping, St. Louis, MO.

Molnar, D.K. and Julien, P.Y. (2000) "Grid-size effects on surface runoff modeling." J. Hydrologic Eng., 5, 8–16.

Moore, I.D. and Grayson, R.B. (1991) "Terrain-based catchment partitioning and runoff prediction using vector elevation data." Water Resour. Res., 27(6), 1177–1191.

Moore, I.D., O'Loughlin, E.M. and Burch, G.J. (1988a) "A contour based topographic model for hydrological and ecological applications." Earth Surf. Processes Landforms, 13, 305–320.

Moore, I.D., Pamuska, J.C., Grayson, R.B., and Srivastava, K.P. (1988b) "Application of digital topographic modeling in hydrology." Proc., Int. Symposium on Modeling Agricultural, Forest, and Rangeland Hydrology, Publication No. 07-88, Am. Soc. of Agric. Engineers, St. Joseph, MI.

Morel-Seytoux, H.J. (1988) "Soil-aquifer-stream interactions—a reductionist attempt toward physical stochastic integration." J. Hydrol. 102, 355–379.

Olivera, F. and Maidment, D. (1999) "GIS-based spatially distributed model for runoff routing." Water Resour. Res., 35(4), 1155–1164.

O'Loughlin, E.N. (1986) "Prediction of surface saturation zones in natural catchments by topographic analysis." Water Resour. Res., 22, 229–246.

Parker G. 2004. "Modeling agricultural best management practices in the South Nation watershed." MASc Thesis, Univ. of Ottawa, Ottawa, ON.

Parysow, P., Gertner, G. and Westervelt, J. (2000) "Efficient approximation for building error budgets for process models." Ecological Modeling, 135, 111-125.

Phillips, D.L. and Marks, D.G. (1996) "Spatial uncertainty analysis: propagation of interpretation errors in spatially distributed models." Ecological Modeling, 91, 213-229.

Robson, A.., Beven, K. and Neal, C. (1992) "Towards identifying sources of subsurface flow: A comparison of components identified by a physically based runoff model and those determined by chemical mixing techniques." Hydrolog. Process., 6, 199–214.

Savic, D.A., Walters, G.A. and Davidson, J.W. (1999) "A genetic programming approach to rainfall-runoff modeling." Water Resour. Manage., 13, 219–231.

Scientific Advisory Panel (1998), "Scientific Advisory Panel July 1998 Meeting Final Report." US Environmental Protection Agency, Arlington, VA.

Scott, R.D., Krehbiel, P.R., and Rison, W. (2001) "The Use of Simultaneous Horizontal and Vertical Transmissions for Dual-Polarization Radar Meteorological Observations". J. Atmos. Oceanic Technol., 18, 629–648.

Seyfried, M.S. and Wilcox, B.P. (1995) "Scale and nature of spatial variability: Field examples having implications for hydrologic modeling." Water Resour. Res., 31, 173–184.

Simanovic, S.P. (1990) "An expert system for the selection of a suitable method for flow measurement in open channels." J. Hydrol., 112, 237–256.

Simoncic, M. (2004), "A Bayesian Network Model of Two-Car Accidents", J. of Transportation and Statistics, 7 (2-3), pp. 13-25.

Singh, V.P. ed. (1995b) Computer models of watershed hydrology, Water Resources Publications, Littleton, CO.

Singh, V.P. (1996) Kinematic wave modeling in water resources: Surface water hydrology, Wiley, NY.

Sivapalan, M. and Wood, E.F. (1986) "Chapter 5: Spatial heterogeneity and scale in the infiltration response of catchments." in Scale problems in hydrology, V.K. Gupta, I. Rodriguez-Iturbe, and E.F. Wood, eds., Kluwer Academic, Dordrecht, The Netherlands, 81–106.

Sivapalan, M., Bloschl, G., Zhang, L., and Vertessy, R. (2003), "Downward approach to hydrological prediction." Hydrological Processes, 17: 2101-2111.

Song, Z. and James, L.D. (1992) "An objective test for hydrologic scale." Water Resour. Bull., 28(5), 833–844.

Thomas, G. and Henderson-Sellers, A. (1991) "An evaluation of proposed representation of subgrid hydrologic processes in climate models." J. Climate, 4, 898–910.

US Department of Agriculture (2001) "AnnAGNPS Version 2: User Documentation.,"USDA-ARS, Oxford, MS.

US Environmental Protection Agency (1997) "Compendium of tools for watershed assessment and TMDL development," EPA, EPA-841-B-97-006, Washington, DC.

US Geological Survey (1999) "National Elevation Dataset (Ed. 1)", EROS Data Cente, Sioux Falls, SD. Available online at http://gisdata.usgs.net/ned/ (retrieved 1/30/2007).

Vieux, B.E. (1988) "Finite element analysis of hydrologic response areas using geographic information systems." PhD dissertation, Michigan State Univ., East Lansing, MI.

Vieux, B.E. (1991) "Geographic information systems and non-point source water quality and quantity modeling." Hydrolog. Process., 5, 101–113.

Vrugt, J.A., Diks, C.G.H., Gupta, H.V., Bouten, W., and J.M. Verstraten (2005) "Improved treatment of uncertainty in hydrologic modeling: Combining the strengths of global optimization and data assimilation." Water Resour. Res. 41(1), 1-17.

Wagener, T., McIntyre, N., Lees, M.J., Wheater, H.S., and Gupta, H.V. (2003) "Towards reduced uncertainty in conceptual rainfall-runoff modeling: Dynamic identifiability analysis." Hydrological Processes 17(2), 455-476.

Wainwright, J. and Mulligan, M. (2004) "Environmental modeling." Eds., John Wiley & Sons, 409 pp.

Wang, Q.J. (1991) "The genetic algorithm and its application to calibrating conceptual rainfall-runoff models." Water Resour. Res., 27(9), 2467–2471.

Wood, E.F., Sivapalan, M., and Beven, K. (1990) "Similarity and scale in catchment storm response." Rev. Geophys., 28, 1–18.

Wood, E.F., Sivapalan, M., Beven, K.J., and Band, L. (1988) "Effects of spatial variability and scale with implications to hydrologic modeling." J. of Hydrol. 102(1-4), pp. 29-47.

Woolhiser, D.A. and Goodrich, D.C. (1988) "Effect of storm rainfall intensity patterns on surface runoff." J. Hydrol., 102, 29–47.

Wurbs, R.A. (1998) "Dissemination of generalized water resources models in the United States." Water Int., 23, 190–198.

Young, C.B., Bradley A.A., Krajewski W.F., Kruger A., and Morrissey, M.L. (2000) "Evaluating NEXRAD Multisensor Precipitation Estimates for Operational Hydrologic Forecasting". J. Hydrometeor, 1, 241–254.

Yu, Z. (1996) "Development of a physically-based distributed-parameter watershed (basin-scale hydrologic model) and its application to Big Darby Creek watershed." PhD dissertation, Ohio State Univ., Columbus, OH.

Zhang, W. and Montgomery, D.R. (1994) "Digital elevation model grid size, landscape representation, and hydrologic simulations." Water Resour. Res., 30, 1019–1028.

Zimmerman, H.J. (2000) "An application-oriented view of modeling uncertainty." European J. of Operational Research, 122, 190-198.

CHAPTER 3

AN OBJECTIVE TEST OF STOCHASTIC BEHAVIOR IN RIVERINE WATER QUALITY MODELS

3.0 CHAPTER OVERVIEW

This chapter was accepted for presentation at the IWA 2008 World Water Congress in Vienna, Austria, and was published in the *Water Science and Technology* 59(1) pp.159-165 (2009).

ABSTRACT

Predictions of river water quality models are subject to substantial uncertainties, which depend not only on parameterization and calibration strategies but also on the structure of the conceptual model itself. To evaluate the importance of this effect and associated implications for stochastic models, investigations were conducted based on a segment of the Potomac River in the eastern US. Two commonly used conceptual representations of real-world processes were used (MIKE11 and QUAL2E), and their simulation of DO, BOD and NH_4 components scrutinized. A GLUE approach to the inverse problem was then used to examine how uncertainty changed along the river network for each conceptual model. Differences were observed not only between deterministic instances of each conceptual model, but also between their response surfaces as a whole. Uncertainties within the river network are substantially influenced by the selection of calibration data used, as well as the primary source of the constituent examined. The suggested methodology can be used to test conceptual model validity for specific applications. The results of this study will help users select and assess models for varied problems, and refine appropriate data collection and monitoring schemes.

Listed keywords were: Water Quality, Numerical Models, Uncertainty, Watershed, MIKE11, and QUAL2E.

3.1 INTRODUCTION

3.1.1 BACKGROUND

Watershed-level modeling has become an essential tool in planning and managing environmental risks and the relationship between pollutant sources and water bodies, and an approved Total Maximum Daily Loading (TMDL) evaluation has become a de facto requisite for assistance funding. Water quality models are generally deployed in such cases to provide insight on source assessments and their impacts on water quality targets as well as the consequences of varied management scenarios (e.g., Parker et al. 2008)

Model parameters are adjusted to fit one or several years of reference data. It is well understood for deterministic models that the chosen 'calibrated' parameter set, and thus simulation results, depend on the reference data and calibration strategy used. Since similar results are often achieved with different approaches, the issue of which parameter set should be used frequently arises. This phenomenon is known as model equifinality.

Stochastic models attempt to mitigate these issues to some degree by representing modeled phenomena as a distribution of possible outcomes. A common implementation is to perturb input parameters, through use of Monte-Carlo simulations, for example, and assess likely outcomes from the results.

Equally important to the stochastic model response, however, is the underlying conceptual model structure itself. In practice, this issue is rarely explicitly considered, as a handful of codes, primarily designed for deterministic simulation, are in wide use. The approach of this paper is to examine and illustrate the stochastic response of two competitive conceptual models for water quality simulation in riverine systems.

3.1.2 WATER QUALITY MODELS

The earliest formal water quality conceptual models, from Streeter and Phelps (1925), as well as others, included a dissolved oxygen (DO) supply and biochemical oxygen demand (BOD) balance. Since that time, as knowledge has progressed, revised conceptual models have been proposed for these and other major processes in river systems (cf. Thomas, 1948; Bowie et al., 1985). Many of these models have in turn found one or more incarnations in a variety of computer codes such as QUAL2E, MIKE11 and others (Brown and Barnwell, 1987; McCutcheon, 1989) to support analyses of problems such as pollution control and land-use and waste-loading planning.

While some models have been expressly developed for stochastic use, such models tend to be more narrowly applicable, and the vast majority of models in regular use remain deterministic models. The EPA, for instance, recommends use of QUAL2E (and the derivative QUAL2EK) in their Better Assessment Science Integrating Point & Nonpoint Sources (BASINS) framework, designed for use by regional, state, and local agencies in examining management alternatives for watersheds (Duda et al., 2003). Sampling methods such as Monte-Carlo simulation are often used to account for (parameter) uncertainties in such deterministic-based models.

3.2 METHODOLOGY

3.2.1 STUDY AREA AND DATA

The Potomac Watershed stretches across approximately 38 000 km^2, of the Eastern US The Potomac River itself covers roughly 620 km from Fairfax Stone in West Virginia to Point Lookout in Maryland. The average river flow at the Washington, DC location is about 310 m^3/s, with minimum and maximum recorded flows of 17 m^3/s (September, 1966) and 12000 m^3/s (March 1936), respectively. The watershed flows into Chesapeake Bay, becoming tidal where the river crosses the Fall Line into the Coastal Plain province. Downstream from here, the water becomes increasingly brackish with a gradual increase in salinity. This study limits itself to the purely freshwater and non-tidal portion of the Potomac (Figure 3.1).

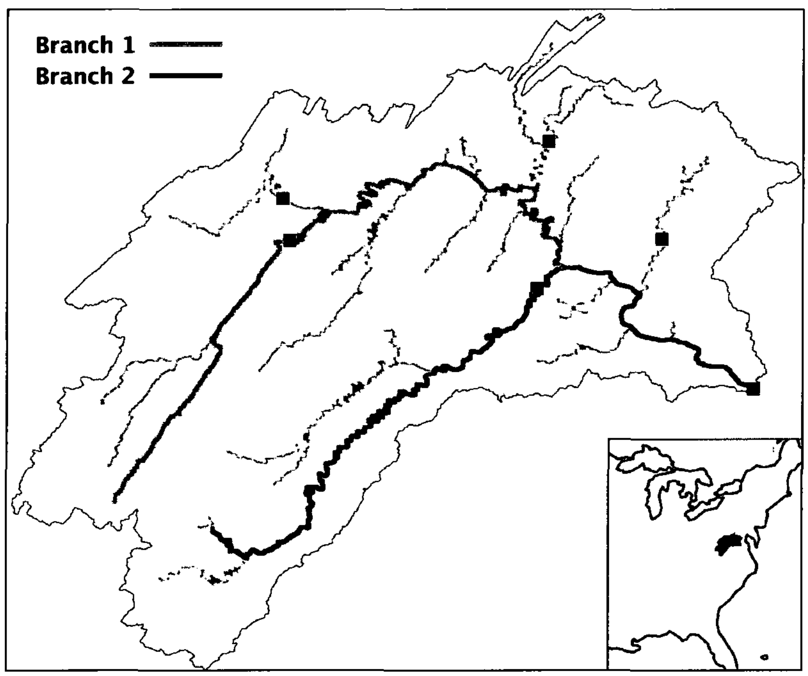


Figure 3.1: Non-tidal Potomac Watershed (location shown in inset). River network as modeled shown in dark grey, with two branches highlighted in orange and blue (green indicates overlapping reaches). Red squares indicate water quality calibration points.

From 1991 to 1996, the US Geological Survey's (USGS) National Water Quality Assessment (NAWQA) program began extensive work in the basin to monitor surface and ground water quality and ecology. That dataset is used here, and draws on over 50 USGS stations to provide information on stream flow quantity for the year 1993. These data are available at up to daily timesteps for individual stations. Water quality data are available at 5 'integrator' and 5 'indicator' stations on a monthly basis. Point Sources loading the river system were identified from US EPA (2007).

3.2.2 Water Quality Simulation

Typical constituents of interest in water quality models include DO, nutrients (e.g., nitrogen, phosphorus), and toxics (e.g., pesticides). For this paper a conversion kinetics model based on the widely used QUAL2E code (see Brown and Barnell, 1987) was compared with the formulation of the MIKE11 code (see DHI, 1992). An extensive review of water quality modeling approaches in beyond the scope of this outline, (but can be found in e.g., Rauch et al., 1998 or Bowie et al., 1985). Appendix G lists representative equations and processes found in a water quality model.

Although similar in overall structure and application, the two kinetic models tested here differ in several important respects. Rapidly biodegradable organic matter demand (BOD) is treated as a single state variable in the QUAL2E models, and as three fractions (dissolved, suspended and sedimented) in the MIKE11 model. In addition, while the base MIKE11 model limits itself to also considering DO and nitrogen species, QUAL2E considers algal biomass, organic nutrient components, as well as a more complex representation of nitrification (where nitrite is tracked).

Output of the two models was compared for stochastic simulation of DO, BOD and ammonia-N (NH_4). Initial ranges for water quality model parameters are estimated from literature values (Bowie et al., 1985). Spatial-varied inputs (e.g., water loadings) for the river system were extracted from the flow gauging station and point source data sets. Flow differences between two sequential stations not explained by one or several point sources were considered to be attributable to baseflow and surface runoff components, distributed evenly over the river length between the two stations. Representative constituent concentrations for these flow components were considered as a further set of parameters to be varied across runs. The candidate range of these model parameters was based on seasonal averages at indicator stations. The addition of this component, essentially a weak NPS model, is useful but may lead to additional challenges (not the least of which is computational requirements), which is likely why others (e.g., Rode, 2007) have preferred to use a point-source only description. Such an approach can also be considered a special case of that applied here, with the constituent contribution parameter set to a fixed value (0).

3.2.3 MODEL RESPONSE EVALUATION

For each conceptual model, the representative model set was then derived. The problem can be viewed as an inverse modeling exercise. It is usual to pose such problems in terms of the observation equation.

$$y_t = g(u_0,...,u_1,\xi o,...,\xi_t,\zeta_t,\theta,t) \qquad (3\text{-}2)$$

In Equation 3-2 terms include the model output (yt) the model inputs (ut), errors associated with model inputs ( ), measurement error ( ), and a vector of model parameters ( ) for each point t. The problem to be solved is the retrieval of the parameter set θ={pi}i=1,...,N and particularly the associated posterior distribution p(θ | y), given N stream data observations y = {siO}i=1,...,N. When p(θ) is defined, Bayesian approaches such as forward (likelihood) models (e.g., the sequential Bayes algorithm) or direct local inverse models are well-suited for the inference of p(θ | y). In more complex cases there may not always be a well-defined posterior parameter distribution [i.e., p(θ)], which is the set of parameters that produce representative models.

A Generalized Likelihood Uncertainty Estimation (GLUE) algorithm, as outlined by Beven and Binley (1992), was used to identify which parameter sets provide an adequate representation of the river system water chemistry. The GLUE framework offers several advantages for these types of problems, as it allows for the very complex likelihood surfaces expected with such parameter interactions. In this technique, the focus is on estimating posterior distributions for predicted variables directly from the outputs of a set of representative models, rather than from a model and an additive residual model. The resulting set of models is further constrained by the calibration data and criteria (cf. Beven, 2001 and Rode et al., 2007), and contains information on the simulation output variability for all representative input sets. The representative set can be viewed as the range of water quality models that conform to the calibration criteria, which in turn are constrained by the specific dataset used. Stated another way, this set contains information on the water quality model output variability for all representative input parameter sets. Furthermore, individual representative models can be weighted according to the degree of belief (or likelihood) in each model. Thus, by making an assumption on the model output distribution structure, a measure of output 'uncertainty' at each location in the riverine system is obtained.

Results from the GLUE examination are presented in several ways. The important concept is that of surface response, which is the range of simulation results at a given point (in space, or time) from those models which are considered representative. A 'narrow' surface response at a given location indicates many models predicting very similar values there, while a 'wider' response suggest a greater variation in predicted outputs among representative models.

3.2.4 Stochastic Response Model Toolkit

With the base models and simulation strategy decided upon, a toolset was developed to facilitate the model response evaluation methodology. A FORTRAN script implementation of the strategy detailed above was developed into a water quality inverse modeling toolkit (dubbed 'qualIT' for reference). The toolkit consists of three major components. The first of these is the run manager, which is responsible for tracking seed numbers and conditions at each run number and generating suitable parameter sets for the subsequent modules. The simulation manager calls the base water quality models, and passes the generated parameter sets for execution. The output processor produces a manageable digest (output fitness at user-specified locations) of run results returned by the conceptual model.

This modular structure is advantageous in that it allows for complete reproducibility of conditions at a given run number. This, in turn, permits efficient use of processing resources for both serial (e.g., calibration at new data locations) and parallel (e.g., base run generation) simulations tasks. Processing was done on an ad hoc 'CONDOR' cluster (cf. Tannenbaum et al., 2002), consisting of up to 5 modern desktop computers (subject to availability) totaling 8 processors at an approximate total of 16 billion cycles per second, and managed by a custom built 'HPC_monitor' package.

3.2.5 Simulation Matrix and Metrics

A base set of runs was conducted for each conceptual model, consisting of 2 million randomized parameter sets from the selected sample space. These initial runs were divided into parallel jobs across several processors, and then reassembled for further processing. Subsequent processing included a sequentially implemented 'base calibration' (representative set selection) based on fitness at each data point. This fitness was based on the absolute relative error (ARE), when compared with annual averages, using the simple relation found in Equation 3-3

$$\text{fitness} = \frac{1}{\text{ARE}} = \left| \frac{C_{\text{observed}}}{C_{\text{approximated}} - C_{\text{observed}}} \right| \tag{3-3}$$

The 'base calibration' selection was designed to capture essentially all runs that could be considered representative at all points. In addition, a narrower 'highest likelihood' surface was also selected, based on fitness of outlet prediction (Eq. 3-3), resulting in a final data set of the 200 highest fitness runs, or 0.01% of the initial runs (see Table 3.1). The resulting run sets share similar characteristics and sample size, suggesting that the selection criteria and initial run size were sufficient to avoid some potential sampling issues.

Table 3.1 Run Calibration and Subset Selection

	Absolute Relative Error at Outlet (%)			**Number of Runs**	**Percent of all Runs**
	DO	**BOD**	**NH_4**		
MIKE11					
Base Calibration	23.22	64.11	37.80	17358	0.86
High-Likelihood	5.32	37.38	6.20	200	0.01
QUAL2E					
Base Calibration	23.19	65.24	41.28	17254	0.86
High-Likelihood	5.32	36.76	6.14	200	0.01

3.2.6 Surface Response Metrics

The basic statistical measure used to describe the response surface in this paper is the coefficient of variation (sometimes termed relative variability), which expresses the dispersion (the standard deviation, σ) of a data set around its mean (μ) (cf. Equation 3-4).

$$c_v = \frac{\sigma}{\mu} \tag{3-4}$$

In this case the data set is the set of output parameter values within the set of representative models. The coefficient of variation, c_v, is useful because it allows the degree of variation in several series of data to be compared, and is therefore often used to assess relative volatility or risk. In addition, an aggregate metric is also used to help summarize and present results:

$$c_{v_{agg}} = \frac{c_{v_{DO}}}{3} + \frac{c_{v_{BOD}}}{3} + \frac{c_{v_{NH4}}}{3} \quad (3\text{-}5)$$

This metric can be thought of as an average equivalent to the coefficient of variation of the three constituents of interest considered here.

3.3 RESULTS AND CONCLUSIONS

3.3.1 RESULTS

The study area was divided into two main branches for discussion here, with an overlapping length of reach near the outlet (see Figure 3.1). As mentioned in the discussion of Equations 3-4 and 3-5, the aggregate coefficient of variation (ACV) metric is useful in comparing surface responses of each model. The ACVs for each conceptual model are presented in Figure 3.4 for both the main and secondary branch.

Figure 3.2 portrays the change in response surface throughout the reach network for each conceptual model. In this way, information on the spatial change of the uncertainty 'cloud' of modeled water quality constituents is presented. Several interesting characteristics are suggested from this initial plot. Firstly, although the MIKE11 response surface is marginally narrower (suggesting lower uncertainty in simulation results), both models appear to behave very similarly near the outlet. Conversely, the models differ significantly in their surface responses over the tributary branches regions.

To some extent this change is to be expected. The water quality calibration points shown in Figure 3.1 are not distributed evenly throughout the watershed. Information from calibration points constrain the model set deemed to be representative and therefore tends to narrow the uncertainty cloud in the region. Though both highlighted branches have a calibration point directly in their lengths, several tributaries of the primary branch (in the north) also pass through calibration points. In this way, additional information is 'flowing' (with the literal water flow) from these tributary reaches into the principal branch. This concept of information (or data) 'flow' is important in interpreting the subsequent model response.

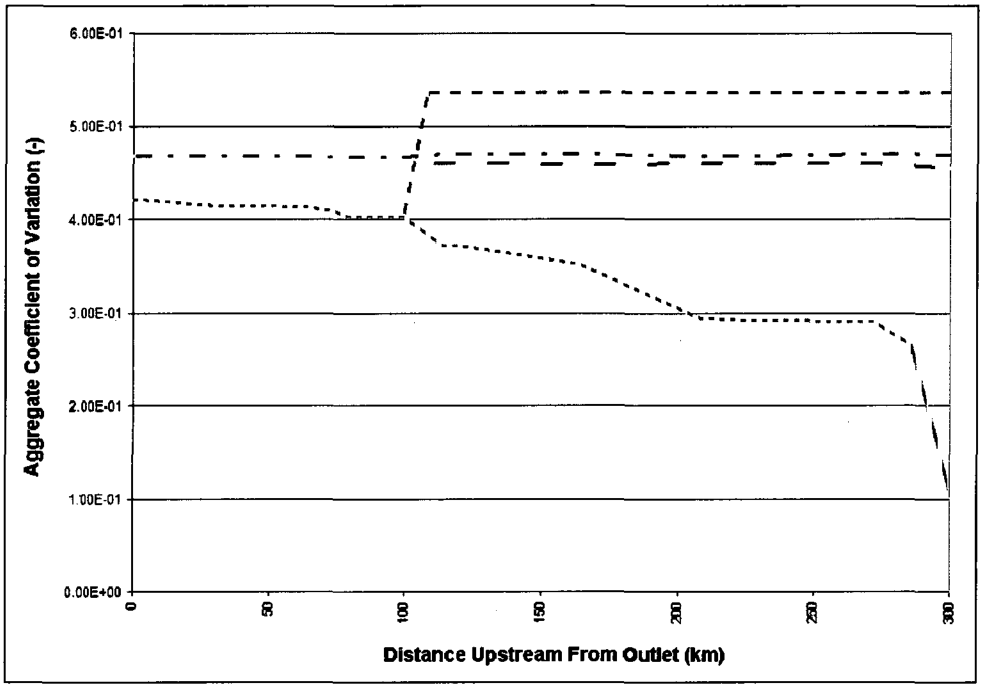


Figure 3.2: Base Calibration Surface Response of MIKE11 (in Orange) and QUAL2E (in Green) conceptual models. Darker lines indicate secondary branches for both models, as defined in Figure 3,1.

Both branches in the QUAL2E model appear to have similar responses to the outlet region, with a relatively similar, steady ACV in each branch. In this base calibration response surface the first branch appears to have a marginally smaller 'spread' than the second one, with a slight rise in uncertainty in each branch as the model moves upstream (away from data inflows). As the two branches mix (near the 100 km mark), the ACV narrows marginally further, suggesting that both branches are contributing to reducing the combined uncertainty, with data and simulation result flows from the second branch supporting the first.

The MIKE11 model appears to respond quite differently in several respects. Firstly, while the ACV near the outlet is similar (in magnitude and stability) to that of the QUAL2E model, there is a considerable difference in the ACV of each main branch upstream of the mixing point. The main branch, with relatively more information, has a much lower ACV than is found at the outlet, and also a much larger variation within the branch itself than was noted in the QUAL2E simulation results. Conversely, the second branch has a larger ACV than is found at the outlet or in the first branch. Also interesting is the comparison in the mixing: though the primary branch accounts for only about 30% more literal water flow than the secondary, the mixed ACV tends decidedly towards the main branch (containing a larger majority of 'data flow'). Unlike the QUAL2E simulation however, the complementary information in the secondary branch does not appear to be contributing to a reduction of the main branch ACV near the outlet.

These differences between conceptual models are a product of several factors. As mentioned earlier, while the calibration and results presented are limited to considering the BOD, DO and NH_4 modeled by the MIKE11 model, the QUAL2E model is also tracking several additional state variables (e.g., phosphorus, algal biomass), and is more parameterized. These 'hidden' conceptual model components can act somewhat as constraining buffers to rapid change, adding some measure of uncertainty-inertia to the QUAL2E simulation results.

A second response surface was also examined, and is shown in Figure 3.3. This reflects a subset of the previous base calibration result set, selected at the outlet from those runs with the highest fitness. This high-likelihood set would perhaps be suitable for management decision making tasks.

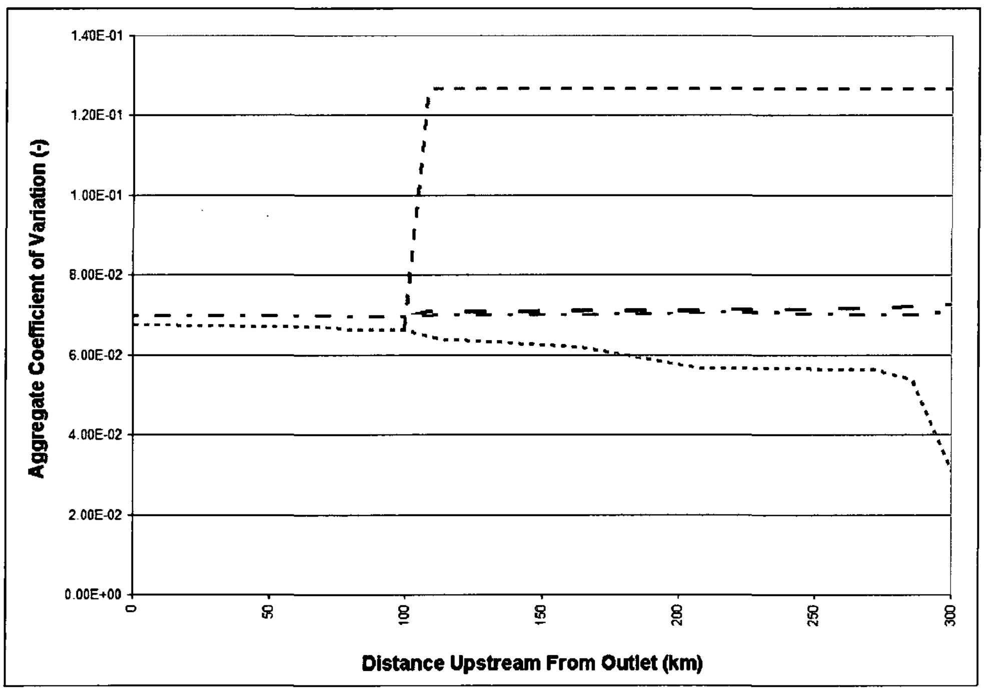


Figure 3.3: High-Likelihood Surface Response of MIKE11 (in Orange) and QUAL2E (in Green) conceptual models. Darker lines indicate secondary branches for both models, as defined in Figure 3,1.

An examination of these results shows essentially the same overall trends as the base calibration uncertainty analysis. Indeed, while the uncertainty cloud spread, as measured by the

ACV, is more narrow for the high likelihood subset (note the change in y-axis scale), both conceptual models still behave similarly towards the outlet and quite differently in the main branches. However, two significant differences are still apparent. The MIKE11 secondary branch surface analysis still leads to a larger ACV than the primary branch, however the difference between the two has been substantially narrowed, and the maximum MIKE11 ACV is now much closer to the maximum QUAL2E ACV in the main branch. The QUAL2E secondary branch has also gained in confidence, and both primary and secondary branches now show roughly equal performance at all locations (cf. Figure 3.2). Taken together, these behaviours help the modeler (and decision maker) to understand how the high-likelihood condition is altering the surface response. In this case the subset is being selected primarily from runs with a narrower range of water quality constituent results in the secondary branch.

The question of relative predictive performance of each base calibration set arises naturally. Indeed, of what use is a narrower response surface in a model if the ARE is noticeably higher? The run summary presented in Table 3.1 addresses this concern and shows that the difference lies not so much in the prediction quality as in the uncertainty surface itself.

In addition to spatial response, the temporal surface response was also examined. This was accomplished by comparing water quality model simulation results from the high-likelihood set (calibrated on an annual basis at the outlet) on a month-by-month basis with observed data. Results are shown as response extents, consisting of the upper and lower 95% bounds of representative model simulation outputs, and means in Figure 3.4.

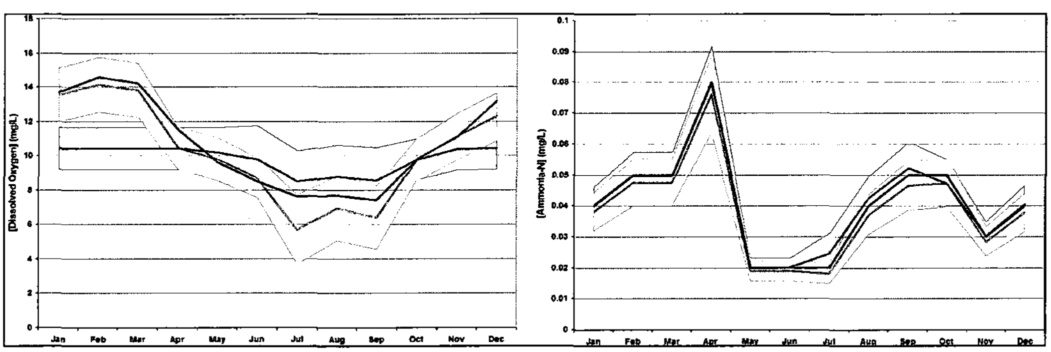


Figure 3.4: High-likelihood surface response (95% bounds) at outlet of MIKE11 (in Orange) and QUAL2E (in Green) conceptual models calibrated on an annual basis. Blue line indicates observed data. Solid lines show mean of representative models.

It should once again be emphasized that the calibration (and selection) was done on an annual basis, so that these plots in fact show data response under 12 flow regimes different to those in the calibration/selection set.

The analogy to the spatial results is striking, particularly in the DO plot. While the ACV of the MIKE11 tends to be much better in flow regimes similar to the annual calibration conditions (i.e. high flows), the width of cloud varies greatly from month to month. Summer conditions contribute substantially less to the 'average' conditions, and are less well represented. The MIKE11 cloud as a whole also appears to track the seasonal changes in the data quite well, as can be seen by following the cloud mean. Conversely, the QUAL2E once again shows signs of model inertia – it tends to reflect the average conditions rather than move to match the changing data. The ACV (cloud width) is again steadier in the QUAL2E model that in the MIKE11 representation.

3.3.2 Conclusions

The suggested methodology can be used to test conceptual model validity for specific applications. The results of this study will help users select and assess models for varied problems, and refine appropriate data collection and monitoring schemes. A common theme that emerges from the observed results is the importance in understanding the response characteristics. As an example, in our chosen case study, an annually calibrated stochastic MIKE11 model might be deemed useful for monthly simulation. The results here suggest that a similarly calibrated QUAL2E model could be decidedly less suitable, depending on the type of problem addressed. Additionally, while both models appear to have approximately the same predictive ability for a given set of calibration criteria, the MIKE11 model appears far more sensitive to data availability. At least in this study, the MIKE11 model response changed greatly depending on the proximity to calibration points, while the QUAL2E model tended to improve less rapidly near high data locations, but also to degrade less away from such locations. This finding has important ramifications for the development of data sampling schemes and model selection in sparse vs. dense data situations. The proposed use of GLUE for selection of a preferred conceptual model structure is a novel addition to the field of water quality modeling.

3.4 References

Beven, K.J. and Binley, A.M. (1992) The future of distributed models: model calibration and predictive uncertainty. Hydrological Processes, 6, 279-298.

Beven, K. J. (2001) Calibration, validation and equifinality in hydrological modeling. In M.G. Anderson and P.D. Bates, eds, Validation in Hydrological Modeling. John Wiley and Sons, Chichester, UK.

Bowie G.L., Mills W.B., Porcella D.B., Campbell C.L., Pagenkopf J.R., Rupp G.L., Johnson K.M., Chan P.W.H., Gherini S.A., and Chamberlin C.E. (1985) Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling (Second Edition). Report EPA/600/3-85/040, US EPA, Athens, GA.

Brown L.C. and Barnwell T.O. (1987) The enhanced stream water quality models QUAL2E and QUAL2E-UNCAS: Documentation and User Manual. Report EPA/600/3-87/007, US EPA, Athens, GA.

DHI (1992). MIKE 11 User Manual. Danish Hydraulic Institute, Denmark.

Duda, P.B., Kittle, J.L., Gray, M.H., Hummel, P.R., Kinerson, R.S., Cocca, P., Wells, D., Wellman, M., Partington, E., and MacWilliams L. 2003. BASINS 4.0 - Flexible integration of components and data for watershed assessment and TMDL development. WEF TMDL 2003, November 16-19, 2003. Chicago, IL. WEF Specialty Conference Proceedings on CD-ROM.

McCutcheon, S.C. (1989). Water Quality Modeling: Volume I, Transport and Surface Exchange in Rivers, CRC Press, Boca Raton, FL.

Parker, G.T., Droste, R.L. and Kennedy, K.J. (2008) Modeling the effect of agricultural best management practices on water quality under various climatic scenarios. J. of Env. Eng. and Sci. 7(1), 9-19.

Rauch W., Henze M., Koncsos L., Reichert P., Shanahan P., Somlyódy L., and Vanrolleghem P.A. (1998) River water quality modeling: I. State of the art. Wat. Sci. Tech. 38(11), 237-244.

Rode, M., Suhr, U., and Wriedt, G. (2007) Multi-objective calibration of a river water quality model—Information content of calibration data. Ecological Modeling, 204(1-2), 129-142.

Streeter, H.W. and Phelps, E.B. (1925) A study of the pollution and natural purification of the Ohio river, III. Factors concernedin the phenomena of oxidation and reaeration, US Public Health Service, Bull. 146.

Tannenbaum, T., Wright, D., Miller, K., and Livny, M. (2002) "Condor - A Distributed Job Scheduler", in Thomas Sterling, editor, Beowulf Cluster Computing with Linux, The MIT Press. ISBN: 0-262-69274-0.

Thomas, H.A. (1948). Pollution load capacity of streams. Water Sewage Works, 95(11), 409-413.

US EPA (2008). Chesapeake Bay Phase 5 Community Watershed Model. In preparation EPA XXX-X-XX-008 Chesapeake Bay Program Office, Annapolis, MD.

CHAPTER 4

STOCHASTIC CALIBRATION OF RIVERINE WATER QUALITY MODELS

4.0 CHAPTER OVERVIEW

This chapter was accepted for presentation at the Water Environment Federation's 81st Annual Technical Exhibition and publication in the proceedings thereof. It is also under consideration for publication in *Water Environment Research.*

ABSTRACT

Though commonly used, the suitability of deterministic calibration criteria for stochastic model calibration and uncertainty analysis is unclear. The approach of this paper is to examine the suitability, relative benefits and substantial disadvantages of 'deterministic-optimization' approaches in stochastic contexts. Three alternate calibration strategies suitable for modeling water quality under uncertainty are proposed and then demonstrated. The findings suggest potential improvements be made to current calibration paradigms.

Absolute relative error (ARE) calibration strategies, and several special applications thereof, were found to match or exceed root mean square error (RMSE) calibration strategies in terms of overall performance, with the enhancement of superior model surface response characteristics. Additionally, applying more stringent ARE criteria were found to improve stochastic calibration response when contrasted with increasing RMSE threshold criteria. Several qualitative benefits of ARE and related metrics were also shown. Since many environmental systems, and almost all water quality models, are subject to substantial uncertainty, approaches such as those proposed hold substantial, widely applicable, benefits.

Listed keywords were: Water Quality, Model, Uncertainty, Calibration, Stochastic.

4.1 INTRODUCTION

4.1.1 BACKGROUND

Watershed-level modeling has become an essential tool in planning and managing environmental risks and the relationship between pollutant sources and water bodies, and an approved Total Maximum Daily Loading (TMDL) evaluation has become a de facto requisite for assistance funding. Water quality models are generally deployed in such cases to provide insight on source assessments and their impacts on water quality targets as well as the consequences of varied management scenarios (e.g., Parker et al., 2008a).

Model parameters are adjusted to fit one or several years of reference data. It is well understood for deterministic models that the chosen 'calibrated' parameter set, and thus simulation results, depends on the reference data and calibration strategy used. Since similar results are often achieved with different approaches, the issue of which parameter set should be used frequently arises. This phenomenon is known as model equifinality.

Stochastic models attempt to mitigate these issues to some degree by representing modeled phenomena as a distribution of possible outcomes. A common implementation is to perturb input parameters, through use of Monte-Carlo simulations for example, and assess likely outcomes from the results.

4.1.2 Water Quality Modeling

Water quality models have evolved from the early dissolved oxygen (DO) supply and biochemical oxygen demand (BOD) considerations of Streeter and Phelps (1925), to modern incarnations in a variety of computer codes which are used to support analysis of problems such as pollution control and land-use and waste-loading planning. Modern codes such as QUAL2E (Brown and Barnwell, 1987) go beyond the oxygen balance and can consider nitrogen, phosphorus and other cycles. As models become more sophisticated, the parameter sets required to calibrate a code for a given application become larger and more complex (Bowie, 1985). The resulting (parameter) uncertainty is a major consideration for the use of modeling results.

While some models have been expressly developed for stochastic use, such models tend to be more narrowly applicable, and the vast majority of models in regular use remain deterministic models. The EPA, for instance, recommends use of QUAL2E (and the derivative QUAL2K) in their Better Assessment Science Integrating Point & Nonpoint Sources (BASINS) framework, designed for use by regional, state, and local agencies in examining management alternatives for watersheds (Duda et al., 2003). Sampling methods such as Monte-Carlo simulation are often used to account for (parameter) uncertainties in such deterministic-based models.

4.1.3 Model Calibration

The Root Mean Square Error (RMSE) is commonly used (along with related metrics) for deterministic model optimization. The advantages of RMSE for this type of problem are several-fold. It is an easily computed and interpreted statistic with the same units at the modeled parameter. Two or more statistical models can be readily compared using the RMSE as a measure of goodness of fit, where the smallest RMSE is interpreted as the 'better' model. A readily identifiable disadvantage to the RMSE for deterministic applications is the effect of localized large errors (even in small spatial, temporal or parameter regions).

The wide use and acceptance of RMSE for these types of problems has led to frequent use of the same methods for stochastic evaluations - either explicitly, or implicitly via post-calibration Monte-Carlo analysis (e.g., Marsili-Libelli and Giusetti, 2008; Rode et al., 2007; van Grievsen and Meixner, 2007). More formally, RMSE and related measures have found ample applications (and justification) in Bayesian approaches, although they may not always be the superior alternative or, indeed, appropriate (see e.g., Romanowicz and Beven, 2006; Ojeda et al., 2007).

4.2 METHODOLOGY

4.2.1 STUDY AREA AND DATA

The Potomac Watershed stretches across approximately 38 000 km^2, of the Eastern US. The Potomac River itself covers roughly 620 km from Fairfax Stone in West Virginia to Point Lookout in Maryland. The average river flow at the Washington, DC location is about 310 m^3/s, with minimum and maximum recorded flows of 17 m^3/s (September 1966) and 12000 m^3/s (March, 1936), respectively. The watershed flows into Chesapeake Bay, becoming tidal where the river crosses the Fall Line into the Coastal Plain province. Downstream from here, the water becomes increasingly brackish with a gradual increase in salinity. This study limits itself to the purely freshwater and non-tidal portion of the Potomac (shown in Figure 4.1).

From 1991 to 1996, the US Geological Survey's (USGS) National Water Quality Assessment (NAWQA) program began extensive work in the basin to monitor surface and ground water quality and ecology. That dataset is used here, and draws on over 50 USGS stations to provide information on stream flow quantity for the year 1993. These data are available at up to daily timesteps for individual stations. Water quality data are available at 5 'integrator' and 5 'indicator' stations on a monthly basis. Point Sources loading the river system were identified from US EPA (2007).

4.2.2 WATER QUALITY SIMULATION

Typical constituents of interest in water quality models include DO, nutrients (e.g., nitrogen, phosphorus), and toxics (e.g., pesticides). For this paper a conversion kinetics model based on the widely used QUAL2E code (see Brown and Barnell, 1987) was used. An extensive review of water quality modeling approaches in beyond the scope of this outline, (but can be found in e.g., Rauch et al., 1998 or Bowie et al., 1985).

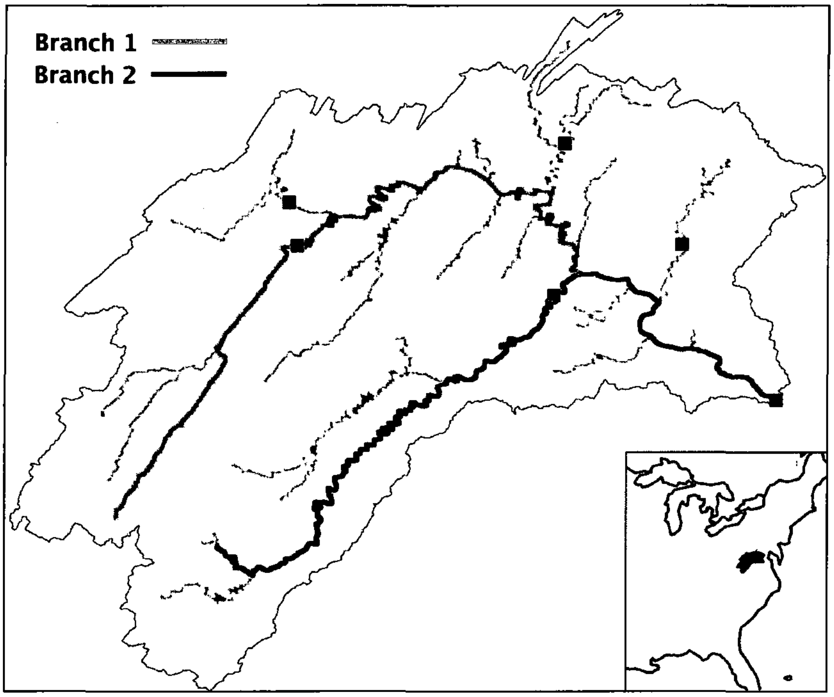


Figure 4.1: Non-tidal Potomac River Watershed (location shown in inset). Red squares indicate water quality calibration points.

Output of the model was compared for stochastic simulation of DO, BOD and ammonia-N (NH_4). Initial ranges for water quality model parameters are estimated from literature values (Bowie et al., 1985). Spatial-varied inputs (e.g., water loadings) for the river system were extracted from the flow gauging station and point source data sets. Flow differences between two sequential stations not explained by one or several point sources were considered to be attributable to baseflow and surface runoff components, distributed evenly over the river length between the two stations. Representative constituent concentrations for these flow components were considered as a further set of parameters to be varied across runs. The candidate range of these model parameters was based on seasonal averages at indicator stations. The addition of this component, essentially a weak NPS model, is useful but may lead to additional challenges (not the least of which is computational), which is likely why others (e.g., Rode, 2007) have preferred to use a point-source only description. Such an approach can also be considered a special case of that applied here, with the constituent contribution parameter set to a fixed value (0).

4.2.3 Model Response Evaluation

For each conceptual model, the representative model set was then derived. The problem can be viewed as an inverse modeling exercise. It is usual to pose such problems in terms of the observation equation:

$$y_t = g(u_0,...,u_1,\xi o,...,\xi_t,\zeta_t,\theta,t) \qquad (4\text{-}1)$$

In Equation 4-1 terms include the model output (yt) the model inputs (ut), errors associated with model inputs ( ), measurement error ( ), and a vector of model parameters ( ) for each point t. The problem to be solved is the retrieval of the parameter set θ={pi}i=1,...,N and particularly the associated posterior distribution p(θ | y), given N stream data observations y = {siO}i=1,...,N. When p(θ) is defined, Bayesian approaches such as forward (likelihood) models (e.g., the sequential Bayes algorithm) or direct local inverse models are well-suited for the inference of p(θ | y). In more complex cases there may not always be a well-defined posterior parameter distribution [i.e., p(θ)], which is the set of parameters that produce representative models.

A Generalized Likelihood Uncertainty Estimation (GLUE) algorithm, as outlined by Beven and Binley (1992), was used to identify which parameter sets provide an adequate representation of the river system water chemistry. The GLUE framework offers several advantages for these types of problems, as it allows for the very complex likelihood surfaces expected with such parameter interactions. In this technique, the focus is on estimating posterior distributions for predicted variables directly from the outputs of a set of representative models, rather than from a model and an additive residual model. The resulting set of models is further constrained by the calibration data and criteria (cf. Beven, 2001 and Rode et al., 2007), and contains information on the simulation output variability for all representative input sets. The representative set can be viewed as the range of water quality models that conform to the calibration criteria, which in turn are constrained by the specific dataset used. Stated another way, this set contains information on the water quality model output variability for all representative input parameter sets. Furthermore, individual representative models can be weighted according to the degree of belief (or likelihood) in each model. Thus, by making an assumption on the model output distribution structure, a measure of output 'uncertainty' at each location in the riverine system is obtained.

4.2.4 Stochastic Response Model Toolkit

With the base models and simulation strategy decided upon, a toolset was developed to facilitate the model response evaluation methodology. A FORTRAN and script implementation of the strategy detailed above was developed into a water quality inverse modeling toolkit (dubbed 'qualIT' for reference). The toolkit consists of 3 major components. The first of these is the run manager, which is responsible for tracking seed numbers and conditions at each run number and generating suitable parameter sets for the subsequent modules. The simulation manager calls the base water quality model, and passes the generated parameter sets for execution. The output processor produces a manageable digest of run results returned by the conceptual model.

This modular structure is advantageous in that it allows for complete reproducibility of conditions at a given run number. This, in turn, permits efficient use of processing resources for both serial (e.g., calibration at new data locations) and parallel (e.g., base run generation) simulations tasks. Processing was done on an ad hoc 'CONDOR' cluster (cf. Tannenbaum et al., 2002), consisting of up to 5 modern desktop computers (subject to availability) totaling 8 processors at an approximate total of 16 billion cycles per second, and managed by the custom built 'HPC_monitor' package.

4.2.5 Simulation Matrix and Metrics

A base set of runs was conducted for each conceptual model, consisting of 2 million randomized parameter sets from the selected sample space. These initial runs were divided into parallel jobs across several processors, and then reassembled for further processing. Subsequent processing included calibration based on fitness at each data point.

Four calibration strategies were defined then tested for stochastic performance in the sparse-data water quality problem (Table 4.1). The first criterion is based on a 'deterministic-optimization' approach, while the remaining criteria used metrics designed to be advantageous in stochastic calibration. Simulations were compared on both a seasonal and annual basis at locations throughout the watershed.

As described in the next section, two calibration levels were considered in the run matrix. The first, 'base calibration' level (ARE and RMSEa) was designed to capture essentially all runs that could be considered representative at all points. A narrower surface response, more in line with typical predictive applications, was also examined (in the WRE and RMSEb calibrations).

Table 4.1. Calibration Criteria Examined

Descriptive Title	***Abbreviated Title***
Root Mean Squared Error Method	*(RMSE)*
Absolute Relative Error Method	*(ARE)*
Weighted Relative Error Method	*(WRE)*
Stochastic Exceedance Calibration Strategy	*(SECS)*

4.2.6 RMSE

The RMSE is calculated according to the following equation:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(c_{model_n} - c_{data_n})^2}{n}} \qquad (4\text{-}2)$$

where c_{datan} and c_{modeln} are the nth observed and simulated constituent concentration, respectively. It should be emphasized that the output for a given model run must be in hand at all space-time locations for which calibration data are available in order to calculate the RMSE.

Problems with actual use of RMSE for surface response evaluation quickly become apparent in the development of multi-objective calibration. It is well understood in a deterministic context that the RMSE is very sensitive to large values and outliers. The same problem manifests itself differently in stochastic contexts, where the inverse of the RMSE is often used as a likelihood measure to weigh model significance. In such instances, even very non-representative models may continue to influence the aggregate surface response. This issue has been raised in the literature (e.g., Beven, 2005), and was supported by preparatory analysis in this study.

In an evaluation of calibration criteria, this issue becomes particularly important, as the problem centers around identifying the surface response of multiple representative models. Therefore, in this context, the approach was to use a binary likelihood function that considers models as either acceptable (representative) or non-acceptable. Therefore, all realizations were passed through a filter that excluded all data with an ARE larger than 2.0 at any location or timeframe (considered 'unreasonable') prior to being considered in the RMSE analysis. The surface response was then analyzed for the 10% of models with the lowest calculated RMSE (base calibration RMSEa) and then again for the 'best' 5% of all eligible models (RMSEb).

While the exclusion of models failing a basic reasonableness test may arguably make for a less pure RMSE surface examined in this analysis, the majority of excluded models will of course have RMSE values higher than the top 10% (itself a somewhat arbitrary distinction) of models in the selected region. It is the belief of the author that this decision is in line with the reasonable application of RMSE as a calibration criterion, since these extreme outliers are (and indeed, should be) in practice excluded from consideration anyways, in quite varied ways.

4.2.7 Absolute Relative Error (ARE)

The ARE calibrations was based on the absolute error relative to data, when compared with annual and seasonal averages, using the simple relation found in Equation 4-3.

$$ARE = \left| \frac{(c_{model} - c_{data})}{c_{data}} \right| \tag{4-3}$$

One challenge with specifying ARE criteria is specifying conditions that are sufficient to suggest model suitability everywhere without excluding models that may perform very well in significant locations but only moderately well in less significant locations. The structure of the ARE allows us to readily handle such constraints however. The ARE base calibration considered all models with an ARE below 0.5 for both DO and NH_4, but a lesser condition of 1.0 for BOD.

4.2.7 Weighted Relative Error (WRE)

The WRE criterion seeks to improve upon the ARE, and is really a special case thereof. In this calibration set, the goal was to generate a surface that may be useful for predictive modeling. As noted, a disadvantage of the ARE is that it may exclude 'good' models because of relatively poor performance in relatively unimportant areas. To address this, the ARE criteria can be adjusted in accordance to a desired degree of tolerance of model performance in a spatial-temporal calibration. The WRE implementation used in this analysis considered all runs that had an ARE at the outlet of 0.25 for DO and NH_4 and 0.5 for BOD, requirements roughly twice as stringent as those in the 'base' calibration. Relative error thresholds at other locations were derived in inverse relation to flow:

$$WRE_{x,y_t} = ARE_{outlet_t} \bullet \frac{Q_{outlet_t}}{Q_{x,y_t}} \quad (4\text{-}4)$$

This strategy permits model candidates that perform well at high flow (Q) locations (x, y closer to the outlet) or periods (t) to be deemed acceptable even with lesser performance at low flow locations.

4.2.8 Stochastic Exceedance Calibration Strategy (SECS)

The SECS was conceived as an additional potential improvement on the ARE/WRE calibrations. In several applications, it is useful to be able to provide conservative calibrations that accurately predict constituents when water quality conditions become 'poor', at the expense of some confidence in model endpoints under 'good' conditions. The SECS, therefore, is a contextual calibration strategy. This type of simulation can be very useful for a variety of management issues, as well as problems considering, for example, environmental stressors on aquatic life (as in Parker, 2004). In the analysis presented here, the SECS calibration was conducted as a version of the WRE calibration that further treated parameter sets which overestimated DO (favorable to aquatic life) or underestimated NH_4 (a potential stressor) as non-representative.

4.2.9 Surface Response Metrics

The basic statistical measure used to describe the response surface in this paper is the coefficient of variation (sometimes termed relative variability), which expresses the dispersion of a data set around its mean (cf. Equation 4-5).

$$c_v = \frac{\sigma}{\mu} \quad (4\text{-}5)$$

The coefficient of variation is useful because it allows the degree of variation in several series of data to be compared, and is therefore often used to assess relative volatility or risk. In addition, an aggregate metric is also used to help summarize and present results:

$$c_{v_{agg}} = \frac{c_{v_{DO}}}{3} + \frac{c_{v_{BOD}}}{3} + \frac{c_{v_{NH4}}}{3} \quad (4\text{-}6)$$

This metric can be thought of as an average equivalent to the coefficient of variation of the three constituents of interest considered here.

4.3 RESULTS

4.3.1 BASE CALIBRATIONS

The study area was divided into two main branches for discussion here, with an overlapping length of reach near the outlet (as shown in Figure 4.1). As mentioned in the discussion of Equations 4-5 and 4-6, the aggregate coefficient of variation (ACV) metric is useful in comparing surface responses of each model. The ACV for the RMSEa and ARE base calibrations is presented in Figure 4.2 for both the main and secondary branch.

This plot can be seen as portraying the change in surface response throughout the reach network for each remaining set of representative models. In this way, information on the spatial change of the uncertainty 'cloud' of modeled water quality constituents is presented. Several interesting characteristics are suggested from this initial plot.

Both ARE and RMSEa calibrations appear to have similar responses, with a relatively steady ACV near the outlet region. Upstream of the mixing point, the simulation results in each branch diverge as the inflow of calibration data in one branch lessens, and the variation in surface response therefore 'spreads'. The major observable difference between the two strategies in this plot is that in the RMSEa case, the main branch (with approximately 30% more flow than the secondary branch) comprises the majority of the variation upstream of the mixing point, while for the ARE calibration the opposite is true. As the two branches mix (near the 100 km mark), information (data and calibration results) flows from each upstream branch into the downstream reach. It also evident that, for these base calibrations, the RMSEa model has a smaller ACV in all locations than the ARE scenario.

The ACV is, as detailed in Equation 4-6, an aggregate metric. While useful for examining broad changes across spatial or temporal dimensions, it is also instructive to examine individual coefficients of variation at a few locations, as in Figure 4.3.

These results inform the observer of several behaviours in the calibrated model response, and illustrate some greater underlying differences between approaches. Both models have similar coefficients of variation for DO, but handle the other constituents quite differently. A predictable behaviour is the emphasis placed on large values (and the associated constituents) by the RMSEa calibration, which appears to be optimizing BOD, DO and NH_4 in turn. This is seen by the fact that the c_v is lower for BOD, which suggests that all representative models are similar with respect to BOD. The ARE scenario is able to place less emphasis on the BOD parameter and seeks instead to improve DO and NH_4 components. Additionally, the extremely narrow variation in the NH_4 constituents suggests the ARE model is being limited by this calibration condition, at both outlet and headwaters locations. This sort of information is useful in identifying, for example, poor data conditions, or inadequate calibration requirements for a given conceptual model.

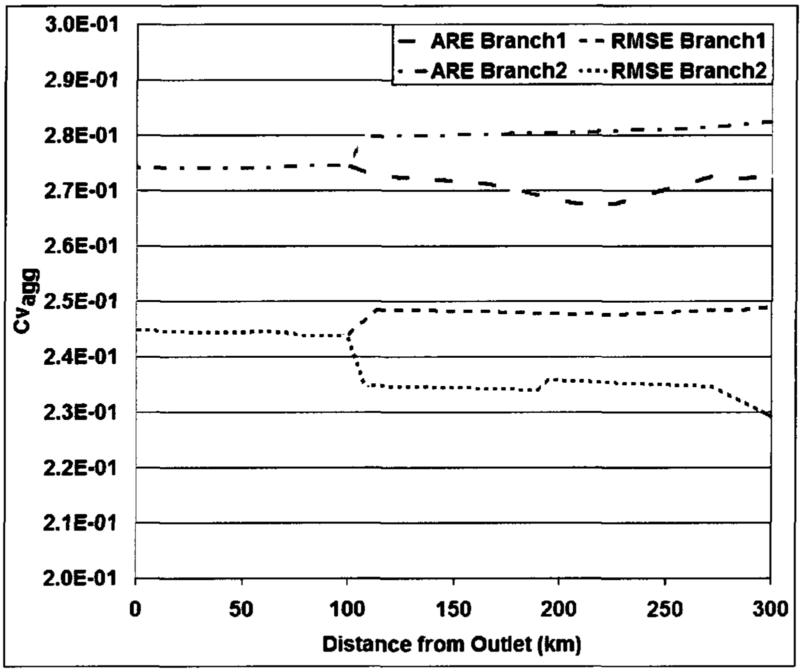


Figure 4.2: ARE and RMSEa calibration scenario ACVs versus position

The effect of the difference in emphasis on BOD can also be examined in a spatial sense, as in Figure 4.4, where the BOD component has been removed from the ACV calculation. The situation in Figure 4.2 is dramatically reversed (note the difference in scale), with the aggregate surface response for DO and NH_4 comparison now performing much better in the ARE scenario.

4.3.2 Improved Calibrations

Secondary, tighter response surfaces were also examined, as derived from the base calibration strategies. These were the WRE and RMSEb simulations shown in Figure 4.5.

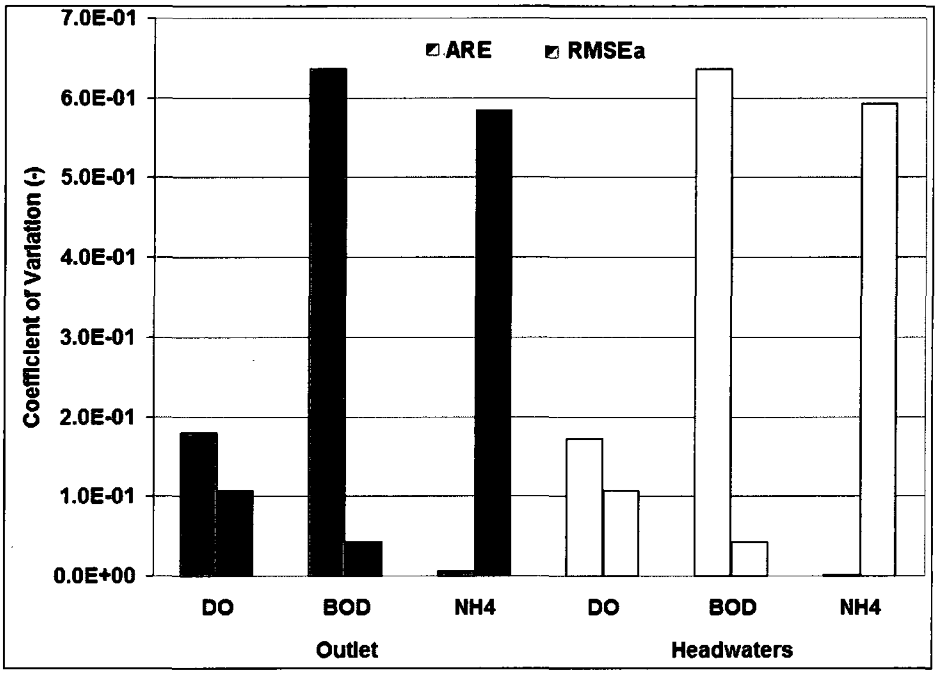


Figure 4.3: Separate CVs in ARE and RMSEa surface response

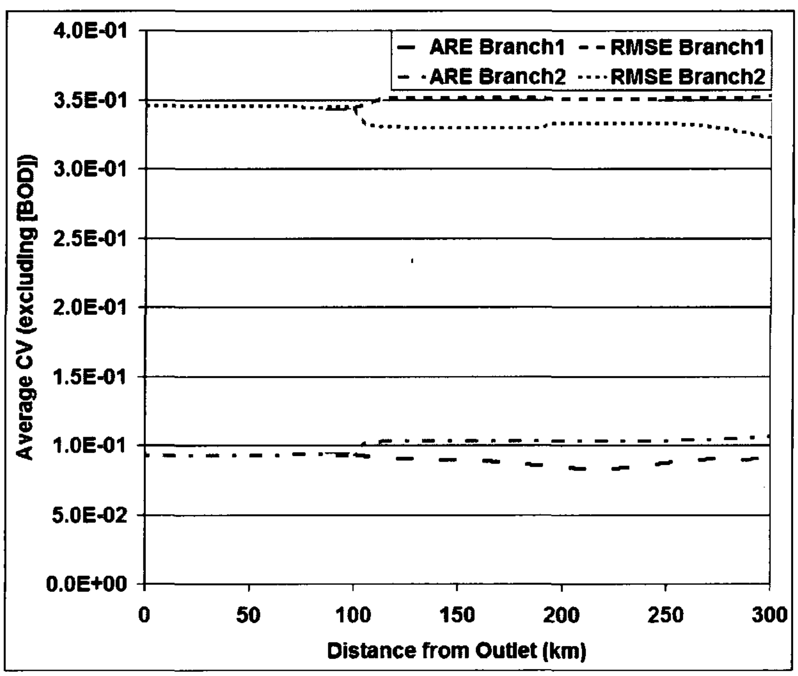


Figure 4.4: ARE and RMSEa (base) calibrated model ACVs (excluding BOD) versus position

Each result reflects a subset of the previous base calibration result sets (the ARE and RMSEa, respectively) which seeks to find a 'high-likelihood' calibrated parameter set yielding improved coefficients of variation. This set is illustrative of the types of calibration improvements that may be useful for management or decision making tasks, given a suitable conceptual model. The ACV change with position for the RMSEb is very similar to that of the base, RMSEa, calibration. The WRE ACV substantially outperforms not only the base ARE scenario, but also when compared to either RMSE calibration. Additionally, both branches perform approximately equally in the WRE scenario.

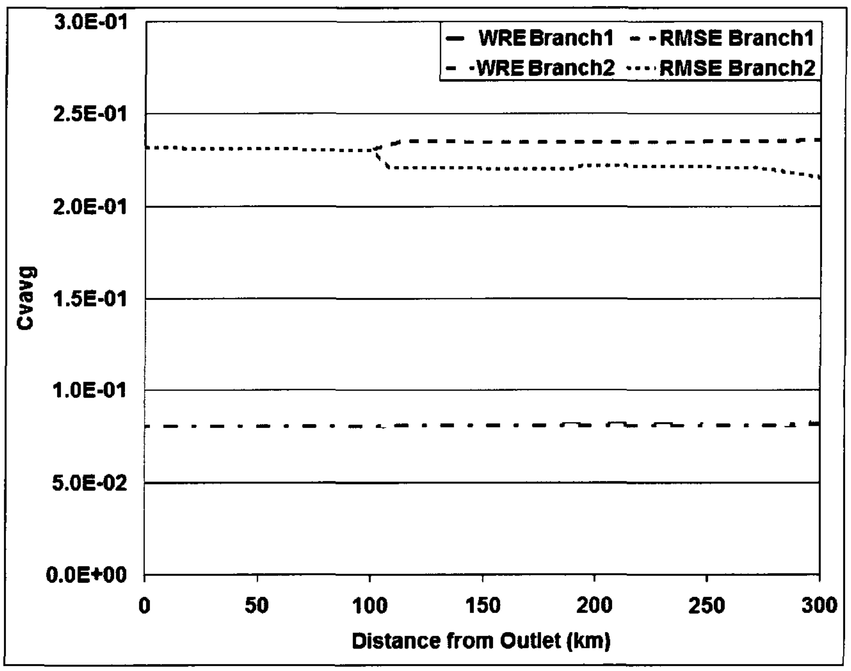


Figure 4.5: WRE and RMSE (high-fitness) calibrated model ACVs (excluding BOD) versus position

In addition to spatial response, the temporal surface response was also examined. This was accomplished by comparing water quality model simulation results from the high-likelihood set on a month-by-month basis with observed data. Results are shown as response 'cloud' extents and means in Figure 4.6.

While the WRE condition has indeed narrowed the model response surface dramatically, and in fact shifted the cloud considerably, the RMSEb shows little improvement over the base calibration, with only a slight narrowing. The difference in cloud shape between the ARE and WRE models, in contrast to the two RMSE cases, belie the predominant selection regions for the added constraints. The surface from the WRE calibration matches expected behaviour, and shows higher variation in low flow regions (e.g., summer) than during high flow periods. The seasonal change in coefficient of variation components was also examined, as shown in Figure 4.7. Examination of these results reinforces the conclusion that the RMSE model has changed little, as it continues to suffer from a high NH_4 component in the ACV as identified in the discussion of Figure 4.3. As before, simultaneous calibration of the relatively large DO and BOD constituents is effectively reducing the importance of the NH_4 simulation. Only as the CV of the BOD increases important do improvements in the NH_4 surface become apparent, indicating possible representative model selection based on NH_4 simulation fitness. Conversely, the WRE model has improved considerably.

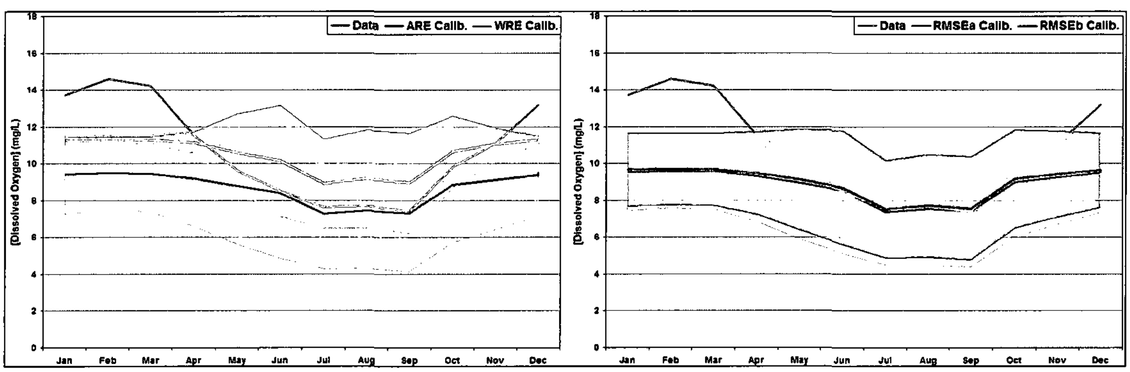


Figure 4.6: DO surface response (95%) for ARE, WRE, RMSEa and RMSEb calibrations. Solid lines indicate means of representative models.

4.3.3 SECS Results

The SECS calibration is a further refinement on the ARE/WRE calibrations that excludes parameters sets leading to overestimates of favorable conditions (e.g., DO) or underestimation of poor conditions (e.g., NH_4). Results for the latter are illustrative, and are shown in Figure 4.8.

As designed, the highlighted results in Figure 4.8 show a reduced subset of the WRE calibration which eliminates non-conservative predictions of NH_4 concentrations. Perhaps more interestingly, the SECS set also excludes models from the WRE criteria that are more conservative than itself in some locations (but non-conservative in others). The resulting surface response is narrowed, near many calibration points, on both the upper and lower bounds.

4.4 Discussion and Conclusion

The suggested methodology can be employed to examine the performance of a calibration strategy for a given conceptual model (or code). It should be emphasized that the calibration set and resulting surface response is also a function of the conceptual model structure itself (as examined in Parker et al., 2008b), as well as the data used for calibration. Some limitations and surface characteristics (e.g., DO under-prediction in Figure 4.6) may result from the conceptual model and data conditions themselves, and be common to all valid parameter sets.

Nevertheless, several important themes and concepts are illustrated in the results presented above.

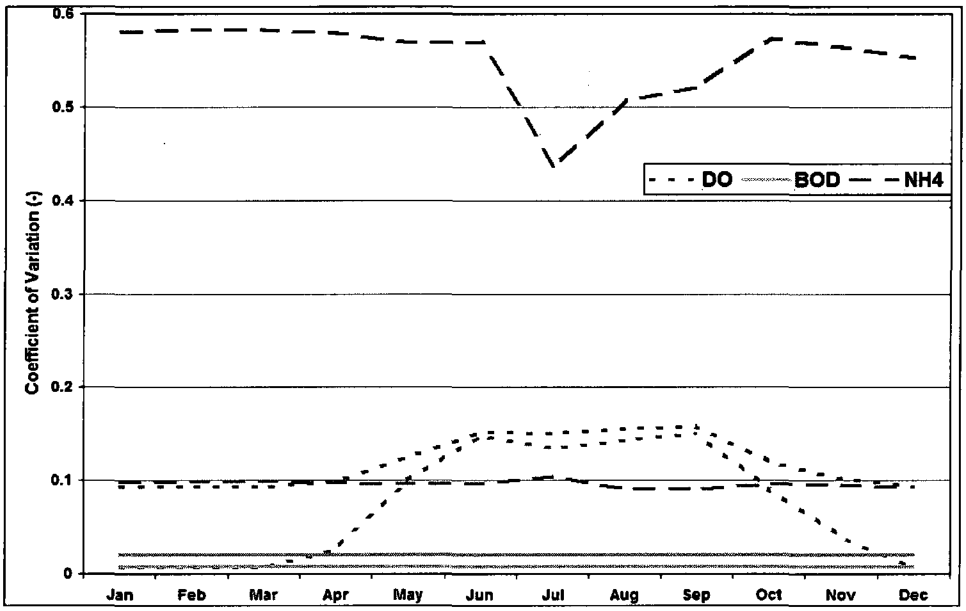


Figure 4.7: Coefficient of variation of DO, BOD and NH_4 response for WRE (green) and RMSEb (blue) calibrations

4.4.1 INTERPRETATION AND IMPLICATIONS

The difference in ACV between the two branches, shown in Figure 4.2, could be expected. Indeed, the water quality calibration points shown in Figure 4.1 are not distributed evenly throughout the watershed. Information from calibration points constrains the representative model set and therefore tends to narrow the uncertainty cloud in the region. Though both highlighted branches have a calibration point directly in their lengths, several tributaries of the primary branch (in the north) also pass through calibration points. In this way, additional information is 'flowing' (with the literal water flow) from these tributary reaches into the principal branch. This concept of information (or data) 'flow' is important in interpreting the subsequent model response. Interestingly, in the RMSEa calibration shown in Figure 4.2, the data-rich primary branch is contributing more uncertainty than the secondary branch for which less data are available. This is the opposite of the behaviour observed in the ARE case, and may indicate that the RMSEa is not making as efficient use of the available data. Instead, as shown in Figure 4.4, the RMSEa appears to be focused on optimizing the largest constituents.

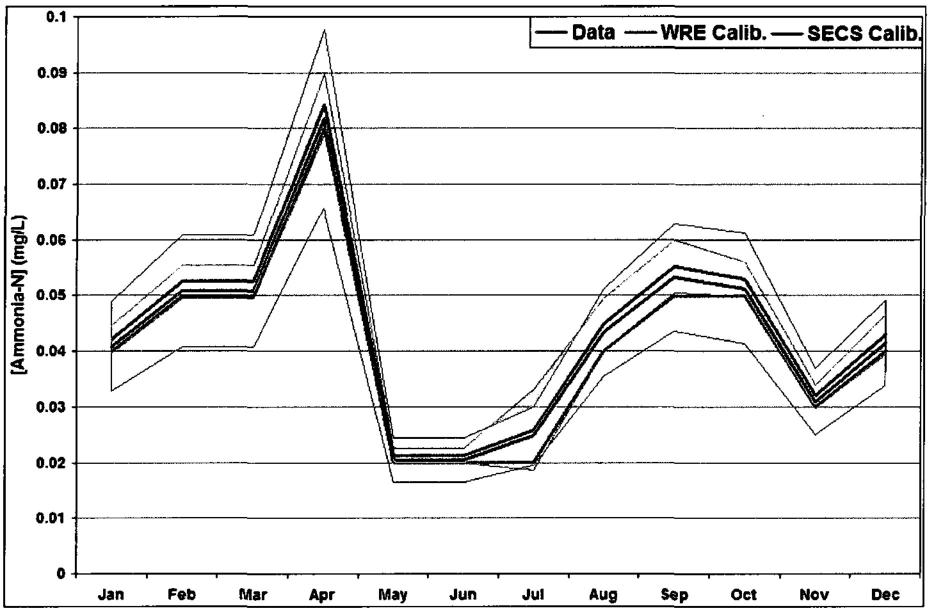


Figure 4.8: Seasonal NH_4 surface response (95%) for SECS and WRE calibrations. Solid lines show mean of representative models.

This highlights one advantage of the ARE approach, which can expressly allow for a lesser confidence requirement in some variables than others. Similar results could potentially be obtained with the RMSE approach through either assigning lesser weights to such variables in the mean calculation or normalizing values. The challenge then becomes assessing the suitability of weights (or normalization strategy), and accounting for these in subsequent model interpretation.

The comparison of WRE and RMSEb results is also significant, and illustrate one disadvantage of using a metric that effectively compresses information irreversibly, such as RMSE, for stochastic calibration in several dimensions, including time, space and also constituent nature. Indeed, while the parameter set for an ARE calibration criterion of 20% will, by definition, consist of individuals that are within 20% of observed data for calibrated conditions, it is difficult, perhaps impossible, to estimate what degree of confidence can be expected in a given RMSE-calibrated parameter space at any particular location or time, or for any constituent. This has important potential implication in predictive contexts, where it may be reasonable to assume a minimum local performance of ARE but not RMSE.

Additionally, optimization with RMSE consists of selecting candidates with a better aggregate measure. This in effect selects a subset of the previous parameter space, but this subset may not offer improvements in any tangible sense, and may be essentially identical. Additionally, the definition of 'better' is poorly defined in such cases, in contrast to the ARE/WRE definitions which explicitly state, and require, minimum performance at each data point. This limitation is evident even in the RMSE setup process, as some filter was needed to limit the effect of very non-representative models. If such models were not excluded, candidates with good fit to outlier or 'highly' weighted values (e.g., BOD) would further degrade results.

By contrast, the ARE performance can be progressively improved by refining the exclusion condition until the exclusion condition is so limiting that the number of representative candidates becomes effectively nil. This inability of the ARE to find satisfactory representative candidates is an important difference (an advantage!) when compared to the RMSE (even exceedingly poor models can be ranked based on RMSE), as it can identify conditions where available information and model structure are unsuitable to a desired confidence in prediction results, and should be revised.

The WRE is a further improvement that can be made to the ARE to address such failures, and the example deployment presented in this paper considers error weighted relative to flow as an optimization strategy for the watershed calibration, permitting relatively high prediction error in regions of low flow. This flow-based calibration is advantageous in that it still allows the calibrated model predictive requirements to be retrieved at any location and flow condition. Alternative potential weighting schemes could include precisely the inverse scheme (in some contexts, conditions during low flow may be most important), or a weight derived from data confidence (based perhaps on time-series variation, equipment or even observer records).

As discussed above (and shown in Figure 4.6), the ability of WRE optimization to select a subset based on additional requirements can lead to substantial changes in surface response when compared to the base calibration, and associated improvements in model performance. Additionally, contextual calibrations can be devised, such as that presented for the SECS scenario (Figure 4.8).

4.4.2 Further Considerations

Several additional, practical issues in the implementation of RMSE and ARE (and related) deserve additional comment, not only in view of model construction and setup, but also in terms of model maintenance and the injection of new data points into previously calibrated models.

An important difference between the proposed calibration criteria methods is that the non-RMSE methods can be applied sequentially. As an example, for the GLUE methodology as applied here, the RMSE calibration must consider every potential 'representative' (i.e., the entire inverse run set) model at each location and timeframe considered. This is because the best 10 or 20% (with lowest RMSE) of the model runs are considered representative, thus all runs must be stored prior to selecting the representative set. Practically, this means that an extremely large number of runs must be conducted (although they can be done in parallel), and addition of new data or calibration conditions will always require consideration of the entire inverse run set. This, in turn, may make previously non-representative models representative.

Conversely, the ARE and related methods are applied sequentially, and progressively eliminate non-representative candidates at each calibration point and condition, based on a fixed calibration criterion. Candidates, once eliminated, are no longer considered, so the set of potential representative runs decreases as the calibration progresses. New data points need only consider the remaining candidates and can further eliminate non-representative models. In contrast to the RMSE method, the calibration process therefore accelerates as it progresses.

The ARE type methods therefore do not allow for rejected models to be redeemed by additional calibration points (though still by revised calibration points) in the same fashion as the RMSE can. As discussed previously, this allows the conditions where inadequate thresholds (too stringent or too lax) have been applied to be readily identified, which can be used to improve subsequent calibrations or identify data points which may be outliers.

4.4.3 Conclusion

It should be noted that the authors, despite a general belief that distinguishing between 'good' and 'bad' representative models is tenuous ground, recognize that RMSE can be appropriately used to weigh degrees of belief within a calibrated (representative) region. The key contention, illustrated by example herein, is that the RMSE is in several respects disadvantageous as the calibration criterion itself in stochastic analysis, and particularly uncertainty analysis of deterministic models through Monte Carlo simulation.

The disadvantages of the RMSE when compared with the alternatives are several-fold. First, it does not explicitly require minimum performance of candidate models with respect to any individual constituent or data point. All three of the suggested alternative calibration strategies do. Secondly, use of higher RMSE as a optimization criteria does relatively little to alter the surface response of candidate models, particularly when compared with strategies such as the WRE (or SECS) which can shape the relative model performance around points (or for applications) of particular interest as needed. Both the base and high fitness RMSE surfaces yielded predictive surfaces with very little improvement over the base ARE surface.

Further problems are involved in model use and interpretation. RMSE does not explicitly models, and can redeem even very bad ones. In contrast, the alternative strategies require the modeler to define minimum performance levels for representative models. RMSE also poses substantial limitations for simulation result interpretation in space and time, due to its compression of data series into a single metric.

A common theme that emerges from the discussion here is the importance in understanding the interaction of data, model structure and calibration criteria in determining suitable parameter sets and associated response characteristics for a given problem. Defining the surface response of calibrated models can yield important information on stochastic model performance in time and space. The findings and type of analysis illustrated have ramifications for the development of data sampling schemes and interpretation as well as calibration itself.

4.5 REFERENCES

Beven, K.J. and Binley, A.M. (1992) The future of distributed models: model calibration and predictive uncertainty. Hydrological Processes, 6: 279-298.

Beven, K.J. (2001) Calibration, validation and equifinality in hydrological modeling. In M.G. Anderson and P.D. Bates, eds, Validation in hydrological modeling. John Wiley and Sons, Chichester, UK.

Beven, K.J. (2005) A Manifesto for the equifinality thesis. Journal of Hydrology, 320: 18-36.

Bowie, G.L., Mills, W.B., Porcella, D.B., Campbell, C.L., Pagenkopf, J.R., Rupp, G.L., Johnson, K.M., Chan, P.W.H., Gherini, S.A., and Chamberlin, C.E. (1985) Rates, constants, and kinetics formulations in surface water quality modeling (Second Edition). Report EPA/600/3-85/040, US EPA, Athens, GA.

Brown L.C. and Barnwell T.O. (1987) The enhanced stream water quality models QUAL2E and QUAL2E-UNCAS: Documentation and User Manual. Report EPA/600/3-87/007, US EPA, Athens, GA.

Duda, P.B., Kittle, J.L., Gray, M.H., Hummel, P.R., Kinerson, R.S., Cocca, P., Wells, D., Wellman, M., Partington, E., and MacWilliams, L.. (2003) BASINS 4.0 - Flexible integration of components and data for watershed assessment and TMDL development. WEF TMDL 2003, Chicago, IL.

Marsili-Libelli, S. and Giusetti, E. (2008) Water quality modeling for small river basins. Environmental Modeling and Software, 23(4): 451-463.

Ojeda, E.C., Déniz, E.G., and Cabrera Ortega, I.J. (2007) Bayesian local robustness under weighted squared-error loss function incorporating unimodality. Statistics and Probability Letters 77(1): 69-74.

Parker, G.T. (2004) Modeling agricultural best management practices in the South Nation watershed. MASc Thesis, Univ. of Ottawa, Ottawa, ON.

Parker, G.T., Droste, R.L., and Kennedy, K.J. (2008a) Modeling the effect of agricultural best management practices on water quality under various climatic scenarios. J. of Env. Eng. and Sci., 7(1): 9-19.

Parker, G.T., Droste, R.L., and Rennie, C.D. (2008b) An objective test of stochastic behaviour in riverine water quality models. International Water Association World Water Congress, Vienna.

Rauch W., Henze, M., Koncsos, L., Reichert, P., Shanahan P., Somlyódy, L., and, Vanrolleghem, P.A. (1998) River water quality modeling: I. State of the art. Wat. Sci. Tech. 38(11): 237-244.

Rode, M., Suhr, U., and Wriedt, G. (2007) Multi-objective calibration of a river water quality model—Information content of calibration data. Ecological Modeling, 204(1-2): 129-142.

Romanowicz, R, and Beven, K.J. (2006) Comments on Generalised Likelihood Uncertainty Estimation. Reliability Engineering and System Safety, 91: 1315–1321.

Streeter, H.W. and Phelps, E.B. (1925) A study of the pollution and natural purification of the Ohio river, III. Factors concerned in the phenomena of oxidation and reaeration, US Public Health Service, Bulletin 146.

Tannenbaum, T., Wright, D., Miller, K., and Livny, M. (2002) Condor - A distributed job scheduler. in Thomas Sterling, editor, Beowulf Cluster Computing with Linux, The MIT Press. ISBN: 0-262-69274-0.

US EPA (2008). Chesapeake Bay Phase 5 Community Watershed model (in preparation). EPA XXX-X-XX-008 Chesapeake Bay Program Office, Annapolis, MD.

van Griensven, A. and Meixner, T. (2007) A global and efficient multi-objective auto-calibration and uncertainty estimation method for water quality catchment models. J. of Hydroinformatics 9(4): 277-291.

CHAPTER 5

MODEL STRUCTURE AND UNCERTAINTY FOR STOCHASTIC NON-POINT SOURCE MODELING APPLICATIONS

5.0 CHAPTER OVERVIEW

This chapter has been submitted for publication in the *Journal of Hydrology*.

ABSTRACT

The uncertainty associated with a rainfall runoff and non-point source loading (NPS) model can be attributed to both the parameterization and model structure. An interesting implication of the areal nature of NPS models is the direct relationship between model structure (i.e., subwatershed size) and sample size for the parameterization of spatial data.

The approach of this research is to find structural limitations in scale for the use of the conceptual NPS model, then examine the scales at which suitable stochastic depictions of key parameter sets can be generated. The overlapping regions are optimal (and possibly the only suitable regions) for conducting meaningful stochastic analysis with a given NPS model.

Previous work has sought to find optimal scales for deterministic analysis (where, in fact, calibration can be adjusted to compensate for sub-optimal scale selection); however, analysis of stochastic suitability and uncertainty associated with both the conceptual model and the parameter set, as presented here, is novel; as is the strategy of delineating a watershed based on the uncertainty distribution

The results of this paper demonstrate a narrow range of acceptable model structure for stochastic analysis in the chosen NPS model. In the case examined, the uncertainties associated with parameterization and parameter sensitivity are shown to be outweighed in significance by those resulting from structural and conceptual decisions.

Listed index terms were: Hydrology, Modeling, Model calibration, Stochastic Hydrology, Watershed. Listed keywords were: Runoff, Model, Non-Point Source, Stochastic, Uncertainty, and TMDL.

5.1 INTRODUCTION

5.1.1 BACKGROUND

Watershed-level modeling has become an essential tool in understanding and managing environmental risks and the relationship between pollutant sources and water bodies. An approved Total Maximum Daily Loading (TMDL) evaluation, for instance, has become a de facto requisite for assistance funding in many locales. Particularly in recent years, an increased focus has been placed upon the issues of both point and non-point pollutant sources at the watershed level. Pollutant loading and hydrology models are deployed in such cases to provide insight on source assessments and their impacts on water quality targets, as well as the consequences of varied management scenarios (e.g., Parker et al., 2008).

These types of assessments have proven to be challenging, particularly in moderately complex to complex systems, where model parameters are adjusted to fit one or several years of reference data. It is well understood for deterministic models that the chosen 'calibrated' parameter set, and thus simulation results, depend on some combination of the reference data and calibration strategy (criteria) chosen. Since similar results are often achieved with different approaches, the issue of which parameter set should be used frequently arises. This phenomenon is known as model equifinality.

Stochastic models attempt to mitigate such issues to some degree by representing modeled phenomena as a distribution of possible outcomes. A common implementation is to perturb input parameters, through use of Monte-Carlo simulations for example, and assess likely outcomes from the results. One advantage of such approaches is that they are readily implemented late in the (otherwise deterministic) model construction timeline, as an added tool for result interpretation.

Equally important to the stochastic model response, however, is the underlying conceptual model structure itself. In practice, this issue is rarely explicitly considered, as a handful of codes, primarily designed for deterministic simulation, are in widespread use.

This paper outlines a method to find limitations in scale for use of a given conceptual model, and then examine the scales at which a suitable stochastic representation of key parameter sets can be obtained. The overlapping regions are optimal, and possibly the only suitable regions, for meaningful stochastic analysis given a non-point source pollutant loading (NPS) model.

5.1.2 Review of Uncertainty and Scale

Most hydrologic models employ point-scale equations based on conservation of mass, momentum, and energy. Often, such computations require data at a scale much finer than is readily available. In such cases, the point-scale equations must be up-scaled in order to conserve mass, momentum, and energy, ensuring compatibility between scales of observed data and governing equations. Therefore, the spatial scale must greatly influence the choice of a model (and vice-versa).

Seyfried and Wilcox (1995) analyzed how the nature of spatial variability affects the hydrological response of a catchment over a range of scales, using several field processes as examples. Kavvas (1999) showed that when larger scale processes are formed by the averaging of small-scale processes, high frequency components of the smaller scale are effectively eliminated, leading to considerable simplification of hydrologic conservation equations. This up-scaling also plays an important role in dealing with those parameters which also vary spatially (e.g., Chen et al. 1994, Kavvas, 1998). Model parameters are usually based on spatial variation of point-scale data (or parameters mapped to such data) obtained using GIS, remote sensing and other tools.

Previous work, focused on identifying the finest scale that can be used to adequately represent spatial variation in a hydrological model. Bathurst (1986) suggested dividing the watershed into elements no larger than 1% of the total area, to ensure that each element was more or less homogeneous; Wood et al. (1988) proposed the notion of a representative elementary area (REA); and several others have examined this issue. Wood et al. (1988) defined the REA as the 'smallest discernible point which is representative of the continuum'. This suggests preferable temporal and spatial scales over which process representation can remain simple, and distributed catchment behaviour represented without the complexity of local heterogeneity. The concept is analogous to the representative elemental volume concept of Hubbert (1956). Blösch et al. (1995) reasoned it is difficult, in practice, to determine the REA because it is strongly controlled by environmental characteristics. Zhang and Montgomery (1994) concluded that grid sizes smaller than the hill-slope length are necessary to adequately simulate the processes controlled by land forms, while Molnar and Julien (2000) found that coarser (0.835 vs. 0.016 km^2) grid-cell resolutions can be used for runoff simulations so long as parameters are appropriately calibrated, and they suggested the primary effect of increasing grid-cell size on simulation parameters is to require an increase in overland and channel roughness parameters.

The methodology presented here aims to assess the relative importance of the uncertainty associated with both scale and parameter issues in hydrological models used for non-point source pollutant loading applications.

5.2 METHODOLOGY

5.2.1 CASE STUDY AREA & DATA

The Potomac Watershed stretches across approximately 38 000 km^2, of the Eastern US. The Potomac River itself covers roughly 620 km from Fairfax Stone in West Virginia to Point Lookout in Maryland. The average river flow at the Washington, D.C location is about 310 m^3/s, with minimum and maximum recorded flows of 17 m^3/s (September 1966) and 12000 m^3/s (March 1936), respectiveely. The watershed flows into Chesapeake Bay, becoming tidal near Washington DC where the river crosses the fall line into the Coastal Plain province. This study limits itself to the purely freshwater and non-tidal portion of the Potomac River.

From 1991 to 1996, the US Geological Survey's (USGS) National Water Quality Assessment (NAWQA) program began extensive work in the basin to monitor surface and ground water quality and ecology. That dataset is used here, drawing on over 50 USGS stations to provide information on stream flow quantity for the year 1993. These data were available at temporal resolutions up to daily timesteps for individual stations. Water quality data are available at 5 'integrator' and 5 'indicator' stations on a monthly basis. Point sources loading the river system were identified from US EPA (2007).

Simulations in this paper were conducted using the continuous-simulation Annualized Agricultural NPS pollutant loading model, developed by the US Department of Agriculture (USDA). AnnAGNPS is a comprehensive package, particularly suited for analyzing non-point source pollutant loading issues at the watershed level. Conceptually, the model subdivides a watershed into homogeneous drainage areas, which are in turn connected by a dendritic reach system. Water and pollutant loadings from individual fields are simulated as runoff events from rainfall, snowmelt, and irrigation data (NPS modeling). Soil loss is calculated based on the Revised Universal Soil Loss Equation (RUSLE). The model also includes a substantial database with values of parameters for agricultural applications and management scenarios (cf. Bosh et al., 1998).

5.2.2 MODEL STRUCTURE SCALING

The initial step in the proposed approach is the determination of scales at which the hydrological and NPS model behave adequately for stochastic analysis. The goal of this stage is to identify a range of model delineation (lumped area and reach networks) which will permit Monte Carlo analysis around a given conceptual model and related parameter set.

The approach used in this paper was to conduct a sensitivity analysis of conceptual model stability at scales between 0.25-15.5 km^2. As the model delineation is also governed by the site topography, the analysis was performed on three sub-watersheds, described in Table 5.1, to isolate conceptual model issues over a plausible range of model structures.

Table 5.1 Subarea Characteristics

Watershed Case	***Drainage Area (km^2)***	***Scales Examined (avg. area, in km^2)***	***Subdivison Count***	***Run Count***
1	*1210*	*0.3-15.5*	*78-4727*	*12*
2	*525*	*0.3-10.9*	*48-1992*	*13*
3	*312*	*0.3-13.6*	*23-1191*	*16*

The model runs were populated with identical, grossly averaged, soil and land-use conditions in each case and the results were examined for changes in runoff volume and sediment transport. Any differences between model outputs, therefore, are products of the union between the discretization and conceptual structure of the model.

5.2.3 MODEL PARAMETER SCALING

With a range of suitable scales for the conceptual model determined, the task now becomes to find the discretization that leads to suitable parameter representation in the same range. In deterministic analysis, parameters (reflecting, for example, land use) are represented as single values. The discretization problem in such instances therefore often seeks to find the degree of 'lumping' (scale) at which a single value, often a weighted average, can be considered representative.

In a stochastic setting, the problem is slightly different. Parameters, in this context, must be considered as distributions of plausible values rather than point values. Therefore, in such cases, we are most interested in determining the scale which allows for a suitable distribution to be fitted to spatial data. In these instances, issues of sampling size and delineation are of increased importance.

A simple conceptual model for examining the effect of spatial parameters on model runoff-related outputs is the rational equation, which can be used to compute the amount of runoff expected for a given area and precipitation. The equation can be formulated as follows:

$$Q = C' \cdot I \cdot A \tag{5-1}$$

Where Q is the peak runoff rate in (m^3/s), I is the rainfall intensity (mm/hr) and A is the drainage area in km^2. C is a parameter reflecting the runoff coefficient, based on a weighted average of recommended values for soil type and land use conditions, in a discrete region. In Equation 1, C' is the modified runoff coefficient for use with these units, which is the nominal runoff coefficient multiplied by a factor of 0.28. Nominal runoff coefficients are estimated from literature values (e.g., McCuen, 2004).

Another simple and widely used equation is the Soil Conservation Service (SCS) Curve Number (CN) method. In this formulation, the runoff is a function of both the CN (which is related to the potential maximum retention after runoff begins), the initial abstractions (which is often taken as function of CN), and the rainfall itself. Practically, this can be considered a special case of the rational equation where C is variable with precipitation for a given CN.

Despite the prevalence of CN methods in parametric models, there are several advantages of using a constant runoff coefficient at a given location (raster pixels) for statistical description and aggregation of runoff characteristics within a given subcatchment. Such an approach approximates, from a single spatial variable, an expected hydrological behaviour useful for a range of climate conditions over the course of a year. Table 5.2 lists the runoff coefficients mapping to Landsat land class used in the analysis below. The approach used here was to examine the spatial variation of these mapped runoff coefficient values and the effect of scale and structure changes on distribution and sampling issues.

Several statistics were calculated via a geospatial information system (GIS) for each discretized area. Primary statistics considered were raster cell count (n), mean of C (μ), standard deviation of C (σ), minimum and maximum values of C (along with range), area and length. Based on these primary statistics, tabular calculations for each cell were conducted to generate descriptive statistics for comparison. Two of these are discussed here, the confidence interval (CI) and the fractional uncertainty (Uf). These descriptive statistics are defined in Equations (5-2) and (5-3).

Where α is the level of significance, $Z_{0.5\alpha}$ is the abscissa under the standard normal curve that contains 0.5α area on either side, (2.58 for an α of 0.01), and CI_α is the value such that the confidence interval is $\mu \pm CI_\alpha$. Several levels of significance were examined, with similar patterns observed. For clarity, the remainder of this paper discusses a value of α of 0.01 when discussing confidence intervals and fractional uncertainties

Table 5.2 Landsat Description and Assigned Runoff Coefficient

Land	**Land Class Description**	**Runoff**
11	Open Water	100
12	Perennial Ice Snow	100
22	High Intensity Residential	60
23	Commercial/Industrial/Transportation	60
82	Row Crops	60
31	Barren Rock/Sand/Clay	50
32	Quarries/Strip Mines/Gravel Pits	50
21	Low Intensity Residential	40
71	Grasslands/Herbaceous	35
84	Fallow	35
83	Small Grains	31
33	Transitional	30
51	Shrubland	30
91	Woody Wetlands	30
92	Emergent Herbaceous Wetlands	30
81	Pasture/Hay	20
85	Urban/Recreational Grasses	20
41	Deciduous Forest	13
42	Evergreen Forest	13
43	Mixed Forest	13
61	Orchards/Vineyards/Other	13

$$CI_{\alpha} = \frac{Z_{\alpha/2}\sigma}{\sqrt{n}} \tag{5-2}$$

(confidence interval is $\mu \pm CI_{\alpha}$; for $\alpha = 0.01$, $Z = 2.58$)

$$U_f = \frac{CI_{\alpha}}{\mu} \tag{5-3}$$

5.3 RESULTS

5.3.1 CONCEPTUAL MODEL AND STRUCTURE SCALING

The tests for conceptual and structural model issues of the AnnAGNPS representation were conducted in three subwatersheds by varying critical source area and minimum source channel length parameters in the topographic parameterization process. Figure 5.1 shows the annual average sediment yield for the tested regions in a range of scale discretizations. Sediment yield was selected as the important model output as it is related to both overall flow volume and erosion of particulate matter into the riverine system. For NPS pollutant modeling application, of the type frequently studied using AnnAGNPS, it is precisely these mechanisms of particular interest when considering transport of dissolved and attached chemicals (nutrients).

As expected, it is apparent that there is noticeable sensitivity to scale in the watershed sediment yield response. In the lower range of average cell area (more discretized structure), the model response appears to be as significantly altered by structure as by the explicit 'parameter' set or topography itself, with nearly a 500% increase in the 0.25-4 km^2 range for all cases. The results were normalized to the 4 km^2 value from Figure 5.1 for additional analysis, as shown in Figure 5.2.

Figure 5.2 shows a region of model stability for a range of discretizations for the considered subwatersheds throughout the study area, bordered on either extreme by regions of greater divergence. To characterize the behaviour of the watershed (and subwatersheds) as a whole, the information can also be presented as a single 'stability' curve, as shown in Figure 5.3.

Figure 5.3 provides a measure of the conceptual model sensitivity to model discretization (structure) in the study area (and subregions thereof).

Results from the parameter scaling tests were derived primarily from spatial distributions of input data, as outlined in the methodology section.

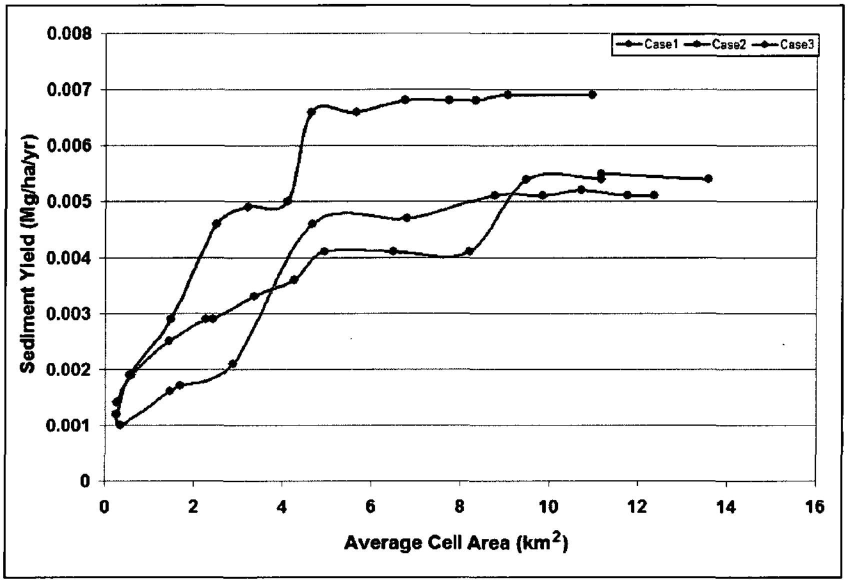


Figure 5.1: Average annual sediment yield variation with scale.

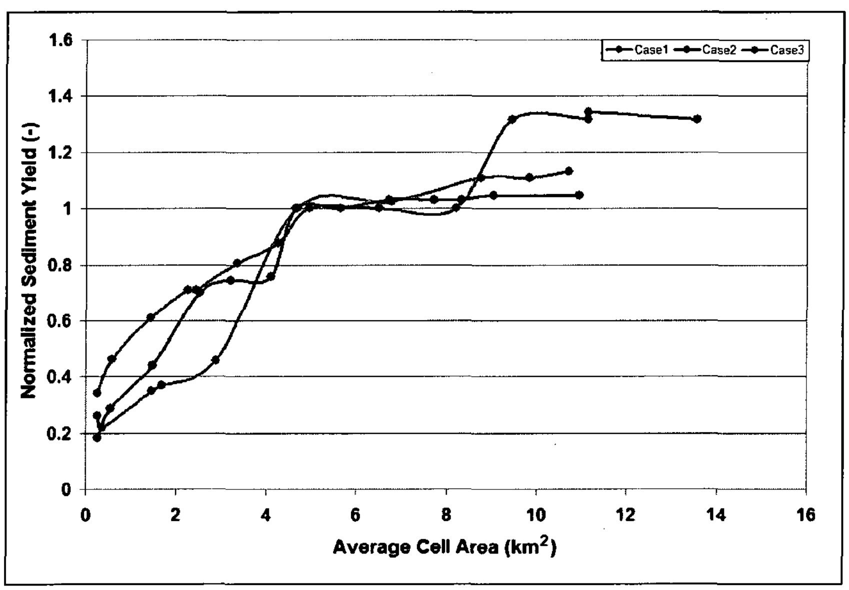


Figure 5.2: Normalized average annual sediment yield variation with scale.

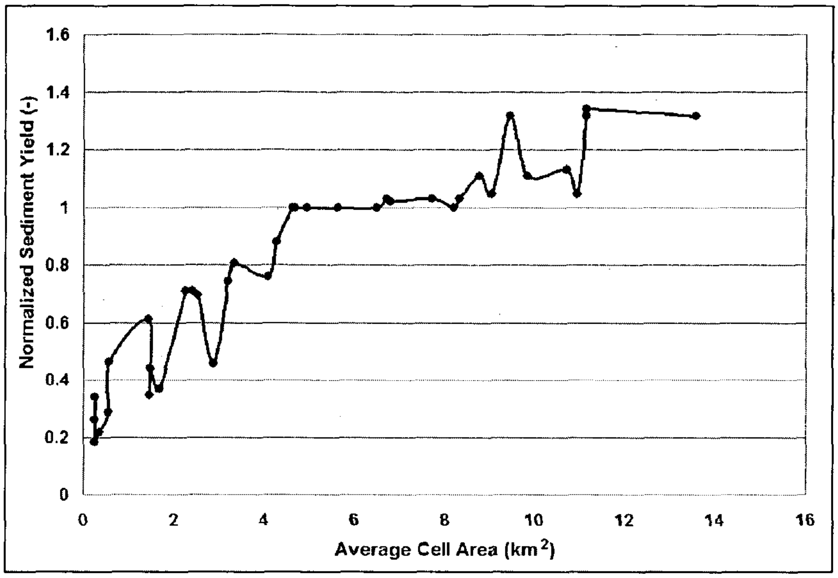


Figure 5.3: Sediment stability curve generated from normalized data in Figure 5.3.

Table 5.3 lists the results of the parameter scaling for 9 different discretizations (one per row) of the entire study area across 6 columns containing descriptive summary statistics. The first column lists the average cell area for each discretization, which is fairly straightforward. The second column lists the percentage of the total study area that is contained in cells with a raster count lower than 30 (and may be under sampled). As the average cell size increases, the number of relatively small cells becomes smaller. The third column shows the average of $CI_{0.01}$ as defined in Equation 5-2. The fourth column shows the same value, corrected this time for the added uncertainty of increasing borders between individual subareas. As the number of cells increases, so do the relative contribution of border cells (which may be split). This was also considered with a conservative calculation based on adjacent cell means. The fifth column, like the second, provides a measure of problematic subregions, by counting the number of cells with a $CI_{0.01}$ greater than an arbitrary cutoff value of 5. The final two columns list the percentage of overall watershed area in high $CI_{0.01}$ regions, relative to the average listed. As shown in Figure 5.5 these cells are, for the most part, high uncertainty areas constrained by topography and network connectivity.

Table 5.3 Descriptive Statistics of Parametric Variation in Study Area

Avg. Cell Size (km^2)	Percent Area with n<30	Avg $CI_{0.01}$	Avg. $CI_{0.01}$ Corrected	$CI_{0.01}$ >5	$CI_{0.01}$> Avg $CI_{0.01}$ (Corrected)	$CI_{0.01}$>Avg $CI_{0.01}\cdot 2$ (Corrected)
2.25	0.471%	2.30	2.41	1580	6.18%	0.93%
3.03	0.259%	2.10	2.19	986	10.37%	1.65%
3.81	0.178%	1.97	2.06	697	8.68%	1.41%
4.66	0.120%	1.86	1.94	516	7.62%	1.32%
6.53	0.071%	1.69	1.76	313	6.52%	1.13%
8.29	0.041%	1.60	1.67	235	5.46%	0.99%
10.2	0.030%	1.50	1.55	174	5.26%	0.88%
15	0.027%	1.43	1.48	121	3.50%	0.57%
42	0.001%	0.85	0.89	15	3.94%	0.79%

Figure 5.4 is related to Table 5.3, and shows the change in fractional parameter uncertainty for the examined discretization scenarios., as described in Equation 5-3, based on a calculation of the $CI_{0.01}$ and the mean for each cell area. The 'no correction' and 'corrected' values are straightforward calculations based on the results of Table 5.3 across individual cells. The 'theoretical' plot is a similar calculation, done based on a $CI_{0.01}$ value calculated from average n, μ and σ for a given discretization.,

5.4 CASE STUDY

5.4.1 SCALE SELECTION

Based on the parameter and conceptual/structural uncertainty tests, a scale in the range of no less than 4 km^2 and not more than 8.5 km^2 average cell area was selected. While it may be argued that a greater average cell area would allow for lesser purely input parameter-related error, the structural uncertainty issues were identified as particularly important outside this range (see Figure 5.3). Additionally, although input parameter uncertainty does decrease at higher scales, the region between about 5-15 km^2 ($CI_{0.01}$ change of 0.43 over ~10 km^2) is considerably flatter than at scales in the 0-5 km^2 ($CI_{0.01}$ change of 0.44 over just ~2.5km^2). Ideally of course, the optimal structural region should overlap a range of scales where optimal parameterization may occur, but as discussed previously, the selected model showed only a relatively narrow region of structural stability. Several alternatives for discretization within this range were considered and tested for parameter uncertainty using descriptive statistics such as CI, including several attempts at zonal discretization based on regional variations in fractional uncertainty. Discretization is based on two principal variables: the minimum source channel length (MSCL) and the critical source area (CSA). The CSA is defined as the minimum area required to support a permanent channel, while the MSCL is a threshold below which first-order channels are not generated in the delineation process. Figure 5.5 shows some of the parametric uncertainty 'hotspots' for a representative discretization.

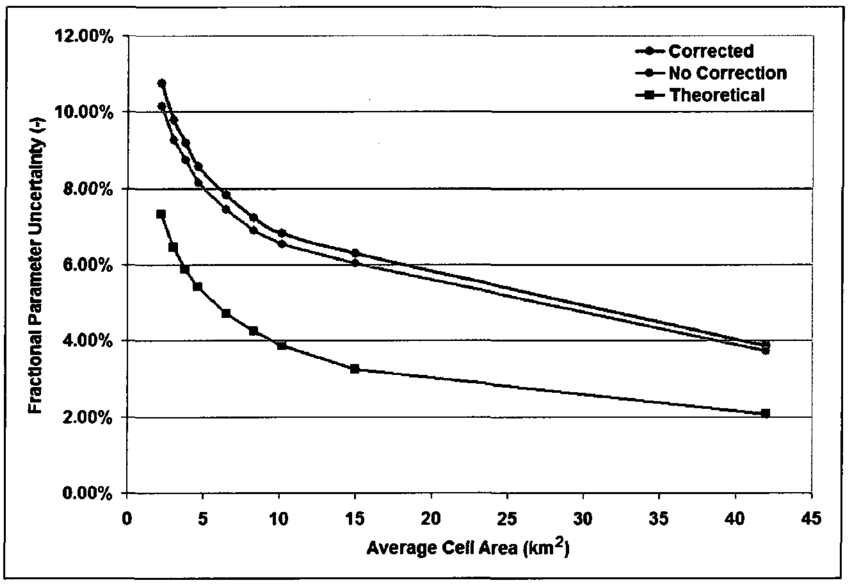


Figure 5.4: Fractional Parameter Uncertainty Change with respect to Discretization.

Spatial varied MSCL and CSA (first larger, then lower by a factor of 2) were tested in these regions in an attempt to force the discretization into larger aggregates (potentially reducing, or outright eliminating, areas of high parameter uncertainty). No substantial difference was found from the spatially varying MSCL or CSA in these high uncertainty areas, even when adding sizeable buffer zones (of up to 10 km). This was interpreted as confirming physical (topographic) limitations forcing the D8 (delineation) and subsequent parameterization algorithms into high uncertainty conditions around certain reach network junctures and edges. In other cases, where topography may not be limiting, this approach could be used to find further improvements to the parameter discretization strategy.

The final run selected had an average area of 8.3 km^2, based on a constant MSCL of 1000 m and a CSA of 1000 hectares.

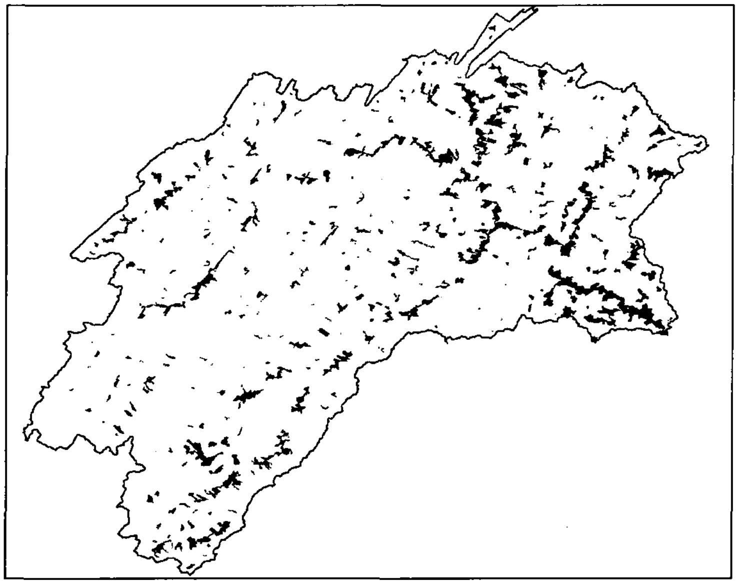


Figure 5.5: High parameter-uncertainty areas in the 6.5 km2 delineation case. Areas shown in orange are areas with 99% CI greater than average.

5.4.2 BASEFLOW SEPARATION

Data for flows were taken from the USGS Surface-Water Daily Data Set for the study period (USGS, 2007). Hydrograph separation was done using the Chapman filter equation, as implemented in the ABSCAN software (Parker, 2006). Digital filter techniques, originally used in signal analysis, were employed in a water resources context by Lyne and Hollick (1979) to separate high frequency (direct runoff) and low frequency (baseflow) components from the streamflow 'signal'. Chapman (1991) noted that the Lyne–Hollick algorithm incorrectly provides a constant streamflow Q, or baseflow b, when direct runoff has ceased and therefore developed the new equation:

$$b_t = \frac{3\alpha - 1}{3 - \alpha} \cdot b_{t-1} + \frac{1 - \alpha}{3 - \alpha} \cdot (Q_t + Q_{t-1}) \qquad (5\text{-}4)$$

which can calculate b at each timestep t given the associated Q. When the quick runoff component has ceased, the filter parameter α becomes the hydrological recession constant a in equation (5-5), commonly used to describe baseflow recession during dry weather periods without groundwater recharge:

$$b_k = ab_k - 1 \tag{5-5}$$

The Chapman method was selected as it offered good performance with a single conceptually-based parameter, α. Values for α were estimated from historical records near the outlet of the study area, taken from Sinclair and Pitz (1999). A value of α=0.5 was used in the model separation.

5.4.3 CALIBRATION

Given the nature of hydrological models, particularly for a watershed of this size and scope, additional adjustments are often necessary on a regional scale to reproduce individual events and/or patterns. Nonetheless, since the object here was to demonstrate the stochastic behaviour of a given calibration, a gross calibration with a higher degree of reproducibility across delineation cases was deemed preferable to a more stringent calibration with lower reproducibility. Therefore, the calibration task was simplified to the adjustment of two key hydrological parameters, specifically the runoff CN and storm distribution type, as well as two erosive parameters: the long term random roughness coefficient along with the sheet and concentrated flow roughness coefficient. Calibrated values for CN are shown in Table 4. The calibrated storm distribution type was adjusted to type III, the random roughness coefficient was held at 64 mm, and the sheet/concentrated flow roughness coefficient was set to 0.13 $m^{-1/3}\cdot s$.

Table 5.4: Calibrated CN Values for AnnAGNPS

	Hydrological Soil Group			
Landuse Class	***A***	***B***	***C***	***D***
Forest	*68*	*70*	*72*	*73*
Pasture	*74*	*78*	*81*	*83*
Rangeland	*74*	*78*	*81*	*83*
Crop	*79*	*88*	*88*	*96*
Urban	*89*	*95*	*96*	*99*

This simplified calibration strategy yielded nearly identical outlet discharge values in the stable structural model range examined. The 10 and 8 km^2 model structures had flow correlation coefficients greater than 99.99% and a RMSE of 3.12 m^3/s. The corresponding sediment correlation coefficient was virtually identical, though with a higher RMSE of 169 Mg. Dynamic sediment yields at the watershed outlet were not computable using higher resolutions than 8 km^2, due to array errors. Figure 5.6 shows the calibrated model values when compared with observed data for 1993.

Though the calibrated simulation results shown in Figure 5.6 do reproduce overall seasonal patterns reasonably well, it has some less-than-ideal properties as well. The model slightly under- and over-predicts observed values in many places, but perhaps more importantly appears somewhat jumpy. This may be attributable to one of several factors, ranging from choice of baseflow model to very localized precipitation events or hydrology that are misrepresented in the climate records or landuse data, respectively. Normally such characteristics could be improved upon by further calibration by e.g., localized adjustment of parameters; however, the requirement for the analysis here is not so much for a perfect calibration as for a highly reproducible, relatively stable one.

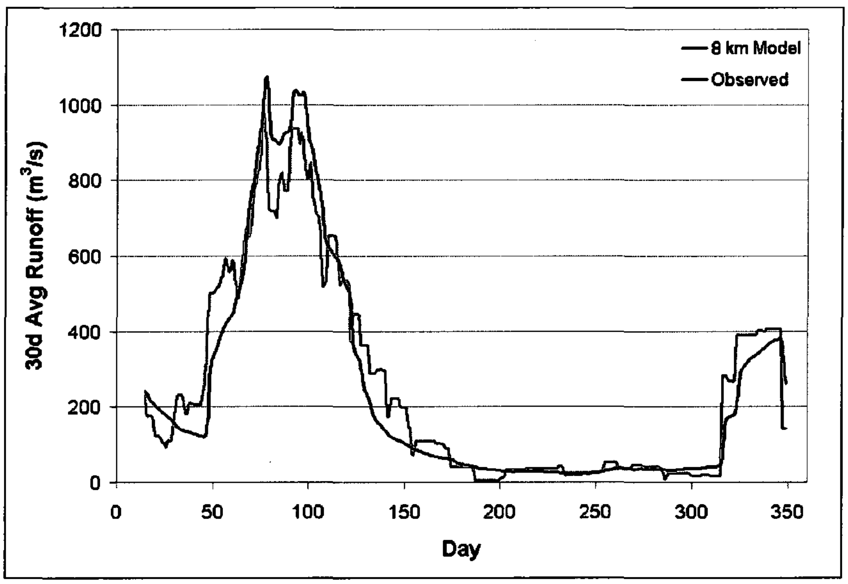


Figure 5.6: Model Calibration results. Plot indicates discharge at outlet.

5.4.4 SIMULATION RESULTS AND COMPARISON

Given that model structures outside the 'stable' region identified in Figure 5.3 had previously shown heightened sensitivity to changes in cell area, a sub-region of the initial calibrated watershed (corresponding to the Shenandoah River branch) was examined for each scale. Figure 5.7 shows the annual distribution of sediment loadings for the watershed examined. In this Figure, annual total sediment yield increases (along the y-axis) as time progresses (along the x-axis). The sediment yield of large discretizations is consistently higher than lower ones, though structures in the 4-10 km^2, and particularly the 6-10 km^2 ranges seem to yield largely similar total annual loads.

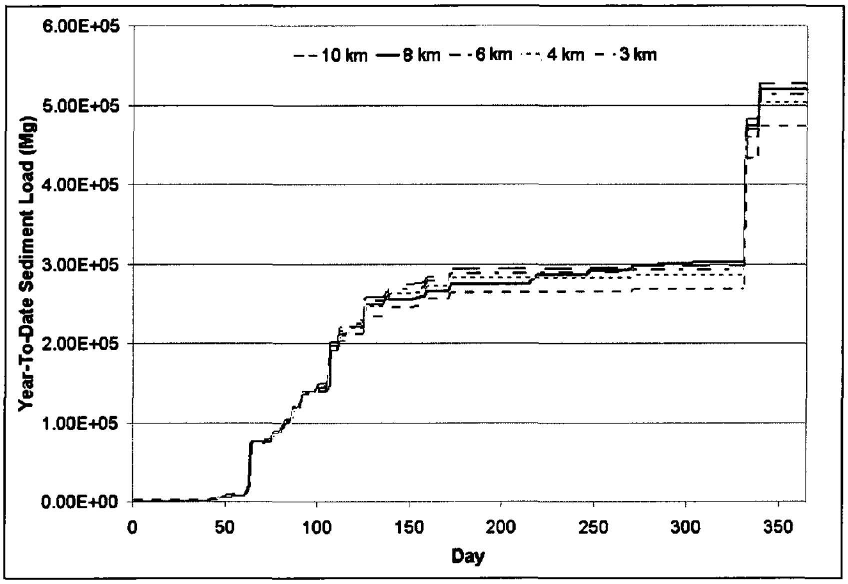


Figure 5.7: Simulated Sediment loadings at Shenandoah Sub-Basin Outlet

The 3 km^2 discretization (outside the stable range), in contrast, shows a more significant decrease in annual sediment yield when compared with the others. This result illustrates one implication of the findings from Figure 5.3. Models calibrated at the outlet will show increased changes in subwatersheds outside the stable model structure scales.

In addition, a sensitivity test was conducted on one of the erosive parameters (relative roughness), which does not directly affect cell area, by testing 'random roughness' parameter values of 32 and 96 mm (50 and 150% of base, respectively). The resulting response areas were compared for each model scale. Figure 5.8 shows the surface response area of the 8 km^2 model, along with the upper and lower limits of the 10 and 3 km^2 models. The 8 km^2 surface is clearly narrower (lower difference between upper and lower limits) than either the 10 or 3 km^2 model, which both show higher sensitivities to changes in the random roughness parameter.

5.5 DISCUSSION

The proposed method was able to identify structural characteristics important in understanding model performance. A range of optimal scales for model construction was determined, and the case study illustrated that discretization at those optimal scales performed in a more robust manner. The predictions of optimally-structured models were less sensitive to structural (e.g., subarea) variations important in model calibration over large areas. Equally, the optimal model showed reduced sensitivity to changes in non-structural parameters. In the context of a Monte-Carlo type approach to uncertainty analysis, the resulting differences (dispersion) in model outputs appear to have been minimized.

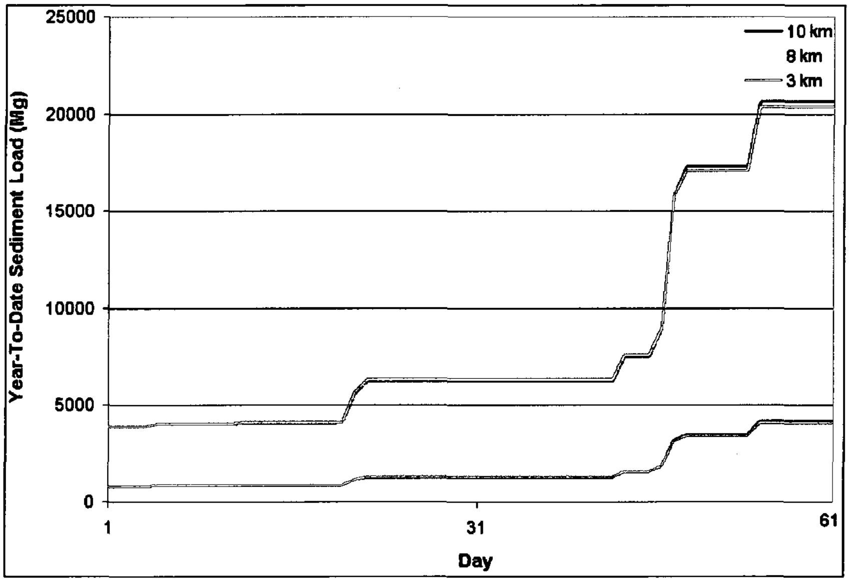


Figure 5.8: Influence of model scale on sediment loading at Shenandoah Sub-Basin Outlet surface response for variation in random roughness parameter between 32 and 96 mm.

The proposed analysis also proved generally useful for interpretation of a given conceptual model. It seems clear from the results presented that scale selection in the AnnAGNPS model is limited by conceptual model uncertainty and stability issues rather than parameter uncertainty, which is more commonly used. To further examine this issue, Figure 5.9 presents an analysis of parameter and scale uncertainty components as observed during the case study.

To generate Figure 5.9, the calibrated model was allowed to vary a sensitive parameter (random roughness) and scale by 25% around the 'optimal' 8 km^2 model, resulting in a case matrix of 9 runs (3 different parameter values at 3 different scales). Absolute relative error (ARE) was examined between minima and maxima at each timestep. It is evident in this plot that the analysis of parameter sensitivity alone is capturing only about half of the variation in simulation results. A related issue is how parameter uncertainty is affected by scale itself. Results from the case study, such as those shown in Figure 5.8 indicate that the 8 km^2 model is minimizing model sensitivity to both structural and parameter changes when compared with values outside the optimal range.

5.6 CONCLUSION

The methodology presented here allows for a reasonable stochastic analysis of pollutant loading problems given a deterministic-based code. The proposed methodology involves testing of conceptual model scale issues, followed by testing of parameter-related scaling issues, and subsequent determination of suitable (optimal) overlapping ranges of scale for stochastic model construction. It should be noted that the authors do not suggest that the application of such codes are without problems associated with the deterministic construction of the model itself. However, the inherent problems of such approaches notwithstanding, they remain by far the most commonly used tools for many important problems (e.g. TMDL), and a need to conduct reasonable analysis of the uncertainty characteristic of new and old models is evident.

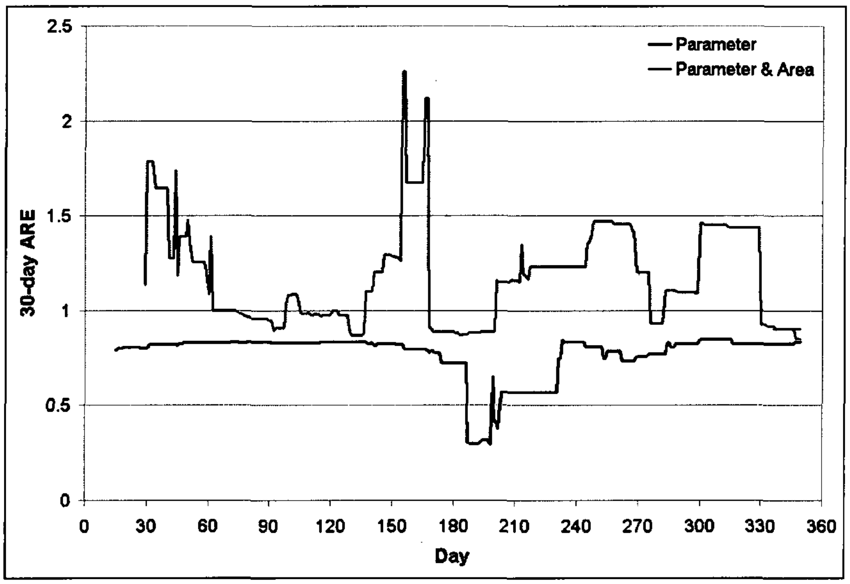


Figure 5.9: Moving Average Relative Error of Parameter and Scale Uncertainty Components in Simulation Results at Shenandoah Outlet for 1993.

Given this caveat, if models are to be constructed using somewhat complex deterministic structures, the type of analysis presented here is invaluable in assessing how a model can be reasonably applied (and then perturbed via e.g. Monte-Carlo analysis), as well as how structural decisions affect the uncertainty associated with the parameterization and the simulation results itself.

In the case presented here (and, it is suggested, most others with comparable models), the uncertainties associated with parameterization and parameter sensitivity are outweighed in significance by those resulting from structural and conceptual decisions. The optimal scale for structural use of the AnnAGNPS model in this watershed was found to be between approximately 4-8.5 km^2. When considering parameter issues within this stable structural scale range, a preferred discretization of 8 km^2 was found. It is hoped that these techniques may shed some light on the relative importance of (parameter) calibration and uncertainty analysis as they are generally performed.

5.7 REFERENCES

Bathurst, J.C. (1986) "Sensitivity analysis of the Systeme Hydrologique European (SHE) for an upland catchment." J. Hydrol., 87, 103–123.

Beven K.J. and Binley A.M. (1992) The future of distributed models: model calibration and predictive uncertainty. Hydrological Processes, 6, 279-298.

Beven, K.J. (2001) Calibration, validation and equifinality in hydrological modeling. In M.G.Anderson and P.D. Bates, eds., Validation in Hydrological Modeling. John Wiley and Sons, Chichester, UK.

Blöschl, G. (2001), "Scaling in hydrology." Hydrological Processes 15, 709-711.

Bosh, D., Theurer, F., Binger, R., Felton, G., and Chaubey, I. (1998) "Evaluation of the AnnAGNPS Water Quality Model." ASAE Paper No. 98-2195, St. Joseph, MI.

Chen, Z.Q., Govindaraju, R.S., and Kavvas, M.L. (1994a) "Spatial averaging of unsaturated flow equations under infiltration conditions over areally heterogeneous fields: 1. Development of models." Water Resour. Res., 30(2), 523–533.

Goodrich, D.C., Woolhiser, D.A., and Keefer, T.O. (1991) "Kinematic routing using finite elements on a triangular irregular network (TIN)." Water Resour. Res., 27(6), 995–1003.

Hubbert, M.K. (1956) "Darcy's law and the field equations of the flow of underground fluids." Transactions of the American Institute of Mining, Metallurgical and Petroleum Engineers 207, 222-239.

Kavvas, M.L. Chen, Z.-Q., Tan, L., Soong, S.-T., Terakawa, A., Yoshitani, J. and Fukami, K. (1998) "A regional scale land surface parameterization based on areally-averaged hydrological conservation equation." Hydrol. Sci. J., 43(4), 611–631.

Kavvas, M.L. (1999) "On the coarse-graining of hydrologic processes with increasing scales." J. Hydrol. 27, 191–202.

McCuen, R.H. (2004) Hydrologic Analysis and Design (3rd edition). Prentice Hall, Upper Saddle River, NJ.

Molnar, D.K. and Julien, P.Y. (2000) "Grid-size effects on surface runoff modeling." J. Hydrologic Eng., 5, 8–16.

Parker, G.T., Droste, R.L., and Kennedy, K.J. (2008) "Modeling the effect of agricultural best management practices on water quality under various climatic scenarios". J. of Env. Eng. and Sci., 7, 1, 9-19.

Seyfried, M.S. and Wilcox, B.P. (1995) "Scale and nature of spatial variability: Field examples having implications for hydrologic modeling." Water Resour. Res., 31, 173–184.

Sinclair, K.A. and Pitz, C.F. (1999) Estimated Baseflow Characteristics of Selected Washington Rivers and Streams, Water Supply Bulletin No. 60, Washington State Department of Ecology Environmental Assessment Program, Olympia, WA.

Song, Z. and James, L.D. (1992) "An objective test for hydrologic scale." Water Resour. Bull., 28(5), 833–844.

Thomas, G. and Henderson-Sellers, A. (1991) "An evaluation of proposed representation of subgrid hydrologic processes in climate models." J. Climate, 4, 898–910.

US EPA (2008). Chesapeake Bay Phase 5 Community Watershed Model In preparation EPA XXX-X-XX-008 Chesapeake Bay Program Office, Annapolis MD.

USGS (2007). USGS surface-water daily data for the Nation. National Water Information System: Web Interface. http://waterdata.usgs.gov/ne/nwis/sw. Accessed January 2007.

Wood, E.F., Sivapalan, M., and Beven, K. (1990) "Similarity and scale in catchment storm response." Rev. Geophys., 28, 1–18.

Wood, E.F., Sivapalan, M., Beven, K.J., and Band, L. (1988) "Effects of spatial variability and scale with implications to hydrologic modeling." J. of Hydrology, 102(1-4), 29-47.

Zhang, W. and Montgomery, D.R. (1994) "Digital elevation model grid size, landscape representation, and hydrologic simulations." Water Resour. Res., 30, 1019–1028.

CHAPTER 6

COUPLING MODEL UNCERTAINTY FOR COUPLED RAINFALL/RUNOFF AND SURFACE WATER QUALITY MODELS

6.0 CHAPTER OVERVIEW

This chapter has been submitted for publication in *Water Research.*

ABSTRACT

Coupled hydrology and water quality models are today an important tool, used in the understanding and management of surface water and watershed areas. Such problems are generally subject to substantial uncertainty in parameters, process understanding, and data. Component models, drawing on different data, different concepts, and different structures, are affected differently by each of these uncertain elements.

This paper proposes a framework wherein the response of component models to their respective uncertain elements can be quantified and assessed, using a hydrological model and water quality model as two exemplars. The resulting assessments can be used to identify model coupling strategies that permit more appropriate use and calibration of individual models, and a better overall coupled model response.

One key finding was that an approximate balance of water quality and hydrological model responses can be obtained using both the QUAL2E and Mike11 water quality models. The balance point, however, does not support a particularly narrow surface response (or stringent calibration criteria) with respect to the water quality calibration data, at least in the case examined here. Additionally, it is clear from the results presented that the structural source of uncertainty is at least as significant as parameter-based uncertainties in areal models.

Listed keywords were: Water Quality, Hydrology, Uncertainty, Watershed, Coupled, Model

6.1 INTRODUCTION

Watershed-level modeling has become an essential tool in planning and managing environmental risks and the relationship between pollutant sources and water bodies, and an approved Total Maximum Daily Loading (TMDL) evaluation has become a de facto requisite for assistance funding. Particularly in recent years, an increasing focus has been made on the issues of both point and non-point pollutant sources at the watershed level, and their associated effects on water quality. Pollutant loading and hydrology models are generally deployed in such cases to provide insight on source assessments and their impacts on water quality targets as well as the consequences of varied management scenarios (e.g., Parker et al., 2008a). Water chemistry is often modeled using a dedicated water quality package, drawing on hydrological model outputs to assess in-stream condition.

These types of assessments have proven to be challenging, particularly in moderately to highly complex systems. Model parameters are adjusted to fit one or several years of reference data. It is well understood for deterministic models that the chosen 'calibrated' parameter set, and thus simulation results, depend on the reference data and the calibration strategy used. Since similar results are often achieved with different approaches, the issue of which parameter set should be used frequently arises. This phenomenon is known as model equifinality.

Stochastic models attempt to mitigate these issues to some degree by representing modeled phenomena as a distribution of possible outcomes. A common implementation is to perturb input parameters, through use of Monte-Carlo simulations for example, and assess likely outcomes from the results. One advantage of this approach is that it is readily implemented late in the (otherwise deterministic) model construction timeline, as an added tool for result interpretation. Much of the literature ignores either expressly or, more often implicitly, the model uncertainty associated with model structure. This omission is particularly problematic in cases where two models are, in effect, joined into a super-structure.

This project emphasizes the formal quantification and handling of both model parameter and model structure components of the uncertainty problem throughout the model construction process. This is in stark contrast to approaches that attempt to qualify such issues during model interpretation phases. Through use of examples, this paper demonstrates how a revised approach can lead to improvements not only to individual component models (better model structure, better calibration) but also to more quantitative ways of balancing component models, and examining problems of sufficient complexity to require the use of coupled models.

6.2 METHODOLOGY

6.2.1 OVERVIEW

This paper proposes a revised methodology for coupling of a hydrological model with a water quality model, in an attempt, for instance, to depict the dynamics of riverine water quality throughout a watershed. Particular emphasis is placed on understanding the issue of equifinality and parameter sensitivity, important in understanding how component and coupled models behave under uncertainty. A case study is also presented.

6.2.2 CASE STUDY REGION

The Potomac Watershed stretches across approximately 38 000 km^2, of the Eastern US The Potomac River itself covers roughly 620 km from Fairfax Stone in West Virginia to Point Lookout in Maryland. The average river flow at the Washington, DC location is about 310 m^3/s, with minimum and maximum recorded flows of 17 m^3/s (September, 1966) and 12000 m^3/s (March, 1936), respectively. The watershed flows into Chesapeake Bay, becoming tidal near Washington DC where the river crosses the Fall Line into the Coastal Plain province. Downstream from here, the water becomes increasingly brackish with a gradual increase in salinity. This study limits itself to the purely freshwater and non-tidal portion of the Potomac River.

From 1991 to 1996, the US Geological Survey's (USGS) National Water Quality Assessment (NAWQA) program began extensive work in the basin to monitor surface and ground water quality and ecology. That dataset is used here, and draws on over 50 USGS stations to provide information on stream flow quantity. These data are available at temporal resolutions up to daily time steps for individual stations. Water quality data are available at 5 'integrator' and 5 'indicator' stations on a monthly basis. Point Sources loading the river system were identified from US EPA (2008). Model calibration was based on the 1993-1994 calendar year. The case study simulation also examines predictive results over the 1994-1995 calendar year.

Simulations in this paper were conducted using the continuous-simulation Annualized Agricultural Non Point Source (AnnAGNPS) pollutant loading model, which was developed by the US Department of Agriculture (USDA). AnnAGNPS is a comprehensive package, particularly suited for analyzing non-point source issues at the watershed level. The watershed is divided into homogeneous drainage areas which are in turn connected by a dendritic reach system. Water and pollutant loadings from individual fields are simulated as runoff events from rainfall, snowmelt, and irrigation data. Soil loss is calculated based on the Revised Universal Soil Loss Equation (RUSLE). The model also includes a substantial database with values of parameters for agricultural applications and management scenarios (cf. Bosh et al., 1998).

Water quality simulations were conducted using the conversion kinetics model of the widely used QUAL2E code (see Brown and Barnell, 1987). Typical constituents of interest in water quality models include dissolved oxygen, nutrients (e.g., nitrogen, phosphorus), and toxics (e.g., pesticides). An extensive review of water quality modeling approaches is beyond the scope of this paper, (but can be found in e.g., Rauch et al., 1998 or Bowie et al., 1985). In addition to dissolved oxygen, nitrogen (including nitrite tracking) and biodegradable organic matter demand, QUAL2E considers algal biomass, organic nutrient and phosphorus components.

6.2.3 Baseflow Separation

Data for flows were taken from the USGS Surface-Water Daily Data Set for the study period (USGS, 2007). Hydrograph separation was done using the Chapman filter equation, as implemented in the ABSCAN software (Parker, 2006). Digital filter techniques, originally used in signal analysis, were employed in a water resources context by Lyne and Hollick (1979) to separate high frequency (direct runoff) and low frequency (baseflow) components from the streamflow 'signal'. Chapman (1991) noted that the Lyne–Hollick algorithm incorrectly provides a constant streamflow Q, or baseflow b, when direct runoff has ceased and therefore developed the new equation:

$$b_t = \frac{3\alpha - 1}{3-\alpha} \cdot b_{t-1} + \frac{1-\alpha}{3-\alpha} \cdot (Q_t + Q_{t-1}) \qquad (5\text{-}4)$$

This equation calculates b at each timestep t given the associated Q. When the quick runoff component has ceased, the filter parameter α becomes the hydrological recession constant a in equation (5-5), commonly used to describe baseflow recession during dry weather periods without groundwater recharge:

$$b_k = ab_k - 1 \qquad (5\text{-}5)$$

The Chapman method was selected as it offered good performance with a single conceptually-based parameter, α. Values for α were estimated from historical records near the outlet of the study area, taken from Sinclair and Pitz (1999). Table 6.1 shows parameterization results of the Chapman filter, with values for α in each column and relative importance of baseflow to streamflow considered in the rows for 4 years (1992-1995). A final value of 0.5 was used in the model separation (cf. Table 6.1).

6.2.4 NPS MODEL EVALUATION

An analysis of uncertainty in the non-point source and hydrological loading component used here (i.e., AnnAGNPS) was conducted using the methodology outlined in Parker et al. (2008d).

Table 6.1: Baseflow Separation Parameterization Test Results for Station 1646500 (Outlet). $\tilde{x}$ indicates median Flow values.

	Chapman Parameter Value				
	0.40	**0.45**	**0.50**	**0.55**	**0.60**
1992					
Qbase:Qtotal	0.49925	0.49915	0.49902	0.49886	0.49866
$\tilde{x}$ base: $\tilde{x}$ total	0.50378	0.51131	0.52648	0.52851	0.52776
$\tilde{x}$ base	81.408	82.624	85.077	85.404	85.282
1993					
Qbase:Qtotal	0.50046	0.50052	0.50059	0.50069	0.50080
$\tilde{x}$ base: $\tilde{x}$ total	0.52458	0.52057	0.52293	0.52316	0.52564
$\tilde{x}$ base	92.043	91.340	91.754	91.794	92.229
1994					
Qbase:Qtotal	0.50005	0.50006	0.50007	0.50008	0.50010
$\tilde{x}$ base: $\tilde{x}$ total	0.52021	0.51903	0.51771	0.52442	0.53327
$\tilde{x}$ base	90.247	90.042	89.813	90.976	92.511
1995					
Qbase:Qtotal	0.49972	0.49968	0.49964	0.49958	0.49950
$\tilde{x}$ base: $\tilde{x}$ total	0.49494	0.49222	0.49471	0.49748	0.49700
$\tilde{x}$ base	94.827	94.305	94.782	95.314	95.221
Average					
Qbase:Qtotal	0.49987	0.49985	0.49983	0.49980	0.49977
$\bar{\tilde{x}}$base: $\bar{\tilde{x}}$total	0.51088	0.51078	0.51546	0.51839	0.52091
$\bar{\tilde{x}}$base	89.631	89.578	90.356	90.872	91.311

The first step in the approach was to determine the scales at which the NPS model behaves adequately for stochastic analysis. The goal of this stage was to identify a range of model delineation (lumped area and reach networks) which could permit Monte Carlo analysis around a given conceptual model and related parameter set. As the model delineation is also governed by the site topography, the analysis was performed on three sub-watersheds to isolate conceptual model issues over a plausible range of model structures. The model runs were populated with identical, grossly averaged, soil and land-use conditions in each case and the results were examined for changes in runoff volume and sediment transport. Any differences between model outputs, therefore, are products of the union between the discretization and conceptual structure of the model.

With a range of suitable scales for the conceptual model determined, the task now becomes to find the discretization that leads to suitable parameter representation in the same range. In a stochastic setting, parameters can be considered as distributions of plausible values rather than point values. Therefore, in such cases, it is most important to determine the scale which allows for a suitable distribution to be fitted to spatial data. The approach used here was to examine the spatial variation of these mapped runoff coefficient values and the effect of scale and structure changes on distribution and sampling issues. Several statistics were calculated via a geospatial information system (GIS) for each discretized area.

Results of the analysis in Parker et al. (2008d) suggest that scale selection in the AnnAGNPS model is limited by conceptual model uncertainty and stability issues rather than parameter uncertainty, which is more commonly used. The appropriate scale appears to be in a relatively narrow range of between 5-10 km^2 average cell area. Additionally, result sensitivity to parameter uncertainty seems to be minimized at near-optimal scales. Figures 6.1 and 6.2 present a summary of the findings in Parker et al. (2008d).

6.2.5 WATER QUALITY MODEL EVALUATION

An analysis of uncertainty associated with the data, calibration and conceptual model of the water quality model used here (i.e., the QUAL2E formulation) was conducted using the GLUE methodology as outlined in Parker et al. (2008b). Output of the model was compared for stochastic simulation of DO, BOD, and ammonia-N (NH_4). Initial ranges for water quality model parameters were estimated from literature values (Bowie et al., 1985).

The representative model set was then derived. The problem can be viewed as an inverse modeling exercise. A Generalized Likelihood Uncertainty Estimation (GLUE) algorithm, as outlined by Beven and Binley (1992), was used to identify which parameter sets provide an adequate representation of the river system water chemistry. In this technique, the focus is on estimating posterior distributions for predicted variables directly from the outputs of a set of representative models, rather than from a model and an additive residual model. The resulting set of models is further constrained by the calibration data and criteria (cf. Beven, 2001 and Rode et al., 2007), and contains information on the simulation output variability for all representative input sets. The representative set can be viewed as the range of water quality model realizations that conform to the calibration criteria, which in turn are constrained by the specific dataset used.

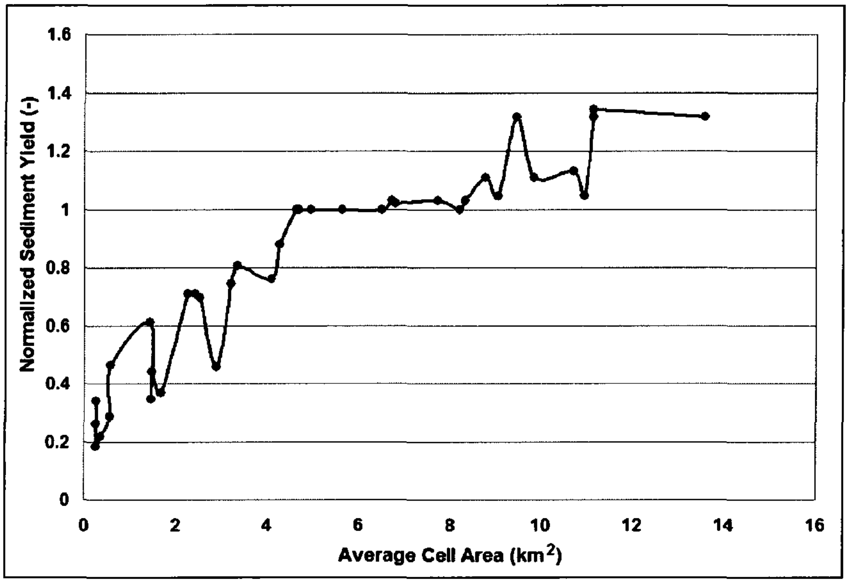


Figure 6.1: Sediment stability curve generated from normalized data for NPS model

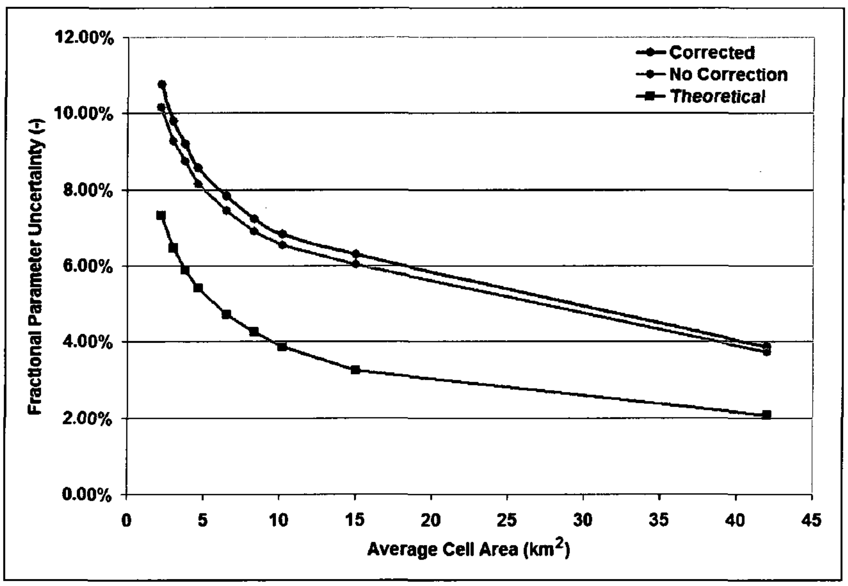


Figure 6.2: Fractional Parameter Uncertainty Change with respect to Discretization for NPS model.

The results in Parker et al. (2008b) quantified the response surface dispersion of the set of representative parameters for the QUAL2E conceptual model in the study region, for several calibration scenarios. It was noted that the calibration set and resulting surface response are also a function of the conceptual model structure itself (as examined in Parker et al., 2008c), as well as the data used for calibration. A representative plot of the analysis conducted is shown in Figure 6.3.

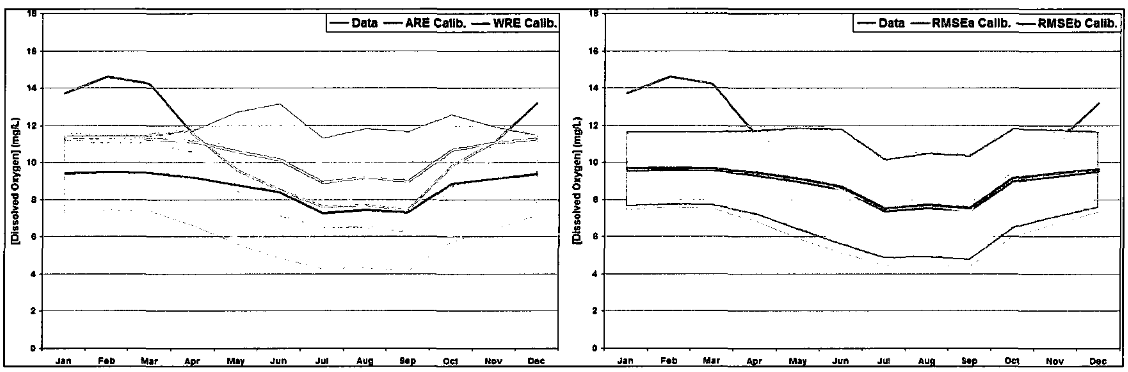


Figure 6.3. DO surface response (95%) for ARE, WRE, RMSEa and RMSEb calibrations Solid lines are mean of representative models.

6.2.6 MODEL RECONCILIATION

The original strategy proposed for this work called for the watershed model discretization to be altered across the space domain based on insights gained from the water quality inverse modeling exercise, and ultimately, by the combination of uncertainty structure of the model for a given water quality calibration criteria and dataset. In such an application, two discretization schemes in particular were proposed. The first, termed the 'balanced' strategy, called for the NPS model discretization to be adjusted to match the dispersion of water quality (WQ) models identified in the inverse modeling problem at points along each major reach. The second scenario which was proposed was the 'equal' strategy, which called for the dispersion of the NPS model to be added to that of the WQ model, and for this sum to be held as a constant throughout the watershed. The first scenario favours consistency of relative contribution to overall uncertainty across models, the second favours consistency of the coupled model uncertainty across the spatial domain.

However, results in Parker et al. (2008d) showed that the NPS model's structural uncertainty is very important at all scales, outside of a relatively narrow range of 'stable' discretization scales (consisting of cell areas from approximately 5-10 km^2). This sensitivity to scale dominates issues of parameter and water quality uncertainty to the extent that it effectively prohibits the use of the model in any reasonable stochastic sense outside that range. These results also call into question the validity of any model using Monte Carlo analysis on this particular code outside the stable region.

Given such a narrow range of suitable behaviour in the rainfall/runoff model, adjustments in model construction to ensure the relative balance of structural, conceptual, and parameter uncertainty conditions must be sought elsewhere. The water quality model response surface derived from the inverse approach is, as discussed in Parker et al. (2008c), a function of the calibration data set itself, the conceptual model, and the calibration criteria. Of these three, the calibration criteria are the most subject to modeler discretion, and also the most readily adjusted. An examination of the suitability of the calibration criteria, when compared with the NPS model response, was conducted.

In discussing model linkages and relative contribution to uncertainty, a common metric across models is needed. This paper focuses on the coefficient of variation (CV) for such purposes. The rationale for this is several-fold. First, the CV is a measure of distribution dispersion that is normalized to the mean value. As this is a dimensionless number, model CVs for, e.g., flows can be reasonably compared to values such as concentration. Equally, use of the CV for reporting and even statistical inference need not make an assumption about the population distribution in question (see, e.g., Sharma, 1994)

6.2.7 Simulation

A simulation was conducted with the coupled land-use and water quality models for the case study dataset. Calibration, as for Parker et al. (2008d), was conducted using the 365 days of 1993, and simulation results for 1994 conditions were compared with the corresponding data points. This simulation is not intended to be considered authoritative in any particular respect; however, it does provide the opportunity to illustrate the process and the resulting coupled model surface response as a forward product (in contrast, for instance, to the inverse response from Parker et al. 2008c).

6.3 Results

6.3.1 Model Reconciliation

The NPS model was tested for output response (parameter sensitivity) at scales where structural uncertainty effect were minimized, pursuant to the work presented in Parker et al. (2008d), and confirms some of the results found therein. Estimates of the parameter-related coefficient of variation observed in the NPS model response are shown in Figure 6.4. The parameter input fractional uncertainty (as derived in Parker 2008d) is shown on the plot, based on sampling of spatial variability (determined by land use data). The 6, 8 and 10 km models were then tested for parameter sensitivity alone, with the corresponding CV computed (points in Figure 6.4). The lines show estimates of these parameter-related CV points relative to changes in the fractional input parameter uncertainty.

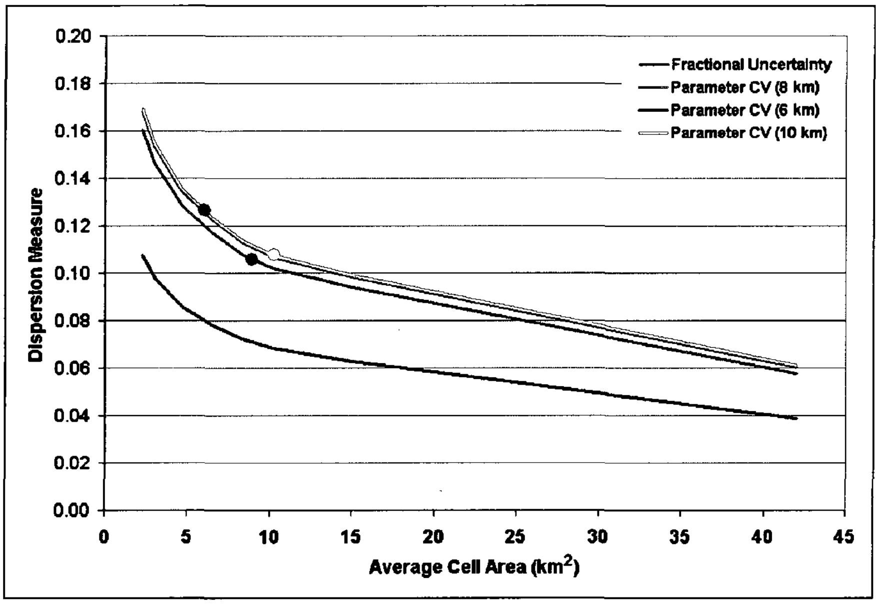


Figure 6.4: Parameter-Related Output Uncertainty for NPS model.

Notably, the parameter sensitivity is minimized in the middle region of the suitable model discretization scales (8 km^2) when compared with regions on the edges (6 and 10 km^2 cases). Though parameter-related uncertainties are also computed (as functions of fractional parameter uncertainty) for scales outside that range in Figure 6.4, in these cases the structural uncertainty dominates. This precludes optimization, and perhaps even reasonable consideration, of uncertainties associated with parameter sensitivity in these cases (see also Parker, 2008d).

With the surface response characteristics of the NPS model characterized, the corresponding responses of the water quality model can now be quantified relative to the first model. As previously discussed, in Parker (2008b,c) for instance, the quality model response is a function of the output data itself, the calibration criteria used to determine representative parameter sets, and of course the conceptual model itself Figure 6.5 shows the surface response, measured using the ACV metric, of two different conceptual models with two different calibration thresholds, as normalized to the response of the NPS model.

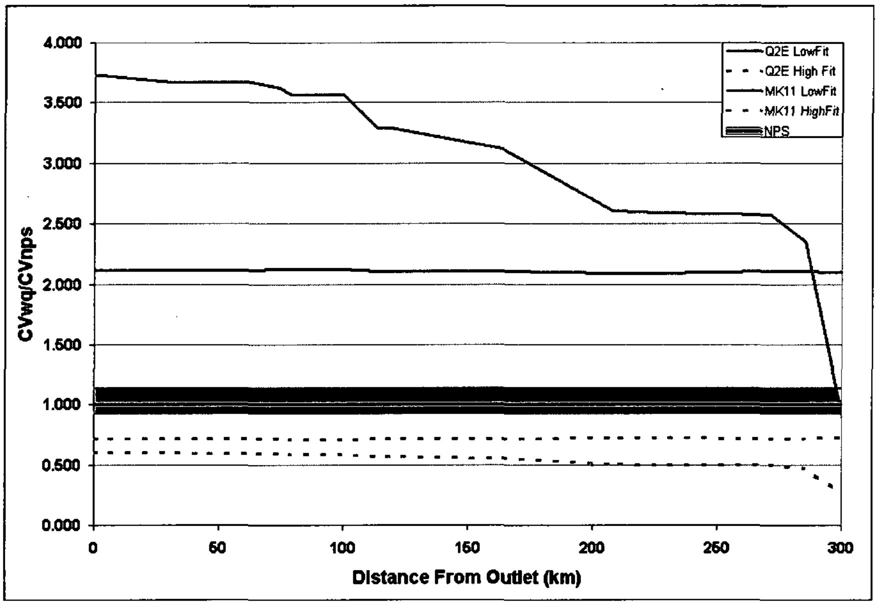


Figure 6.5: Surface Response of water quality models predictions normalized to rainfall//runoff model. CV_{wq} and CV_{nps} are the coefficient of variation associated with the WQ and NPS models, respectively.

As mentioned, each conceptual was subject to two calibration levels, a low fitness one, intended to include most model that could reasonably be considered representative, and a higher fitness one with better overall predictive ability. These strategies are discussed in further detail in Parker (2008c). Figure 6.5 is helpful in predicting how the joint response of the coupled rainfall/runoff and quality models will be affected by the individual responses at locations throughout the stream and cell network. The NPS model response is shown as a (narrow) range of parameter uncertainties (shaded region), corresponding to acceptable discretizations.

Generally, when the CV associated with the water quality model is much larger than this range, the quality model can be interpreted as under constrained when compared with the hydrological model, and contributes disproportionately to uncertainty in the coupled model output. The water quality data are then being under used. Conversely, when the water quality CV is too low, the data and calibration are constraining the parameter set to such an extent that the NPS model is not contributing much information (or not reducing the range of plausible values), and the quality is essentially over calibrated.

As can be seen in Figure 6.5, the Mike11 conceptual model response can change significantly depending on the proximity to data points, whereas the QUAL2E model tends to be relatively more even throughout the watershed. While this, as discussed in Parker et al. (2008b), may pose a disadvantage for QUAL2E in many applications (for instance, scenarios where a wider range of structurally stable rainfall/runoff discretizations could be explored), in this particular case, it means that both the approximately 'balanced' and 'equal' uncertainty coupling strategies proposed are likely to be best met by the QUAL2E conceptual model. Indeed, both conditions can be approximately met with the same discretization. In this case, the QUAL2E high fit calibration criteria provided the best match of water quality parameter uncertainty to NPS model structural uncertainty.

The model response can be further defined by examination of the relative contribution of CV for individual calibration criteria (e.g., for BOD, as in Figure 6.6).

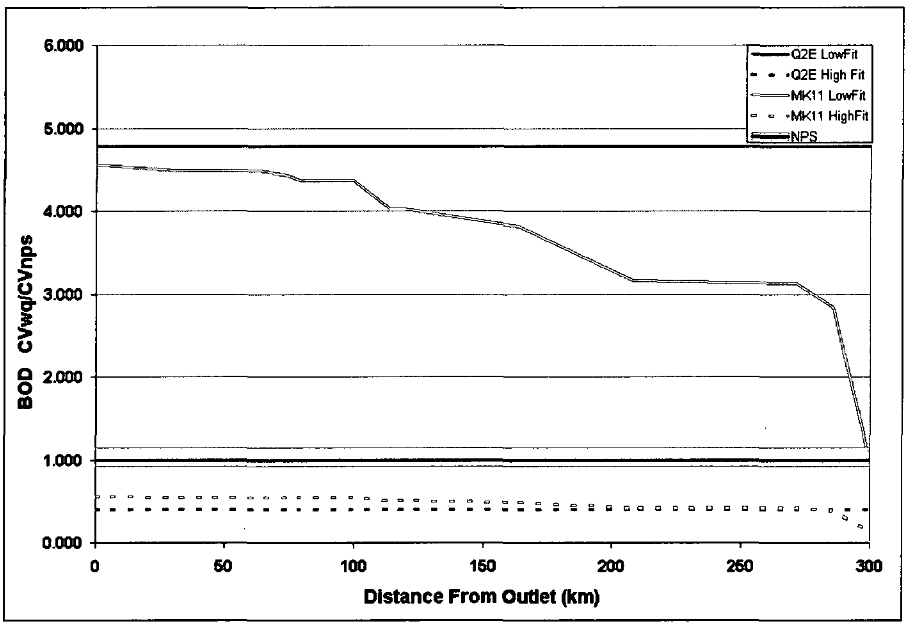


Figure 6.6: Surface Response of BOD predictions normalized to rainfall//runoff model.

Such information can potentially identify circumstances when adjustment of calibration criteria for individual components may be advantageous.

6.3.2 CASE STUDY SIMULATION

As discussed in the methodology section, and in more detail in previous papers, the case study run set was calibrated using the 1993 dataset. Figure 6.7 shows the rainfall/runoff modeled and observed streamflow values for that period in the first 365 points, followed by the 1994 simulation results and data. Precipitation data are shown on the second axis.

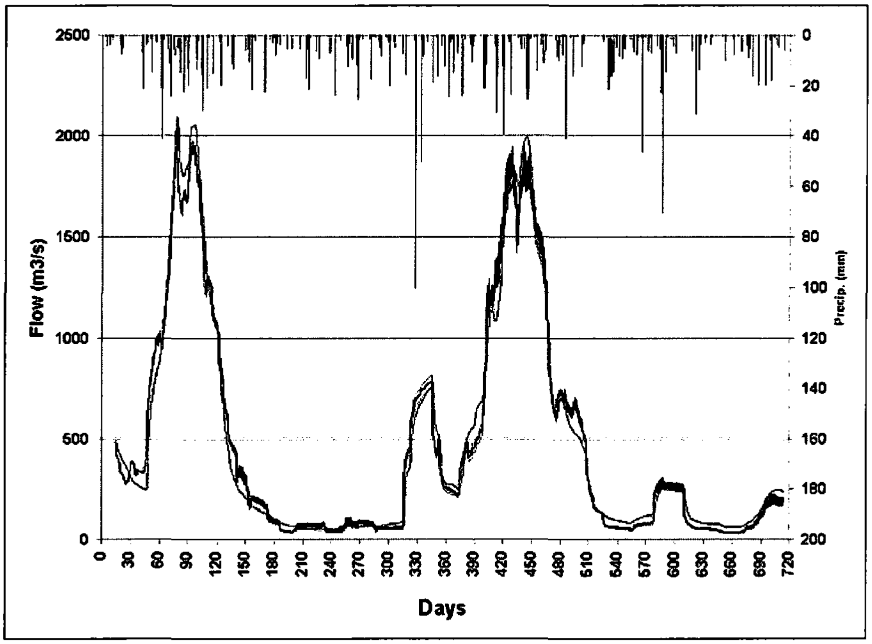


Figure 6.7: Simulated (in blue) and Observed (in Orange) Catchment Response, plotted as 30 d average flows vs. precipitation.

The modeled values in Figure 6.7 are displayed as ranges, derived from a Monte Carlo sensitivity analysis around the calibrated conditions of the 8 km^2 discretization case. The range of values tested was derived from the corresponding parameter uncertainty at that scale, as derived from spatial statistics (see Parker, 2008d). Overall, the fit to data is quite good, though the model appears to somewhat under predict flows during relatively dry periods. This may be due to baseflow separation, climate information, or issues related to the particular calibration methodology used, s as discussed in Parker 2008d.

Water and nutrient loading results from the NPS model were then used to feed a series of water quality simulations, based on the QUAL2E conceptual model. Parameter ranges for kinetics were derived from the 'high-fitness' calibration. Defined in Parker et al. (2008c), this calibration is weighted to station data based on flow at that station, and considers all parameter sets that predict DO and NH_4 species concentrations within 25% of observed values and BOD concentration within 50% of observed data at the outlet. As shown in Figure 6.5, and discussed previously, this particular calibration leads to an approximately balanced model construction, with a relatively constant combined uncertainty as an additional benefit. A slightly less stringent calibration criterion could also have been used had the balance between the two models not been deemed acceptable, as it was in this case.

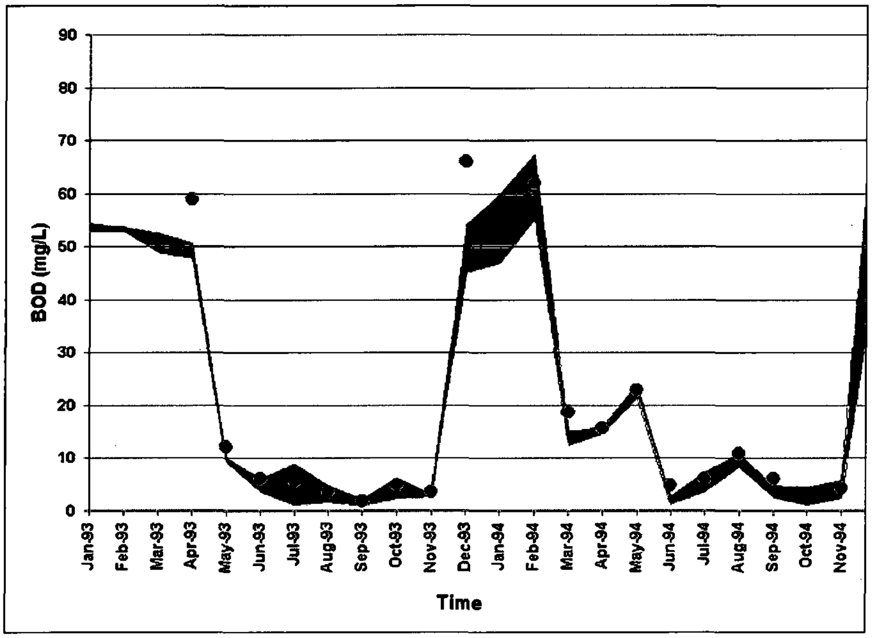


Figure 6.8: Simulated vs. Observed in-stream BOD concentration at outlet, for the 1993-1994 period.

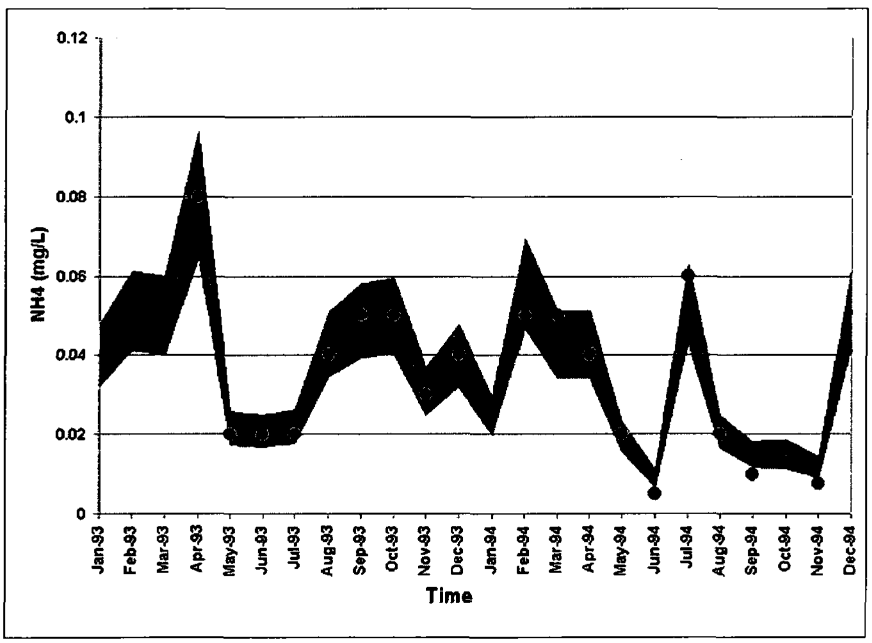


Figure 6.9: Simulated vs. Observed in-stream NH4-species concentration at outlet, for the 1993-1994 period.

Figures 6.8 and 6.9 show coupled simulation results (in blue) for water quality constituents at the outlet, with available data points shown in orange.

Overall the simulation results are quite good. The inverse model suggested in-stream constituents such as the ammonia species could be well predicted, and the results depicted in Figure 6.9 appear to confirm this. More interestingly, perhaps, is the improvement that can be seen in Figure 6.8 for BOD, which is one of the constituents more closely associated with areal sources and runoff events. It is clear, in this plot, that the inflow of a relatively large amount of data on landuse, management, climate and topography, as interpreted by the NPS model, has greatly improved the predictive ability of the coupled model. This, of course, is precisely why the use of coupled models is often necessary, and particularly valuable in dynamic simulation.

6.4 Discussion and Conclusions

The approach proposed here allowed for a detailed examination of coupled watershed hydrology and water quality model construction, particularly in view of stochastic problems.

One key finding was that an approximate balance of water quality and hydrological model response can be obtained using both the QUAL2E and Mike11 water quality models. The balance point, however, does not support a particularly narrow surface response (or stringent calibration criteria) with respect to the water quality calibration data, at least in the case examined here. Additionally, the QUAL2E model structure may be advantageous for problems where a constant or balanced uncertainty condition is desired. This may be counterintuitive, given, for instance, the relatively good performance of the Mike11 in calibration tests (as shown in Parker, 2008b). It is due, however, not only to QUAL2E's relative surface response inertia, but just as importantly to the narrow range of suitable discretizations in the NPS model used here.

Improvements in the balance point can potentially be sought in several ways. First, additional data for use in the landuse model can help to narrow the reasonable range of model responses after calibration. As that response narrows, additional riverine water quality data (and/or more stringent calibration criteria) can improve spatial and temporal calibration stringency by minimizing, for instance, the relative weight of data and sampling uncertainty in the calibration set.

Just as importantly however, are the structural limitations evident in Parker et al. (2008d), that are restated here. Indeed, the effect of structural/conceptual uncertainty outside a narrow range dwarfs that of parameter uncertainty, where, it is fair to say, a disproportionate amount of effort has, and continues to be, spent. Improvements in coupled model construction can be sought here, by judicious selection of model structure (and discretization), as well perhaps as use of conceptual models more stable with respect to scale variations.

Some of these issues, such as the suitability of a water quality conceptual model, the suitability of calibration criteria, and the specific response associated with a sparse dataset, are no doubt associated with the particular topography, topology and other characteristics of the study region examined here. Others, such as conceptual model stability with respect to scale, model inertia or parameter sensitivity, are more likely tied to the specific tools used in this study. The approach proposed, however, can be readily applied to a wide variety of deterministic codes that are currently in regular use for coupled model applications under uncertainty. Such an analysis, as demonstrated here, can yield valuable information on model behaviour, and readily suggests opportunities for improvement in coupled model use and interpretation.

6.5 REFERENCES

Beven, K.J. (2001) Calibration, validation and equifinality in hydrological modeling. In M.G.Anderson and P.D. Bates, editors, Validation in Hydrological Modeling. John Wiley and Sons, Chichester, UK.

Beven, K.J. and Binley, A.M. (1992) The future of distributed models: model calibration and predictive uncertainty. Hydrological Processes, 6, 279-298.

Bosh, D., Theurer, F., Binger, R., Felton, G., and Chaubey, I. (1998) "Evaluation of the AnnAGNPS water quality model." ASAE Paper No. 98-2195, St. Joseph, MI.

Bowie G.L., Mills W.B., Porcella D.B., Campbell C.L., Pagenkopf J.R., Rupp G.L., Johnson K.M., Chan P.W.H., Gherini S.A., and Chamberlin C.E. (1985) Rates, Constants, and kinetics formulations in surface water quality modeling (Second Edition). Report EPA/600/3-85/040, US EPA, Athens, GA.

Chapman T.G. 1991. Comment on 'Evaluation of automated techniques for base flow and recession analyses' by R.J. Nathan and T.A. McMahon. Water Resources Research 27: 1783–1784.

Lyne VD, Hollick M. 1979. Stochastic time-variable rainfall runoff modeling. Hydrology and Water Resources Symposium, Institution of Engineers Australia, Perth; 89–92.

Parker, G. 2006. Automated Baseflow Separation for Canadian Datasets (ABSCAN): User's Manual. Thinknew Analytics. Ottawa, Canada. http://www.thinknew.ca/.

Parker, G.T., Droste, R.L., and Kennedy, K.J. (2008a) Modeling the effect of agricultural best management practices on water quality under various climatic scenarios. Journal of Env. Eng. and Sci., 7, 1, 9-19.

Parker, G.T., Droste, R.L., and Rennie, C.D. (2008b) An objective test of stochastic behaviour in riverine water quality models. International Water Association World Water Congress, Vienna.

Parker, G.T., Droste, R.L., and Rennie, C.D. (2008c) Stochastic calibration of riverine water quality models. Water Environment Federation Annual Technical Exhibition and Conference, Chicago, IL.

Parker, G.T., Droste, R.L., and Rennie, C.D. (2008d) Model structure and uncertainty for stochastic non-point source modeling applications (in preparation).

Rauch W., Henze M., Koncsos L., Reichert P., Shanahan P., Somlyódy L., and Vanrolleghem P.A. (1998) River water quality modeling: I. State of the art. Wat. Sci. Tech. 38(11), 237-244.

Rode, M., Suhr, U., and Wriedt, G. (2007) Multi-objective calibration of a river water quality model—Information content of calibration data. Ecological Modeling 204(1-2), 129-142.

Sharma, K.K. (1994). Asymptotic sampling distribution of inverse coefficient-of-variation and its applications. IEEE Transactions on Reliability 43 (4), 630-633.

US EPA (2008). Chesapeake Bay Phase 5 Community Watershed Model In preparation EPA XXX-X-XX-008 Chesapeake Bay Program Office, Annapolis, MD.

USGS (2007). USGS Surface-Water Daily Data for the Nation. National Water Information System: Web Interface. http://waterdata.usgs.gov/ne/nwis/sw. Accessed January 2007.

CHAPTER 7

CONCLUSIONS

7.1 SUMMARY OF RESULTS

7.1.1 WATER QUALITY MODELING ISSUES

The suggested use of GLUE methodologies can be used to test conceptual model structure and model calibration criteria suitability for specific applications.

A common theme that emerged from the conceptual model comparison was the importance of understanding the response characteristics. As an example, in the chosen case study, an annually calibrated stochastic MIKE11 model might be deemed useful for monthly simulation. The results suggest that a similarly calibrated QUAL2E model could be decidedly less suitable, depending on the type of problem addressed. Additionally, while both models appear to have approximately the same predictive ability for given set of calibration criteria, the MIKE11 model appears far more sensitive to data availability. At least in this study, the MIKE11 model response changed greatly depending on the proximity to calibration points, while the QUAL2E model tended to improve less rapidly near high data locations, but also to degrade less when it was away from such locations. This finding, and type of analysis, has important ramifications for the development of data sampling schemes and model selection in sparse vs. dense data situations.

The calibration tests reiterate the importance of model structure and data flow issues in determining appropriate use of a model. The key contention of the calibration study, illustrated by example, was that the RMSE, though in wide use, is in several respects disadvantageous as the calibration criteria itself in stochastic analysis, and particularly uncertainty analysis. Instead, the use of lossless criteria, spatially weighed criteria, and/or exceedance criteria may be preferable for many real-world applications. One distinct feature of any such calibration criterion is the ability for calibration to fail (no suitable parameter set found) given an unsuitable criteria or dataset.

The results of these studies will help users select and assess models for varied problems, and refine appropriate data collection and monitoring schemes. The findings and type of analysis illustrated have ramifications for the development of data sampling schemes and interpretation as well as calibration and conceptual model selection (or construction) themselves.

7.1.2 NPS MODELING ISSUES

The rainfall/runoff assessment methodology presented is for a reasonable stochastic analysis of pollutant loading problems given a deterministic-based code. The inherent problems of such approaches notwithstanding, such models remain by far the most commonly used tools for many important problems (e.g., TMDL), and a need to conduct reasonable analysis of uncertainty of new and old models is evident. The type of analysis presented can assess how such models may be reasonably applied (and then perturbed via, e.g., Monte-Carlo analysis), and how structural decisions affect the uncertainty associated with the parameterization and the simulation results itself.

In the case presented here (and, it is suggested, most others with comparable models), the uncertainties associated with parameterization and parameter sensitivity are outweighed in significance with those resulting from structural and conceptual decisions. It is hoped that this may shed some light on the relative importance of (parameter) calibration and uncertainty analysis as they are generally used.

7.1.3 COUPLED MODEL ISSUES

The final paper presented a detailed examination of coupled watershed hydrology and water quality model construction, particularly in view of stochastic problems. One key finding was that an approximate balance of water quality and hydrological model response can be obtained using both the QUAL2E and Mike11 water quality models.

Improvements in the balance point can potentially be sought in several ways. First, additional data for use in the landuse model can help to narrow the reasonable range of model responses after calibration. As that response narrows, additional riverine water quality data (and/or more stringent calibration criteria) can improve spatial and temporal calibration stringency by minimizing, for instance, the relative weight of data and sampling uncertainty in the calibration set.

Just as important however, are the structural limitations. Indeed, the effect of structural/conceptual uncertainty outside a narrow range dwarfs that of parameter uncertainty, where, it is fair to say, a disproportionate amount of effort has, and continues to be, spent. Improvements in coupled model construction can be sought here, by judicious selection of model structure (and discretization), as well perhaps as use of conceptual models more stable with respect to scale variations.

Some of these issues, such as the suitability of a water quality conceptual model, the suitability of calibration criteria, and the specific response associated with a sparse dataset, are no doubt associated with the particular topography, topology and other characteristics of the study region examined here. Others, such as conceptual model stability with respect to scale, model inertia or parameter sensitivity, are more likely tied to the specific tools used in this study. The approach proposed, however, can be readily applied to a wide variety of deterministic codes that are currently in regular use for coupled modeled applications under uncertainty; such an analysis, as demonstrated here, can yield valuable information on model behaviour, and readily suggests opportunities for improvement in coupled model use and interpretation.

7.2 CONCLUSIONS

This study proposed a fundamental rethink of the overall algorithmic approach to coupled modeling of watershed and the associated riverine systems therein. The implementation of specific numerical techniques for a given modeling task almost always involves a series of uncertain decisions with several contrasting candidate approaches. A word of note on the guiding principles of the decision-tree associated with this particular realization follows.

In an attempt to characterize the processes stochastically, the proposed methodology includes the generation at several steps of many Monte-Carlo type simulations. The objective each time this technique is used is a set of parameter and model realizations that are as self-consistent and consistent with available data as possible. The advantages of a fairly simple, broadly applied sampling method that allows for complex parameter interaction, equifinality, and many different types of performance measures are deemed to outweigh the associated disadvantages, chiefly the increased requirement for high performance and/or parallel computing resources.

Emphasis has also been placed on using broadly reproducible methods, not only in terms of code design (e.g., robust pseudo-random number generation with seed values), but also with respect to data and conceptual model requirements. The methodology proposed is based, whenever possible, on choosing data sources and processing methods that minimize the need for qualitative assessments. While the approach does not preclude adjustments based on user expertise, it minimizes the need for extensive interpretation between data processing steps, a feature which not only simplifies user input, but also facilitates future use and interpretation of the model, due to the high reproducibility of each step. Additionally, this approach enables two models, distinct in time and location, to be compared for additional insights or planning at higher scales.

While attempts to identify uncertainty issues are nothing new (see the above Literature Review section for an overview), the approach specified in this proposal does have some distinguishing features, particularly with respect to water quality applications. As noted by Gupta et al. (1998):

'We disagree with the seemingly widespread conviction that the model calibration problem will simply disappear with the availability of more and better field measurements. This paper suggests that the emergence of a new and more powerful model calibration paradigm must include recognition of the inherent multiobjective nature of the problem and must explicitly recognize the role of model [structure] error.'

Previous work (e.g., Vrugt et al., 2005) has focused extensively on finding analytical solutions to these types of errors, based either on relatively simple conceptual models themselves, or on relatively simple characterization of model response. As a result, these approaches have found limited applications in real world problems, where relatively complex models, generally designed for deterministic problems, are used to answer relatively complex questions.

The state-of the-art, in this respect, is not unlike that of a common game, chess. In stark contrast to watershed systems, comprised of thousands of state variables, unclear land, soil and hydrological boundaries, and imperfect conceptual models, chess is a relatively simple problem. The coordinate system is two-dimensional, with each subdivision falling into one of two classes. There are 7 types of components, with well defined rules governing movement through time and space. Initial conditions are absolute and known, and the entire system can, at any time, be described with 32 state variables or less. Despite the relative simplicity of the chess system, no analytical solution has ever been found. But programs and computers that play chess far better than most humans are able to can still be built. This is accomplished largely through the use of quantitative metrics, values based on both objective and heuristic concepts (such as 'pawn structure', 'material', and 'king safety') that can be used to evaluate the relative strength or importance of one set of positions when compared to another. This is the space that the work proposed here hopes to occupy.

It is believed that the methodology outlined here is consistent with this ideology, and does begin to explicitly address the uncertainty and error associated with model structural features, at both the component model and coupled model level. The methodology used can be readily applied to a wide variety of computer codes and conceptual models, without extensive modification thereof, and offers the ability to generate and observe quantitative metrics at several stages. These metrics have applications beyond the construction of new models and can be used to qualify and reconcile results from third-party models.

REFERENCES

Abbott, M.B., Bathurst, J.C., Cunge, J.A., O'Connell, P.E., and Rasmussen, J. (1986a) "An introduction to the European Hydrologic System-Systeme Hydrologique Europeen, SHE, 1: History and philosophy of a physically-based, distributed modeling system." J. Hydrol., 87, 45–59.

Abbott, M.B., Bathurst, J.C., Cunge, J.A., O'Connell, P.E., and Rasmussen, J. (1986b) "An introduction to the European Hydrologic System-Systeme Hydrologique Europeen, SHE, 2: Structure of a physically-based, distributed modeling system." J. Hydrol., 87, 61–77.

Adar, E.M. and Neuman, S.P. (1988) "Estimates of spatial recharge distribution using environmental isotopes and hydrochemical data, II. Application to Aravaipa Valley in Southern Arizona, USA." J. Hydrol., 97, 279–302.

Bathurst, J.C. (1986) "Sensitivity analysis of the Systeme Hydrologique European (SHE) for an upland catchment." J. Hydrol., 87, 103–123.

Beasley, D.B., Huggins, L.F., and Monke, E.J. (1980) "ANSWERS: a model for watershed planning." Trans. ASAE, 23, 938–944.

Beven, K. (1993) "Prophecy, reality and uncertainty in distributed hydrololgical modeling." Advance in Water Resources, 16, 41-51.

Beven, K. and Binley, A.M. (1992) "The future of distributed models: model calibration and predictive uncertainty." Hydrological Processes, 6, 279-298.

Beven, K. J. (2001) Calibration, validation and equifinality in hydrological modeling. in M.G.Anderson and P.D. Bates, eds., Validation in Hydrological Modeling. John Wiley and Sons, Chichester, UK.

Blöschl, G., Grayson, R.B., and Sivapalan, M. (1995) "On the representative elementary area (REA) concept and its utility for distributed rainfall-runoff modeling." in J.D.Kalma and M. Sivapalan (eds.) Scale issues in hydrological modeling, John Wiley & Sons, Chichester, 71-88.

Blöschl, G. (2001), "Scaling in hydrology." Hydrological Processes 15: 709-711.

Bocchiola, D. (2007) "Use of scale recursive estimation for assimilation of precipitation data from TRMM (PR and TMI) and NEXRAD." Advances in Water Resour., 30(11), 2354-2372.

Borah, D.K. and Bera, M. (2003) "Watershed-scale hydrologic and nonpoint-source pollution models: review of mathematical bases." Trans. of the ASAE. Vol. 46(6), 1553-1566.

Borah, D.K. and Bera, M. (2004) "Watershed-scale hydrologic and nonpoint-source pollution models: Review of applications." Trans. of the ASAE. Vol. 47(3), 789-803.

Bosh, D., Theurer, F., Binger, R., Felton, G., and Chaubey, I. (1998) "Evaluation of the AnnAGNPS water quality model." ASAE Paper No. 98-2195, St. Joseph, MI.

Bowie G.L., Mills W.B., Porcella D.B., Campbell C.L., Pagenkopf J.R., Rupp G.L., Johnson K.M., Chan P.W.H., Gherini S.A., and Chamberlin C.E. (1985) Rates, constants, and kinetics formulations in surface water quality modeling (Second Edition). Report EPA/600/3-85/040, US EPA, Athens, GA.

Brown L.C. and Barnwell T.O. (1987) The enhanced stream water quality models QUAL2E and QUAL2E-UNCAS: Documentation and user manual. Report EPA/600/3-87/007, US EPA, Athens, GA.

Brewster, K., White, L., Johnson, B., and Brotzge, J. (2005) "Selecting the sites for casa netrad, a collaborative radar network." 85th AMS Annual Meeting, American Meteorological Society - Combined Preprints, 3715-3722

Chapman TG. 1991. Comment on 'Evaluation of automated techniques for base flow and recession analyses' by R. J. Nathan and T. A. McMahon. Water Resources Research 27: 1783–1784.

Chen, J.M., Chen, X., Ju, W., and Geng, X. (2005) "Distributed hydrological model for mapping evapotranspiration using remote sensing input." J. of Hydrology 305 (1-4), 15-39.

Chen, Z.Q., Govindaraju, R.S., and Kavvas, M.L. (1994a) "Spatial averaging of unsaturated flow equations under infiltration conditions over areally heterogeneous fields: 1. Development of models." Water Resour. Res., 30(2), 523–533.

Chen, Z.Q., Govindaraju, R.S., and Kavvas, M.L. (1994b) "Spatial averaging of unsaturated flow equations under infiltration conditions over areally heterogeneous fields: 2. Numerical simulations." Water Resour. Res., 30(2), 535–548.

Clarke, R.T. (1973) "A review of some mathematical models used in hydrology, with observations on their calibration and use." J. Hydrol., 19, 1–20.

Coskun, H.G. (2008) "An integrated approach for environmental security in the nato countries based on remote sensing and GIS technologies ". NATO Security through Science Series C: Environmental Security, 3-15.

Cummings, N.W. (1935) "Evaporation from water surfaces: Status of present knowledge and need for further investigations." Trans., AmGeophys. Union, 16(2), 507–510.

De Roo, A.P.J., Hazelhoff, L., and Heuvelink, G.B.M. (1992) "The use of Monte Carlo simulations to estimate the effects of spatial variability of infiltration on the output of a distributed hydrological and erosion model." Hydrological Processes, 6, 127-143.

DHI (1992). MIKE 11 User Manual. Danish Hydraulic Institute, Denmark.

Duda, P.B., Kittle, J.L., Gray, M.H., Hummel, P.R., Kinerson, R.S., Cocca, P., Wells, D., Wellman, M., Partington, E., and MacWilliams, L.. 2003. BASINS 4.0 - Flexible Integration of Components and Data for Watershed Assessment and TMDL Development. WEF TMDL 2003, November 16-19, 2003. Chicago, IL. WEF Specialty Conference Proceedings on CD-ROM.

Dunkle, S.A., Plummer, L.N., Busenberg, E., Phillips, P.J., Denver, J.M., Hamilton, P.A., Michel, R.L., and Coplen, T.B. (1993) "Chloroflurocarbons (CC13F and CC12F2) as dating tools and hydrologic tracers in shallow groundwater of the Delmarva Peninsula, Atlantic Coastal Plain, United States." Water Resour. Res., 29, 3837–3860.

Duan, Q., Sorooshian, S., and Gupta, V. (1992) "Effective and efficient global optimization for conceptual rainfall-runoff models." Water Resour. Res., 26(4), 1015-31.

Fortin, J.P., Turcotte, R., Massicotte, S., Moussa, R., Fitzback, J., and Villeneuve, J.P. (2001a) "A distributed watershed model compatible with remote sensing and GIS data. I: Description of model." J. Hydrologic Eng., 6(2), 91–99.

Fortin, J.P., Turcotte, R., Massicotte, S., Moussa, R., Fitzback, J., and Villeneuve, J.P. (2001b) "A distributed watershed model compatible with remote sensing and GIS data II: Application to Chaudiere watershed." J. Hydrologic Eng., 6(2), 100–108.

Freer, J., Beven, A.M., and Ambroise, B. (1996) "Bayesian estimation of uncertainty in runoff prediction and the value of data: An application of the GLUE approach." Water Resour. Res., 32, 2161–2173.

Gashing, J., Reboh, R., and Rewiter, J. (1981) "Development of a knowledge-based expert system for water resource problems." Final Rep. Stanford Research Institute, Menlo Park, CA.

Gerhart, J.M., (1991) "National water-quality assessment program--The Potomac River basin" US Geological Survey Open-File Report 91-157.

Goodrich, D. and Woolhiser, D.A. (1991) "Catchment hydrology." Rev. Geophys., 29, 202–209.

Grayson, R.B. and Blöschl, G. (2001) "Spatial patterns in catchment Hydrology: Observations and Mmodeling. Eds., Cambridge University Press, Cambridge, UK, 404 pp.

Green, W.H. and Ampt, C.A. (1911) "Studies on soil physics: 1. Flow of water and air through soils." J. Agric. Sci., 4, 1–24.

Gupta, H.V., Sorooshian, S., and Yapo, P.O. (1998) "Toward improved calibration of hydrologic models: Multiple and noncommensurable measures of information." Water Resour. Res., 34(4), 751–763.

Häkanson, L. (1996) "A general method to define confidence limits for model predictions based on validations." Ecological Modeling, 91, 153-168.

Hall, J. and Anderson, M.G. (2002) "Handling uncertainty in extreme or unrepeatable hydrological processes – the need for an alternative paradigm." Hydrological Processes 16, 1867-1870.

Heuvelink, G.B.M. (1992) "Error Propagation in Quantitative Spatial Modeling: Applications in Geographical Information Systems." Netherlands Geographical Studies, Knag/Faculteit Ruimtelijke Wetenschappen Universiteit Utrecht, Utrecht.

Horton, R.E. (1919). "Rainfall interception." Monthly Weather Rev., 147, 603–623.

Horton, R.E. (1933) "The role of infiltration in the hydrologic cycle." Trans., Am. Geophys. Union, 145, 446–460.

Horton, R.E. (1935) "Surface runoff phenomena, Part 1—Analysis of hydrograph." Horton Hydrology Laboratory Publication No. 101, Voorheesville, NY.

Horton, R.E. (1939) "Analysis of runoff plot experiments with varying infiltration capacities." Trans., Am. Geophys. Union 20(IV), 683–694.

Horton, R.E. (1940) "An approach toward a physical interpretation of infiltration capacity." Soil Sci. Soc. Am. Proc., 5, 399–417.

Horton, R.E. (1945) "Erosional development of streams and their drainage basins: Hydrophysical approach to quantitative geomporphology." Bull. Geol. Soc. Am., 56, 275–370.

Hubbert, M.K. (1956) "Darcy's law and the field equations of the flow of underground fluids." Trans. of the Am. Institute of Mining, Metallurgical and Petroleum Engineers 207, 222-239.

Hughes, D.A. (1993) "Variable time intervals in deterministic hydrological models." J. Hydrol. 143, 217–232.

Hursh, C.R. (936) "Storm water and absorption." Trans., Am. Geophys. Union, 17(II), 301–302.

Hursh, C.R. (944). "Appendix B—Report of the subcommittee on subsurface flow." Trans., Am. Geophys. Union, 25, 743–746.

Hursh, C.R. and Brater, E.F. (1944) "Separating hydrographs into surface- and subsurface-flow." Trans., Am. Geophys. Union, 25, 863– 867.

Hsu, K. L., Gupta, H. V., and Sorooshian, S. (1995) "Artificial neural network modeling of the rainfall-runoff process." Water Resour. Res., 31(0), 2517–2531.

Julien, P.Y., Saghafian, B., and Ogden, F.L. (1995) "Raster-based hydrologic modeling of spatially varied surface runoff." Water Resour Bull., 31(3), 523–536.

Kavvas, M.L. Chen, Z.-Q., Tan, L., Soong, S.-T., Terakawa, A., Yoshitani, J. and Fukami, K. (1998) "A regional scale land surface parameterization based on areally-averaged hydrological conservation equation." Hydrol. Sci. J., 43(4), 611–631.

Kavvas, M.L. (1999) "On the coarse-graining of hydrologic processes with increasing scales." J. Hydrol. 27, 191–202.

Kaya, S., Sokol, J., and Pultz, T.J. (2004) "Monitoring environmental indicators of vector-borne disease from space: a new opportunity for RADARSAT-2". Can. J. Remote Sensing, 30(3), 560–565.

Kite, G.W. and Kouwen, N. (1992) "Watershed modeling using land classification." Water Resour. Res., 28(2), 3193–3200.

Klepper, O., Scholten, H., and van de Kamer, J.P.G. (1991) "Prediction uncertainty in an ecological model of the Oosterschelde estuary." J. Forecast., 10, 191–209.

Klepper, O. (1997) "Multivariate aspects of model uncertainty analysis tools for sensitivity analysis and calibration." Ecological Modeling, 101, 1-13.

Kuczera, G. (1983a) "Improved parameter inference in catchment models.1: Evaluating parameter uncertainty." Water Resour. Res., 19, 1151–1162.

Kuczera, G. (1983b) "Improved parameter inference in catchment models. 2: Combining different kinds of hydrologic data and testing their compatibility." Water Resour. Res., 19, 1163–1172.

Leavesley, G.H., and Stannard, L.G. (1990) "Application of remotely sensed data in a distributed parameter watershed model." Proc., Workshop on Applications of Remote Sensing in Hydrology, National Hydrologic Research Center, Environment Canada, Saskatoon, SK.

Legates, D.R. and McCabe, Jr., G.J. (1999) "Evaluating the use of 'goodness-of-fit' measures in hydrologic and hydroclimatic model validation." Water Resour. Res., 35, 233-241.

Liao, S-H. (2005) "Expert system methodologies and applications—a decade review from 1995 to 2004." Expert Systems with Applications, 28(1) January 2005, 93-103.

Liu, Y., Guo, H., Zhang, Z., Wang, L., Dai, Y., and Fan, Y. (2007) "An optimization method based on scenario analysis for watershed management under uncertainty." Environmental Management 39(5), 678-690.

Loague, K.M. (1988) "Impact of rainfall and soil hydraulic property information on runoff predictions at the hillslope scale." Water Resour. Res., 24(9), 1501–1510.

Lorrai, M. and Sechi, G.M. (1995) "Neural nets for modeling rainfall/runoff transformations." Water Resour. Manage., 9, 299–313.

Lyne VD, Hollick M. 1979. Stochastic time-variable rainfall runoff modeling. Hydrology and Water Resources Symposium, Institution of Engineers Australia, Perth; 89–92.

Mark, D.M. (1978) "Concepts of 'data structure' for digital terrain models." Proc., Symposium on DTMs, American Society of Photogrammetry/American Congress of Surveying and Mapping, St. Louis, MO.

Marsili-Libelli, S. and Giusetti, E. (2008) Water quality modeling for small river basins. Environmental Modeling and Software, 23(4): 451-463.

McCuen, R.H. (2004) Hydrologic Analysis and Design (3rd edition). Prentice Hall, Upper Saddle River, NJ.

McCutcheon, S.C. (1989). Water Quality Modeling: Volume I, Transport and Surface Exchange in Rivers, CRC Press, Boca Raton, FL.

Molnar, D.K. and Julien, P.Y. (2000) "Grid-size effects on surface runoff modeling." J. Hydrologic Eng., 5, 8–16.

Moore, I.D. and Grayson, R.B. (1991) "Terrain-based catchment partitioning and runoff prediction using vector elevation data." Water Resour. Res., 27(6), 1177–1191.

Moore, I.D., O'Loughlin, E.M., and Burch, G.J. (1988a) "A contourbased topographic model for hydrological and ecological applications." Earth Surf. Processes Landforms, 13, 305–320.

Moore, I.D., Pamuska, J.C., Grayson, R.B., and Srivastava, K.P. (1988b) "Application of digital topographic modeling in hydrology." Proc., Int. Symposium on Modeling Agricultural, Forest, and Rangeland Hydrology, Publication No. 07-88, Am. Soc.y of Agricultural Engineers, St. Joseph, MI.

Morel-Seytoux, H.J. (1988) "Soil-aquifer-stream interactions—a reductionist attempt toward physical stochastic integration." J. Hydrol. 102, 355–379.

Ojeda, E.C., Déniz, E.G., Cabrera Ortega, I.J. (2007) Bayesian local robustness under weighted squared-error loss function incorporating unimodality. Statistics and Probability Letters 77 (1), 69-74.

Olivera, F. and Maidment, D. (1999) "GIS-based spatially distributed model for runoff routing." Water Resour. Res., 35(4), 1155–1164.

O'Loughlin, E.N. (1986) "Prediction of surface saturation zones in natural catchments by topographic analysis." Water Resour. Res., 22, 229–246.

Parker, G.T. (2004) Modeling agricultural best management practices in the South Nation watershed. MASc Thesis, Univ. of Ottawa, Ottawa, ON.

Parker, G.T. (2006). Automated baseflow separation for Canadian datasets (ABSCAN): User's Manual. Thinknew Analytics. Ottawa, Canada. http://www.thinknew.ca/.

Parker, G.T., Droste, R.L., and Kennedy, K.J. (2008a) "Modeling the effect of agricultural best management practices on water quality under various climatic scenarios." J. of Env. Eng. and Sci., 7(1), 9-19.

Parysow, P., Gertner, G., and Westervelt, J. (2000) "Efficient approximation for building error budgets for process models." Ecological Modeling, 135, 111-125.

Phillips, D.L. and Marks, D.G. (1996) "Spatial uncertainty analysis: propagation of interpretation errors in spatially distributed models." Ecological Modeling, 91, 213-229.

Rauch W., Henze M., Koncsos L., Reichert P., Shanahan P., Somlyódy L., and Vanrolleghem P.A. (1998) "River water quality modeling: I. State of the art." Wat. Sci. Tech. 38(11), 237-244.

Robson, A., Beven, K., and Neal, C. (1992) "Towards identifying sources of subsurface flow: A comparison of components identified by a physically based runoff model and those determined by chemical mixing techniques." Hydrolog. Process., 6, 199–214.

Rode, M., Suhr, U., and Wriedt, G. (2007) Multi-objective calibration of a river water quality model—Information content of calibration data. Ecological Modeling 204(1-2), 129-142.

Romanowicz, R. and Beven, K.J. (2006) Comments on Generalised Likelihood Uncertainty Estimation. Reliability Engineering and System Safety, 91, 1315–1321.

Savic, D.A., Walters, G.A., and Davidson, J.W. (1999) "A genetic programming approach to rainfall-runoff modeling." Water Resour. Manage., 13, 219–231.

Scientific Advisory Panel (1998), "Scientific advisory panel July 1998 meeting final report," US Environmental Protection Agency, Arlington, VA.

Scott, R.D., Krehbiel, P.R., and Rison, W. (2001) "The Use of Simultaneous Horizontal and Vertical Transmissions for Dual-Polarization Radar Meteorological Observations". J. Atmos. Oceanic Technol., 18, 629–648.

Seyfried, M.S. and Wilcox, B.P. (1995) "Scale and nature of spatial variability: Field examples having implications for hydrologic modeling." Water Resour. Res., 31, 173–184.

Sharma, K.K. (1994). Asymptotic sampling distribution of inverse coefficient-of-variation and its applications. IEEE Transactions on Reliability 43(4), 630-633.

Simanovic, S.P. (1990) "An expert system for the selection of a suitable method for flow measurement in open channels." J. Hydrol., 112, 237–256.

Simoncic, M. (2004), "A Bayesian Network Model of Two-Car Accidents", J. of Transportation and Statistics, 7 (2-3), pp. 13-25.

Sinclair, K.A. and Pitz, C.F. (1999) Estimated Baseflow Characteristics of Selected Washington Rivers and Streams, Water Supply Bulletin No. 60, Washington State Department of Ecology Environmental Assessment Program, Olympia, WA.

Singh, V.P. ed. (1995b) Computer models of watershed hydrology, Water Resources Publications, Littleton, CO.

Singh, V.P. (1996) Kinematic wave modeling in water resources: Surface water hydrology, Wiley, NY.

Sivapalan, M. and Wood, E.F. (1986) "Chapter 5: Spatial heterogeneity and scale in the infiltration response of catchments." Scale problems in hydrology, V.K. Gupta, I. Rodriguez-Iturbe, and E.F. Wood, eds., Kluwer Academic, Dordrecht, The Netherlands, 81–106.

Sivapalan, M., Bloschl, G., Zhang, L., and Vertessy, R. (2003), "Downward approach to hydrological prediction." Hydrological Processes, 17: 2101-2111.

Song, Z. and James, L.D. (1992) "An objective test for hydrologic scale." Water Resour. Bull., 28(5), 833–844.

Streeter, H.W. and Phelps, E.B. (1925) A study of the pollution and natural purification of the Ohio river, III. Factors concernedin the phenomena of oxidation and reaeration, US Public Health Service, Bulletin 146.

Tannenbaum, T., Wright, D., Miller, K., and Livny, M. (2002) "Condor - A Distributed Job Scheduler." in T. Sterling, ed., Beowulf Cluster Computing with Linux, The MIT Press. ISBN: 0-262-69274-0.

Thomas, G. and Henderson-Sellers, A. (1991) "An evaluation of proposed representation of subgrid hydrologic processes in climate models." J. Climate, 4, 898–910.

Thomas, H.A. (1948). Pollution load capacity of streams. Water Sewage Works, 95(11), 409-413.

US Department of Agriculture (2001) "AnnAGNPS Version 2: User Documentation.,"USDA-ARS, Oxford, MS.

US.Environmental Protection Agency (1997) "Compendium of tools for watershed assessment and TMDL development." EPA, EPA-841-B-97-006, Washington, DC.

US EPA, (2008). Chesapeake Bay Phase 5 Community Watershed Model In preparation EPA XXX-X-XX-008 Chesapeake Bay Program Office, Annapolis MD.

US Geological Survey (1999) "National Elevation Dataset (Ed. 1)", EROS Data Cente, Sioux Falls, SD. Available online at http://gisdata.usgs.net/ned/ (retrieved 1/30/2007).

US Geological Survey (2007). USGS Surface-Water Daily Data for the Nation. National Water Information System: Web Interface. http://waterdata.usgs.gov/ne/nwis/sw. Accessed January 2007.

van Griensven, A. and Meixner, T. (2007) A global and efficient multi-objective auto-calibration and uncertainty estimation method for water quality catchment models. J. of Hydroinformatics, 9 (4), 277-291.

Vieux, B.E. (1988) "Finite element analysis of hydrologic response areas using geographic information systems." PhD dissertation, Michigan State Univ., East Lansing, MI.

Vieux, B.E. (1991) "Geographic information systems and non-point source water quality and quantity modeling." Hydrolog. Process., 5, 101–113.

Vrugt, J.A., Diks, C.G.H., Gupta, H.V., Bouten, W., and Verstraten, J.M. (2005) "Improved treatment of uncertainty in hydrologic modeling: Combining the strengths of global optimization and data assimilation." Water Resour. Res. 41(1), 1-17.

Wagener, T., McIntyre, N., Lees, M.J., Wheater, H.S., and Gupta, H.V. (2003) "Towards reduced uncertainty in conceptual rainfall-runoff modeling: Dynamic identifiability analysis." Hydrological Processes 17 (2), 455-476.

Wainwright, J. and Mulligan, M. (2004) "Environmental modeling." Eds., John Wiley & Sons, 409 pp.

Wang, Q.J. (1991) "The genetic algorithm and its application to calibrating conceptual rainfall-runoff models." Water Resour. Res., 27(9), 2467–2471.

Wood, E.F., Sivapalan, M., and Beven, K. (1990) "Similarity and scale in catchment storm response." Rev. Geophys., 28, 1–18.

Wood, E.F., Sivapalan, M., Beven, K.J., and Band, L. (1988) "Effects of spatial variability and scale with implications to hydrologic modeling." J. of Hydrology 102 (1-4), 29-47.

Woolhiser, D.A. and Goodrich, D.C. (1988) "Effect of storm rainfall intensity patterns on surface runoff." J. Hydrol., 102, 29–47.

Wurbs, R.A. (1998) "Dissemination of generalized water resources models in the United States." Water Int., 23, 190–198.

Young, C.B., Bradley A.A., Krajewski W.F., Kruger A., and Morrissey, M.L. (2000) "Evaluating NEXRAD multisensor precipitation estimates for operational hydrologic forecasting". J. Hydrometeor., 1, 241–254.

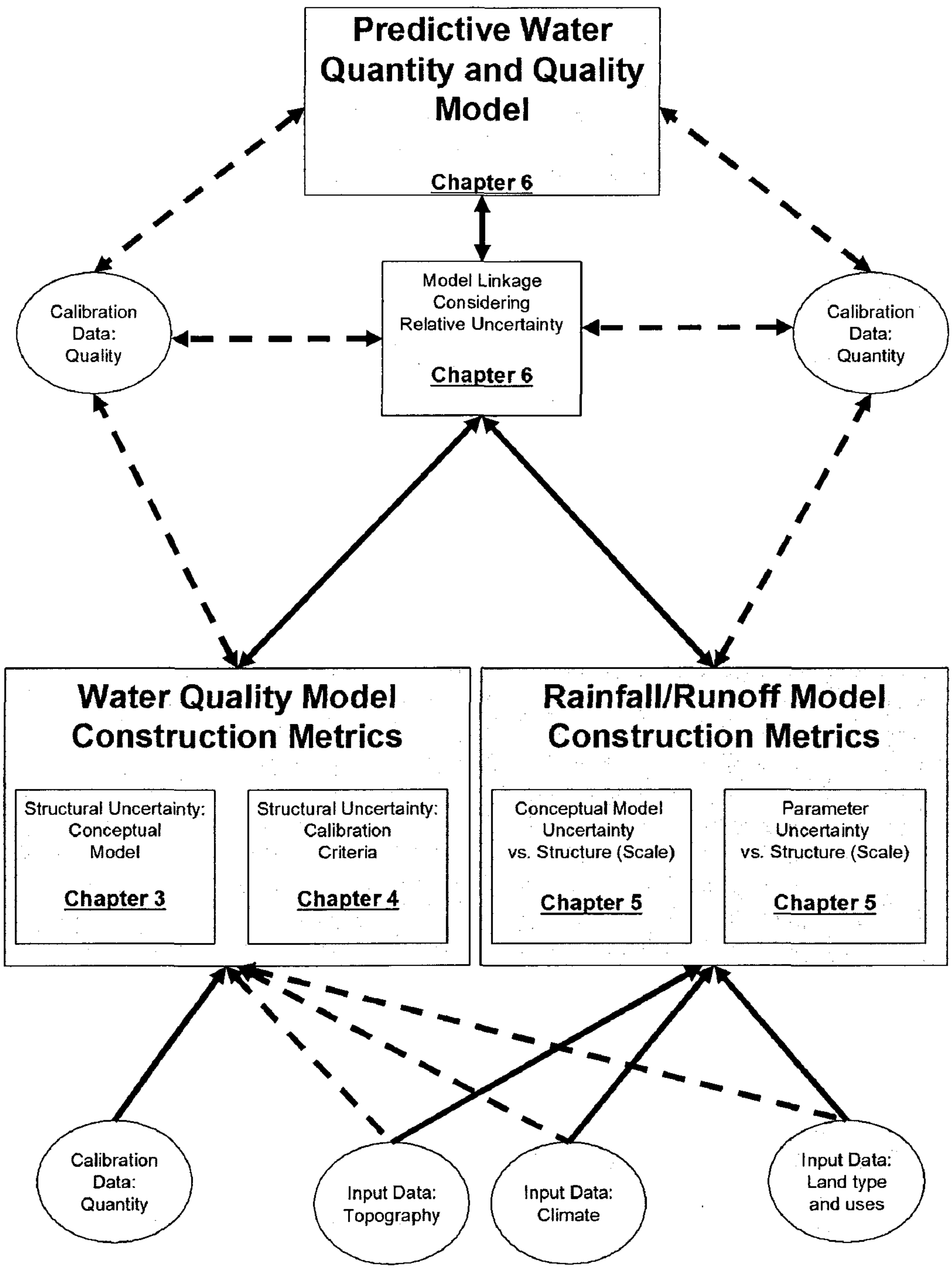
Yu, Z. (1996) "Development of a physically-based distributed-parameter watershed (basin-scale hydrologic model) and its application to Big Darby Creek watershed." PhD dissertation, Ohio State Univ., Columbus, OH.

Zhang, W. and Montgomery, D.R. (1994) "Digital elevation model grid size, landscape representation, and hydrologic simulations." Water Resour. Res., 30, 1019–1028.

Zimmerman, H.J. (2000) "An application-oriented view of modeling uncertainty." European J. of Operational Research, 122, 190-198.

APPENDICES

APPENDIX A: CHAPTER FLOWCHART FOR PREDICTIVE MODEL CONSTRUCTION



APPENDIX B: CONFIGURATION & CONTROL PROCEDURES

B.1. Purpose

The policies and practice listed here are designed to minimize the risks of errors in calculation and data manipulation tasks, to ensure that the solution and results are of the highest quality and that the methodologies are consistent.

Analyses performed by hand or with custom tools are not exempt from the quality requirements specified here. However, for those cases, the analyst often has a better grasp and control over the limitations, assumptions and methodology than when using complex computer codes. Calculations and tasks routinely performed with well-established or previously developed computer codes present a particular challenge because these codes are highly complex, may be supplied by an external source, and are designed to work for a specific range of problems. Complacency and over-confidence in the codes may lead to erroneous results. The policies and practices here should help to ensure that the results are consistently of the highest quality.

B.2. Source Code Quality Assurance Requirements

A configuration control system must be in place to track version changes in the source code. Each version of the source code must be assigned a unique version number. Previously tested and "known-good" versions of source are to be archived and retrievable. The changes between two versions of the code must be documented.

If the source of the program, the compiler, or the operating system is modified or upgraded, the quality assurance (QA) qualification process must be repeated to verify the validity of the program. Additionally, programs acquired through third parties must be verified 'in-house' before being QA qualified.

B.3. Program Testing

In order for a program to pass the QA qualification process, it must pass a series of test problems. The test problems are conducted, and must be run to completion without crashing. The results of the test problems are then extensively compared to a previously known good solution, if available. Any discrepancies or anomalies (precision or round-off errors, for example) must be documented and explained. Upon passing qualification, the date, size and version of the source code and executable files must be recorded.

The AnnAGNPS 2.01c package used was obtained from the USDA website at http://www.sedlab.olemiss.edu/agnps.html. The code was then verified by running the example cases provided, the "Beaver Creek" and "Mission Creek" data files, and comparing the outputs with the shipped results. The output files were identical to the reference results for both cases, and so the system was deemed tested and known-good.

The utilities constructed were tested extensively against data entered and processed manually, so as to ensure proper behaviour. Additionally, diagnostic runs were conducted with variable tracking ('debugging') tools to ensure that data were being loaded, handled, and outputted as desired. Backups of all 'good' versions were made, and any new features or modifications from a tested version were handled according to the configuration control procedure (described under Section A.4).

B.4. CONFIGURATION CONTROL

The latest QA qualified version of a given program should be under the "**\ProgramName\current**" directory. Previously known good versions are archived under "**\ProgramName\Old versions**" as zip files bearing the version name. Versions pending QA qualification are placed under the "**\ProgramName\pending\versionanme**" folder. All files should be regularly backed up to a writable CD or similar "read-only" storage.

APPENDIX C: METADATA

This section contains some representative metadata files for important datasets used in this study. Complete metadata information is available in electronic form on the companion disc to this thesis.

C.1. TOPOGRAPHIC METADATA (SRTM)

Shuttle Radar Topography Mission (SRTM) Elevation Data Set

Part 1: Set-Specific Metadata

Identification_Information:

Citation:
Citation_Information:
Originator: National Aeronautics and Space Administration (NASA)
Originator: National Geospatial-Intelligence Agency (NGA)
Originator: German Aerospace Center (DLR)
Originator: Italian Space Agency (ASI)
Publication_Date: 2002
Title: Shuttle Radar Topography Mission (SRTM) Elevation Data Set
Geospatial_Data_Presentation_Form: SDE raster digital data
Publication_Information:
Publication_Place: Sioux Falls, SD
Publisher: U.S. Geological Survey
Online_Linkage: <http://seamless.usgs.gov>
Description:
Abstract:
The Shuttle Radar Topography Mission (SRTM) aboard the Space Shuttle Endeavour, launched on Feb. 11, 2000. SRTM used the same radar instrument that comprised the Spaceborne Imaging Radar-C/X-Band Synthetic Aperture Radar (SIR-C/X-SAR) that flew twice on the Space Shuttle Endeavour in 1994. SRTM was assigned to collect 3-D measurements of the Earth's surface. To collect the 3-D data, engineers added a 60-meter (approximately 200-foot) mast, installed additional C-band and X-band antennas, and improved tracking and navigation devices. The mission is a cooperative project between NASA, the National Geospatial-Intelligence Agency (NGA) of the U.S. Department of Defense and the German and Italian space agencies. It is managed by NASA's Jet Propulsion Laboratory (JPL), Pasadena, CA, for NASA's Earth Science Enterprise, Washington, D.C.
Purpose:
The objective of the SRTM mission is to obtain elevation radar data on a near-global scale and generate the most complete high-resolution digital topographic database of the Earth. The information collected by SRTM will be used to provide a tool to enhance the activities of scientists, the military, commercial, and civilian users.
Supplemental_Information:
Additional Reference: <http://www.jpl.nasa.gov/srtm/index.html>

Processing Information:Program Name: SRTM2DSM_DTED_3.AMLObjective: Process srtm data to a digital surface model in grid format.Procedure:Copy filesRename to latlon.dt1 formatCreate GRIDDefine projection as geographic with WGS84 datumProject grid from decimal seconds to decimal degreesConvert to real data type

Environment:

[Ed: See Part 2]

Time_Period_of_Content:

Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20000211
Ending_Date: 20000222
Currentness_Reference: publication date
Status:
Progress: In work
Maintenance_and_Update_Frequency: As needed
Spatial_Domain:

[Ed: See Part 2]

Keywords:
Theme:
Theme_Keyword_Thesaurus: GCMD Parameter Keywords
Theme_Keyword: EARTH SCIENCE
Theme_Keyword: LAND SURFACE
Theme_Keyword: TOPOGRAPHY
Theme_Keyword: LANDFORMS
Theme_Keyword: TERRAIN ELEVATION
Theme_Keyword: 3-ARC-SECOND DEM
Theme_Keyword: CARTOGRAPHY
Theme_Keyword: DEM
Theme_Keyword: DIGITAL ELEVATION MODEL
Theme_Keyword: DIGITAL SURFACE MODEL
Theme_Keyword: DIGITAL MAPPING
Theme_Keyword: EDC
Theme_Keyword: EROS
Theme_Keyword: GEODATA
Theme_Keyword: GIS
Theme_Keyword: MAPPING
Theme_Keyword: RASTER
Theme_Keyword: USGS
Place:
Place_Keyword_Thesaurus: GCMD Location Keywords
Place_Keyword: NORTH AMERICA
Place_Keyword: AFRICA
Place_Keyword: EUROPE
Place_Keyword: ASIA
Place_Keyword: GLOBAL
Access_Constraints: None
Use_Constraints:
None. Acknowledgement of the originating agencies would be appreciated in products derived from these data.
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Customer Services Representative
Contact_Organization:
The National Center for Earth Resources Observation and Science (EROS)
Contact_Address:
Address_Type: mailing and physical address

Address:
U.S. Geological Survey, The National Center for Earth Resources Observation and Science (EROS)
City: Sioux Falls
State_or_Province: SD
Postal_Code: 57198
Country: USA
Contact_Voice_Telephone: 605-594-6151
Contact_Facsimile_Telephone: 605-594-6589
Contact_Electronic_Mail_Address: custserv@usgs.gov
Native_Data_Set_Environment:
Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 1; ESRI ArcCatalog 9.0.0.535

Data_Quality_Information:
Logical_Consistency_Report:
To collect the 3-D data, engineers added a 60-meter (approximately 200-foot) mast, installed additional C-band and X-band antennas, and improved tracking and navigation devices
Completeness_Report: Shuttle Radar Topography Mission (SRTM) Elevation Data Set
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
The mission objective is to produce digital topographic map products with <=20 m absolute horizontal circular accuracy. All accuracies are quoted at the 90% level, consistent with National Map Accuracy Standards.
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report:
The mission objective is to produce digital topographic map products with <=16 m absolute vertical height accuracy and <= 10 m relative vertical height accuracy. All accuracies are quoted at the 90% level, consistent with National Map Accuracy Standards.
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator: NASA, NGA, DLR, and ASI
Publication_Date: 2002
Title: SRTM Data Collection
Type_of_Source_Media: raster digital data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20020211
Ending_Date: 20020222
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: SRTM 2000
Source_Contribution: NASA, NGA, DLR, and ASI
Source_Information:
Source_Citation:
Citation_Information:
Originator: Jet Propulsion Laboratory
Publication_Date: 2002
Title: JPL Processing
Online_Linkage: <ftp://edcsgs9.cr.usgs.gov/pub/srtm>
Type_of_Source_Media: raster digital data

Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20020211
Ending_Date: 20020222
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: JPL 2002
Source_Contribution: NASA, NGA, DLR, and ASI
Source_Information:
Source_Citation:
Citation_Information:
Originator: National Geospatial-Intelligence Agency
Publication_Date: 2002
Title: NGA Processing
Type_of_Source_Media: raster digital data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20020211
Ending_Date: 20020222
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: NGA 2003
Source_Contribution: NASA, NGA, DLR, and ASI
Source_Information:
Source_Citation:
Citation_Information:
Originator:
U.S. Geological Survey, The National Center for Earth Resources Observation and Science (EROS)
Publication_Date: 2004
Title: EROS Processing
Online_Linkage: <http://seamless.usgs.gov>
Type_of_Source_Media: raster digital data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20020211
Ending_Date: 20020222
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: EROS 2003
Source_Contribution: NASA, NGA, DLR, and ASI
Process_Step:
Process_Description:
SRTM data is being processed in a systematic fashion using the SRTM Ground Data Processing System (GDPS) supercomputer system at the Jet Propulsion Laboratory. Data are being mosaicked into approximately 14,000 one degree by one degree cells and formatted according to the Digital Terrain Elevation Data (DTED) specification for delivery to NGA, who will use it to update and extend their DTED products. Data are being processed on a continent-by-continent basis beginning with North America. NGA will apply several post-processing steps to these data including editing, spike and well removal, water body leveling and coastline definition. Following these "finishing" steps data will be returned to NASA for distribution to the scientific and civil user communities, as well as the public.

Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20020211
Ending_Date: 20020222
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: JPL 2002
Source_Contribution: NASA, NGA, DLR, and ASI
Source_Information:
Source_Citation:
Citation_Information:
Originator: National Geospatial-Intelligence Agency
Publication_Date: 2002
Title: NGA Processing
Type_of_Source_Media: raster digital data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20020211
Ending_Date: 20020222
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: NGA 2003
Source_Contribution: NASA, NGA, DLR, and ASI
Source_Information:
Source_Citation:
Citation_Information:
Originator:
U.S. Geological Survey, The National Center for Earth Resources Observation and Science (EROS)
Publication_Date: 2004
Title: EROS Processing
Online_Linkage: <http://seamless.usgs.gov>
Type_of_Source_Media: raster digital data
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20020211
Ending_Date: 20020222
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: EROS 2003
Source_Contribution: NASA, NGA, DLR, and ASI
Process_Step:
Process_Description:
SRTM data is being processed in a systematic fashion using the SRTM Ground Data Processing System (GDPS) supercomputer system at the Jet Propulsion Laboratory. Data are being mosaicked into approximately 14,000 one degree by one degree cells and formatted according to the Digital Terrain Elevation Data (DTED) specification for delivery to NGA, who will use it to update and extend their DTED products. Data are being processed on a continent-by-continent basis beginning with North America. NGA will apply several post-processing steps to these data including editing, spike and well removal, water body leveling and coastline definition. Following these "finishing" steps data will be returned to NASA for distribution to the scientific and civil user communities, as well as the public.

one degree "cells". The edges of each cell are matched with the edges of adjacent cells to assure continuity.
Source_Used_Citation_Abbreviation: JPL 2002
Process_Date: 2002
Source_Produced_Citation_Abbreviation: NGA 2003
Process_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization:
National Aeronautics and Space Administration (NASA) Jet Propulsion Lab (JPL)
Contact_Position: N/A
Contact_Address:
Address_Type: mailing address
Address: 4800 Oak Grove Drive
City: Pasadena
State_or_Province: CA
Postal_Code: 91009
Country: USA
Contact_Voice_Telephone: (818) 354-4321
Contact_Facsimile_Telephone: n/a
Contact_Electronic_Mail_Address: n/a
Contact_Instructions: <http://www.jpl.nasa.gov/about_JPL/>
Process_Step:
Process_Description:
Process SRTM data to a digital surface model in grid format. To complete this step run SRTM2DSM_3_DTED.AML which renames the data files, creates a GRID, defines projection as geographic with WGS84 datum, project grid from decimal seconds to decimal degrees, and converts to real data type.
Source_Used_Citation_Abbreviation: NGA 2003
Process_Date: 2002
Source_Produced_Citation_Abbreviation: EROS 2003
Process_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: National Geospatial-Intelligence Agency
Contact_Position: n/a
Contact_Address:
Address_Type: mailing address
Address: n/a
City: Bethesda
State_or_Province: MD
Postal_Code: 20816-5003
Contact_Voice_Telephone: (818) 354-4321
Contact_Facsimile_Telephone: n/a
Contact_Electronic_Mail_Address: n/a
Contact_Instructions: <http://www.nga.mil>
Process_Step:
Process_Description:
The metadata was imported and updated for display through the Seamless Data Distribution System.
Process_Date: 2004
Process_Contact:
Contact_Information:

Contact_Organization_Primary:
Contact_Organization: National Center for Earth Resorces Observation and Science
Contact_Position: Customer Service Representative
Contact_Address:
Address_Type: mailing and physical address
Address: National Center for Earth Resorces Observation and Science
City: Sioux Falls
State_or_Province: SD
Postal_Code: 57198
Country: USA
Contact_Voice_Telephone: 605-594-6151
Contact_TDD/TTY_Telephone: 605-594-6933
Contact_Facsimile_Telephone: 605-594-6589
Contact_Electronic_Mail_Address: custserv@usgs.gov
Hours_of_Service: 8-4 CT, M-F

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Raster
Raster_Object_Information:
Raster_Object_Type: Pixel
Row_Count: 270000
Column_Count: 1296000
Vertical_Count: 1

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Geographic:
Latitude_Resolution: 1.000000
Longitude_Resolution: 1.000000
Geographic_Coordinate_Units: Decimal degrees
Geodetic_Model:
Horizontal_Datum_Name: D_WGS_1984
Ellipsoid_Name: WGS_1984
Semi-major_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.257224
Vertical_Coordinate_System_Definition:
Altitude_System_Definition:
Altitude_Datum_Name: N/A
Altitude_Resolution: 1.000000
Altitude_Distance_Units: meters
Altitude_Encoding_Method:
Explicit elevation coordinate included with horizontal coordinates

---

Entity_and_Attribute_Information:
Overview_Description:
Entity_and_Attribute_Overview: N/A
Entity_and_Attribute_Detail_Citation: N/A

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:

Contact_Organization:
The National Center for Earth Resources Observation and Science (EROS)
Contact_Position: Customer Services Representative
Contact_Address:
Address_Type: mailing and physical address
Address:
U.S. Geological Survey, The National Center for Earth Resources Observation and Science (EROS)
City: Sioux Falls
State_or_Province: SD
Postal_Code: 57198
Country: USA
Contact_Voice_Telephone: 605-594-6151
Contact_TDD/TTY_Telephone: 605-594-6933
Contact_Facsimile_Telephone: 605-594-6589
Contact_Electronic_Mail_Address: custserv@usgs.gov
Hours_of_Service: 8-4 CT, M-F
Resource_Description: Downloadable Data
Distribution_Liability:
Although these data have been processed successfully on a computer system at the U.S. Geological Survey, The National Center for Earth Resources Observation and Science (EROS), no warranty expressed or implied is made by either regarding the utility of the data on any system, nor shall the act of distribution constitute any such warranty. The USGS will warrant the delivery of this product in computer-readable format and will offer appropriate adjustment of credit when the product is determined unreadable by correctly adjusted computer peripherals, or when the physical medium is delivered in damaged condition. Requests for adjustments of credit must be made within 90 days from the date of this shipment from the ordering site.
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Format_Name: ARCE
Transfer_Size: 1.000
Digital_Transfer_Option:
Online_Option:
Computer_Contact_Information:
Network_Address:
Network_Resource_Name: <http://seamless.usgs.gov>
Fees: None

Metadata_Reference_Information:
Metadata_Date: 20050330
Metadata_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization:
The National Center for Earth Resources Observation and Science (EROS)
Contact_Position: Customer Services Representative
Contact_Address:
Address_Type: mailing and physical address
Address:
U.S. Geological Survey, The National Center for Earth Resources Observation and Science (EROS)
City: Sioux Falls
State_or_Province: SD

Postal_Code: 57198
Country: USA
Contact_Voice_Telephone: 605-594-6151
Contact_TDD/TTY_Telephone: 605-594-6933
Contact_Facsimile_Telephone: 605-594-6589
Contact_Electronic_Mail_Address: custserv@usgs.gov
Hours_of_Service: 8-4 CT, M-F
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: local time
Metadata_Access_Constraints: None
Metadata_Use_Constraints: None
Metadata_Security_Information:
Metadata_Security_Classification_System: N/A
Metadata_Security_Classification: Unclassified
Metadata_Security_Handling_Description: N/A
Metadata_Extensions:
Online_Linkage: <http://www.esri.com/metadata/esriprof80.html>
Profile_Name: ESRI Metadata Profile

Generated by mp version 2.8.6 on Wed Mar 30 14:29:24 2005

Part 2: Tile-Specific Metadata

Tile: 01074556

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N38W080	-80.000138889	37.999861111	-78.999861111	39.000138889	253	1484	792.593676758	235.019210815	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:16:19 Thursday
N39W079	-79.000138889	38.999861111	-77.999861111	40.000138889	101	1017	371.049438477	163.550765991	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:38:12 Thursday
N38W078	-78.000138889	37.999861111	-76.999861111	39.000138889	-21	570	86.738952637	52.366630554	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:11:54 Thursday
N39W080	-80.000138889	38.999861111	-78.999861111	40.000138889	216	1373	638.807983398	194.185089111	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:40:58 Thursday
N38W079	79.000138889	37.999861111	77.999861111	39.000138889	43	1227	353.119232178	196.984664917	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:14:07 Thursday
N39W078	-78.000138889	38.999861111	-76.999861111	40.000138889	-8	748	190.851715088	96.483070374	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:35:13 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-79.19915144
East_Bounding_Coordinate:-77.63897197
*North_Bounding_Coordinate:*39.72993205
*South_Bounding_Coordinate:*38.5535064

Tile: 07949871

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N40W079	-79.000138889	39.999861111	-77.999861111	41.000138889	167	959	502.530303955	128.651092529	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:06:01 Thursday
N40W078	-78.000138889	39.999861111	-76.999861111	41.000138889	83	755	312.265228272	130.6118927	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:03:30 Thursday
N39W079	-79.000138889	38.999861111	-77.999861111	40.000138889	101	1017	371.049438477	163.550765991	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:38:12 Thursday
N39W078	-78.000138889	38.999861111	-76.999861111	40.000138889	-8	748	190.851715088	96.483070374	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:35:13 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-78.98351648
East_Bounding_Coordinate:-77.0614962
*North_Bounding_Coordinate:*40.77130882
*South_Bounding_Coordinate:*39.78934207

Tile: 08865688

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N41W079	-79.000138889	40.999861111	-77.999861111	42.000138889	219	770	555.802124023	85.165901184	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:36:49 Thursday
N41W078	-78.000138889	40.999861111	-76.999861111	42.000138889	144	803	507.040557861	133.583511353	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:33:36 Thursday
N40W079	-79.000138889	39.999861111	-77.999861111	41.000138889	167	959	502.530303955	128.651092529	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:06:01 Thursday
N40W078	-78.000138889	39.999861111	-76.999861111	41.000138889	83	755	312.265228272	130.6118927	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:03:20 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-78.98351648
East_Bounding_Coordinate:-77.0614962
*North_Bounding_Coordinate:*41.75327557
*South_Bounding_Coordinate:*40.77130882

Tile: 15731280

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N38W080	-80.000138889	37.999861111	-78.999861111	39.000138889	253	1484	792.393676758	235.019210815	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:16:19 Thursday
N37W078	-78.000138889	36.999861111	-76.999861111	38.000138889	-76	168	62.799663544	29.543678284	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 08:54:10 Thursday
N38W078	-78.000138889	37.999861111	-76.999861111	39.000138889	-21	570	86.738952637	52.366630554	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:11:54 Thursday
N37W079	-79.000138889	36.999861111	-77.999861111	38.000138889	41	1207	167.454559326	89.441680908	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 08:56:13 Thursday
N37W080	-80.000138889	36.999861111	-78.999861111	38.000138889	115	1290	399.801086426	192.210281372	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 08:58:15 Thursday
N38W079	79.000138889	37.999861111	77.999861111	39.000138889	43	1227	352.119232178	196.984664917	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:14:07 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-79.19915144
East_Bounding_Coordinate:-77.63897197
*North_Bounding_Coordinate:*38.5535064
*South_Bounding_Coordinate:*37.37708076

Tile: 27472325

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N41W081	-81.000138889	40.999861111	-79.999861111	42.000138889	170	521	325.30392456	65.855377197	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:42:59 Thursday
N41W080	-80.000138889	40.999861111	-78.999861111	42.000138889	248	694	462.797119141	58.314289093	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:39:49 Thursday
N41W079	-79.000138889	40.999861111	-77.999861111	42.000138889	219	770	555.802124023	85.165901184	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:36:49 Thursday
N40W081	-81.000138889	39.999861111	-79.999861111	41.000138889	174	484	341.692932129	40.372882843	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:10:53 Thursday
N40W080	-80.000138889	39.999861111	-78.999861111	41.000138889	158	912	401.53908081	109.982543945	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:08:26 Thursday
N40W079	79.000138889	39.999861111	77.999861111	41.000138889	167	959	502.530303955	128.651092529	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:06:01 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-80.90553677
East_Bounding_Coordinate:-78.98351648
*North_Bounding_Coordinate:*41.75327557
*South_Bounding_Coordinate:*40.77130882

Tile: 28901439

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N38W079	-79.000138889	37.999861111	-77.999861111	39.000138889	43	1227	352.119232178	196.984664917	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:14:07 Thursday
N38W078	-78.000138889	37.999861111	-76.999861111	39.000138889	-21	570	86.738952637	52.366630554	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:11:54 Thursday
N37W079	-79.000138889	36.999861111	-77.999861111	38.000138889	41	1207	167.454559326	89.441680908	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 08:56:13 Thursday
N37W078	-78.000138889	36.999861111	-76.999861111	38.000138889	-76	168	62.799663544	29.543678284	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 08:54:10 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-78.4112977
East_Bounding_Coordinate:-77.201711
*North_Bounding_Coordinate:*38.37501159
*South_Bounding_Coordinate:*37.26956149

Tile: 43140235

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N38W080	80.000138889	37.999861111	78.999861111	39.000138889	253	1484	792.393676758	235.019210815	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:16:19 Thursday
N38W081	-81.000138889	37.999861111	-79.999861111	39.000138889	204	1479	679.328491211	267.112762451	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:18:34 Thursday
N37W081	-81.000138889	36.999861111	-79.999861111	38.000138889	286	1326	690.018371582	150.921182861	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:00:21 Thursday
N37W080	80.000138889	36.999861111	78.999861111	38.000138889	115	1290	399.801086426	192.210281372	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 08:58:15 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-80.75933091
East_Bounding_Coordinate:-79.19915144
*North_Bounding_Coordinate:*38.5535064
*South_Bounding_Coordinate:*37.37708076

Tile: 44841636

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N39W081	-81.000138889	38.999861111	-79.999861111	40.000138889	176	711	360.923156738	61.572605133	METERS	0.000277778	WGS81	WGS84_GEOID	11 Mar 04 09:44:06 Thursday
N38W080	-80.000138889	37.999861111	-78.999861111	39.000138889	253	1484	792.393676758	235.019210815	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:16:19 Thursday
N38W081	-81.000138889	37.999861111	-79.999861111	39.000138889	204	1479	679.328491211	267.112762451	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:18:34 Thursday
N39W080	-80.000138889	38.999861111	-78.999861111	40.000138889	216	1333	638.807983398	191.185089111	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:40:58 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-80.75933091
East_Bounding_Coordinate:-79.19915144
*North_Bounding_Coordinate:*39.72993205
*South_Bounding_Coordinate:*38.5535064

Tile: 50333339

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N39W077	-77.000138889	38.999861111	-75.999861111	40.000138889	-57	375	110.979217529	83.311721802	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:31:54 Thursday
N40W077	-77.000138889	39.999861111	-75.999861111	41.000138889	12	641	224.42086792	108.811668396	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:00:58 Thursday
N40W078	78.000138889	39.999861111	76.999861111	41.000138889	83	755	312.265228272	130.6118927	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:03:20 Thursday
N39W078	-78.000138889	38.999861111	-76.999861111	40.000138889	-8	748	190.851715088	96.482070374	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:35:13 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-77.19859874
East_Bounding_Coordinate:-76.5946583
*North_Bounding_Coordinate:*40.15772319
*South_Bounding_Coordinate:*39.04420801

Tile: 69642906

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N39W079	-79.000138889	38.999861111	-77.999861111	40.000138889	101	1017	371.049438477	162.550765991	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:38:12 Thursday
N39W078	-78.000138889	38.999861111	-76.999861111	40.000138889	-8	748	190.851715088	96.482070374	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:35:13 Thursday
N38W079	79.000138889	37.999861111	77.999861111	39.000138889	43	1227	352.119232178	196.984664917	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:14:07 Thursday
N38W078	-78.000138889	37.999861111	-76.999861111	39.000138889	-21	570	86.738952637	52.366630554	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:11:54 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-78.4112977
East_Bounding_Coordinate:-77.201711
*North_Bounding_Coordinate:*39.48046168
*South_Bounding_Coordinate:*38.37501159

Tile: 72948997

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N39W078	-78.000138889	38.999861111	-76.999861111	40.000138889	-8	748	190.851715088	96.483070374	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:35:13 Thursday
N39W077	-77.000138889	38.999861111	-75.999861111	40.000138889	-57	375	110.979217529	85.311721802	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:31:54 Thursday
N39W076	-76.000138889	38.999861111	-74.999861111	40.000138889	-48	274	33.887851715	44.382068634	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:29:07 Thursday
N38W078	-78.000138889	37.999861111	-76.999861111	39.000138889	-21	570	86.738952637	52.366630554	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:11:54 Thursday
N38W077	-77.000138889	37.999861111	-75.999861111	39.000138889	-44	119	17.275043488	21.883937836	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:09:47 Thursday
N38W076	-76.000138889	37.999861111	-74.999861111	39.000138889	-35	51	8.774813652	7.574468613	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:07:55 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-77.201711
East_Bounding_Coordinate:-75.9921243
*North_Bounding_Coordinate:*39.48046168
*South_Bounding_Coordinate:*38.37501159

Tile: 75513725

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N40W081	-81.000138889	39.999861111	-79.999861111	41.000138889	174	484	341.692932129	40.372582843	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:10:53 Thursday
N40W080	-80.000138889	39.999861111	-78.999861111	41.000138889	158	913	401.53908081	109.982543945	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:08:26 Thursday
N40W079	-79.000138889	39.999861111	-77.999861111	41.000138889	167	959	502.530303955	128.651092529	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 10:06:01 Thursday
N39W081	-81.000138889	38.999861111	-79.999861111	40.000138889	176	714	360.923156738	61.572605133	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:44:06 Thursday
N39W080	-80.000138889	38.999861111	-78.999861111	40.000138889	216	1233	638.807983398	194.185089111	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:40:58 Thursday
N39W079	79.000138889	38.999861111	77.999861111	40.000138889	101	1017	371.049438477	163.550765991	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:38:12 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-80.90553677
East_Bounding_Coordinate:-78.98351648
*North_Bounding_Coordinate:*40.77130882
*South_Bounding_Coordinate:*39.78934207

Tile: 86264021

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N38W078	-78.000138889	37.999861111	-76.999861111	39.000138889	-21	570	86.738952637	52.366630554	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:11:54 Thursday
N38W077	-77.000138889	37.999861111	-75.999861111	39.000138889	-44	119	17.275043488	21.883937836	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:09:47 Thursday
N38W076	76.000138889	37.999861111	74.999861111	39.000138889	35	51	8.774813652	7.574468613	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:07:55 Thursday
N37W078	-78.000138889	36.999861111	-76.999861111	38.000138889	-76	168	62.799663544	29.543678281	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 08:54:10 Thursday
N37W077	-77.000138889	36.999861111	-75.999861111	38.000138889	-44	69	13.262137413	15.141786575	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 08:51:54 Thursday
N37W076	-76.000138889	36.999861111	-74.999861111	38.000138889	-47	89	1.281260626	4.040606976	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 08:50:06 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-77.201711
East_Bounding_Coordinate:-75.9921243
*North_Bounding_Coordinate:*38.37501159
*South_Bounding_Coordinate:*37.26956149

94076717

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N39W081	-81.000138889	38.999861111	79.999861111	40.000138889	176	714	360.923156738	61.572605133	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:44:06 Thursday
N39W080	-80.000138889	38.999861111	-78.999861111	40.000138889	216	1233	638.807983398	194.185089111	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:40:58 Thursday
N39W079	-79.000138889	38.999861111	-77.999861111	40.000138889	101	1017	371.049438477	163.550765991	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:38:12 Thursday
N38W081	81.000138889	37.999861111	79.999861111	39.000138889	204	1479	679.328491211	267.112762451	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:18:34 Thursday
N38W080	80.000138889	37.999861111	78.999861111	39.000138889	253	1484	792.393676758	235.019210815	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:16:19 Thursday
N38W079	-79.000138889	37.999861111	-77.999861111	39.000138889	43	1227	353.119232178	196.984664917	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:14:07 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-80.90553677
East_Bounding_Coordinate:-78.98351648
*North_Bounding_Coordinate:*39.78934207
*South_Bounding_Coordinate:*38.80737532

95780076

Environment:

COVERAGE	XMIN	YMIN	XMAX	YMAX	ZMIN	ZMAX	ZMEAN	ZSIGMA	ZUNITS	RESOLUTION	HDATUM	VDATUM	TIMESTAMP
N39W079	-79.000138889	38.999861111	-77.999861111	40.000138889	101	1017	371.049438477	163.550765991	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:38:12 Thursday
N39W078	-78.000138889	38.999861111	-76.999861111	40.000138889	-8	748	190.851715088	96.483070374	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:35:13 Thursday
N38W079	-79.000138889	37.999861111	-77.999861111	39.000138889	43	1227	353.119232178	196.984664917	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:14:07 Thursday
N38W078	-78.000138889	37.999861111	-76.999861111	39.000138889	-21	570	86.758952637	52.366630554	METERS	0.000277778	WGS84	WGS84_GEOID	11 Mar 04 09:11:54 Thursday

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-78.98351648
East_Bounding_Coordinate:-77.0614962
*North_Bounding_Coordinate:*39.78934207
*South_Bounding_Coordinate:*38.80737532

C.2. WATER QUALITY AND QUANTITY METADATA (NAWQA)

Water-Quality Assessment of the Potomac River Basin:
Water-Quality and Selected Spatial Data, 1992-96

Introduction

T e U.S. Geological Survey (USGS) implemented t e National Water-Quality Assessment (NAWQA) Program to describe t e status and trends in t e quality of t e Nation's surface water and ground water and to provide scientific understanding of t e natural and uman-induced factors t at affect water quality. In 1991, twenty study units were started. Additional study units began in 1994 and 1997. Data collection and analysis in eac study unit follows national guidelines for t e NAWQA Program, but also addresses t e issues most important to t at study unit. NAWQA is designed to produce a weal of water-quality information to assist policy makers and managers at t e national, state, and local levels in making more informed decisions.

In 1991, t e Potomac River Basin study unit began planning assessment activities. T e basin was subdivided into eig t subunits based on p ysiograp ic and geologic c aracteristics, w ic were determined to be t e most influential natural factors affecting water quality. Water-quality sampling began in 1992. T e first ig -intensity data-collection p ase of t e study unit spanned from 1993 to 1995; muc of t e data collection focused on t e Great Valley Carbonate, Piedmont, Triassic Lowlands, and Valley and Ridge subunits. Hundreds of water-quality c aracteristics were measured in different media during t is time, including ground water, streamwater, streambed sediments, and aquatic biological tissues. Fis communities and stream abitat also were sampled. In addition, spatial data suc as geology, land use, ydrograp y, and ot er waters ed c aracteristics were compiled into a geograp ic information system (GIS) to support t e assessment. After 1995 t e project entered a period of less frequent sampling called t e low-intensity p ase.

Purpose and scope

T is report presents data collected and compiled during t e first ig -intensity p ase of t e Potomac NAWQA study unit. Data are presented from 138 ground-water wells and 125 stream sites. Ground-water measurements compiled in t is report include c emical, p ysical, and water-level data. Streamwater measurements compiled include c emical, p ysical, streamflow, bed-sediment contaminants, aquatic-tissue contaminants, fis community, and selected stream abitat data. Quality-control c emical data are also presented. Basinwide and site-specific spatial data compiled by t e study unit are also distributed wit t is report.

Study design and sampling methods

T e study design and sampling met ods developed for t e Potomac NAWQA study unit are consistent wit t e national NAWQA guidelines (Gilliom and ot ers, 1995). T e design permits an integrated assessment of conditions at local, regional, and national scales. For more information refer to t e report, "Design and Implementation of a Sampling Strategy for a Water-Quality Assessment of t e Potomac River Basin" (Ger art and Brakebill, 1996). Sampling met ods and protocols for t e NAWQA Program are documented in a series of guideline documents. Citations for t ese can be found in t e Selected references section of t is report.

Using this report

T e data presented in t is report are organized according to t e Potomac River Basin study unit's design. T is report is a companion to t e report, "Design and Implementation of a Sampling Strategy for a Water-Quality Assessment of t e Potomac River Basin" (Ger art and Brakebill, 1996). T e data can be accessed two ways, viewing t e data on screen or downloading t e data. T e 'view data' tables present selected analytes only. Due to size constraints on computer screens and t e time it takes for larger tables to be viewed on screen, t e analytes were abridged to facilitate an easy glance at t e data presented in t is report. T e download files contain all data for eac sub eading. T e download files are in a tab-delimited ASCII format wit comment lines set aside by t e pound key (#), a field name line, and a field definition line.

T e selected spatial data section contains t e metadata for t ose geograp ic information system (GIS) data sets t at were used by t e study unit for analysis. T e metadata complies wit Federal Geograp ic Data Committee (FGDC) standards. To download t e actual data go to t e Distribution Information link.

Acknowledgments

T e aut ors would like to t ank Scott Ator, Jo n Battista, Bruce Bernard, Joel Blomquist, Matt ew Ferrari, Gary Fis er, James Ger art, Liz Gno, Mic ael Hackney, Kalman Illyefalvi, P yllis Illyefalvi, James Jeffries, Jon Kaye, Step en Maskol, C eric Miller, Mastin Mount, Mic ael S ackelford, Gianni Venturi, William Werk eiser, and Humbert Zappia for t eir contributions to t is report. T ese members of t e study-unit team collected and reviewed t ese data. T anks also to Jerry Garrett for t e advice on producing t is report. T e aut ors would also like to recognize t e numerous landowners t at provided access to wells and stream sites for sample collection.

Special t anks to Dan Cincotta from t e West Virginia Department of Natural Resources for verifying our fis specimens.

Some of t e monitoring data included in t is report were partially funded by t e Interstate Commission on t e Potomac River Basin. USGS personnel using sampling and analytical met ods comparable to NAWQA protocols collected t ese data.

For more information

T is report is being distributed by CD-ROM and on t e World Wide Web.
Requests for information or data related to t is report s ould be directed to:

Potomac NAWQA C ief
U.S. Geological Survey
8987 Yellow Brick Road
Baltimore, Maryland 21237
(410)238-4200

Forward to next page
Back to table of contents
Last modified: Wed Nov 12 16:34:39 1997

Potomac N WQ :
Sampling approaches and sampling stations

fix1 - Integrator Surface-Water Site: Water quality and ecology (multiple samples)
fix2 - Indicator Surface-Water Site: Water quality and ecology (multiple samples)
bst - Streambed Sediment and Aquatic Biological Tissues
bed - Streambed Sediment only
tis - Aquatic Biological Tissues only
synh - Major Tributaries Synoptic: Water Quality (one sample)
syn1 - reat Valley Carbonate Surface-Water Synoptic: Water quality and ecology (one sample)
syn2 - Piedmont Surface-Water Synoptic: Water quality and ecology (one sample)
syn3 - Triassic Lowlands Surface-Water Synoptic: Water quality and ecology (one sample)
syn4 - Valley and Ridge Surface-Water Synoptic: Water quality and ecology (one sample)

To search on a specific station identifier, use your browser's search mode

USGS station id	Station name	fix1	fix2	bst	synh	syn1	syn2	syn3	syn4
01654000	Accotink Creek near Annandale, VA		fix2	bst			syn2		
01638994	Alloway Creek near Harney, MD							syn3	
01651010	Anacostia River near Bladensbur , MD			bed					
01619500	Antietam Creek near Sharpsbur , MD				synh				
01660350	Aquia Creek near Garrisonville, VA						syn2		
01639462	Bear Brook near Frizzellbur , MD						syn2		
01643820	Beaverdam Creek near Unison, VA						syn2		
01643300	Bennett Creek near Hyattstown, MD						syn2		
01639400	Bi Pipe Creek at Bachman Mills, MD						syn2		
01620995	Black Run at Rawley Sprin s, VA								syn4
01621400	Blacks Run at Harrisonbur , VA					syn1			
01643615	Broad Run at Elmar, MD							syn3	
01637950	Broad Run near Jefferson, MD						syn2		
01635045	Buffalo Marsh Run near Middletown, VA					syn1			
01656725	Bull Run near Catharpin, VA							syn3	
01657000	Bull Run near Manassas, VA			bst					
01636460	Bullskin Run above Kabletown, WV					syn1			
01646350	Cabin John Creek at Rockville, MD						syn2		
01611500	Cacapon River near Great Cacapon, WV			bst	synh				
01642200	Carroll Creek at Frederick, MD					syn1			
01638050	Catoctin Creek at Olive, MD				synh				
01638480	Catoctin Creek at Taylorstown, VA		fix2	bst	synh		syn2		
01614110	Conococheague Creek trib. near Fayetteville, PA					syn1			
01614500	Conococheague Creek at Fairview, MD	fix1		bst	synh				
01613082	Cove Run at Warfordsbur , PA								syn4
01643705	Cromwell Run near Atoka, VA						syn2		
01656870	Cub Run at Old Lee Rd near Chantilly, VA							syn3	
01613060	Cummin s Run near Needmore, PA								syn4
01645725	Difficult Run near Vienna, VA						syn2		
01610990	Dillons Run at Capon Brid e, WV								syn4
01605800	Dry Run near Cherry Grove, WV								syn4
01614130	Fallin Sprin at Chambersbur , PA					syn1			
01656772	Flat Branch at Manassas Park, VA							syn3	
01639380	Flat Run at Emmitsbur , MD							syn3	
01656920	Flatlick Branch at Braddock Rd near Chantilly, VA							syn3	
01624670	Folly Mills Creek near Staunton, VA					syn1			
01652370	Fourmile Run at Arlin ton, VA						syn2		
01641930	Glade Creek near Walkersville, MD					syn1			
01644000	Goose Creek near Leesbur , VA			bst	synh				
01656102	Goslin Run near Aden, VA							syn3	
01644481	Great Seneca Creek at Goshen, MD						syn2		
01619200	Hamilton Creek at Ha erstown, MD					syn1			
01636215	Happy Creek at Crosby Stadium at Front Royal, VA					syn1			
01614010	Harlan Run near Sprin Mills, WV					syn1			
01632750	Holmans Run at Quicksbur , VA					syn1			
01605950	Jordan Run near Hopeville, WV								syn4
01656655	Kettle Run near Nokesville, VA							syn3	
01610185	Kimsey Run near Lost River, WV								syn4
01624490	Lewis Creek at Staunton, VA					syn1			
01613510	Little Cove Creek near Sylvan, PA								syn4
01640000	Little Pipe Creek at Avondale, MD						syn2		
01638920	Littles Run near Gettysbur , PA							syn3	
01611205	Maple Run near Slanesville, WV								syn4
01617800	Marsh Run at Grimes, MD			bst		syn1			
01619140	Marsh Run at Reid, MD					syn1			
01625000	Middle River near Grottoes, VA			bst	synh				
01604400	Mill Creek at Burlin ton, WV								syn4
01629550	Mill Creek near Hambur , VA					syn1			
01608300	Mill Run near Romney, WV								syn4
01639000	Monocacy River at Brid eport, MD		fix2	bst	synh				
01643020	Monocacy River at Reich's Ford Brid e near Frederick, MD (Q@01643000*)	fix1		bst	synh				
01620850	Mossy Creek near Sprin Creek, VA					syn1			

01621050	Muddy Creek at Mount Clinton, Va. **		fix2	bst		syn1			
01608150	Mudlick Run near Moorefield, WV								syn4
01638740	Mummasbur Run near Gettysbur , PA							syn3	
01659000	North Branch Chopawamsic Creek near Joplin, VA						syn2		
01600000	North Branch Potomac River at Pinto, MD			bzd	synh				
01595000	North Branch Potomac River at Steyer, MD			bzd					
01603000	North Branch Potomac River near Cumberland, MD		fix1	bst	synh				
01647720	North Branch Rock Creek near Norbeck, MD						syn2		
01643800	North Fork Goose Creek near Lincoln, VA						syn2		
01633000	North Fork Shenandoah River at Mt Jackson, VA				synh				
01634000	North Fork Shenandoah River near Strasbur , VA			bst	synh				
01606720	North Mill Creek near Petersbur , WV								syn4
01622000	North River at Burketown, VA				synh				
01620500	North River near Stokesville, VA								syn4
01616500	Opequon Creek near Martinsbur , WV			bst	synh				
01634100	Paddy Run near Zepp, VA								syn4
01636305	Pa e Brook at Boyce, VA					syn1			
01649200	Paint Branch at Colle e Park, MD						syn2		
01601470	Piney Mountain Creek at LaVale, MD								syn4
01624950	Polecat Draft near Piedmont, VA					syn1			
01626950	Porterfield Run near Crimora, VA					syn1			
01652589	Potomac River below Oxon Creek at Washin ton, DC			bzd					
01646580	Potomac River at Chain Brid e at Washin ton, DC (Q@01646500*)		fix1		synh				
01618000	Potomac River at Shepherdstown, WV			bst					
01652588	Potomac River near Alexandria, VA			tis					
01618200	Rattlesnake Run near Shepherdstown, WV					syn1			
01638450	Richard Creek near Waterford, VA						syn2		
01614525	Rockdale Run at Fairview, MD					syn1			
01640155	Sams Creek near Union Brid e, MD						syn2		
01596500	Sava e River near Barton, MD			bzd					
01605900	Seneca Creek near One a, WV								syn4
01636500	Shenandoah River at Millville, WV		fix1	bst	synh				
01631700	Shoemaker River near Faulks Run, VA								syn4
01639440	Silver Run near Silver Run, MD						syn2		
01650900	Sli o Creek at Takoma Park, MD						syn2		
01606500	South Branch Potomac River near Petersbur , WV				synh				
01608500	South Branch Potomac River near Sprin field, WV		fix1	bst	synh				
01642425	South Fork Lin anore Creek near Lin anore, MD						syn2		
01606600	South Fork Lunice Creek near Maysville, WV								syn4
01658500	South Fork Quantico Creek near Independent Hill, VA						syn2		
01631000	South Fork Shenandoah River at Front Royal, VA				synh				
01629500	South Fork Shenandoah River near Luray, VA				synh				
01631020	South Fork Shenandoah River Below Cabin Run at Front Royal, VA (Q@01631000*)			bst					
01608000	South Fork South Branch Potomac River near Moorefield, WV		fix2	bst	synh				
01627500	South River at Harriston, VA			bst	synh				
01611120	Sperry Run at Rio, WV								syn4
01661050	St.Clement Creek near Clements, MD			bst					
01611130	Tear Coat Creek near Rio, WV								syn4
01605490	Thorn Creek near Moatstown, WV								syn4
01633730	Toms Brook at Toms Brook, VA					syn1			
01615520	Town Run at Winchester, VA					syn1			
01610250	Trout Run near Wardensville, WV								syn4
01617010	Tuscarora Creek at Martinsbur , WV					syn1			
01614350	Welsh Run at Welsh Run, PA					syn1			
01605220	West Strait Creek near Monterey, VA								syn4
01610063	White Sulfur Run near Flintstone, MD								syn4
01638895	Whites Run near Two Tavern's, PA							syn3	
01657435	Wolf Run near Clifton, VA						syn2		

** Q denotes that discharge measurements were taken at a different point on the stream than the actual sample.*
Discharge from the stated Station was used.
*** Five additional surface-water sites were located within the small-scale ground-water flow-system study in the Muddy Creek watershed, near Mount Clinton, VA.*

Potomac N WQ :
Stream site locations

Table is in alphabetical order by stream name. To search on a specific station identifier, use your browser's search mode.

[DMS- d gr s, minut s, s conds: FIPS- F d ral information proc ssing standard cod]

USGS station Id	Station name	Latitude (DMS)	Longitude (DMS)	State code (FIPS)	County code (FIPS)
01654000	Accotink Cr k n ar Annandal , VA	384846	0771343	51	059
01638994	Alloway Cr k n ar Harn y, MD	394349	0770915	42	001
01651010	Anacostia Riv r at Blad nsburg, MD	385525	0765620	24	033
01619500	Anti tam Cr k n ar Sharpsburg, MD	392701	0774352	24	043
01660350	Aquia Cr k n ar Garrisonvill , VA	382906	0772930	51	179
01639462	B ar Branch n ar Frizz llburg, MD	393753	0770438	24	013
01643820	B av rdam Cr k n ar Unison, VA	390235	0774601	51	107
01643300	B nn tt Cr k n ar Hyattstown, MD	391831	0771755	24	021
01639400	Big Pip Cr k at Bachman Mills, MD	393939	0765654	24	013
01620995	Black Run at Rawl y Springs, VA	383030	0790331	51	165
01621400	Blacks Run at Harrisonburg, VA	382552	0785302	51	660
01643615	Broad Run at Elm r, MD	390722	0772852	24	031
01637950	Broad Run n ar J ff rson, MD	392200	0773512	24	021
01635045	Buffalo Marsh Run n ar Middl town, VA	390334	0781817	51	069
01656725	Bull Run n ar Catharpin, VA	385321	0773414	51	153
01657000	Bull Run n ar Manassas, VA	384752	0772728	51	059
01636460	Bullskin Run abov Kabl town,WV	391310	0775159	54	037
01646350	Cabin John Cr k at Rockvill , MD	390321	0770906	24	031
01611500	Cacapon Riv r n ar Gr at Cacapon, WV	393443	0781834	54	065
01642200	Carroll Cr k at Fr d rick, MD	392504	0772534	24	021
01638050	Catoctin Cr k at Oliv , MD	391956	0773445	24	021
01638480	Catoctin Cr k at Taylorstown, VA	391518	0773436	51	107
01614110	Conococh agu Cr k Trib. at Fay tt vill , PA	395441	0773418	42	055
01614500	Conococh agu Cr k at Fairvi w, MD	394257	0774928	24	043
01613082	Cov Run at Warfordsburg, PA	394545	0781107	42	057
01643705	Cromw ll Run n ar Atoka, VA	385551	0774836	51	061
01656870	Cub Run at Old L Rd. n ar Chantilly, VA	385256	0772813	51	059
01613060	Cummings Run n ar N dmor , PA	395249	0780842	42	057
01645725	Difficult Run n ar Vi nna, VA	385411	0771908	51	059
01610990	Dillons Run at Capon Bridg , WV	391730	0782640	54	027
01605800	Dry Run n ar Ch rry Grov , WV	383720	0793215	54	071
01614130	Falling Spring at Chamb rsburg, PA	395621	0773901	42	055
01656772	Flat Branch at Manassas Park, VA	384654	0772913	51	153
01639380	Flat Run at Emmitsburg, MD	394229	0771919	24	021
01656920	Flatlick Branch n ar Chantilly, VA	385203	0772751	51	059
01624670	Folly Mills Cr k n ar Staunton, VA	380542	0790515	51	015
01652370	Fourmil Run at Arlington, VA	385204	0770740	51	013
01641930	Glad Cr k n ar Walk rsvill , MD	392834	0772220	24	021
01644000	Goos Cr k n ar L sburg, VA	390110	0773440	51	107
01656102	Goslin Run n ar Ad n, VA	383640	0773304	51	153
01644481	Gr at S n ca Cr k at Gosh n, MD	391204	0771216	24	031
01619200	Hamilton Cr k at Hag rstown, MD	393831	0774216	24	043
01636215	Happy Cr k at Crosby Stadium at Front Royal, VA	385543	0781126	51	187
01614010	Harlan Run n ar Spring Mills, WV	393333	0775735	54	003
01632750	Holmans Run at Quicksburg, VA	384207	0784054	51	171
01605950	Jordan Run n ar Hop vill , WV	385908	0791559	54	023
01656655	K ttl Run n ar Nok svill , VA	384328	0773632	51	153
01610185	Kims y Run n ar Lost Riv r, WV	385806	0785403	54	031
01624490	L wis Cr k at Staunton, VA	380903	0790334	51	790
01613510	Littl Cov Cr k n ar Sylvan, PA	394424	0780150	42	057
01640000	Littl Pip Cr k at Avondal , MD	393340	0770238	24	013
01638920	Littl s Run n ar G ttysburg, PA	394653	0771144	42	001
01611205	Mapl Run n ar Slan svill , WV	392056	0783107	54	027
01617800	Marsh Run at Grim s, MD	393053	0774638	24	043
01619140	Marsh Run at R id, MD	394237	0774027	24	043
01625000	Middl Riv r n ar Grotto s, VA	381542	0785144	51	015
01604400	Mill Cr k at Burlington, WV	392020	0785519	54	057
01629550	Mill Cr k n ar Hamburg, VA	383807	0783042	51	139
01608300	Mill Run n ar Romn y, WV	391809	0784802	54	027
01639000	Monocacy Riv r at Bridg port, MD	394043	0771406	24	021
01643020	Monocacy Riv r at R ichs Ford Bridg n ar Fr d rick, MD	392316	0772240	24	021
01620850	Mossy Cr k n ar Spring Cr k, VA	382312	0790052	51	165
01621050	Muddy Cr k at Mount Clinton, VA	382911	0785740	51	165

0162101710	SW-04 Muddy Cr k Flowpath study, VA.	383213	0785737	51	165
0162101730	SW-05 (conflu nc) Muddy Cr k Flowpath study, VA.	383211	0785721	51	165
0162101750	SW 03 Muddy Cr k Flowpath study, VA.	383205	0785715	51	165
0162101770	SW-02 Muddy Cr k Flowpath study, VA.	383202	0785712	51	165
0162101790	SW 01 Muddy Cr k Flowpath study, VA.	383152	0785709	51	165
01608150	Mudlick Run n ar Moor fi ld, WV	390824	0785635	54	031
01638740	Mummasburg Run n ar G ttysburg, PA	395149	0771723	42	001
01659000	North Branch Chopawamsic Cr k n ar Joplin, VA	383358	0772548	51	179
01600000	North Branch Potomac Riv r at Pinto, MD	393359	0785025	54	057
01595000	North Branch Potomac Riv r at St y r, MD	391807	0791826	24	023
01603000	North Branch Potomac Riv r n ar Cumb rland, MD	393718	0784624	24	001
01647720	North Branch Rock Cr k n ar Norb ck, MD	390659	0770609	24	031
01643800	North Fork Goos Cr k n ar Lincoln, VA	390534	0774300	51	107
01633000	North Fork Sh nandoah Riv r at Mount Jackson, VA	384444	0783821	51	171
01634000	North Fork Sh nandoah Riv r n ar Strasburg, VA	385836	0782011	51	187
01606720	North Mill Cr k n ar P t rsburg, WV	385518	0791048	54	023
01622000	North Riv r n ar Burk town, VA	382025	0785450	51	165
01620500	North Riv r n ar Stok svill , VA	382009	0791422	51	015
01616500	Op quon Cr k n ar Martinsburg, WV	392525	0775620	54	003
01634100	Paddy Run n ar L banon Church, VA	390255	0782940	51	069
01636305	Pag Brook at Boyc , VA	390550	0780304	51	043
01649200	Paint Branch at Coll g Park, MD	390116	0765645	24	033
01601470	Pin y Mountain Cr k at Laval , MD	393926	0784835	24	001
01624950	Pol cat Draft n ar Pi dmont, VA	381308	0785231	51	015
01626950	Port ri ld Run n ar Crimora, VA	380754	0785230	51	015

01652589	Potomac Riv r b low Oxon Cr k at Washington, DC	384806	0770136	24	033
01646580	Potomac Riv r at Chain Bridg , at Washington, DC	385546	0770702	51	013
01618000	Potomac Riv r at Sh ph rdstown, WV	392604	0774807	54	037
01652588	Potomac Riv r n ar Al xandria, VA	384903	0770218	11	001
01618200	Rattl snak Run n ar Sh ph rdstown, WV	392401	0774629	54	037
01638450	Richard Cr k n ar Wat rford, VA	391303	0773750	51	107
01614525	Rockdal Run at Fairvi w, MD	394207	0775045	24	043
01640155	Sams Cr k n ar Union Bridg , MD	393215	0771016	24	013
01596500	Savag Riv r n ar Barton, MD	393405	0790610	24	023
01605900	S n ca Cr k n ar On go, WV	385133	0792817	54	071
01636500	Sh nandoah Riv r at Millvill , WV	391655	0774722	54	037
01631700	Sho mak r Riv r n ar Fulks Run, VA	383825	0785338	51	165
01639440	Silv r Run n ar Silv r Run, MD	394038	0770537	24	013
01650900	Sligo Cr k at Takoma Park, MD	385859	0770002	24	031
01606500	South Branch Potomac Riv r n ar P t rsburg, WV	385928	0791034	54	023
01608500	South Branch Potomac Riv r n ar Springfi ld, WV	392649	0783916	54	027
01642425	South Fork Linganor Cr k at Linganor , MD	392625	0771240	24	021
01606600	South Fork Lunic Cr k n ar Maysvill , WV	390407	0790734	54	023
01658500	South Fork Quantico Cr k n ar Ind p nd nt Hill, VA	383514	0772544	51	153
01631000	South Fork Sh nandoah Riv r at Front Royal, VA	385450	0781240	51	187
01629500	South Fork Sh nandoah Riv r n ar Luray, VA	383846	0783206	51	139
01631020	South Fork Sh n ndoah Riv r Bl Cabin Run at Front Royal, VA	385615	0781252	51	187
01608000	South Fork South Branch Potomac Riv r n ar Moor fi ld, WV	390044	0785723	54	031
01627500	South Riv r at Harriston, VA	381307	0785013	51	015
01611120	Sp rry Run at Rio, WV	390802	0783932	54	027
01661050	St Cl m nt Cr k n ar Cl m nts, MD	382000	0764331	24	037
01611130	T ar Coat Cr k n ar Rio, WV	391303	0784050	54	027
01605490	Thorn Cr k n ar Moatstown, WV	383227	0792154	54	071

01633720	Toms Brook at Toms Brook, VA	385642	0782632	51	171
01615520	Town Run at Winch st r, VA	391012	0780940	51	840
01610250	Trout Run n ar Ward nsvill , WV	385920	0783923	54	031
01617010	Tuscarora Cr k at Martinsburg, WV	392715	0775741	54	003
01614350	W lsh Run at W lsh Run, PA	394610	0775030	42	055
01605220	W st Strait Cr k n ar Mont r y, VA	382632	0793220	51	091
01610063	Whit Sulfur Run n ar Flintston , MD	393930	0782753	24	001
01638895	Whit s Run n ar Two Tav rns, PA	394807	0771044	42	001
01657435	Wolf Run n ar Clifton, VA	384409	0772151	51	059

C.3. LANDUSE METADATA (NLCD)

National Land Cover Database Zone 59 Land Cover Layer

Metadata also available as

Metadata:

Identification_Information:
Citation:
Citation_Information:
Originator: U.S. Geological Survey
Publication_Date: 20030901
Title: National Land Cover Database Zone 59 Land Cover Layer
Edition: 1.0
Geospatial_Data_Presentation_Form: remote-sensing image
Series_Information:
Series_Name: None
Issue_Identification: None
Publication_Information:
Publication_Place: Sioux Falls, SD
Publisher: U.S. Geological Survey
Other_Citation_Details:
References:Homer, C., C. Huang, L. Yang, B. Wylie and M. Coan, 2004. Development of a 2001 national land cover database for the United States. Photogrammetric Engineering and Remote Sensing Vol.70,No.7,pp 829-840 or online at www.mrlc.gov/publications.The USGS acknowledges the support of NARSAL at the University of Georgia in development of data in this zone.
Online_Linkage: <http://www.mrlc.gov>
Description:
Abstract:
The National Land Cover Database 2001 land cover layer for mapping zone 59 was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. The MRLC Consortium is a partnership of federal agencies (www.mrlc.gov), consisting of the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), the U.S. Forest Service (USFS), the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM) and the USDA Natural Resources Conservation

Service (NRCS). One of the primary goals of the project is to generate a current, consistent, seamless, and accurate National Land cover Database (NLCD) circa 2001 for the United States at medium spatial resolution. This landcover map and all documents pertaining to it are considered "provisional" until a formal accuracy assessment can be conducted. For a detailed definition and discussion on MRLC and the NLCD 2001 products, refer to Homer et al. (2004) and <http://www.mrlc.gov/mrlc2k.asp>.

The NLCD 2001 is created by partitioning the U.S. into mapping zones. A total of 66 mapping zones were delineated within the conterminous U.S. based on ecoregion and geographical characteristics, edge matching features and the size re uirement of Landsat mosaics. Mapping zone 59 encompasses whole or portions of several states, including the states of South Carolina, North Carolina, and Virginia. Questions about the NLCD mapping zone 59 can be directed to the NLCD 2001 land cover mapping team at the National Center, EROS, Sioux Falls, SD (605) 594-6151 or mrlc@usgs.gov.

Purpose:
The goal of this project is to provide the Nation with complete, current and consistent public domain information on its land use and land cover.
Supplemental_Information:
Corner Coordinates (center of pixel, projection meters)Upper Left Corner: 124575 meters(X), 1831230 meters(Y)Lower Right Corner: 1627410 meters(X), 1377660 meters(Y)Spatial-specific information not available
Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 19991030
Ending_Date: 20020704
Currentness_Reference: ground condition
Status:
Progress: In work
Maintenance_and_ pdate_Frequency: As needed
Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate:-80.75933091
East_Bounding_Coordinate:-77.63897197
*North_Bounding_Coordinate:*39.72993205
*South_Bounding_Coordinate:*37.37708076
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: Land Cover
Theme_Keyword: GIS
Theme_Keyword: U.S. Geological Survey
Theme_Keyword: USGS
Theme_Keyword: digital spatial data
Theme:
Theme_Keyword_Thesaurus: ISO 19115 Category
Theme_Keyword: imagery
Theme_Keyword: Base Maps
Theme_Keyword: Earth Cover
Place:

Place_Keyword_Thesaurus:
U.S. Department of Commerce, 1995, Countries, dependencies, areas of special sovereignty, and their principal administrative divisions, Federal Information Processing Standard 10-4.): Washington, D.C., National Institute of Standards and Technology
Place_Keyword: United States
Place_Keyword: U.S.
Place_Keyword: US
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: Zone 59
Place:
Place_Keyword_Thesaurus:
U.S. Department of Commerce, 1987, Codes for the identification of the States, the District of Columbia and the outlying areas of the United States, and associated areas (Federal Information Processing Standard 5-2): Washington, D.C., National Institute of Standards and Technology
Place_Keyword: South Carolina
Place_Keyword: North Carolina
Place_Keyword: Virginia
Place_Keyword: SC
Place_Keyword: NC
Place_Keyword: VA
Place_Keyword: Southern Piedmont
Place_Keyword: Northern Piedmont
Access_Constraints: None
se_Constraints: None
Point_of_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: U.S. Geological Survey
Contact_Position: Customer Services Representative
Contact_Address:
Address_Type: mailing and physical address
Address: National Center, EROS
Address: 47914 252nd Street
City: Sioux Falls
State_or_Province: SD
Postal_Code: 57198-0001
Country: USA
Contact_Voice_Telephone: 605/594-6151
Contact_TDD/TTY_Telephone: 605/594-6933
Contact_Facsimile_Telephone: 605/594-6589
Contact_Electronic_Mail_Address: custserv@usgs.gov
Hours_of_Service: 0800 - 1600 CT, M - F (-6h CST/-5h CDT GMT)
Contact_Instructions:
The USGS point of contact is for uestions relating to the data display and download from this web site. For uestions regarding data content and uality, refer to:<http://www.mrlc.gov/mrlc2k.asp> or email: mrlc@usgs.gov
Data_Set_Credit: U.S. Geological Survey, NARSAL
Security_Information:
Security_Classification_System: None

Security_Classification: Unclassified
Security_Handling_Description: N/A
Native_Data_Set_Environment:
Microsoft Windows 2000 Version 5.1 (Build 2600) Service Pack 1; ESRI ArcCatalog 9.0.0.535

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
The information on data uality for mapping zone 59 was generated by the Decision Tree algorithm that conducts a cross-validation for assessing classification and prediction reliability. No formal independent accuracy assessment of mapping zone 59 land cover has been made. The regression tree algorithm employed in NLCD 2001 mapping offers a cross-validation option for assessing classification and prediction reliability. Cross-validation can provide relatively reliable estimates for land cover predictions if the reference data used for cross-validation are collected based on a statistically valid sampling design. For mapping zone 59 land cover modeling, a 5-fold cross-validation was conducted by dividing the entire training data set into 5 subsets of e ual size. For each model run, an accuracy estimate was derived using one subset to evaluate the model prediction (with the model developed using the remaining training samples). This process was repeated 5 times. After all 5 runs, an average value of all accuracy estimates from the 5 runs were computed. Users should be cautioned that these cross-validation results provide users with only first-order estimates of data uality, and should not be considered a formal accuracy assessment. This landcover map and all documents pertaining to it are considered "provisional" until a formal accuracy assessment can be conducted.
Quantitative_Attribute_Accuracy_Assessment:
Attribute_Accuracy_Value: 83.9
Attribute_Accuracy_Explanation:
The above listed value is the overall accuracy obtained for the land cover data using a cross-validation estimate from the decision tree model. This document and the described landcover map are considered "provisional" until a formal accuracy assessment is completed. The U.S. Geological Survey can make no guarantee as to the accuracy or completeness of this information, and it is provided with the understanding that it is not guaranteed to be correct or complete. Conclusions drawn from this information are the responsibility of the user.
Logical_Consistency_Report:
The NLCD 2001 database for mapping zone 59 consists of three main data products including: (1) per pixel classified land-cover data (2) sub-pixel percent imperviousness and (3) sub-pixel percent tree canopy density. The land-cover database also includes three additional metadata layers that provide users a spatial node map of the land cover classification. The three layers are: (a) a spatial node map of the land cover classification, (b) a spatial confidence map of the land cover classification, and, (c) a text file of logical statements related to the land cover classification.

Conceptually, the descriptive tree is a classification tree generated by using the final minimum-map- unit land cover product (1 acre) as training data, and Landsat and other ancillary data as predictors. The goal of the descriptive tree is to summarize the effects of boosted trees (10 se uential classification trees) into a single condensed decision tree that can be used as a diagnostic tool for the classification process. This descriptive tree can be used to assess the relative importance of each of the input data sets on each land cover class. Such information may also be useful to customize the minimum-mapping-unit classification to meet a user's specific needs through raster modeling. Descriptive trees usually capture 60 to 80% of the information from the original land cover data.

The leaf or terminal nodes of the descriptive tree are assigned to se uential numbers (called node numbers) and mapped across the entire mapping zone on a pixel-by-pixel basis. These node numbers can then be matched with the various conditional statements associated with each respective terminal node. This spatial layer appears similar to a cluster map, but is the result of a supervised classification - not an unsupervised clustering. This node map can potentially be used as input by users to customize NLCD land cover, by linking the spatial extent of an individual node with the rules of the conditional statement.

The Land Cover spatial classification confidence data layer is provided to users to help determine the per-pixel spatial confidence of the NLCD 2001 land cover prediction from the descriptive tree. The C5 algorithm produces an estimate (a value between 0% and 100%) that indicates the confidence of rule predictions at each node based on the training data. This spatial confidence map should be considered as only one indicator of relative reliability of the land cover classification, rather than a precise estimate. Users should be aware that this estimate is made based on only training data, and is derived from a generalized descriptive decision tree that reproduces the final land cover data. However, this layer provides valuable insight for a user to determine the risk or confidence they choose to place in each pixel of land cover.

A logic statement from a descriptive tree classification describes each classification rule for each classified pixel. An example of the logic statement follows:

IF tasseled-cap wetness > 140 and imperviousness = 0 and canopy density < 4, then classify as Water

This logic file can be used in combination with the spatial node map to identify classification logic and allow modifications of the classification based on user's knowledge and/or additional data sets.

Additional information may be found at <http://www.mrlc.gov/mrlc2k_nlcd.asp>.

Completeness_Report:
This NLCD product of mapping zone 59 Land Cover layer is the version dated 20050131.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report: N/A
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report: N/A
Lineage:
Process_Step:
Process_Description:
The land cover classification was achieved by use of a classification and decision tree method (DT) using a combination of Landsat imagery and ancillary data. The specific DT program employed is called C5, which implements a gain ratio criterion in tree development and pruning (Quinlan, 1993). C5 also implemented several advanced features that can aid and improve land cover classification, including boosting and cross-validation. Boosting is a techni ue for improving classification accuracy, while cross-validation can provide certain level of estimation regarding the land cover classification uality. In addition, C5 can generate a confidence estimate for each classified pixel and record the associated classification logic in a text file

that can be readily interpreted and incorporated into a metadata system.

To conduct the land cover classification using DT, a large uantity of training data is re uired. For mapping zone 59, training data were collected from several combined sources including USGS DOQQsNote that the training data were used to map all land cover classes except for four classes in urban and sub-urban areas (developed open space, low intensity developed, medium intensity developed, high intensity developed). All urban and suburban land cover classes were mapped and uality assessed separately through a sub-pixel uantification of impervious surfaces using a regression tree modeling method.

Following the development of the best classification through decision tree modeling, additional steps were re uired to complete the final land cover product. The four classes in urban and suburban areas were determined from the percent imperviousness mapping product (described in the next section). The threshold for the four classes is: (1) developed open space (imperviousness < 20%), (2) low-intensity developed (imperviousness from 20 - 49%), (3) medium intensity developed (imperviousness from 50 -79%), and (4) high-intensity developed (imperviousness > 79%). Other classes of forest and non-forest were combined with the urban classes to complete the land cover product. Finally visual inspection of the classification was made with areas/pixels that were wrongly classified delineated first as an "area of interest" (AOI), subse uently then limited manual editing was done to eliminate the classification error within the AOI.

The completed single pixel product was then generalized to a 1 acre (approximately 5 ETM+ 30 m pixel patch) minimum mapping unit product using a "smart eliminate" algorithm. This aggregation program subsumes pixels from the single pixel level to a 5-pixel patch using a ueens algorithm at doubling intervals. The algorithm consults a weighting matrix to guide merging of cover types by similarity, resulting in a product that preserves land cover logic as much as possible.Ac uisition dates of Landsat ETM+ (TM) scenes used for land cover classification in zone 59 are as follows:
SPRING-
Index 5 for Path 15/Row 34 on 03/24/00 = Scene_ID 7015034000008450
Index 7 for Path 15/Row 34 on 04/09/00 = Scene_ID 7015034000010050
Index 6 for Path 15/Row 35 on 03/08/00 = Scene_ID 7015035000006850
Index 4 for Path 16/Row 34 on 03/07/00 = Scene_ID 5016034000006710
Index 3 for Path 16/Row 35 on 03/05/02 = Scene_ID 7016035000206450
Index 3 for Path 16/Row 36 on 03/05/02 = Scene_ID 7016036000206450
Index 2 for Path 17/Row 34 on 03/25/01 = Scene_ID 7017034000108450
Index 1 for Path 17/Row 35 on 02/24/02 = Scene_ID 7017035000205550
Index 1 for Path 17/Row 36 on 02/24/02 = Scene_ID 7017036000205550
Index 8 for Path 18/Row 35 on 01/22/02 = Scene_ID 5018035000202210
LEAF ON (Summer)-
Index 5 for Path 15/Row 34 on 05/03/00 = Scene_ID 5015034000012410
Index 4 for Path 15/Row 35 on 07/04/02 = Scene_ID 7015035000218550
Index 3 for Path 16/Row 34 on 05/26/00 = Scene_ID 5016034000014710
Index 2 for Path 16/Row 35 on 06/09/02 = Scene_ID 7016035000216050
Index 2 for Path 16/Row 36 on 06/09/02 = Scene_ID 7016036000216050
Index 1 for Path 17/Row 34 on 06/10/00 = Scene_ID 7017034000016250
Index 1 for Path 17/Row 35 on 06/10/00 = Scene_ID 7017035000016250

Index 1 for Path 17/Row 36 on 06/10/00 = Scene_ID 7017036000016250
Index 6 for Path 18/Row 35 on 04/30/00 = Scene_ID 7018035000012150
LEAF-OFF (Fall)-
Index 7 for Path 15/Row 34 on 11/06/01 = Scene_ID 7015034000131050
Index 7 for Path 15/Row 35 on 11/06/01 = Scene_ID 7015035000131050
Index 6 for Path 16/Row 34 on 11/08/99 = Scene_ID 7016034009931250
Index 4 for Path 16/Row 35 on 10/28/01 = Scene_ID 7016035000130150
Index 5 for Path 16/Row 36 on 11/10/00 = Scene_ID 7016036000031550
Index 3 for Path 17/Row 34 on 10/30/99 = Scene_ID 7017034009930350
Index 2 for Path 17/Row 35 on 10/19/01 = Scene_ID 7017035000129251
Index 1 for Path 17/Row 36 on 10/16/00 = Scene_ID 7017036000029050
Index 8 for Path 18/Row 35 on 10/26/01 = Scene_ID 7018035000129950

Landsat data and ancillary data used for the land cover prediction -

Data Type of DEM composed of 1 band of Continuous Variable Type.

Data Type of Slope composed of 1 band of Continuous Variable Type.

Data Type of Aspect composed of 1 band of Categorical Variable Type.

Data type of Position Index composed of 1 band of Continuous Variable Type.

Source_ sed_Citation_Abbreviation: Landsat ETM, DOQQ, USDA, FIA, DEM, National Center,EROS, IKONOS
Process_Date: 20050131
Source_Produced_Citation_Abbreviation: USGS NLCD
Process_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization:
Natural Resources Spatial Analysis Laboratory, University of Georgia
Contact_Person: Kevin Samples
Contact_Address:
Address_Type: mailing and physical address
Address: NARSAL
Address: Institute of Ecology, University of Georgia
City: Athens
State_or_Province: GA
Postal_Code: 30602
Country: USA
Contact_Voice_Telephone: 706-542-3489
Contact_TDD/TTY_Telephone: NA
Contact_Facsimile_Telephone: NA
Contact_Electronic_Mail_Address: ksamples@uga.edu

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Raster
Raster_Object_Information:
Raster_Object_Type: Pixel

National Land Cover Database Zone 59 Land Cover Layer

Row_Count: 15120
Column_Count: 12723
Vertical_Count: 1

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Map_Projection:
Map_Projection_Name: Albers Conical E ual Area
Albers_Conical_Equal_Area:
Standard_Parallel: 29.500000
Standard_Parallel: 45.500000
Longitude_of_Central_Meridian: -96.000000
Latitude_of_Projection_Origin: 23.000000
False_Easting: 0.000000
False_Northing: 0.000000
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: row and column
Coordinate_Representation:
Abscissa_Resolution: 30.000000
Ordinate_Resolution: 30.000000
Planar_Distance_ nits: meters
Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.257222

Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: Layer_1
Entity_Type_Definition: NLDC Land Cover Layer
Entity_Type_Definition_Source: National Land Cover Database 2001
Attribute:
Attribute_Label: ObjectID
Attribute_Definition: Internal feature number
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
nrepresentable_Domain:
Se uential uni ue whole numbers that are automatically generated.
Attribute:
Attribute_Label: Count
Attribute_Definition:
A nominal integer value that designates the number of pixels that have each value in the file; histogram column in ERDAS Imagine raster attributes table
Attribute_Definition_Source: NLCD 2001
Attribute_Domain_Values:
nrepresentable_Domain: Integer

Attribute:
Attribute_Label: Value
Attribute_Definition:
Land Cover Class Code Value. Class definitions marked with an asterisk (*) are Coastal NLCD Classes only.
Attribute_Definition_Source: NLCD 2001
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: 1
Enumerated_Domain_Value_Definition: No data value, Alaska zones only
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 11
Enumerated_Domain_Value_Definition:
Open Water - All areas of open water, generally with less than 25% cover or vegetation or soil
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 12
Enumerated_Domain_Value_Definition:
Perennial Ice/Snow - All areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 21
Enumerated_Domain_Value_Definition:
Developed, Open Space - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 22
Enumerated_Domain_Value_Definition:
Developed, Low Intensity -Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 23
Enumerated_Domain_Value_Definition:
Developed, Medium Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for

50-79 percent of the total cover. These areas most commonly include single-family housing units.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 24
Enumerated_Domain_Value_Definition:
Developed, High Intensity - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to100 percent of the total cover.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 31
Enumerated_Domain_Value_Definition:
Barren Land (Rock/Sand/Clay) - Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 32
Enumerated_Domain_Value_Definition:
Unconsolidated Shore* - Unconsolidated material such as silt, sand, or gravel that is subject to inundation and redistribution due to the action of water. Characterized by substrates lacking vegetation except for pioneering plants that become established during brief periods when growing conditions are favorable. Erosion and deposition by waves and currents produce a number of landforms representing this class.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 41
Enumerated_Domain_Value_Definition:
Deciduous Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 42
Enumerated_Domain_Value_Definition:
Evergreen Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover

class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 43
Enumerated_Domain_Value_Definition:
Mixed Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 51
Enumerated_Domain_Value_Definition:
Dwarf Scrub - Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 52
Enumerated_Domain_Value_Definition:
Shrub/Scrub - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 71
Enumerated_Domain_Value_Definition:
Grassland/Herbaceous - Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 72
Enumerated_Domain_Value_Definition:
Sedge/Herbaceous - Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 73
Enumerated_Domain_Value_Definition:
Lichens - Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover

class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 74
Enumerated_Domain_Value_Definition:
Moss- Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 81
Enumerated_Domain_Value_Definition:
Pasture/Hay - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 82
Enumerated_Domain_Value_Definition:
Cultivated Crops - Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 90
Enumerated_Domain_Value_Definition:
Woody Wetlands - Areas where forest or shrub land vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 91
Enumerated_Domain_Value_Definition:
Palustrine Forested Wetland* -Includes all tidal and non-tidal wetlands dominated by woody vegetation greater than or e ual to 5 meters in height and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Total vegetation coverage is greater than 20 percent.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 92
Enumerated_Domain_Value_Definition:
Palustrine Scrub/Shrub Wetland* - Includes all tidal and non-tidal wetlands dominated by woody vegetation less than 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to

ocean-derived salts is below 0.5 percent. Total vegetation coverage is greater than 20 percent. The species present could be true shrubs, young trees and shrubs or trees that are small or stunted due to environmental conditions.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 92
Enumerated_Domain_Value_Definition:
Estuarine Forested Wetland* - Includes all tidal wetlands dominated by woody vegetation greater than or e ual to 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is e ual to or greater than 0.5 percent. Total vegetation coverage is greater than 20 percent.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 94
Enumerated_Domain_Value_Definition:
Estuarine Scrub/Shrub Wetland* - Includes all tidal wetlands dominated by woody vegetation less than 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is e ual to or greater than 0.5 percent. Total vegetation coverage is greater than 20 percent.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 95
Enumerated_Domain_Value_Definition:
Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 96
Enumerated_Domain_Value_Definition:
Palustrine Emergent Wetland (Persistent)* - Includes all tidal and non-tidal wetlands dominated by persistent emergent vascular plants, emergent mosses or lichens, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Plants generally remain standing until the next growing season.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 97
Enumerated_Domain_Value_Definition:
Estuarine Emergent Wetland* - Includes all tidal wetlands dominated by erect, rooted, herbaceous hydrophytes (excluding mosses and lichens) and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is e ual to or greater than 0.5 percent and that are

present for most of the growing season in most years. Perennial plants usually dominate these wetlands.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 98
Enumerated_Domain_Value_Definition:
Palustrine A uatic Bed* - The Palustrine A uatic Bed class includes tidal and nontidal wetlands and deepwater habitats in which salinity due to ocean-derived salts is below 0.5 percent and which are dominated by plants that grow and form a continuous cover principally on or at the surface of the water. These include algal mats, detached floating mats, and rooted vascular plant assemblages.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Enumerated_Domain:
Enumerated_Domain_Value: 99
Enumerated_Domain_Value_Definition:
Estuarine A uatic Bed* - Includes tidal wetlands and deepwater habitats in which salinity due to ocean-derived salts is e ual to or greater than 0.5 percent and which are dominated by plants that grow and form a continuous cover principally on or at the surface of the water. These include algal mats, kelp beds, and rooted vascular plant assemblages.
Enumerated_Domain_Value_Definition_Source: NLCD 2001 land cover class descriptions
Attribute:
Attribute_Label: Red
Attribute_Definition:
Red color code for RGB slice by value for canopy image display purposes. The value is arbitrarily assigned by the display software package, unless defined by user. Standard user defined ramp for NLCD project is start color light gray, end color red.
Attribute_Definition_Source: NLCD 2001
Attribute_Domain_Values:
Range_Domain:
Range_Domain_Minimum: 0
Range_Domain_Maximum: 100
Attribute_ nits_of_Measure: CSS Color Value Percentage
Attribute_Measurement_Resolution: 0.1
Attribute:
Attribute_Label: Green
Attribute_Definition:
Green color code for RGB slice by value for canopy image display purposes. The value is arbitrarily assigned by the display software package, unless defined by user. Standard user defined ramp for NLCD project is start color light gray, end color red.
Attribute_Definition_Source: NLCD 2001
Attribute_Domain_Values:
Range_Domain:
Range_Domain_Minimum: 0
Range_Domain_Maximum: 100
Attribute_ nits_of_Measure: CSS Color Value Percentage

Attribute_Measurement_Resolution: 0.1
Attribute:
Attribute_Label: Blue
Attribute_Definition:
Blue color code for RGB slice by value for canopy image display purposes. The value is arbitrarily assigned by the display software package, unless defined by user. Standard user defined ramp for NLCD project is start color light gray, end color red.
Attribute_Definition_Source: NLCD 2001
Attribute_Domain_Values:
Range Domain:
Range_Domain_Minimum: 0
Range_Domain_Maximum: 100
Attribute_ nits_of_Measure: CSS Color Value Percentage
Attribute_Measurement_Resolution: 0.1
Attribute:
Attribute_Label: Opacity
Attribute_Definition:
A measure of how opa ue, or solid, a color is displayed in a layer.
Attribute_Definition_Source: NLCD 2001
Attribute_Domain_Values:
Range_Domain:
Range_Domain_Minimum: 0
Range_Domain_Maximum: 100
Attribute_ nits_of_Measure: Percentage
Attribute_Measurement_Resolution: 0.1
Overview_Description:
Entity_and_Attribute_Overview:
Attributes defined by USGS and ESRI.
Class Red Green Blue
0 0.000000000 0.000000000 0.000000000
1 0.000000000 1.000000000 0.000000000
11 0.325490196 0.462745098 0.662745098
12 0.854901961 0.913725490 1.000000000
21 0.913725490 0.819607843 0.815686275
22 0.890196078 0.615686275 0.545098039
23 0.976470588 0.000000000 0.000000000
24 0.705882353 0.000000000 0.000000000
31 0.741176471 0.725490196 0.670588235
32 1.000000000 1.000000000 1.000000000
41 0.443137255 0.701960784 0.419607843
42 0.137254902 0.423529412 0.231372549
43 0.752941176 0.827450980 0.607843137
51 0.694117647 0.588235294 0.235294118
52 0.835294118 0.764705882 0.533333333
71 0.925490196 0.925490196 0.796078431
72 0.823529412 0.823529412 0.505882353
73 0.635294118 0.796078431 0.321568627
74 0.513725490 0.725490196 0.619607843
81 0.901960784 0.882352941 0.282352941
82 0.709803922 0.486274510 0.200000000
90 0.760784314 0.878431373 0.949019608

95 0.486274510 0.674509804 0.772549020
Entity_and_Attribute_Detail_Citation:
Attribute accuracy is described, where present, with each attribute defined in the Entity and Attribute Section. Note: To ensure all areas of mapping zone 59 are completely covered, a 3,000 meter (100 Landsat pixels) buffer was added to the boundary of mapping zone 59.

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: U.S. Geological Survey
Contact_Position: Customer Service Representative
Contact_Address:
Address_Type: mailing and physical address
Address: National Center, EROS
Address: 47914 252nd Street
City: Sioux Falls
State_or_Province: SD
Postal_Code: 57198-0001
Country: USA
Contact_Voice_Telephone. 605/594-6151
Contact_TDD/TTY_Telephone: 605/594-6933
Contact_Facsimile_Telephone: 605/594-6589
Contact_Electronic_Mail_Address: custserv@usgs.gov
Hours_of_Service: 0800 - 1600 CT, M - F (-6h CST/-5h CDT GMT)
Contact_Instructions:
The USGS point of contact is for uestions relating to the data display and download from this web site. Questions about the NLCD mapping zone 59 can be directed to the NLCD 2001 land cover mapping team at the National Center, EROS, Sioux Falls, SD (605) 594-6151 or mrlc@usgs.gov.
Resource_Description: Downloadable data
Distribution_Liability:
Although these data have been processed successfully on a computer system at the USGS, no warranty expressed or implied is made by the USGS regarding the use of the data on any other system, nor does the act of distribution constitute any such warranty. Data may have been compiled from various outside sources. Spatial information may not meet National Map Accuracy Standards This information may be updated without notification. The USGS shall not be liable for any activity involving these data, installation, fitness of the data for a particular purpose, its use, or analyses results.
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Format_Name: Arc/Info Export Format and/or ArcView Shapefile
Format_Version_Number: ArcGIS 9.0
Format_Specification: ASCII
Transfer_Size: 0.001
Digital_Transfer_Option:
Online_Option:
Computer_Contact_Information:

Network_Address:
Network_Resource_Name: <http://seamless.usgs.gov>
Access_Instructions:
The URL <http://seamless.usgs.gov> provides a map interface that allows for data downloads within a customer defined area of interest. Zoom tools are available that can be used to investigate areas of interest on the map interface. The download tool allows the customer to capture layers from the map, utilizing the Seamless Data Distribution System process for downloading. A re uest summary page is then generated with the download layers listed. By clicking the "download" button on the summary page, a zipped file will be generated that can be saved on the customer's computer. The file can then be unzipped and imported into various user software applications.
Online_Computer_and_Operating_System: Not available for dissemination
Fees: None
Ordering_Instructions: Contact Customer Services
Turnaround: Variable
Custom_Order_Process: Contact Customer Services Representative
Technical_Prerequisites:
ESRI ArcMap Suite and/or Arc/Info software, and supporting operating systems.

Metadata_Reference_Information:
Metadata_Date: 20050617
Metadata_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: U.S. Geological Survey
Contact_Position: Customer Services Representative
Contact_Address:
Address_Type: mailing and physical address
Address: National Center, EROS
Address: 47914 252nd Street
City: Sioux Falls
State_or_Province: SD
Postal_Code: 57198-0001
Country: USA
Contact_Voice_Telephone: 605/594-6151
Contact_TDD/TTY_Telephone: 605/594-6933
Contact_Facsimile_Telephone: 605/594-6589
Contact_Electronic_Mail_Address: custserv@usgs.gov
Hours_of_Service: 0800 - 1600 CT, M - F (-6h CST/-5h CDT GMT)
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC STD 001 1998
Metadata_Time_Convention: local time
Metadata_Access_Constraints: None
Metadata_ se_Constraints: None
Metadata_Security_Information:
Metadata_Security_Classification_System: None
Metadata_Security_Classification: None
Metadata_Security_Handling_Description: None

Metadata_Extensions:
Online_Linkage: <http://www.esri.com/metadata/esriprof80.html>
Profile_Name: ESRI Metadata Profile

Generated by mp version 2.8.6 on Fri Jun 17 12:02:56 2005

C.4. SOIL METADATA (STATSGO)

```
                              soi _metadata_dc001.txt
Identification_Information:
  Citation:
    Citation_Information:
      Originator:
        U.S. Department of Agricu ture, Natura  Resources
        Conservation Service
      Pub ication_Date: 20060914
      Tit e: Soi  Survey Geographic (SSURGO) database for District of Co umbia
      Pub ication Information:
        Pub ication_P ace: Fort Worth, Texas
        Pub isher:
          U.S. Department of Agricu ture, Natura  Resources
          Conservation Service
      Other_Citation_Detai s: dc001
      On ine_Linkage: URL:http://Soi DataMart.nrcs.usda.gov/
  Description:
    Abstract:
      This data set is a digita  soi  survey and genera  y is the most
      detai ed  eve  of soi  geographic data deve oped by the Nationa
      Cooperative Soi  Survey. The information was prepared by digitizing
      maps, by compi ing information onto a p animetric correct base
      and digitizing, or by revising digitized maps using remote y
      sensed and other information.

      This data set consists of georeferenced digita  map data and
      computerized attribute data. The map data are in a soi  survey area
      extent format and inc ude a detai ed, fie d verified inventory
      of soi s and misce  aneous areas that norma  y occur in a repeatab e
      pattern on the  andscape and that can be cartographica  y shown at
      the sca e mapped. A specia  soi  features  ayer (point and  ine
      features) is optiona . This  ayer disp ays the  ocation of features
      too sma   to de ineate at the mapping sca e, but they are  arge
      enough and contrasting enough to significant y inf uence use and
      management. The soi  map units are  inked to attributes in the
      Nationa  Soi  Information System re ationa  database, which gives
      the proportionate extent of the component soi s and their properties.
    Purpose:
      SSURGO depicts information about the kinds and distribution of
      soi s on the  andscape. The soi  map and data used in the SSURGO
      product were prepared by soi  scientists as part of the Nationa
      Cooperative Soi  Survey.
    Supp ementa _Information:
      Digita  versions of hydrography, cu tura  features, and other
      associated  ayers that are not part of the SSURGO data set may be
      avai ab e from the primary organization  isted in the Point of
      Contact.
  Time_Period_of_Content:
    Time_Period_Information:
      Range_of_Dates/Times:
        Beginning_Date: 20060914
        Ending_Date: 20060914
    Currentness_Reference: pub ication date
  Status:
    Progress: Comp ete
    Maintenance_and_Update_Frequency: As needed
  Spatia _Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -77.122
      East_Bounding_Coordinate: -76.906
      North_Bounding_Coordinate: 38.998
      South_Bounding_Coordinate: 38.790
  Keywords:
    Theme:
                                    Page 1
```

```
                              soi _metadata_dc001.txt
      Theme_Keyword_Thesaurus: None
      Theme_Keyword: soi  survey
      Theme_Keyword: soi s
      Theme_Keyword: Soi  Survey Geographic
      Theme_Keyword: SSURGO
    P ace:
      P ace_Keyword_Thesaurus: USGS Geographic Names Information System (GNIS)
      P ace_Keyword: District of Co umbia
      P ace Keyword: Washington West Quadrang e
      P ace_Keyword: Washington East Quadrang e
      P ace_Keyword: A exandria Quadrang e
      P ace_Keyword: Anacostia Quadrang e
  Access_Constraints: None
  Use_Constraints:
    The U.S. Department of Agricu ture, Natura  Resources Conservation
    Service, shou d be acknow edged as the data source in products
    derived from these data.

    This data set is not designed for use as a primary regu atory too
    in permitting or citing decisions, but may be used as a reference
    source. This is pub ic information and may be interpreted by
    organizations, agencies, units of government, or others based on
    needs; however, they are responsib e for the appropriate
    app ication. Federa , State, or  oca  regu atory bodies are not to
    reassign to the Natura  Resources Conservation Service any
    authority for the decisions that they make. The Natura  Resources
    Conservation Service wi   not perform any eva uations of these maps
    for purposes re ated so e y to State or  oca  regu atory programs.

    Photographic or digita  en argement of these maps to sca es greater
    than at which they were origina  y mapped can cause misinterpretation
    of the data. If en arged, maps do not show the sma   areas of
    contrasting soi s that cou d have been shown at a  arger sca e. The
    depicted soi  boundaries, interpretations, and ana ysis derived from
    them do not e iminate the need for onsite samp ing, testing, and
    detai ed study of specific sites for intensive uses. Thus, these data
    and their interpretations are intended for p anning purposes on y.
    Digita  data fi es are periodica  y updated. Fi es are dated, and
    users are responsib e for obtaining the  atest version of the data.
  Point_of_Contact:
    Contact_Information:
      Contact Organization Primary:
        Contact_Organization: U.S. Department of Agricu ture, Natura  Resources
Conservation Service
      Contact_Position: State Soi  Scientist
      Contact_Address:
        Address_Type: mai ing address
        Address: USDA - Natura  Resources Conservation Service
        Address: Mary and State Office
        Address: John Hanson Business Center
        Address: 339 Busch's Frontage Road #301
        City: Annapo is
        State or Province: MD
        Posta _Code: 21401-5534
      Contact_Voice_Te ephone: 443-482-2913
      Contact_TDD/TTY_Te ephone: (202) 720-2600
      Contact_E ectronic_Mai _Address: james.brown@md.usda.gov
Data_Qua ity_Information:
  Attribute_Accuracy:
    Attribute_Accuracy_Report:
      Attribute accuracy is tested by manua
      comparison of the source with hard copy p ots and/or symbo ized
      disp ay of the map data on an interactive computer graphic system.
                                    Page 2
```

Se ected attributes that cannot be visua y verified on p ots or on screen are interactive y queried and verified on screen. In addition, the attributes are tested against a master set of va id attributes. A attribute data conform to the attribute codes in the signed c assification and corre ation document and amendment(s).

Logica _Consistency_Report:

Certain node/geometry and topo ogy GT- po ygon/chain re ationships are co ected or generated to satisfy topo ogica requirements (the GT po ygon corresponds to the soi de ineation). Some of these requirements inc ude: chains must begin and end at nodes, chains must connect to each other at nodes, chains do not extend through nodes, eft and right GT-po ygons are defined for each chain e ement and are consistent throughout, and the chains representing the imits of the fi e are free of gaps. The tests of ogica consistency are performed using vendor software. A interna po ygons are tested for c osure with vendor software and are checked on hard copy p ots. A data are checked for common soi ines (i.e., adjacent po ygons with the same abe). Edge ocations genera y do not deviate from center ine to center ine by more than 0.01 inch.

Comp eteness_Report:

A map unit is a co ection of areas defined and named in terms of their soi components or misce aneous areas or both. Each map unit differs in some respect from a others in a survey area and each map unit has a symbo that unique y identifies the map unit on a soi map. Each individua area, point, or ine so identified on the map is a de ineation.

Soi Scientists identify sma areas of soi s or misce aneous areas that have properties and behavior significant y different than the named soi s in the surrounding map unit. These minor components may be indicated as specia features. If they have a minima effect on use and management, or cou d not be precise y ocated, they may not be indicated on the map.

A map unit has specified kinds of soi s or misce aneous areas (map unit components), each with a designated range in proportionate extent. Map units inc ude one or more kinds of soi or misce aneous area. Misce aneous areas are areas that have itt e or no recognizab e soi .

Specific Nationa Cooperative Soi Survey standards and procedures were used in the c assification of soi s, design and name of map units, and ocation of specia soi features. These standards are out ined in Agricu tura Handbook 18, Soi Survey Manua , 1993, USDA, NRCS; Agricu tura Handbook 436, Soi Taxonomy, 1995, USDA, NRCS; and a Amendments; Keys to Soi Taxonomy, (current issue) USDA, NRCS; Nationa Soi Survey Handbook, tit e 430-VI,(current issue) USDA, NRCS.

The actua composition and interpretive purity of the map unit de ineations were based on data co ected by scientists during the course of preparing the soi maps. Adherence to Nationa Cooperative Soi Survey standards and procedures is based on peer review, qua ity contro , and qua ity assurance. Qua ity contro is out ined in the memorandum of understanding for the soi survey area and in documents that reside with the Natura Resources Conservation Service state soi scientist. Four kinds of map units are used in soi surveys: consociations, comp exes, associations, and undifferentiated groups.

Consociations - Consociations are named for the dominant soi . In a consociation, de ineated areas use a sing e name from the dominant component in the map unit. Dissimi ar components are

minor in extent. The soi component in a consociation may be identified at any taxonomic eve . Soi series is the owest taxonomic eve . A consociation that is named as a misce aneous area is dominant y that kind of area and minor components do not significant y affect the of the map unit. The tota amount of dissimi ar inc usions of other components in a map unit genera y does not exceed about 15 percent if imiting and 25 percent if non imiting. A sing e component of a dissimi ar imiting inc usion genera y does not exceed 10 percent if very contrasting.

Comp exes and associations - Comp exes and associations consist of two or more dissimi ar components that occur in a regu ar y repeating pattern. The tota amount of other dissimi ar components is minor extent. The fo owing arbitrary ru e determines whether comp ex or association is used in the name. The major components of an association can be separated at the sca e of mapping. In either case, because the major components are sufficient y different in morpho ogy or behavior, the map unit cannot be ca ed a consociation. In each de ineation of a comp ex or an association, each major component is norma y present though their proportions may vary appreciab y from one de ineation to another. The tota amount of inc usions in a map unit that are dissimi ar to any of the major components does not exceed 15 percent if imiting and 25 percent if non imiting. A sing e kind of dissimi ar imiting inc usion usua y does not exceed 10 percent.

Undifferentiated groups - Undifferentiated groups consist of two or more components that are not consistent y associated geographica y and, therefore, do not a ways occur together in the same map de ineation. These components are inc uded in the same named map unit because their use and management are the same or very simi ar for common uses. Genera y they are grouped together because some common feature, such as steepness, stoniness, or f ooding, determines their use and management. If two or more additiona map units wou d serve no usefu purpose, they may be inc uded in the same unit. Each de ineation has at east one of the major components, and some may have a of them. The same princip es regarding the proportion of minor components that app y to consociations a so app y to undifferentiated groups. The same princip es regarding proportion of inc usion app y to undifferentiated groups as to consociations.

Minimum documentation consists of three comp ete soi profi e descriptions that are co ected for each soi added to the egend, one additiona per 3,000 acres mapped; three 10 observation transects for each map unit, one additiona 10 point transect per 3,000 acres.

A defined standard or eve of confidence in the interpretive purity of the map unit de ineations is attained by adjusting the kind and intensity of fie d investigations. Fie d investigations and data co ection are carried out in sufficient detai to name map units and to identify accurate y and consistent y areas of about 10 acres.

Positiona _Accuracy:

Horizonta _Positiona _Accuracy:

Horizonta _Positiona _Accuracy_Report:

The accuracy of these digita data is based upon their compi ation to base maps that meet Nationa Map Accuracy Standards at a sca e of 1 inch equa s 1,000 feet. The difference in positiona accuracy between the soi boundaries and specia soi features ocations in the fie d and their digitized map ocations is unknown. The

```
 ccationa  accuracy of soi  de ineations on the ground varies
with the transition between map units.

For examp e, cn  ong gent y s oping  andscapes the transition
occurs gradua  y over many feet. Where  andscapes change
abrupt y from steep to  eve , the transition wi   be very
narrow. Soi  de ineation boundaries and specia  soi  features
genera  y were digitized within 0.01 inch of their  ocations on
the digitizing source. The digita  map e ements are edge matched
between data sets. The data a ong each quadrang e edge are
matched against the data for the adjacent quadrang e. Edge
 ocations genera  y do not deviate from center ine to center ine
by more than 0.01 inch.
Lineage:
  Source_Information:
    Source_Citation:
      Citation_Information:
        Originator:
          U.S. Department of Agricu ture, Natura
          Conservation Service
        Pub ication_Date: 1976
        Tit e:
          Soi  Survey of
          District of Co umbia
        Geospatia _Data_Presentation_Form: at as
        Pub ication_Information:
          Pub ication_P ace: Washington, D.C.
          Pub isher: U.S. Government Office
    Source_Sca e_Denominator: 12000
    Type_of_Source_Media: paper
    Source_Time_Period_of_Content:
      Time_Period_Information:
        Range_of_Dates/Times:
          Beginning_Date: 1975
          Ending_Date: 1976
      Source_Currentness_Reference: pub ication date
    Source_Citation_Abbreviation: NRCS1
    Source_Contribution:
      information for soi  and map unit
      de ineation, specia  soi  feature  ocation and data on soi
      properties
  Source_Information:
    Source_Citation:
      Citation_Information:
        Originator: U.S. Department of the Interior
        Pub ication_Date: unpub ished materia
        Tit e: DLG-3 fi es
        Geospatia _Data_Presentation_Form: map
    Source_Sca e_Denominator: 24000
    Type_of_Source_Media: digita
    Source_Time_Period_of_Content:
      Time Period Information:
        Sing e_Date/Time:
          Ca endar_Date: 1998
      Source_Currentness_Reference: 1998
    Source_Citation_Abbreviation: DOI
    Source_Contribution:
      digita  information containing area and specia
      features
  Source_Information:
    Source_Citation:
      Citation_Information:
        Originator: U.S. Geo ogica  Survey
```



```
        Pub ication_Date: 2005
        Tit e: Nationa  Aeria  Photography Progran (NAPP)
        Geospatia _Data_Presentation_Form: remote sensing image
        Pub ication_Information:
          Pub ication_P ace: Sa t Lake City, Utah
          Pub isher:
            U.S. Department of Agricu ture,
            Aeria  Photography Fie d Office, (APFO)
    Source_Sca e_Denominator: 100000
    Type_of_Source_Media: stab e-base materia
    Source_Time_Period_of_Content:
      Time_Period_Information:
        Range_of_Dates/Times:
          Beginning_Date: 1997
          Ending_Date: 2003
      Source_Currentness_Reference: pub ication date
    Source_Citation_Abbreviation: USGS1
    Source_Contribution: base used for fie d mapping
  Source_Information:
    Source_Citation:
      Citation_Information:
        Originator:
          U.S. Department of Agricu ture,
          Natura  Resources Conservation Service
        Pub ication_Date: unpub ished materia
        Tit e:
          ARC GIS GEODATABASE fi es for the soi  survey of
          District of Co umbia
        Geospatia _Data_Presentation_Form: map
    Source_Sca e_Denominator: 24000
    Type_of_Source_Media: CD-ROM
    Source_Time_Period_of_Content:
      Time_Period_Information:
        Sing e_Date/Time:
          Ca endar_Date: 2006
      Source_Currentness_Reference: 2006
    Source_Citation_Abbreviation: NRCS2
    Source_Contribution:
      digita  information containing area and specia
      soi  features for eva uation
  Source_Information:
    Source_Citation:
      Citation_Information:
        Originator:
          U.S. Department of Agricu ture, Natura  Resources
          Conservation Service
        Pub ication_Date: 2006
        Tit e:
          Nationa  Soi  Information System (NASIS) database for
          District of Co umbia
        Geospatia _Data_Presentation_Form: tabu ar digita  data
        Pub ication Information:
          Pub ication_P ace: Fort Co  ins, Co orado
          Pub isher:
            U.S. Department of Agricu ture, Natura  Resources
            Conservation Service, Information Techno ogy Center
    Type_of_Source_Media: on ine
    Source_Time_Period_of_Content:
      Time_Period_Information:
        Sing e_Date/Time:
          Ca endar_Date: 2006
      Source_Currentness_Reference: export certification date
    Source Citation Abbreviation: NRCS3
```

```
                         soi _metadata_dc001.txt
  Source_Contribution:
    map unit  egend used for comparison to spatia
    map unit  abe s
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator:
        U.S. Department of Agricu ture,
        Natura  Resources Conservation Service
      Pub ication_Date: 2006
      Tit e: Nationa  Soi  Information System (NASIS) data base
      Geospatia _Data_Presentation_Form: tabu ar digita  data
      Pub ication_Information:
        Pub ication_P ace: Fort Co  ins, Co orado
        Pub isher:
          U.S. Department of Agricu ture.
          Natura  Resources Conservation Service
  Type_of_Source_Media: database
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Range_of_Dates/Times:
        Beginning_Date: 2006
        Ending_Date: 2006
    Source_Currentness_Reference: pub ication date
  Source_Citation_Abbreviation: NASIS
  Source_Contribution: attribute (tabu ar) information
Process_Step:
  Process_Description:
    District of Co umbia had a previous y
    pub ished soi  survey, 1976, at a sca e of 1:12000. An eva uation
    of the survey conc uded that soi  de ineations and map unit
    components were accurate.
  Source_Used_Citation_Abbreviation: NRCS1
  Process_Date: 1976
Process_Step:
  Process_Description:
    The origina  hard copy pub ication was hand
    digitized with a digitizing tab et using the GRASS program. The
    digita   ine work was then vectorized using LT+ by the Department
    of the Interior. DLG-3 fi es were created.
  Source_Used_Citation_Abbreviation: NRCS1
  Process_Date: 1998
Process_Step:
  Process_Description:
    DLG-3 fi es were imported to ArcMap 9.0 to
    correct a ignment issues with the current photobase. The Spatia
    Adjustment too  was used to rubber sheet the  ine work to NAPP
    imagery by soi  scientists on staff at the MLRA Region office in
    Morgantown WV. The data was checked for topo ogy errors and Geodatabase
    fi es were forwarded to the Montana digitizing unit in Bozeman, MT.
    for review and certification.
  Source Used Citation Abbreviation: DOI, USGS1
  Process_Date: 2006
Process_Step:
  Process_Description: The ARC INTERCHANGE fi es and a verified map unit  egend
were imported to ARC/INFO, version 9.1 by certification staff at the Montana
Digitizing Unit.  The data were processed through eva uation macros dated June 2004.
The map unit  abe s were compared to the Nationa  Soi  Information System map unit
 egend. The data were up oaded to the Soi  Data warehouse staging server.
  Source_Used_Citation_Abbreviation: NRCS2, NRCS3
  Process_Date: 2006
Process_Step:
  Process Description: The Natura  Resources Conservation Service State Soi
                                   Page 7
```

```
                         soi _metadata_dc001.txt
Scientist or de egate, upon comp etion of data qua ity verification, determined that
the tabu ar data shou d be re eased for officia  use. A se ected set of map units
and components in the soi  survey  egend was copied to a staging database, and
rating va ues for se ected interpretations were generated. The  ist of se ected
interpretations is stored in the database tab e named sainterp.
      Source_Used_Citation_Abbreviation: NASIS
      Process_Date: 20060914
    Process_Step:
      Process_Description: The Natura  Resources Conservation Service State Soi
Scientist or de egate verified that the  abe s on the digitized soi  map units  ink
to map units in the tabu ar database, and certified the joined data sets for re ease
to the Soi  Data warehouse. A system assigned version number and date stamp were
added and the data were copied to the data warehouse. The tabu ar data for the map
units and components were extracted from the data warehouse and reformatted into the
soi  data de ivery data mode , then stored in the Soi  Data Mart. The spatia  data
were copied to the Soi  Data Mart without change.  A   DHS and MIL interps were
added.  A so, Qu mapunit added to match spatia  data.
      Source_Used_Citation_Abbreviation: NASIS
      Process_Date: 20060914
    Process_Step:
      Process_Description: The spatia  data's coordinate system was transformed to
UTM Zone 16, Northern Hemisphere (NAD 83) using ESRI ArcObjects 8.3
"ConvertFeatureC ass" and exported to an ESRI shapefi e.
      Source_Used_Citation_Abbreviation: NASIS
      Process_Date: 20070320
Spatia _Data_Organization_Information:
  Direct_Spatia _Reference_Method: Vector
Spatia _Reference_Information:
  Horizonta _Coordinate_System_Definition:
    P anar:
      Grid_Coordinate_System:
        Grid_Coordinate_System_Name: Universa  Transverse Mercator
        Universa _Transverse_Mercator:
          UTM_Zone_Number: 18
          Transverse_Mercator:
            Sca e_Factor_at_Centra _Meridian: 0.999600
            Longitude_of_Centra _Meridian: -75.000000
            Latitude_of_Projection_Origin: 0.000000
            Fa se_Easting: 500000.000000
            Fa se_Northing: 0.000000
      P anar_Coordinate_Information:
        P anar_Coordinate_Encoding_Method: coordinate pair
        P anar_Distance_Units: meters
        Coordinate_Representation:
          Abscissa_Reso ution: 0.000032
          Ordinate_Reso ution: 0.000032
    Geodetic_Mode :
      Horizonta _Datum_Name: North American Datum of 1983
      E  ipsoid_Name: Geodetic Reference System 80
      Semi-major_Axis: 6378137.000000
      Denominator_of_F attening_Ratio: 298.257222
Entity_and_Attribute_Information:
  Detai ed_Description:
    Entity_Type:
      Entity_Type_Labe : Specia  Soi  Features
      Entity_Type_Definition:
        Specia  Soi  Features represent soi , misce  aneous area, or  andform
        features that are too sma   to be digitized as soi  de ineations
        (area features).
      Entity_Type_Definition_Source: Agricu tura  Handbook 18, Soi  Survey Manua ,
1993, USDA, SCS.
    Attribute:
      Attribute_Labe : Specia  Soi  Features Codes
                                   Page 8
```

```
      Attribute_Definition:
        Specia  Soi  Features  abe s represent specific Specia  Soi
        Features. These features are identified with a descriptive
         abe . The  abe  is assigned to the point or  ine assigned
        to represent the feature on maps.
      Attribute_Definition_Source:
        Agricu tura  Handbook 18, Soi  Survey Manua , 1993, USDA, SCS;
        Nationa  Soi  Survey Handbook, Tit e 430-VI, part 647
        (current issue), USDA, NRCS.
      Attribute_Domain_Va ues:
        Codeset_Domain:
          Codeset_Name: C assification and Corre ation of the Soi s of District of
Co umbia
          Codeset_Source:
            U.S. Department of Agricu ture, Natura  Resources
            Conservation Service
  Overview_Description:
    Entity_and_Attribute_Overview:
      Map Unit De ineations are c osed po ygons that may be dominated
      by a sing e soi  or misce  aneous area component p us a  owab e
      simi ar or dissimi ar soi s, or they can be geographic mixtures
      of groups of soi s or soi s and misce  aneous areas.

      The map unit symbo  unique y identifies each c osed map unit
      de ineation. Each symbo  corresponds to a map unit name. The
      map unit key is used to  ink to information in the Nationa
      Soi  Information System tab es.

      Map Unit De ineations are described by the Nationa  Soi
      Information System database. This attribute database gives the
      proportionate extent of the component soi s and the properties for
      each soi . The database contains both estimated and measured data
      on the physica  and chemica  soi  properties and soi
      interpretations for engineering, water management, recreation,
      agronomic, wood and, range, and wi d ife uses of the soi .

      The Nationa  Soi  Information System database contains static
      metadata. It documents the data structure and inc udes such
      information as what tab es, co umns, indexes, and re ationships
      are defined as we   as a variety of attributes of each of these
      database objects. Attributes inc ude tab e and co umn
      descriptions and detai ed domain information.

      The Nationa  Soi  Information System database a so contains a
      distribution metadata. It records the criteria used for se ecting
      map units and components for inc usion in the set of distributed
      data.

      Specia  features are described in the feature tab e.  It inc udes an
      area symbo , feature  abe , feature name, and feature description for
      each specia  and ad hoc feature in the survey area.
    Entity and Attribute Detai  Citation:
      Soi  Taxonomy: A basic system of soi  c assification for making and
      interpreting soi  surveys. Agricu tura  Handbook 436, 1999, USDA, SCS.

      Keys to Soi  Taxonomy (current issue), USDA, SCS.

      Nationa  Soi  Survey Handbook, Tit e 430-VI, part 647 (current
      issue), USDA, NRCS.

      Agricu tura  Handbook 18, Soi  Survey Manua , 1993, USDA, SCS.
Distribution_Information:
  Distributor:
```


soi _metadata_dc001.txt

```
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization:
          U.S. Department of Agricu ture, Natura
          Resources Conservation Service, Nationa
          Cartography and Geospatia  Center
      Contact_Address:
        Address_Type: mai ing and physica  address
        Address: 501 West Fe ix Street, Bui ding 23, P.O. Box 6567
        City: Fort Worth
        State_or_Province: Texas
        Posta _Code: 76115
      Contact_Voice_Te ephone: 800 672 5559
      Contact_TDD/TTY_Te ephone: 202 720 2600
      Contact_Facsimi e_Te ephone: 817 509 3469
  Resource_Description: District of Co umbia SSURGO
  Distribution_Liabi ity:
    A though these data have been processed successfu  y on a computer
    system at the U.S. Department of Agricu ture, no warranty expressed
    or imp ied is made by the Agency regarding the uti ity of the data
    on any other system, nor sha   the act of distribution constitute
    any such warranty. The U.S. Department of Agricu ture wi   warrant
    the de ivery of this product in computer readab e format, and wi
    offer appropriate adjustment of credit when the product is determined
    unreadab e by correct y adjusted computer input periphera s, or
    when the physica  medium is de ivered in damaged condition. Request
    for adjustment of credit must be made within 90 days from the date
    of this shipment from the ordering site.

    The U.S. Department of Agricu ture, nor any of its agencies are
     iab e for misuse of the data, for damage, for transmission of
    viruses, or for computer contamination through the distribution of
    these data sets. The U.S. Department of Agricu ture (USDA) prohibits
    discrimination in a   its programs and activities on the basis of race,
    co or, nationa  origin, sex, re igion, age, disabi ity, po itica
    be iefs, sexua  orientation, or marita  or fami y status. (Not a
    prohibited bases app y to a   programs.)
  Standard_Order_Process:
    Digita _Form:
      Digita _Transfer_Information:
        Format_Name: ArcView shapefi e
        Format_Information_Content: spatia
        Fi e_Decompression_Technique: WinZip or equiva ent
        Transfer_Size: 5.9
      Digita _Transfer_Option:
        On ine_Option:
          Computer_Contact_Information:
            Network_Address:
              Network_Resource_Name: URL:http://Soi DataMart.nrcs.usda.gov/
          Access_Instructions:
            Se ect desired survey area at above Internet Web site. An emai
            address is required for receipt of instructions on retrieva  via
            anonymous FTP. Anticipate a de ay between submission of request
            at Web site and receipt of emai  message.
    Digita _Form:
      Digita _Transfer_Information:
        Format_Name: ARC/INFO coverage
        Format_Information_Content: spatia
        Fi e_Decompression_Technique: WinZip or equiva ent
        Transfer_Size: 5.9
      Digita _Transfer_Option:
        On ine_Option:
          Computer Contact Information:
```

```
      Network_Address:
        Network_Resource_Name: URL:http://Soi DataMart.nrcs.usda.gov/
      Access_Instructions:
        Se ect desired survey area at above Internet Web site. An emai
        address is required for receipt of instructions on retrieva  via
        anonymous FTP. Anticipate a de ay between submission of request
        at Web site and receipt of emai  message.
Digita _Form:
  Digita _Transfer_Information:
    Format_Name: ARC/INFO interchange fi e
    Format_Information_Content: spatia
    Fi e_Decompression_Technique: WinZip or equiva ent
    Transfer_Size: 5.9
  Digita _Transfer_Option:
    On ine_Option:
      Computer_Contact_Information:
        Network_Address:
          Network_Resource_Name: URL:http://Soi DataMart.nrcs.usda.gov/
      Access_Instructions:
        Se ect desired survey area at above Internet Web site. An emai
        address is required for receipt of instructions on retrieva  via
        anonymous FTP. Anticipate a de ay between submission of request
        at Web site and receipt of emai  message.
Digita _Form:
  Digita _Transfer_Information:
    Format_Name: ASCII
    Format_Information_Content: keys and attributes
    Fi e_Decompression_Technique: WinZip or equiva ent
    Transfer_Size: 31.5
  Digita _Transfer_Option:
    On ine_Option:
      Computer_Contact_Information:
        Network_Address:
          Network_Resource_Name: URL:http://Soi DataMart.nrcs.usda.gov/
      Access_Instructions:
        Se ect desired survey area at above Internet Web site. An emai
        address is required for receipt of instructions on retrieva  via
        anonymous FTP. Anticipate a de ay between submission of request
        at Web site and receipt of emai  message.
Fees:
  There is current y no direct charge for requesting data or for
  retrieva  via FTP.
Ordering_Instructions:
  Visit the above mentioned Internet Web Site, se ect state or
  territory, then se ect individua  soi  survey area of interest.
  Spatia   ine data and  ocations of specia  feature symbo s are in
  ESRI ArcGIS (ArcView,ArcInfo) shapefi e, coverage and interchange
  (i.e., export) formats. The Nationa  Soi  Information System
  attribute soi  data are avai ab e in variab e  ength, pipe
  de imited, ASCII fi e format.
Turnaround: Typica  y within four hours
Metadata Reference Information:
  Metadata_Date: 20070320
  Metadata_Contact:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: U.S. Department of Agricu ture, Natura  Resources
Conservation Service
      Contact_Position: State Soi  Scientist
      Contact_Address:
        Address_Type: mai ing address
        Address: USDA - Natura  Resources Conservation Service
        Address: Mary and State Office
```



```
        Address: John Hanson Business Center
        Address: 339 Busch's Frontage Road #301
        City: Annapo is
        State_or_Province: MD
        Posta _Code: 21401-5534
      Contact_Voice_Te ephone: 443-482-2913
      Contact_TDD/TTY_Te ephone: (202) 720-2600
      Contact_E ectronic_Mai _Address: james.brown@md.usda.gov
  Metadata_Standard_Name: Content Standard for Digita  Geospatia  Metadata
  Metadata_Standard_Version: FGDC-STD-001-1998
```

APPENDIX D : DATA OVERVIEW

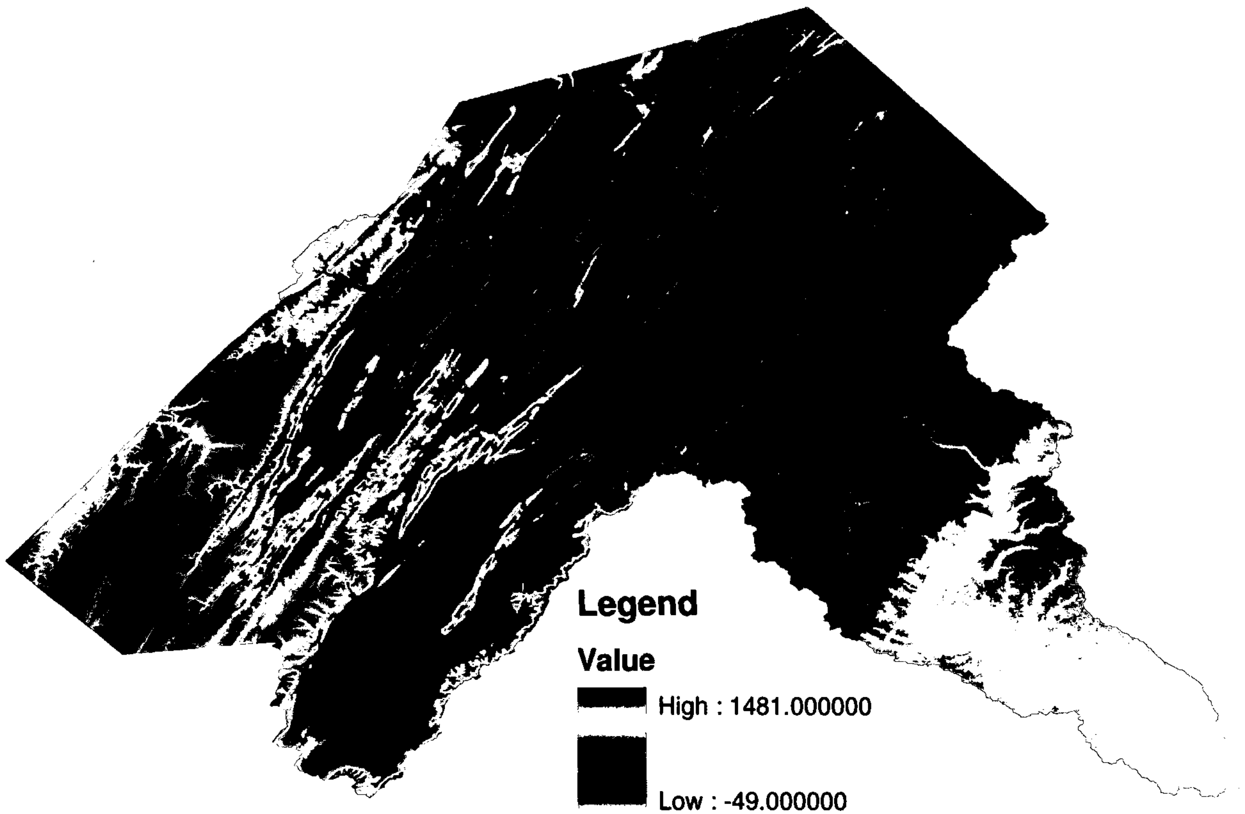


Figure D.1: Topographic characteristics of the Potomac Basin. Legend indicates Digital Elevation Model values relative to sea-level, in meters.

Figure D.2: Landsat-derived landclass information for the Potomac Basin. Legend indicates Landsat TM-2 class.

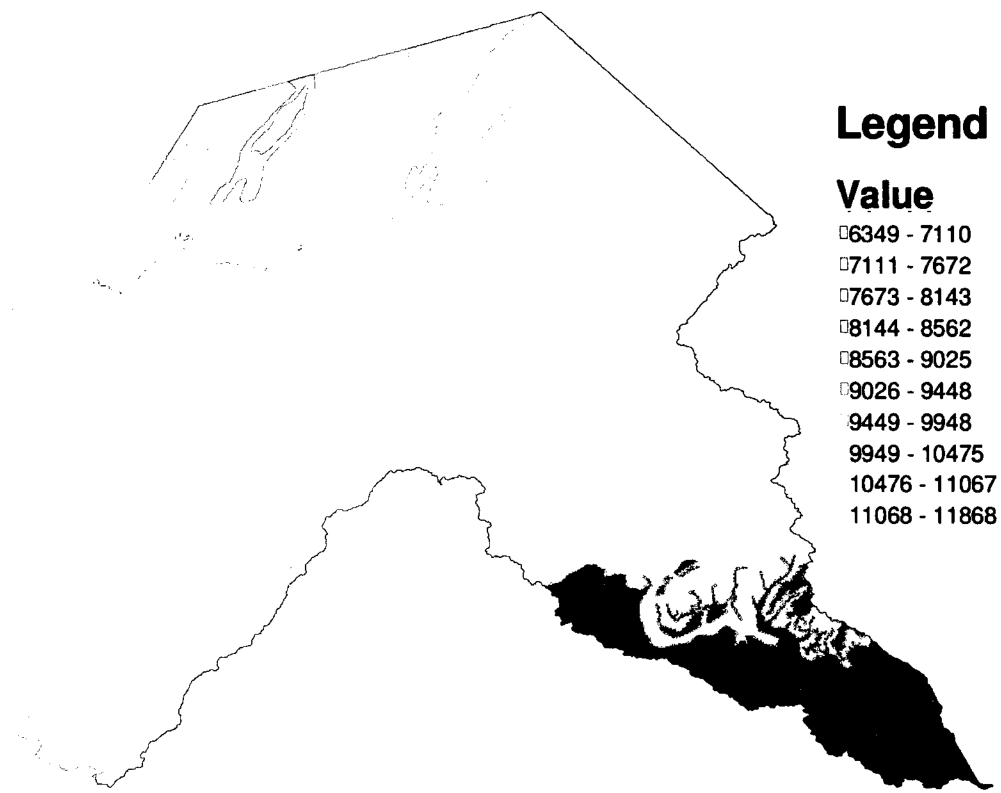


Figure D.3: Spatial variation in Soil Class in the Potomac Basin. Legend indicates soil class code.

APPENDIX E: SAMPLE ANNAGNPS FILES

E.1. DISCRETUZATION RESULTS: ANNAGNPS_CELL.DAT (8.3KM²)

[illegible] Version 1.10 [illegible] AnnAGNPS [illegible] & [illegible] data are [illegible] from TOPAGNPS-related parameters.
Potomac Run [illegible] Watershed
8.29km2 run
initial testing

Cell ID	Drain. Area [ha]	Avg. Elev. [m]	Avg. Aspect [Deg]	Land Slope [m/m]	--Sheet Flow-- Slope [m/m]	Length [m]	--Shallow Flow-- Slope [m/m]	Length [m]	--Concentrated-- Slope [m/m]	Length [m]	--LS-- Factor [-]	Aspect Correl [-]	Order Raster [code]	Cell ID
22	765.70	36	75	.04256	.00001	50	.01000	50	.01625	4899	1.161	.4917	/	22
23	160.40	8	215	.02047	.00001	50	.01500	50	.01000	1026	.752	.6075	/	23
32	1756.15	76	52	.05518	.00001	50	.00335	50	.01742	7632	1.565	.4254	/	32
33	1321.64	68	199	.05632	.00001	50	.00001	50	.02203	5324	1.626	.5936	/	33
41	1001.16	117	62	.03856	.00001	50	.00001	50	.03860	6988	.883	.2146	7	41
42	1522.64	96	357	.04192	.00001	50	.00001	50	.01519	5886	1.005	.3567	7	42
43	[illegible]	87	[illegible]	[illegible]	.00001	50	.00400	50	.00827	[illegible]	.761	[illegible]	7	43
52	[illegible]	87	64	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	.8176	7	52
53	126.00	32	229	.06340	.00001	50	.00600	50	.01565	1829	1.917	.7764	7	53
62	[illegible]	59	[illegible]	.07505	.00001	50	.00001	50	[illegible]	2642	2.208	[illegible]	7	62
63	[illegible]	75	238	.06172	.00001	50	.00569	50	.01928	[illegible]	1.239	[illegible]	7	63
72	1567.60	79	78	.05126	.00001	50	.00268	50	.01405	6080	1.412	.3962	7	72
73	1126.21	64	[illegible]	[illegible]	.00001	50	.00569	50	.01585	4936	1.226	[illegible]	7	73
81	1007.16	117	49	.04806	.00001	50	.01211	50	.01561	5088	1.190	.2644	7	81
82	267.50	88	269	.04776	.00001	50	.01469	50	.03950	1222	1.278	.5255	7	82
83	255.97	97	66	.04651	.00001	50	.01557	50	.01974	1736	1.245	.5625	/	83
92	1161.97	98	17	.05376	.00001	50	.01125	50	.01611	6045	1.465	.2758	/	92
93	259.70	52	152	.06177	.00001	50	.00001	50	.05098	2518	1.714	.7075	/	93
102	25.11	59	240	.10412	.00001	50	.09546	50	.25436	505	2.665	.5015	/	102
103	55.39	73	172	.07524	.00001	50	.00001	50	.05238	1439	2.034	.8112	/	103
112	1268.90	92	345	.04274	.00001	50	.00535	50	.01217	4539	1.050	.3950	/	112
113	1157.99	95	105	.03766	.00001	50	.00653	50	.01012	6224	.972	.5035	7	113
122	13.53	66	311	.02271	.00001	50	.01400	50	.03961	315	.358	.8465	7	122
123	[illegible]	68	148	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	123
132	23.11	67	238	.02445	.00001	50	.01778	50	.02725	687	.449	.6030	7	132
133	[illegible]	68	131	.02954	.00001	50	.01333	50	.05158	705	.547	.9322	7	133
141	[illegible]	149	[illegible]	.02756	.00001	50	[illegible]	50	[illegible]	5923	[illegible]	[illegible]	7	141
142	[illegible]	178	268	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	.5246	7	142
143	[illegible]	96	[illegible]	.04806	.00001	50	.00463	50	.02213	1380	1.307	.6331	7	143
152	[illegible]	87	257	.04139	.00001	50	.01469	50	[illegible]	[illegible]	.582	[illegible]	7	152
153	[illegible]	90	[illegible]	[illegible]	.00001	50	.01205	50	[illegible]	2476	.550	[illegible]	7	153
161	1051.58	115	327	.05672	.00001	50	.01309	50	.01065	5191	.665	.2110	7	161
162	127.00	93	247	.03950	.00001	50	.01022	50	.02527	2329	.555	.6935	/	162
163	61.00	91	21	.06137	.00001	50	.00587	50	.03694	920	1.521	.7937	/	163
172	263.50	104	340	.03542	.00001	50	.00736	50	.01513	3693	.647	.3976	/	172
173	60.75	83	165	.06043	.00001	50	.00246	50	.02050	795	.880	.8156	/	173
182	71.28	83	313	.04652	.00001	50	.00469	50	.03676	777	1.117	.5721	/	182
183	59.94	98	134	.04817	.00001	50	.00567	50	.03702	904	1.299	.8555	7	183
191	1106.46	123	62	.03252	.00001	50	.00336	50	.00771	4621	.762	.1772	7	191
192	1677.50	117	311	.03540	.00001	50	.00001	50	.00972	5011	.692	.3166	/	192
193	652.66	113	115	.03852	.00001	50	.00001	50	.01742	2670	.567	.5541	7	193
201	1600.87	125	67	.03217	.00001	50	.00041	50	.03700	6677	.766	.1550	7	201
202	157.95	104	339	.04166	.00001	50	.00733	50	.03255	1050	1.211	.5835	7	202
203	[illegible]	104	146	[illegible]	.00001	50	.00001	50	[illegible]	1411	.551	[illegible]	7	203
211	[illegible]	121	[illegible]	[illegible]	.00001	50	.00705	50	.00992	6648	.731	.2616	7	211
212	[illegible]	49	8	.06347	.00001	50	.00647	50	.07703	560	1.127	[illegible]	7	212
213	[illegible]	104	146	.07764	.00001	50	.00669	50	.03568	2411	.964	.2576	7	213
221	[illegible]	118	65	.05240	.00001	50	.00001	50	[illegible]	4815	.605	.2376	7	221
222	409.05	95	16	.03615	.00001	50	.00001	50	.01901	2342	.669	.5167	/	222
223	[illegible]	87	[illegible]	[illegible]	.00001	50	.00001	50	.04088	[illegible]	[illegible]	.5100	7	223
231	1002.20	116	133	[illegible]	.00001	50	.00477	50	.00792	[illegible]	.861	[illegible]	7	231
232	105.92	86	40	.03545	.00001	50	.00001	50	.06005	507	.759	.4432	/	232
233	165.49	90	175	.03865	.00001	50	.00772	50	.03222	1292	.856	.6577	/	233
242	1374.97	88	132	.04945	.00001	50	.00001	50	.01197	5482	1.315	.3433	/	242
243	1355.11	84	257	.05974	.00001	50	.00001	50	.02403	2595	1.359	.5076	7	243
251	1349.76	95	26	.04276	.00001	50	.01333	50	.01129	6746	1.061	.2412	7	251
252	64.24	73	37	.06765	.00001	50	.01459	50	.05000	904	1.722	.7162	/	252
253	32.40	53	153	.02872	.00001	50	.02067	50	.05566	215	.570	.7357	7	253
262	75.33	53	46	.02565	.00001	50	.01607	50	.02529	595	.337	.6056	7	262
263	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	1.663	[illegible]	7	263
272	[illegible]	55	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	785	.598	[illegible]	7	272
273	[illegible]	86	[illegible]	[illegible]	.00001	50	.00460	50	[illegible]	[illegible]	[illegible]	[illegible]	7	273
282	[illegible]	42	256	[illegible]	.00001	50	[illegible]	50	.00119	[illegible]	.386	.2540	7	282
283	[illegible]	72	160	[illegible]	.00001	50	.00001	50	[illegible]	907	2.294	.9356	7	283
291	1005.02	115	49	.05352	.00001	50	.00001	50	.09803	5569	.622	.1464	7	291
292	675.42	84	11	.04175	.00001	50	.00001	50	.01084	6067	1.025	.3275	/	292
293	[illegible]	106	48	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	293
302	209.42	76	37	.05205	.00001	50	.01657	50	.02093	2515	1.409	.6276	7	302
303	501.02	90	215	.05424	.00001	50	.00522	50	.01765	2043	1.455	.5027	/	303
311	2056.31	119	351	.02365	.00001	50	.00001	50	.00622	5562	.571	.2403	/	311
312	2600.98	101	251	.03356	.00001	50	.00511	50	.01575	4145	.788	.5547	/	312
313	2702.10	97	60	.02526	.00001	50	.00457	50	.00707	5902	.557	.4150	7	313
322	8.91	52	58	.00370	.00001	50	.00001	50	.00001	318	[illegible]	.8755	7	322
323	.01	53	156	.00001	.00001	50	.00001	50	.00001	35	.022	1.0000	/	323
332	[illegible]	66	47	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	.458	[illegible]	7	332
333	[illegible]	81	121	[illegible]	.00001	50	.00001	50	[illegible]	2599	.560	.5055	7	333
341	1129.61	84	255	.02567	.00001	50	.01525	50	.00760	6537	.506	.5325	7	341
342	25.52	52	15	.01441	.00001	50	.01022	50	.02764	271	.263	.4755	/	342
343	[illegible]	58	71	.02155	.00001	50	[illegible]	50	.00638	4497	.494	[illegible]	7	343
352	.61	51	120	.00001	.00001	64	.00001	0	.00001	0	.028	1.0000	7	352
362	121.50	53	25	.01471	.00001	50	.00001	50	.00748	515	.224	.5365	/	362
363	166.86	63	139	.01226	.00001	50	.00069	50	.00023	1612	.265	.5565	/	363
372	605.14	76	221	.02471	.00001	50	.00535	50	.00951	2456	.545	.2586	/	372
373	2077.65	81	105	.02614	.00001	50	.01522	50	.00766	6764	.558	.2767	/	373
382	247.05	77	238	.02500	.00001	50	.01567	50	.01714	1094	.573	.5555	/	382
383	79.38	70	57	.01233	.00001	50	.00001	50	.00848	1050	.243	.7562	7	383
391	1005.21	86	392	.02645	.00001	50	.00278	50	.01002	5391	.607	.3121	7	391
392	[illegible]	78	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	392
393	[illegible]	75	4	[illegible]	.00001	50	.00556	50	[illegible]	[illegible]	.477	[illegible]	7	393
402	610.61	79	221	.02114	.00001	50	.00667	50	.00974	2549	.361	.4462	7	402
403	[illegible]	75	146	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	403
412	[illegible]	59	224	[illegible]	.00001	50	[illegible]	50	.04287	597	.448	[illegible]	7	412
413	[illegible]	69	77	[illegible]	.00001	50	.00567	50	.00769	[illegible]	[illegible]	.5246	7	413
422	[illegible]	90	[illegible]	[illegible]	.00001	50	[illegible]	50	.00559	[illegible]	[illegible]	[illegible]	7	422
423	[illegible]	85	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	4475	[illegible]	[illegible]	7	423
431	[illegible]	109	[illegible]	[illegible]	.00001	50	[illegible]	50	.00661	[illegible]	[illegible]	[illegible]	7	431
432	113.50	90	238	.02047	.00001	50	.00283	50	.01047	1739	.455	.4005	/	432
433	51.84	66	355	.01235	.00001	50	.00001	50	.01151	904	.369	.6351	/	433
441	1027.69	118	283	.02155	.00001	50	.00446	50	.01002	4845	.500	.3325	/	441
442	1008.45	104	253	.02045	.00001	50	.00001	50	.00705	6134	.475	.3015	/	442
443	546.39	98	17	.01756	.00001	50	.01355	50	.01264	2329	.427	.4355	/	443
451	1216.62	87	90	.01753	.00001	50	.00001	50	.00277	7562	.252	.1652	/	451
452	211.64	82	1	.01030	.00001	50	.00355	50	.00580	2390	.239	.5025	7	452
453	29.37	81	78	.01161	.00001	50	.00240	50	.00012	108	.263	.6741	7	453
462	[illegible]	91	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	462
463	1600.91	91	135	.02252	.00001	50	.00422	50	.00709	4067	.459	.4424	7	463
471	[illegible]	115	95	.02162	.00001	50	.00001	50	[illegible]	7362	.468	.1967	7	471
472	[illegible]	100	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	472
473	[illegible]	86	148	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	.408	[illegible]	7	473
481	[illegible]	115	[illegible]	.02951	.00001	50	.00001	50	.00784	5399	.606	.3432	7	481
482	[illegible]	107	97	[illegible]	.00001	50	.01574	50	.00913	[illegible]	[illegible]	[illegible]	7	482
483	[illegible]	108	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	.6026	7	483
491	1269.61	105	75	.02454	.00001	50	.00001	50	.00972	6571	.550	.4012	7	491
492	550.63	79	27	.01726	.00001	50	.00711	50	.00596	5002	.256	.3575	/	492
493	1440.18	89	144	.02105	.00001	50	.00001	50	.01100	4797	.496	.3956	/	493
503	1.24	61	215	.00126	.00001	50	.00046	50	.00221	35	.047	.8167	/	503
512	565.01	70	51	.02241	.00001	50	.00001	50	.01540	1609	.505	.5680	/	512
513	573.29	61	215	.02544	.00001	50	.00001	50	.00874	5582	.576	.3816	/	513
522	335.56	85	327	.04606	.00001	50	.00001	50	.01957	1975	1.063	.4345	7	522
523	678.65	98	103	.03003	.00001	50	.00001	50	.00992	5510	.574	.2852	7	523
532	556.16	93	205	.04465	.00001	50	.00378	50	.01166	2615	1.062	.3656	/	532
533	46.55	77	105	.04936	.00001	50	.01546	50	.05954	525	1.150	.7155	7	533
542	460.06	100	291	.05957	.00001	50	.00350	50	.01523	1661	1.416	.7364	7	542
543	[illegible]	96	[illegible]	[illegible]	.00001	50	.00447	50	[illegible]	2151	.673	.5155	7	543
551	[illegible]	139	14	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	551
552	[illegible]	135	255	[illegible]	.00001	50	[illegible]	50	[illegible]	2856	.443	[illegible]	7	552
553	[illegible]	97	87	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	.6038	7	553
562	[illegible]	110	17	[illegible]	.00001	50	.00001	50	[illegible]	2868	[illegible]	[illegible]	7	562
563	[illegible]	107	181	[illegible]	.00001	50	.00001	50	[illegible]	4431	[illegible]	[illegible]	7	563
572	102.07	105	232	.05772	.00001	50	.01469	50	.06242	1646	1.411	.7327	/	572
573	[illegible]	89	82	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	.246	[illegible]	7	573
581	[illegible]	119	28	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	581
582	655.05	115	272	.05753	.00001	50	.00001	50	.01630	2585	.679	.4651	/	582
583	234.69	100	65	.02832	.00001	50	.00001	50	.01764	1230	.579	.8026	/	583
592	565.52	121	342	.05641	.00001	50	.00001	50	.03567	3530	1.419	.4366	/	592
593	1673.29	132	129	.05240	.00001	50	.00001	50	.02229	5641	1.242	.4264	7	593
601	1052.19	210	316	.10216	.00001	50	.00001	50	.06401	5320	2.773	.3332	7	601
602	743.58	171	314	.09250	.00001	50	.03335	50	.05472	2133	2.462	.7456	/	602
603	519.21	154	108	.06366	.00001	50	.02111	50	.03334	2605	1.325	.6716	7	603
612	1061.05	150	311	.06031	.00001	50	.00001	50	.02051	4671	1.339	.4470	7	612
613	[illegible]	138	146	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	613
621	[illegible]	218	221	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	621
622	[illegible]	165	226	[illegible]	.00001	50	.00001	50	[illegible]	780	[illegible]	[illegible]	7	622
623	[illegible]	176	62	[illegible]	.00001	50	.00001	50	[illegible]	830	[illegible]	[illegible]	7	623
632	[illegible]	177	220	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	.649	[illegible]	7	632
633	55.46	162	163	.05257	.00001	50	.00001	50	.02217	1286	.550	.9274	7	633
641	1000.25	182	117	.03855	.00001	50	.00001	50	.00967	7224	.707	.1654	/	641
642	[illegible]	197	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	642
643	1649.23	175	121	.04905	.00001	50	.00001	50	.01372	5752	1.100	.3400	7	643
651	1240.11	171	38	.04728	.00001	50	.00001	50	.01312	5756	1.122	.1653	/	651
652	65.47	162	13	.03773	.00001	50	.00001	50	.04859	597	.810	.5856	/	652
653	243.60	152	155	.03612	.00001	50	.02111	50	.01934	2133	.769	.5865	/	653
662	712.60	115	45	.05211	.00001	50	.01263	50	.02076	2216	1.212	.4505	7	662
663	1590.06	135	185	.05945	.00001	50	.00511	50	.00703	5749	1.494	.3344	7	663
672	1660.01	135	367	.06724	.00001	50	.01111	50	.01118	5157	1.772	.3155	/	672

[illegible]	[illegible]	147	[illegible]	[illegible]	.00001	50	.00913	50	[illegible]	[illegible]	1.491	[illegible]	7	[illegible]
561	[illegible]	143	[illegible]	[illegible]	.00001	50	.00467	50	[illegible]	[illegible]	[illegible]	[illegible]	7	561
562	456.02	135	238	.05822	.00001	50	.00711	50	.01643	3744	.557	.4605	7	562
563	483.32	139	88	.04614	.00001	50	.00001	50	.01472	2012	1.170	.4257	✓	563
[illegible]	[illegible]	164	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
593	1052.47	139	151	.04007	.00001	50	.00001	50	.00598	3656	1.014	.4815	✓	593
701	1050.42	109	55	.04401	.00001	50	.05111	50	.01465	5130	1.094	.1542	✓	701
702	1010.77	154	311	.06300	.00001	50	.00001	50	.01191	7124	1.006	.3924	✓	702
703	1012.41	156	105	.03908	.00001	50	.00001	50	.01061	5406	.929	.4345	✓	703
712	254.03	132	357	.05221	.00001	50	.00001	50	.02674	1466	1.267	.5355	✓	712
713	573.11	162	178	.06362	.00001	50	.02378	50	.02276	3170	1.040	.5405	✓	713
722	355.26	160	315	.06724	.00001	50	.00622	50	.02450	2208	1.115	.6630	7	722
723	166.05	133	121	.06321	.00001	50	.03889	50	.03620	923	1.361	.7660	7	723
[illegible]	[illegible]	161	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	1.160	[illegible]	7	[illegible]
733	119.66	136	51	.04204	.00001	50	.00001	50	.02606	1613	1.572	.7302	7	733
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	162	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
761	[illegible]	190	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
763	627.60	160	77	.05374	.00001	50	.01267	50	.02747	1826	1.241	.5731	✓	763
772	149.85	166	324	.04741	.00001	50	.00001	50	.02292	1500	1.138	.6653	✓	772
773	300.61	155	129	.04767	.00001	50	.00001	50	.02796	2118	1.137	.6038	✓	773
781	1020.51	225	65	.09101	.00001	50	.00001	50	.05655	4003	2.541	.3606	✓	781
782	686.07	174	308	.05205	.00001	50	.00001	50	.02624	2624	1.209	.5347	✓	782
783	694.45	180	103	.04870	.00001	50	.00001	50	.04426	3955	1.235	.5627	✓	783
792	459.24	169	12	.05162	.00001	50	.02950	50	.02560	1057	1.265	.4257	7	792
793	477.05	168	162	.05132	.00001	50	.00001	50	.02656	1912	1.221	.4800	7	793
604	46.14	161	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	650	2.098	[illegible]	7	604
603	56.70	159	143	.06210	.00001	50	.00844	50	.04071	2005	1.454	.8025	7	603
611	1018.17	258	53	.11375	.00001	50	.05467	50	.04714	5925	1.970	.0805	7	611
614	530.86	214	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	1184	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	204	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
622	130.41	158	[illegible]	.06504	.00001	50	.00001	50	.03475	831	1.328	.6134	7	622
[illegible]	[illegible]	125	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	850	1.630	[illegible]	7	[illegible]
634	941.09	220	9	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
633	635.76	226	162	.14024	.00001	50	.00001	50	.14167	1750	5.759	.7765	7	633
641	1070.92	405	163	.15466	.00001	50	.01632	50	.07255	4601	4.379	.4032	✓	641
642	1146.96	297	26	.14155	.00001	50	.00001	50	.06072	3875	4.116	.4925	✓	642
643	760.55	301	163	.14260	.00001	50	.00001	50	.08646	3766	3.593	.7981	✓	643
651	1006.02	394	127	.14455	.00001	50	.03267	50	.07137	5445	4.063	.5211	✓	651
652	52.37	197	102	.04852	.00001	50	.00001	50	.03612	1047	1.368	.7665	✓	652
653	144.16	255	325	.15532	.00001	50	.33333	50	.11362	1609	4.372	.9126	7	653
661	1107.27	218	179	.16217	.00001	50	.00001	50	.05556	7594	4.748	.3790	7	661
662	50.22	173	65	.06076	.00001	50	.00001	50	.06031	522	1.566	.6604	✓	662
663	144.93	182	201	.04801	.00001	50	.00001	50	.03451	1230	1.347	.5512	7	663
671	1160.73	450	113	.16535	.00001	50	.51111	50	.07683	3218	4.121	.5142	7	671
672	1375.10	223	79	.08130	.00001	50	.00001	50	.04725	3431	2.155	.4837	7	672
[illegible]	[illegible]	287	[illegible]	.11467	.00001	50	.00001	50	.08565	[illegible]	[illegible]	[illegible]	7	[illegible]
681	[illegible]	511	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	681
[illegible]	[illegible]	187	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	205	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	176	26	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
693	61.81	160	209	.05412	.00001	50	.00001	50	.03665	1702	1.320	.7015	✓	693
501	[illegible]	169	[illegible]	[illegible]	.00001	50	.00667	50	[illegible]	[illegible]	[illegible]	[illegible]	7	501
[illegible]	[illegible]	165	[illegible]	[illegible]	.00001	50	.00001	50	.01664	[illegible]	.644	.5304	7	[illegible]
505	150.66	145	152	.04021	.00001	50	.00001	50	.01612	690	.615	.7051	✓	505
512	453.60	164	83	.03604	.00001	50	.00001	50	.01272	3508	.671	.4517	✓	512
513	744.35	137	184	.03720	.00001	50	.00956	50	.01714	3167	.671	.5255	✓	513
521	1130.76	283	125	.09904	.00001	50	.00001	50	.06765	5939	2.560	.5557	7	521
522	359.25	180	42	.06342	.00001	50	.01156	50	.01961	1020	.558	.6543	7	522
523	1258.74	256	121	.08367	.00001	50	.01800	50	.05547	7025	2.164	.5905	✓	523
531	1176.50	264	145	.09872	.00001	50	.00001	50	.06053	5951	2.352	.6757	7	531
532	1075.62	229	124	.07712	.00001	50	.00001	50	.06747	3905	2.002	.6903	7	532
[illegible]	[illegible]	167	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	142	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	169	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	1.026	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	149	146	[illegible]	.00001	50	.00689	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
562	204.03	129	140	.05060	.00001	50	.00867	50	.03072	1354	1.250	.6095	7	562
563	321.94	151	157	.04041	.00001	50	.00533	50	.01765	2546	.615	.6625	✓	563
571	[illegible]	509	[illegible]	[illegible]	.00001	50	.01111	50	[illegible]	[illegible]	[illegible]	[illegible]	7	571
572	2826.05	151	67	.05192	.00001	50	.00822	50	.00035	5091	.720	.2365	7	572
573	326.64	165	173	.03775	.00001	50	.01222	50	.01751	3272	.606	.4427	✓	573
581	1278.95	152	116	.03750	.00001	50	.00600	50	.01194	6677	.614	.2851	✓	581
582	551.61	144	58	.04047	.00001	50	.00956	50	.01454	4411	.629	.4361	✓	582
583	141.44	140	156	.04024	.00001	50	.00001	50	.03233	1919	.649	.6172	7	583
591	[illegible]	136	58	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	591
593	1827.36	153	206	.04230	.00001	50	.00001	50	.02116	5327	.572	.5856	✓	593

1001	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1002	1740.46	250	38	.09674	.00001	50	.00001	50	[illegible]	5298	[illegible]	[illegible]	7	1002
1003	68.22	158	293	.04176	.00001	50	.01289	50	.02562	1084	1.027	.0025	7	1003
1011	1001.66	242	151	.08115	.00001	50	.00001	50	.04370	5957	2.063	.5076	✓	1011
1012	[illegible]	155	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1012
1013	231.12	174	213	.04657	.00001	50	.00001	50	.03665	2099	1.375	.7205	✓	1013
1022	361.51	110	55	.04555	.00001	50	.00844	50	.02121	1935	1.147	.4783	✓	1022
1023	821.57	147	255	.07162	.00001	50	.01689	50	.02625	4654	1.602	.5555	✓	1023
1031	1005.50	307	135	.10457	.00001	50	.01400	50	.05145	5774	2.749	.5700	✓	1031
1032	2238.36	153	58	.04615	.00001	50	.01467	50	.01217	5634	1.135	.3681	✓	1032
1033	2752.71	157	178	.04702	.00001	50	.02444	50	.02605	5254	1.129	.3503	✓	1033
1041	1051.16	160	255	.05505	.00001	50	.00001	50	.01591	5932	1.253	.2956	7	1041
1042	2470.75	162	151	.05915	.00001	50	.00001	50	.01032	6042	.525	.2666	7	1042
[illegible]	[illegible]	[illegible]	298	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1051	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1052	2351.72	135	66	.04520	.00001	50	.01067	50	.01693	7000	1.061	.2262	7	1052
[illegible]	[illegible]	139	150	[illegible]	.00001	50	.00622	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1061	[illegible]	180	104	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	1.178	[illegible]	7	[illegible]
1062	[illegible]	114	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1062
[illegible]	[illegible]	114	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	66	50	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	24	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1083	855.74	77	315	.02505	.00001	50	.00778	50	.00777	5506	.549	.4621	✓	1083
1092	327.24	63	53	.04445	.00001	50	.00001	50	.02561	1773	1.174	.5661	✓	1092
1093	74.52	57	201	.01423	.00001	50	.00444	50	.01767	904	.221	.5556	✓	1093
1101	1410.12	100	73	.05651	.00001	50	.00001	50	.01666	5514	.665	.2147	✓	1101
1102	48.60	80	314	.04450	.00001	50	.00001	50	.04445	578	.585	.5231	✓	1102
1103	120.41	26	94	.02655	.00001	50	.01956	50	.01384	2335	.624	.4870	✓	1103
1111	1016.35	157	132	.07067	.00001	50	.02822	50	.02194	6547	1.640	.5516	7	1111
1112	120.92	82	51	.02205	.00001	50	.00267	50	.01239	1028	.477	.3814	7	1112
[illegible]	[illegible]	87	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1122	261.07	68	139	.01261	.00001	50	.01044	50	.01026	1987	.421	.4263	7	1122
1123	[illegible]	87	[illegible]	.05574	.00001	50	.00311	50	.01334	[illegible]	.649	[illegible]	7	[illegible]
[illegible]	[illegible]	66	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	55	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1141	[illegible]	148	[illegible]	.07331	.00001	50	.00001	50	.02447	7787	1.507	[illegible]	7	[illegible]
[illegible]	[illegible]	26	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	112	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1151	1656.56	124	115	.04576	.00001	50	.04000	50	.02132	7559	1.125	.6735	7	1151
1152	304.56	90	95	.03200	.00001	50	.01044	50	.02001	2415	.701	.6078	✓	1152
1153	151.16	74	235	.02307	.00001	50	.00667	50	.00655	1770	.539	.5651	✓	1153
1162	1129.03	87	151	.03155	.00001	50	.00001	50	.00780	7633	.731	.2950	✓	1162
1163	2121.20	100	212	.04175	.00001	50	.01067	50	.02215	5407	1.061	.3056	✓	1163
1172	367.74	85	52	.05217	.00001	50	.00001	50	.02246	2500	1.432	.5028	✓	1172
1173	454.54	85	219	.03267	.00001	50	.00600	50	.01484	3421	.772	.5711	7	1173
1181	1159.01	128	96	.04257	.00001	50	.00001	50	.02172	7031	1.216	.4676	7	1181
1182	766.13	90	337	.03317	.00001	50	.01244	50	.01327	3026	.757	.4654	✓	1182
1183	676.71	99	106	.03473	.00001	50	.02489	50	.02725	6233	.529	.4052	7	1183
1192	4.50	65	138	.01162	.00001	50	.01422	50	.04551	125	.251	.1200	7	1192
1193	[illegible]	69	150	.02016	.00001	50	.00001	50	.02343	163	.772	[illegible]	7	1193
[illegible]	400.66	69	16	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	85	188	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	1.742	[illegible]	7	[illegible]
[illegible]	[illegible]	112	58	.08666	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	149.34	94	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	136	238	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1223	1219.05	122	145	.04877	.00001	50	.00889	50	.01432	8703	1.379	.4902	✓	1223
[illegible]	[illegible]	98	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	112	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1242	1734.31	163	297	.05905	.00001	50	.01400	50	.01516	7711	1.457	.3022	✓	1242
1243	357.36	123	138	.06336	.00001	50	.00001	50	.05566	1084	1.526	.7062	✓	1243
1252	129.60	119	215	.06161	.00001	50	.01733	50	.00425	2099	1.778	.2215	✓	1252
1253	71.26	120	133	.04702	.00001	50	.00001	50	.02263	1031	1.155	.7315	7	1253
1262	334.32	124	271	.04109	.00001	50	.00001	50	.02163	2180	.964	.5893	7	1262
1263	110.16	120	87	.04211	.00001	50	.00001	50	.02294	1177	.947	.7621	✓	1263
1271	1060.54	155	294	.06530	.00001	50	.00001	50	.02255	5172	1.555	.3155	7	1271
1272	58.62	122	263	.05514	.00001	50	.00800	50	.02411	1210	.746	.7267	7	1272
[illegible]	[illegible]	123	[illegible]	.05751	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1281	[illegible]	202	104	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1282	[illegible]	155	[illegible]	.05604	.00001	50	.01956	50	[illegible]	[illegible]	.661	[illegible]	7	1282
[illegible]	[illegible]	161	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	148	44	.05466	.00001	50	.00001	50	[illegible]	4644	[illegible]	[illegible]	7	[illegible]
1293	1527.62	152	155	.05465	.00001	50	.00444	50	.01267	3600	1.357	.6305	7	1293
1301	1620.46	250	92	.08228	.00001	50	.00001	50	.05016	5507	2.125	.2051	✓	1301
[illegible]	[illegible]	211	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1303	209.75	199	115	.04832	.00001	50	.00001	50	.03253	2108	1.155	.7152	7	1303
1311	1115.27	264	190	.09433	.00001	50	.00001	50	.05703	4707	2.520	.1035	✓	1311
1312	833.45	257	195	.10111	.00001	50	.02244	50	.04555	6445	2.718	.5955	✓	1312
1313	133.35	236	273	.07666	.00001	50	.00001	50	.08117	1048	1.666	.8174	✓	1313
1321	1125.34	185	110	.06076	.00001	50	.00001	50	.00613	6562	1.277	.4804	7	1321
[illegible]	[illegible]	155	53	.04145	.00001	50	.00001	50	[illegible]	6116	1.001	[illegible]	7	[illegible]
1323	855.56	161	155	.03844	.00001	50	.00889	50	.01311	2400	.679	.4560	✓	1323

[illegible]	[illegible]	189	[illegible]	.06648	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1332	545.14	155	45	.04255	.00001	50	.00289	50	.00666	2795	.526	.2554	7	1332
1333	822.56	161	157	.05555	.00001	50	.00489	50	.01140	5006	.621	.5500	7	1333
1341	1015.74	137	156	.03916	.00001	50	.00556	50	.01625	5007	.511	.3050	/	1341
1344	86.59	142	87	.06342	.00001	50	.01511	50	.05567	997	1.575	.6882	7	1344
1345	19.44	113	226	.09345	.00001	50	.00001	50	.10686	342	2.457	.0385	/	1345
1352	364.15	119	50	.04916	.00001	50	.00556	50	.01641	5591	1.272	.5080	/	1352
1353	1069.20	164	255	.09484	.00001	50	.00001	50	.05666	4973	2.854	.5672	/	1353
1362	65.43	102	352	.13065	.00001	50	.00422	50	.10761	612	4.420	.7500	/	1362
1363	60.15	96	169	.05826	.00001	50	.00001	50	.03625	1751	1.331	.8050	/	1363
1372	1739.56	125	12	.05555	.00001	50	.00733	50	.01302	7221	1.500	.3701	/	1372
1373	1124.28	114	158	.05666	.00001	50	.00001	50	.02618	3511	1.444	.6561	7	1373
1381	1319.05	136	37	.09075	.00001	50	.04378	50	.05292	3622	2.425	.5835	7	1381
1384	[illegible]	178	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	.450	[illegible]	7	1384
[illegible]	[illegible]	139	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1392	265.66	111	47	.15026	.00001	50	.00778	50	.13171	1661	4.555	.5433	7	1392
[illegible]	[illegible]	147	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1404	[illegible]	152	148	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1404
1405	[illegible]	175	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1405
[illegible]	[illegible]	278	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1414	[illegible]	216	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1414
1415	[illegible]	218	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1415
1422	105.60	136	20	.22050	.00001	50	.00001	50	.12635	1520	6.621	.6041	/	1422
1423	101.25	201	162	.31946	.00001	50	.00001	50	.21341	1556	9.518	.6977	/	1423
1432	1116.95	183	315	.14326	.00001	50	.01778	50	.07451	5288	4.361	.7521	/	1432
1433	750.06	137	145	.08901	.00001	50	.00001	50	.01530	5045	2.479	.5905	/	1433
1442	45.05	116	271	.07256	.00001	50	.00001	50	.06706	920	1.677	.7113	/	1442
1443	653.74	128	115	.03574	.00001	50	.00444	50	.00665	7509	.660	.2955	/	1443
1452	2227.50	220	320	.11502	.00001	50	.01950	50	.05241	5591	3.150	.5025	7	1452
1453	450.41	125	140	.07916	.00001	50	.03604	50	.03592	1755	2.147	.4530	7	1453
1464	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1464
1465	222.75	121	60	.05910	.00001	50	.00001	50	.02172	2031	1.417	.4925	7	1465
1471	1000.15	283	302	.12591	.00001	50	.00001	50	.05237	6243	3.471	.5056	7	1471
1474	[illegible]	259	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1474
1475	[illegible]	155	65	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1475
1482	111.04	173	304	.09423	.00001	50	.00001	50	.05637	1084	2.638	.5656	7	1482
1483	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	.546	[illegible]	7	1483
1494	[illegible]	161	408	.08850	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1494
1495	278.64	129	107	.05122	.00001	50	.00001	50	.01625	1230	1.270	.4075	7	1495
1502	153.00	156	225	.06170	.00001	50	.00001	50	.04481	1510	1.412	.5573	/	1502
1503	126.85	161	55	.07865	.00001	50	.00001	50	.04546	1227	2.062	.6643	/	1503
1512	2957.26	237	300	.11655	.00001	50	.00001	50	.07375	5392	3.221	.5800	/	1512
1513	355.36	134	120	.03765	.00001	50	.00644	50	.01366	3695	.665	.5707	/	1513
1522	1914.84	256	318	.11661	.00001	50	.00933	50	.06411	5547	3.208	.6034	/	1522
1523	235.26	135	122	.05637	.00001	50	.00001	50	.02253	1721	1.457	.5624	7	1523
1531	1125.09	[illegible]	320	.12207	.00001	50	.00001	50	.05521	3871	3.666	.5270	7	1531
1532	150.66	139	313	.09516	.00001	50	.00001	50	.09536	2084	2.573	.7400	/	1532
1533	32.40	164	33	.09665	.00001	50	.00001	50	.12665	308	3.025	.6042	7	1533
1542	152.76	175	303	.13487	.00001	50	.00001	50	.05667	1729	[illegible]	.6614	7	1542
[illegible]	[illegible]	147	[illegible]	.09772	.00001	50	.00689	50	.03997	979	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	182	[illegible]	[illegible]	.00001	50	.00003	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	164	[illegible]	.06651	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	45.56	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	650	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	154	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	1.220	[illegible]	7	[illegible]
1574	19.44	149	245	.06299	.00001	50	[illegible]	50	[illegible]	650	[illegible]	.7744	7	1574
1575	17.01	132	49	.02854	.00001	50	.00578	50	.02625	941	.520	.6457	/	1575
1584	[illegible]	160	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1584
1585	[illegible]	160	[illegible]	.06206	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1585
1592	7.25	152	221	.05062	.00001	50	.02867	50	.06210	215	1.126	.4080	/	1592
1593	8.10	143	51	.12366	.00001	50	.00001	50	.11215	342	3.208	.9874	/	1593
1601	1154.75	375	326	.14013	.00001	50	.00001	50	.05735	5361	3.626	.5753	/	1601
1602	166.86	182	220	.06256	.00001	50	.00001	50	.03385	941	1.735	.7062	7	1602
1603	65.20	131	343	.05225	.00001	50	.00001	50	.05450	1035	1.365	.7582	7	1603
1611	1138.05	314	330	.12562	.00001	50	.00867	50	.06217	5411	3.557	.3941	/	1611
1612	49.41	153	275	.07605	.00001	50	.01089	50	.10600	435	2.351	.6424	7	1612
1613	381.60	217	26	.14912	.00001	50	.00001	50	.06572	3847	4.605	.5843	7	1613
[illegible]	[illegible]	157	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	151	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	257	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	150	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	341	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1642	42.90	179	272	.09676	.00001	50	.00001	50	.07442	1571	2.645	.5457	7	1642
1643	70.47	200	23	.15206	.00001	50	.03244	50	.09572	1429	4.560	.7850	/	1643
1644	[illegible]	285	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1644
1653	1020.32	151	115	.05122	.00001	50	.01689	50	.00794	5061	.706	.3012	7	1653
1662	570.55	172	227	.08556	.00001	50	.00001	50	.05068	3220	2.350	.5575	/	1662
1663	1555.20	170	123	.04027	.00001	50	.00001	50	.00772	9480	1.005	.3026	/	1663
1671	1053.50	374	320	.15562	.00001	50	.00001	50	.07895	5793	4.570	.5375	/	1671
1672	750.55	129	309	.10370	.00001	50	.00001	50	.07403	6511	3.564	.4812	7	1672
1673	45.34	186	8	.21451	.00001	50	.00001	50	.24264	535	6.347	.6617	7	1673
1682	746.35	205	315	.11041	.00001	50	.00001	50	.03746	5352	3.154	.4722	/	1682

[illegible]	[illegible]	159	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	150	285	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1693	550.32	172	105	.04064	.00001	50	.00153	50	.02060	2002	1.247	.6025	7	1693
1701	1402.11	401	321	.15123	.00001	50	.01267	50	.05824	5562	4.437	.5205	/	1701
1704	45.76	153	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1704
1705	174.56	226	250	.12426	.00001	50	.00001	50	.06083	2226	3.616	.6271	/	1705
1712	320.50	190	207	.10455	.00001	50	.00001	50	.06885	2705	3.155	.6650	/	1712
1713	211.41	158	138	.06512	.00001	50	.00001	50	.02240	2313	1.100	.6355	/	1713
1721	1056.24	309	217	.14072	.00001	50	.00001	50	.06571	4157	4.111	.4650	/	1721
1722	381.28	269	311	.13475	.00001	50	.00001	50	.09006	4651	3.660	.5824	/	1722
1723	56.42	203	33	.13552	.00001	50	.05222	50	.10502	1190	4.168	.7572	/	1723
1732	189.26	181	357	.09355	.00001	50	.04853	50	.08511	2562	2.574	.8156	7	1732
1733	112.56	167	162	.06444	.00001	50	.01600	50	.05593	1519	1.566	.8354	7	1733
1741	[illegible]	596	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1741
1744	[illegible]	279	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1744
1745	2836.05	523	15	.15057	.00001	50	.04422	50	.03457	6240	3.729	.4526	7	1745
[illegible]	[illegible]	151	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	126	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	128	[illegible]	[illegible]	.00001	50	.00001	50	.05644	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	121	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	1.496	[illegible]	7	[illegible]
[illegible]	56.49	149	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	1.666	[illegible]	7	[illegible]
[illegible]	[illegible]	156	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1782	81.56	156	251	.04475	.00001	50	.00311	50	.02603	1047	1.053	.5650	/	1782
1783	12.56	153	59	.08003	.00001	50	.00001	50	.06503	470	2.109	.9377	/	1783
1791	1552.70	274	325	.10415	.00001	50	.03556	50	.03551	6214	2.656	.3726	/	1791
1792	339.76	173	234	.05555	.00001	50	.01400	50	.01341	3335	.655	.4355	/	1792
1793	149.34	181	350	.04600	.00001	50	.00953	50	.02747	1916	1.029	.6272	/	1793
1802	463.32	230	273	.09301	.00001	50	.03044	50	.09392	1519	2.513	.6151	/	1802
1803	369.42	210	48	.08341	.00001	50	.00001	50	.02150	1953	2.331	.6556	7	1803
1811	1322.22	200	200	.10016	.00001	50	.00001	50	.07420	6032	3.579	.3107	7	1811
1814	[illegible]	207	449	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1814
1815	67.20	[illegible]	33	.13520	.00001	50	.00001	50	.12751	1069	3.625	.9544	7	1815
1821	1052.65	517	[illegible]	.20434	.00001	50	.01267	50	.08057	4151	6.775	.5203	7	1821
1824	[illegible]	[illegible]	119	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1824
1825	[illegible]	242	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1825
1833	7.35	159	3	.06903	.00001	50	.01233	50	.05774	788	1.709	.9277	7	1833
1834	[illegible]	152	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1834
1835	[illegible]	185	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1835
1852	2346.36	254	212	.11710	.00001	50	.00001	50	.08346	5465	3.261	.5016	7	1852
1853	1556.17	193	136	.07610	.00001	50	.03222	50	.02501	2946	1.540	.4575	/	1853
1862	2472.53	403	270	.15432	.00001	50	.06178	50	.06595	6347	4.565	.6126	/	1862
1863	757.35	237	89	.13062	.00001	50	.05133	50	.02261	4703	3.556	.4042	/	1863
1871	1302.76	620	3	.24651	.00001	50	.00001	50	.13505	5036	7.324	.6570	/	1871
1872	2051.78	529	217	.20066	.00001	50	.05422	50	.07172	7593	6.043	.6356	/	1872
1873	209.35	365	106	.11532	.00001	50	.02911	50	.07225	1571	3.466	.6077	7	1873
1881	1300.25	486	36	.19707	.00001	50	.00001	50	.09571	7842	6.044	.3701	7	1881
1882	158.45	315	20	.10007	.00001	50	.02778	50	.04745	2264	2.611	.4950	/	1882
1883	24.32	292	144	.05349	.00001	50	.00001	50	.05698	432	1.529	.6951	7	1883
1892	17.31	170	[illegible]	.08045	.00001	50	.00001	50	.09413	435	2.460	.7354	7	1892
1893	19.44	167	[illegible]	.06055	.00001	50	.00001	50	.04433	533	1.720	.9045	7	1893
1904	[illegible]	275	114	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1904
1905	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00556	50	.01564	[illegible]	[illegible]	[illegible]	7	1905
1911	[illegible]	389	158	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1911
1914	[illegible]	284	108	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1914
1915	[illegible]	106	58	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1915
1921	1017.36	313	231	.13723	.00001	50	.00001	50	.06603	5827	3.651	.2804	/	1921
1924	[illegible]	256	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1924
1925	[illegible]	218	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1925
1932	477.50	194	65	.07216	.00001	50	.00001	50	.03207	3511	2.010	.4805	/	1932
1933	269.56	201	166	.08894	.00001	50	.01422	50	.04356	1950	2.260	.6815	/	1933
1942	2511.61	217	310	.08724	.00001	50	.00001	50	.01644	5762	2.447	.3652	/	1942
1943	3350.16	285	125	.16352	.00001	50	.00001	50	.08664	4549	4.527	.6554	7	1943
1951	1020.05	537	316	.20856	.00001	50	.00001	50	.10792	7289	6.229	.5103	7	1951
1952	566.27	272	255	.12427	.00001	50	.03467	50	.05055	3378	3.650	.4224	/	1952
1953	264.36	258	19	.16470	.00001	50	.00001	50	.13462	1376	5.548	.7895	7	1953
1962	721.33	200	213	.08954	.00001	50	.00001	50	.07537	2403	2.554	.4172	7	1962
[illegible]	[illegible]	289	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	80.56	251	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	46.45	226	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	505	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	267	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
1985	38.37	261	366	.17520	.00001	50	.00001	50	.17464	432	5.424	.9302	7	1985
1991	1130.66	469	321	.20306	.00001	50	.00001	50	.10475	4770	6.425	.5450	/	1991
1994	[illegible]	258	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	1994
1995	106.11	273	3	.12074	.00001	50	.00001	50	.10500	1612	3.626	.8052	7	1995
2002	515.50	224	350	.00420	.00001	50	.05644	50	.06501	2077	2.424	.3300	/	2002
2003	1076.45	299	143	.16436	.00001	50	.00001	50	.13144	3012	5.029	.5731	/	2003
2011	1029.51	750	276	.22761	.00001	50	.00001	50	.07181	7577	7.013	.3563	/	2011
2012	2740.71	434	276	.17042	.00001	50	.00001	50	.10016	2911	5.120	.4056	7	2012
2013	1479.04	464	316	.20944	.00001	50	.00001	50	.11026	4733	6.770	.5052	7	2013
2022	1327.65	260	316	.07155	.00001	50	.00001	50	.01591	4347	1.538	.3657	/	2022

2023	1946.43	322	133	.14693	.00001	50	.00001	50	.10771	3653	4.436	.7054	P	2023
2031	1104.03	273	298	.05061	.00001	50	.00001	50	.02404	5380	1.185	.5544	P	2031
2032	387.71	260	250	.04078	.00001	50	.00001	50	.02053	3613	1.066	.4701	P	2032
2033	[illegible]	244	35	.05609	.00001	50	.00001	50	.03079	[illegible]	1.373	.2836	P	2033
2042	400.14	233	317	.05520	.00001	50	.01430	50	.02692	1789	1.767	.4701	P	2042
2043	775.98	335	139	.16122	.00001	50	.00001	50	.10703	3810	4.951	.7241	P	2043
2053	17.82	334	259	.06778	.00001	50	.00001	50	.13529	358	1.710	.0806	P	2053
[illegible]	40.50	251	90	[illegible]	.00001	50	.00001	50	.03906	960	1.426	.0907	P	[illegible]
2062	972.62	272	232	.05466	.00001	50	.00001	50	.01455	2628	1.334	.6602	P	2062
2063	984.35	[illegible]	558	[illegible]	.00001	50	.05747	50	[illegible]	4364	1.092	[illegible]	P	2063
2071	[illegible]	656	344	[illegible]	.00001	50	.00001	50	.10767	[illegible]	6.074	.2800	P	2071
2072	[illegible]	426	344	[illegible]	.00001	50	.00001	50	[illegible]	2445	[illegible]	[illegible]	P	2072
2073	1070.02	504	277	.15060	.00001	50	.01125	50	.07727	6017	4.660	.5359	P	2073
2081	1157.40	683	295	.24751	.00001	50	.00001	50	.06303	5221	7.651	.5276	P	2081
2082	232.28	356	254	.05459	.00001	50	.00578	50	.01399	1055	2.663	.6350	P	2082
2083	380.70	294	11	.17519	.00001	50	.00001	50	.13408	1750	5.707	.7096	P	2083
2092	328.35	248	283	.04296	.00001	50	.01111	50	.01553	1679	1.031	.3926	P	2092
2093	610.74	252	46	.04094	.00001	50	.00001	50	.01789	3785	1.017	.2225	P	2093
2101	1014.53	613	317	.24686	.00001	50	.00001	50	.05359	6555	7.824	.4194	P	2101
2102	1014.12	303	258	.07086	.00001	50	.05578	50	.09871	3434	1.954	.4984	P	2102
2103	2345.76	481	333	.16260	.00001	50	.00001	50	.11806	7583	4.985	.6127	P	2103
2112	454.94	257	287	.02536	.00001	50	.00622	50	.00989	4427	.677	.4568	P	2112
2113	528.62	255	97	.04615	.00001	50	.00001	50	.01895	2495	1.142	.5708	P	2113
2121	[illegible]	[illegible]	305	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	2121
2122	[illegible]	[illegible]	385	.12520	.00001	50	.00001	50	.10778	[illegible]	[illegible]	[illegible]	P	2122
2123	1002.59	322	14	.07696	.00001	50	.04641	50	.04524	4471	2.017	.5687	P	2123
2132	[illegible]	[illegible]	504	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	.5682	P	2132
2133	[illegible]	274	87	.03419	.00001	50	.00001	50	.01868	[illegible]	.945	.3105	P	2133
2142	4.05	276	500	.01029	.00001	50	.00001	50	.00253	252	.140	.6061	P	2142
2143	1.53	275	30	.01277	.00001	50	.00001	50	.00550	91	.226	.5081	P	2143
2151	1245.63	424	302	.14726	.00001	50	.00001	50	.04837	7171	4.971	.3752	P	2151
2152	47.78	297	275	.02550	.00001	50	.05311	50	.07150	1159	.696	.7465	P	2152
2153	30.59	201	351	.02212	.00001	50	.00580	50	.02450	1121	.702	.6710	P	2153
2161	1001.16	562	304	.28518	.00001	50	.02778	50	.15161	5525	5.317	.4735	P	2161
2162	325.62	275	267	.05723	.00001	50	.00001	50	.12516	2356	2.770	.7387	P	2162
2163	1595.70	491	336	.16017	.00001	50	.06446	50	.02491	5230	5.526	.5982	P	2163
2171	1006.02	312	310	.24093	.00001	50	.01716	50	.11890	5555	7.641	.5428	P	2171
2172	305.37	335	322	.05556	.00001	50	.00511	50	.03175	1466	1.368	.6768	P	2172
2173	1321.11	413	49	.12708	.00001	50	.07046	50	.06783	4577	2.217	.6549	P	2173
2182	1406.16	257	324	.05295	.00001	50	[illegible]	50	.07410	[illegible]	1.354	.3750	P	2182
2183	[illegible]	[illegible]	117	.14428	.00001	50	.00001	50	.06288	[illegible]	4.765	.3092	P	2183
2191	[illegible]	355	3	[illegible]	.00001	50	.00001	50	.04453	9568	[illegible]	.4786	P	2191
2192	1698.37	275	263	.07602	.00001	50	.00001	50	.01084	5637	.845	.2837	P	2192
2193	[illegible]	289	[illegible]	.05881	.00001	50	[illegible]	50	[illegible]	[illegible]	.946	[illegible]	P	2193
2202	1456.00	287	322	.04080	.00001	50	.00001	50	.02795	3472	.992	.2465	P	2202
2203	1530.00	255	153	.12260	.00001	50	.00001	50	.00575	6256	2.742	.7571	P	2203
2212	857.06	256	295	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	1.765	.4870	P	2212
2213	[illegible]	233	112	.11066	.00001	50	.00001	50	.06656	5669	2.307	.6062	P	2213
2221	1345.86	573	0	.22672	.00001	50	.07244	50	.07656	5104	9.902	.2346	P	2221
2222	736.20	222	259	.06040	.00001	50	.00644	50	.02070	2670	2.531	.6515	P	2222
2223	716.34	262	23	.11665	.00001	50	.05222	50	.07510	7694	3.383	.7690	P	2223
2232	212.22	292	289	.03507	.00001	50	.00522	50	.02398	3655	.976	.6297	P	2232
2233	132.84	265	97	.05244	.00001	50	.00001	50	.02227	1551	1.414	.5909	P	2233
2241	1015.74	455	341	.26620	.00001	50	.00001	50	.07715	6233	6.786	.3536	P	2241
2242	902.34	465	315	.16634	.00001	50	.00001	50	.06024	8713	5.865	.7134	P	2242
2243	85.05	286	63	.10407	.00001	50	.00001	50	.06907	360	2.266	.6726	P	2243
2252	676.78	284	319	.05567	.00001	50	.00155	50	.02179	2365	1.632	.4299	P	2252
2253	1064.62	283	122	.12554	.00001	50	.00001	50	.10613	5166	4.137	.6266	P	2253
2262	1410.21	303	280	.14185	.00001	50	.07069	50	.08622	4269	4.357	.5065	P	2262
2263	[illegible]	275	79	[illegible]	.00001	50	.00669	50	.01648	[illegible]	.894	.4767	P	2263
2271	[illegible]	[illegible]	283	[illegible]	.00001	50	.00001	50	.07148	[illegible]	10.285	[illegible]	P	2271
2272	76.06	214	265	[illegible]	.00001	50	.00001	50	.13231	[illegible]	[illegible]	.6680	P	2272
2273	72.50	234	45	.15299	.00001	50	.00001	50	.05000	745	3.031	.6900	P	2273
2282	[illegible]	[illegible]	509	[illegible]	.00001	50	.00001	50	.03011	[illegible]	1.515	.3255	P	2282
2283	[illegible]	248	116	.12508	.00001	50	.06044	50	.06815	[illegible]	[illegible]	.5945	P	2283
2292	758.57	233	251	.04235	.00001	50	.00623	50	.02308	5709	1.018	.5650	P	2292
2293	106.84	290	45	.03793	.00001	50	.00646	50	.02299	1117	.968	.7544	P	2293
2302	127.58	295	224	.03579	.00001	50	.01046	50	.03176	1666	.712	.7743	P	2302
2303	46.19	235	15	.04405	.00001	50	.01725	50	.03119	1254	1.077	.7061	P	2303
2311	1018.17	593	266	.25678	.00001	50	.00001	50	.05477	6651	6.443	.3190	P	2311
2312	182.25	335	177	.04754	.00001	50	.00001	50	.04907	761	1.000	.6521	P	2312
2313	70.14	335	272	.04059	.00001	50	.01222	50	.04600	321	1.264	.6822	P	2313
2322	1711.00	413	228	.11190	.00001	50	.05669	50	.05024	5277	3.130	.6005	P	2322
2323	767.58	236	356	.04393	.00001	50	.02022	50	.02691	3502	1.050	.6076	P	2323
2332	546.75	513	151	.24020	.00001	50	.00001	50	.16579	2675	5.121	.7292	P	2332
2333	362.69	447	313	.23475	.00001	50	.00001	50	.12785	1037	7.067	.6330	P	2333
2341	[illegible]	565	252	[illegible]	.00001	50	.00001	50	.02805	[illegible]	[illegible]	.2986	P	2341
2342	911.46	[illegible]	150	.28011	.00001	50	.05660	50	.17506	3708	[illegible]	.4952	P	2342
2343	553.25	605	205	.22762	.00001	50	.04844	50	.15402	2551	7.590	.6721	P	2343
2351	1066.37	687	272	.21500	.00001	50	.00525	50	.06205	6056	5.615	.4650	P	2351
2352	500.42	557	129	[illegible]	.00001	50	.02542	50	.21614	1794	6.346	.5906	P	2352

2353	1709.10	697	310	.23534	.00001	50	.03000	50	.10350	6456	7.697	.5569	P	2353
2361	1211.76	522	289	.24731	.00001	50	.00001	50	.12288	4728	7.906	.5128	P	2361
2362	530.22	472	210	.20150	.00001	50	.05333	50	.05296	2261	6.366	.4091	P	2362
2363	1755.94	585	336	.20763	.00001	50	.00001	50	.17986	5591	6.755	.5374	P	2363
2372	705.51	504	291	.02662	.00001	50	.00622	50	.01139	5445	.616	.3709	P	2372
2373	1197.52	272	108	.06503	.00001	50	.00001	50	.05637	6597	2.525	.5382	P	2373
2382	301.12	395	249	.07788	.00001	50	.00001	50	.07338	4069	.515	.4030	P	2382
2383	185.79	380	47	.01607	.00001	50	.00001	50	.02885	3603	.395	.3408	P	2383
2391	1072.92	527	504	.15318	.00001	50	.00001	50	.06515	8562	3.964	.5619	P	2391
2392	456.76	331	239	.04074	.00001	50	.00001	50	.01740	[illegible]	.894	.5718	P	2392
2393	[illegible]	334	503	[illegible]	.00001	50	.00001	50	.03918	8671	.865	.4987	P	2393
2402	29.56	324	534	.00807	.00001	50	.00001	50	.00447	650	.155	.4802	P	2402
2403	4.06	202	141	.00610	.00001	50	.00211	50	.00579	215	.142	.4659	P	2403
2412	26.75	205	332	.01393	.00001	50	.00378	50	.00009	205	.230	.4955	P	2412
2413	15.44	286	93	.01217	.00001	50	.00001	50	.00764	380	.335	.7996	P	2413
2421	1015.79	612	287	.21542	.00001	50	.01657	50	.06102	6470	5.672	.4026	P	2421
2422	1562.49	435	258	.05708	.00001	50	.03622	50	.06651	9664	2.756	.4832	P	2422
2423	2014.47	485	336	.15073	.00001	50	.00001	50	.06111	8236	4.607	.4068	P	2423
2432	630.99	252	310	.03550	.00001	50	.07567	50	.05205	4123	2.886	.5649	P	2432
2433	482.51	335	91	.02690	.00001	50	.00001	50	.03081	3766	.665	.4018	P	2433
2442	434.16	407	230	.20395	.00001	50	.00001	50	.05807	1256	6.342	.5851	P	2442
2443	903.96	425	348	.15566	.00001	50	.06230	50	.06023	6130	6.326	.5041	P	2443
2451	1017.56	655	519	.23066	.00001	50	.00001	50	.12721	5017	7.400	.4920	P	2451
2452	[illegible]	410	186	[illegible]	.00001	50	.00001	50	.11449	[illegible]	3.914	.3719	P	2452
2453	40.50	401	587	.14557	.00001	50	[illegible]	50	.13546	550	4.205	.3780	P	2453
2461	1104.22	606	332	.24121	.00001	50	.02178	50	.07030	5657	7.786	.3796	P	2461
2462	[illegible]	546	119	[illegible]	.00001	50	[illegible]	50	.05578	[illegible]	6.285	[illegible]	P	2462
2463	334.00	483	103	.21576	.00001	50	.00001	50	.15099	1544	7.367	.6480	P	2463
2472	282.00	202	557	.01795	.00001	50	.00511	50	.01111	3096	.400	.5052	P	2472
2473	2112.40	243	136	.04313	.00001	50	.00001	50	.01512	9615	1.026	.4560	P	2473
2481	1104.84	497	352	.21654	.00001	50	.06000	50	.09131	7086	5.906	.2627	P	2481
2482	486.01	220	500	.03215	.00001	50	.04211	50	.02979	5017	.722	.5505	P	2482
2483	35.69	223	356	.04466	.00001	50	.00570	50	.04709	635	1.127	.5357	P	2483
2492	1164.78	376	334	.05266	.00001	50	.00001	50	.08472	5613	2.737	.7087	P	2492
2493	375.89	318	135	.02484	.00001	50	.00678	50	.01306	3361	.565	.5634	P	2493
2501	1006.02	535	316	.25165	.00001	50	.00001	50	.05002	7455	6.407	.3705	P	2501
2502	46.17	310	273	.02183	.00001	50	.01246	50	.01892	432	.454	.6865	P	2502
2503	28.35	314	330	.02656	.00001	50	.01457	50	.02296	705	.761	.6606	P	2503
2512	351.54	365	329	.05352	.00001	50	.00507	50	.06779	4524	1.170	.7851	P	2512
2513	65.61	317	137	.02511	.00001	50	.00403	50	.07779	531	.877	.7668	P	2513
2521	[illegible]	593	734	[illegible]	.00001	50	.00001	50	.06119	[illegible]	6.776	.4165	P	2521
2522	50.15	316	203	.02502	.00001	50	.00001	50	.04102	[illegible]	.854	.5612	P	2522
2523	90.72	346	9	[illegible]	.00001	50	.01047	50	.04309	217	1.301	.6977	P	2523
2532	454.71	[illegible]	587	.10156	.00001	50	.00001	50	.05050	[illegible]	3.964	[illegible]	P	2532
2533	14.65	306	153	.02508	.00001	50	.00001	50	.04481	488	.767	.5560	P	2533
2542	34.02	315	329	.05640	.00001	50	.00001	50	.04522	616	1.674	.7920	P	2542
2543	[illegible]	315	153	[illegible]	.00001	50	[illegible]	50	[illegible]	1699	.462	[illegible]	P	2543
2551	1174.60	523	344	.25406	.00001	50	.00001	50	.05312	[illegible]	6.192	.4205	P	2551
2552	1740.69	572	277	.26330	.00001	50	.00001	50	.10209	4645	6.877	.4756	P	2552
2553	1075.60	555	61	.26909	.00001	50	.00001	50	.16450	2705	5.054	.5169	P	2553
2562	140.13	233	18	.04643	.00001	50	.00001	50	.01862	2644	1.196	.6541	P	2562
2563	26.73	209	143	.01524	.00001	50	.00333	50	.01492	612	.406	.7746	P	2563
2572	1125.09	307	336	.07879	.00001	50	.00001	50	.05065	5532	2.175	.6269	P	2572
2573	515.97	222	123	.02400	.00001	50	.00001	50	.03569	3287	.551	.3924	P	2573
2581	1245.85	573	325	.25476	.00001	50	.00001	50	.07805	6224	6.398	.4567	P	2581
2582	95.62	240	293	.04295	.00001	50	.00001	50	.04291	1483	.855	.7860	P	2582
2583	85.05	351	7	.05198	.00001	50	.00001	50	.04767	1086	1.292	.7865	P	2583
2592	2277.72	434	323	.11148	.00001	50	.02111	50	.05698	9438	3.365	.6219	P	2592
2593	1261.38	334	134	.02495	.00001	50	.01069	50	.03870	6456	.566	.4609	P	2593
2601	[illegible]	564	580	[illegible]	.00001	50	.00001	50	.06170	4840	4.213	.3666	P	2601
2602	601.39	[illegible]	297	[illegible]	.00001	50	.00001	50	.03165	[illegible]	3.885	[illegible]	P	2602
2603	467.51	485	587	.15046	.00001	50	.00659	50	.07559	4635	4.905	.6375	P	2603
2612	12.15	221	2	.01717	.00001	50	.00660	50	.02004	125	.396	.4062	P	2612
2613	37.87	[illegible]	117	.03400	.00001	50	.00001	50	.04069	470	.715	.5066	P	2613
2622	415.58	335	520	[illegible]	.00001	50	.01860	50	.07551	2000	.476	.6460	P	2622
2623	374.22	234	123	.02210	.00001	50	.01173	50	.03017	2601	.515	.4035	P	2623
2631	1004.40	493	310	.13244	.00001	50	.00001	50	.05923	10336	4.256	.6373	P	2631
2632	157.14	255	309	.02704	.00001	50	.00446	50	.01507	2785	.641	.4630	P	2632
2633	40.50	237	0	.01463	.00001	50	.00735	50	.00876	597	.410	.5275	P	2633
2642	3624.75	442	292	.06271	.00001	50	.00001	50	.06212	10533	2.460	.7026	P	2642
2643	1777.14	361	54	.05483	.00001	50	.00001	50	.01024	9372	1.376	.1850	P	2643
2651	1000.85	672	203	.32176	.00001	50	.00001	50	.07780	5776	11.044	.1738	P	2651
2652	575.15	496	203	.10980	.00001	50	.00001	50	.14094	3046	3.469	.5561	P	2652
2653	693.36	521	337	.15051	.00001	50	.00001	50	.13453	3683	5.920	.7891	P	2653
2662	955.80	422	292	.00257	.00001	50	.07079	50	.06071	6726	1.655	.0394	P	2662
2663	591.70	377	109	.03849	.00001	50	.01311	50	.01266	3564	.857	.4875	P	2663
2671	[illegible]	[illegible]	256	[illegible]	.00001	50	.00001	50	.04122	[illegible]	6.814	.3876	P	2671
2672	[illegible]	[illegible]	251	.11302	.00001	50	.00001	50	.17781	3988	3.289	.5795	P	2672
2673	592.11	601	510	.18505	.00001	50	.03255	50	.06905	5205	5.148	.5957	P	2673
2682	904.96	201	296	.02207	.00001	50	.00001	50	.01512	5231	.512	.6731	P	2682
2683	[illegible]	[illegible]	93	.02770	.00001	50	[illegible]	50	.01171	5510	.850	[illegible]	P	2683

2691	[illegible]	564	[illegible]	[illegible]	.00001	50	[illegible]	50	.06645	[illegible]	[illegible]	[illegible]	?	2691
2692	[illegible]	594	[illegible]	[illegible]	.00001	50	.00001	50	.02525	[illegible]	.545	.8554	?	2692
2693	124.74	403	314	.02924	.00001	50	.00001	50	.01636	1004	.559	.7854	?	2693
2702	304.77	402	301	.09810	.00001	50	.00001	50	.07602	8076	2.810	.7142	/	2702
2705	99.69	509	[illegible]	.05888	.00001	50	.00001	50	.03674	1004	[illegible]	[illegible]	?	2705
2712	1504.81	450	277	.07842	.00001	50	.06267	50	.06295	8031	2.202	.6054	/	2712
2713	246.24	300	51	.05426	.00001	50	.00822	50	.01811	1043	.773	.6452	/	2713
2721	1117.50	619	235	.22811	.00001	50	.00001	50	.09461	6129	7.158	.1945	/	2721
2722	615.58	473	226	.13332	.00001	50	.00001	50	.06540	1503	3.031	.7054	/	2722
2723	1828.16	570	312	.18641	.00001	50	.05664	50	.06643	7087	5.366	.4662	/	2723
2732	573.46	408	312	.04773	.00001	50	.00001	50	.02152	6030	1.116	.5554	/	2732
2733	1438.56	409	113	.05530	.00001	50	.00444	50	.00744	7761	.645	.3022	?	2733
2741	1359.55	523	210	.15836	.00001	50	.00001	50	.07522	5645	4.750	.0666	?	2741
2742	142.56	440	[illegible]	.05452	.00001	50	.00001	50	.03783	1591	1.115	.6117	?	2742
2744	[illegible]	446	7	.09588	.00001	50	.00001	50	.06077	4221	1.645	.7161	?	2744
2752	175.77	394	211	.02645	.00001	50	.00600	50	.00152	1409	.306	.4702	?	2752
2754	120.36	404	118	.02444	.00001	50	.00001	50	.00204	1464	.525	.5642	?	2754
2761	1650.22	572	146	.16868	.00001	50	.00001	50	.06445	6648	5.225	.0748	?	2761
2762	142.06	241	244	.08002	.00001	50	.00001	50	.01667	1301	2.246	.6665	?	2762
2764	68.08	245	24	.11861	.00001	50	.05773	50	.04506	647	5.246	.6791	?	2764
2774	1465.05	253	439	.09111	.00001	50	.00001	50	.04406	5972	4.401	.5066	?	2774
2775	2062.44	442	125	.05500	.00001	50	.00001	50	.01140	7044	.626	.5645	?	2775
2782	311.41	451	315	.07316	.00001	50	.04000	50	.05403	1600	1.653	.6858	/	2782
2783	182.26	419	77	.02227	.00001	50	.00844	50	.01563	1771	.514	.6108	/	2783
2791	1646.35	556	250	.17827	.00001	50	.00001	50	.05492	5898	5.555	.2955	/	2791
2792	111.78	454	250	.09278	.00001	50	.00001	50	.06112	1931	2.562	.5372	/	2792
2793	29.16	452	38	.13560	.00001	50	.04232	50	.14586	522	3.624	.8218	/	2793
2802	1503.36	480	305	.10323	.00001	50	.02222	50	.03524	5948	3.154	.4442	/	2802
2803	346.08	452	08	.02212	.00001	50	.00922	50	.01527	1147	.319	.5526	?	2803
2811	1360.61	719	311	.22416	.00001	50	.00001	50	.05002	5802	6.309	.4722	?	2811
2812	[illegible]	745	367	.17788	.00001	50	.05420	50	.08026	705	2.140	.6699	?	2812
2813	420.35	710	227	.20387	.00001	50	.00001	50	.13207	1912	6.145	.7203	?	2813
2822	1116.95	689	217	.23934	.00001	50	.00001	50	.21506	3934	7.007	.8277	?	2822
2823	1162.46	586	[illegible]	.17169	.00001	50	.05800	50	.04703	7250	5.179	.7167	?	2823
2831	1095.07	743	455	.20754	.00001	50	.00001	50	.05617	6678	6.250	.4026	?	2831
2832	145.29	684	317	.21323	.00001	50	.05064	50	.18767	1138	6.165	.7691	?	2832
2833	48.84	549	118	.22496	.00001	50	.00001	50	.11947	565	5.700	.9136	?	2833
2841	1062.07	724	154	.25506	.00001	50	.00001	50	.04606	5877	5.450	.2550	?	2841
2842	152.21	507	357	.17822	.00001	50	.00001	50	.11391	1196	5.559	.6345	?	2842
2843	256.34	656	161	.27747	.00001	50	.00001	50	.16323	1612	9.020	.8705	/	2843
2852	717.66	421	345	.01940	.00001	50	.00156	50	.00505	2953	.442	.4356	/	2852
2853	1702.31	430	148	.02855	.00001	50	.00333	50	.00672	6973	.547	.3884	/	2853
2861	1024.65	801	102	.20624	.00001	50	.05333	50	.06275	7522	9.024	.2942	/	2861
2862	812.61	481	318	.05047	.00001	50	.05600	50	.02797	3046	1.451	.4966	/	2862
2863	923.92	505	70	.06845	.00001	50	.00772	50	.01382	3272	1.529	.5732	?	2863
2872	1160.22	470	6	.04112	.00001	50	.00001	50	.03722	8242	.342	.6046	?	2872
2873	675.54	428	172	.02276	.00001	50	.00001	50	.00676	1918	.515	.6745	/	2873
2881	1031.13	758	28	.23301	.00001	50	.00001	50	.06016	8137	7.335	.3855	?	2881
2882	120.41	493	339	.32621	.00001	50	.03822	50	.03560	870	.321	.8412	?	2882
2883	1667.33	655	36	.14782	.00001	50	.00001	50	.05546	3996	4.487	.5712	?	2883
2884	1402.47	524	6	.10856	.00001	50	.00600	50	.06562	3944	[illegible]	.6656	?	2884
2885	1026.55	422	140	.05578	.00001	50	.01138	50	.00647	4008	.409	.5422	?	2885
2904	65.05	475	173	.05741	.00001	50	.00224	50	.03593	814	1.461	.7762	?	2904
2905	52.74	483	116	.06642	.00001	50	.00001	50	.03183	944	1.647	.6471	?	2905
2911	1056.09	617	335	.13140	.00001	50	.05064	50	.09642	4611	[illegible]	.7762	?	2911
2912	140.04	551	215	.04540	.00001	50	.04378	50	.04774	4132	.557	.8654	/	2912
2914	19.44	486	[illegible]	.05368	.00001	50	.00001	50	.04433	548	1.321	.8120	?	2914
2921	1095.50	628	407	.10428	.00001	50	.00001	50	.04554	5629	2.558	.4520	?	2921
2922	1170.55	661	326	.12707	.00001	50	.00001	50	.06725	6146	3.571	.6912	/	2922
2923	341.82	522	57	.06621	.00001	50	.01556	50	.01653	2968	1.405	.2855	/	2923
2932	133.65	477	751	.05763	.00001	50	.00001	50	.03693	1084	1.474	.7346	/	2932
2933	102.06	481	156	.10544	.00001	50	.02911	50	.05705	848	2.517	.7552	?	2933
2941	1010.31	521	53	.02007	.00001	50	.00001	50	.00432	7202	.520	.2106	?	2941
2942	155.09	497	326	.04357	.00001	50	.01022	50	.03312	867	1.131	.5544	/	2942
2943	55.06	497	113	.05369	.00001	50	.01533	50	.05707	342	1.741	.6662	?	2943
2951	1010.13	580	63	.08542	.00001	50	.00001	50	.01450	7709	2.242	.2400	?	2951
2954	1450.47	548	46	.06109	.00001	50	.04822	50	.01554	6665	1.662	.2639	?	2954
2955	1420.37	560	[illegible]	.08476	.00001	50	.04913	50	.01776	8542	2.450	.2872	?	2955
2961	1091.16	415	60	.05012	.00001	50	.00001	50	.01013	5553	.640	.2532	?	2961
2964	130.06	534	[illegible]	.05438	.00001	50	.00956	50	.01170	1200	.661	.4816	?	2964
2965	435.35	532	141	.07059	.00001	50	.04067	50	.03914	4058	1.050	.5537	?	2965
2972	59.66	526	60	.02433	.00001	50	.00378	50	.01136	1013	.628	.5272	?	2972
2973	152.26	550	220	.04077	.00001	50	.00001	50	.02662	1685	1.110	.4663	/	2973
2984	67.00	554	40	.05036	.00001	50	.00570	50	.03735	651	1.218	.7674	?	2984
2985	10.07	535	167	.04162	.00001	50	.00001	50	.02566	889	1.192	.6800	?	2985
2992	379.85	550	259	.03411	.00001	50	.00911	50	.02104	1357	.720	.6435	/	2992
2993	527.31	567	134	.03966	.00001	50	.00044	50	.00595	3621	.688	.4650	/	2993
3002	456.53	563	259	.03416	.00001	50	.00001	50	.01084	2658	.775	.5150	/	3002
3003	181.93	565	129	.04715	.00001	50	.00001	50	.02459	1211	1.395	.7513	?	3003
3012	361.98	573	217	.02936	.00001	50	.00953	50	.01471	3531	.646	.5772	?	3012
3013	226.14	563	117	.06306	.00001	50	.00001	50	.03175	923	1.747	.4651	/	3013

3021	1195.76	548	7	.04657	.00001	50	.00256	50	.00617	6724	1.417	.2617	?	3021
3022	298.02	553	226	.05306	.00001	50	.00467	50	.03554	2011	.627	.6257	?	3022
3023	531.50	551	20	.05095	.00001	50	.06111	50	.02002	5540	.739	.2975	?	3023
3032	343.21	550	235	.03725	.00001	50	.00009	50	.01245	2001	.677	.3145	/	3032
3033	1746.54	563	148	.05846	.00001	50	.02667	50	.01295	12502	1.472	.3112	?	3033
3042	717.66	572	285	.05016	.00001	50	.00001	50	.02180	5557	1.249	.3042	/	3042
3043	549.52	557	50	.04522	.00001	50	.00001	50	.01535	3096	1.147	.4452	/	3043
3053	4.05	551	160	.03486	.00001	50	.01556	50	.02692	305	.446	.5854	/	3053
3061	1016.12	414	48	.04751	.00001	50	.00001	50	.01224	8575	1.150	.1555	/	3061
3062	3907.28	397	309	.04456	.00001	50	.01111	50	.01291	5377	1.071	.2733	/	3062
3063	1020.60	390	105	.04422	.00001	50	.00001	50	.01405	3530	1.142	.5961	/	3063
3072	1559.56	368	122	.04500	.00001	50	.00001	50	.01745	3654	1.210	.1565	?	3072
3073	707.25	385	120	.05100	.00001	50	.01267	50	.01903	3522	1.369	.4220	?	3073
3084	1408.25	407	146	.05339	.00001	50	.00674	50	.01117	4995	1.455	.2365	?	3084
3085	662.60	434	127	.05865	.00001	50	.01623	50	.01847	5724	1.461	.5404	?	3085
3091	1027.61	434	317	.05506	.00001	50	.01753	50	.01906	4592	1.330	.2941	?	3091
3094	149.55	412	227	.07425	.00001	50	.00001	50	.01411	3093	1.744	.6062	?	3094
3095	746.35	413	67	.07296	.00001	50	.00284	50	.01415	2260	1.730	.2779	?	3095
3104	575.56	413	400	.04806	.00001	50	.00753	50	.00615	4000	1.268	.2441	?	3104
3105	2190.37	419	144	.05006	.00001	50	.00001	50	.01275	6510	1.236	.1352	?	3105
3111	1065.15	433	48	.07406	.00001	50	.00001	50	.00954	4998	1.766	.3869	?	3111
3112	1121.64	427	415	.04424	.00001	50	.00680	50	.00867	5758	1.081	.2986	?	3112
3113	180.38	413	91	.05064	.00001	50	.00956	50	.02126	1644	1.210	.6414	/	3113
3122	283.29	418	5	.04783	.00001	50	.01409	50	.01216	3167	1.217	.2077	/	3122
3123	42.53	427	165	.07944	.00001	50	.01022	50	.06277	777	2.703	.8162	/	3123
3132	837.54	434	326	.05254	.00001	50	.00001	50	.03605	2552	1.221	.5670	/	3132
3133	1515.81	451	131	.05858	.00001	50	.05711	50	.02615	5581	1.537	.5065	/	3133
3141	1031.16	586	132	.08755	.00001	50	.01622	50	.01535	7338	2.565	.3160	/	3141
3142	717.00	460	240	.06755	.00001	50	.00001	50	.02573	1751	1.734	.6405	?	3142
3143	2729.70	552	111	.07358	.00001	50	.00001	50	.02424	7537	1.568	.4421	?	3143
3144	[illegible]	490	118	.05822	.00001	50	.00001	50	.02606	6555	2.401	.2146	?	3144
3152	130.44	431	73	.04470	.00001	50	.00001	50	.03576	1795	1.341	.4935	?	3152
3153	193.05	419	128	.05126	.00001	50	.01333	50	.03533	1211	1.358	.4635	?	3153
3154	446.47	458	47	.05645	.00001	50	.00001	50	.02298	3244	2.144	.3421	?	3154
3155	250.40	463	126	.09601	.00001	50	.00001	50	.02457	4215	2.227	.2310	?	3155
3171	1001.16	515	22	.08750	.00001	50	.03289	50	.01997	6160	2.355	.2455	?	3171
3174	45.44	458	13	.08224	.00001	50	.04511	50	.02546	546	2.105	.2542	?	3174
3175	25.45	475	146	.18887	.00001	50	.00001	50	.10870	500	5.408	.8672	?	3175
3182	255.25	593	21	.15469	.00001	50	.05089	50	.07061	1576	4.198	.4802	?	3182
3183	753.82	510	156	.09400	.00001	50	.00067	50	.01842	3452	2.509	.4221	/	3183
3191	1004.53	556	239	.07476	.00001	50	.00001	50	.01852	7465	2.079	.3472	/	3191
3192	58.24	529	292	.14066	.00001	50	.00001	50	.10151	743	4.377	.5935	/	3192
3193	34.32	510	123	.07319	.00001	50	.01222	50	.04452	667	2.281	.7304	/	3193
3201	1016.17	574	55	.06075	.00001	50	.01356	50	.02127	8746	1.534	.2966	/	3201
3202	101.25	515	346	.08506	.00001	50	.01356	50	.07442	432	2.565	.6663	?	3202
3203	59.31	527	155	.10506	.00001	50	.01622	50	.06164	627	3.206	.7200	?	3203
3211	1196.12	421	95	.05546	.00001	50	.00001	50	.01262	6996	1.625	.2065	/	3211
3212	24.20	387	5	.08807	.00001	50	.00001	50	.07726	345	2.551	.7506	?	3212
3213	16.20	332	157	.09759	.00001	50	.00001	50	.08506	252	3.100	.9210	?	3213
3233	777.36	356	371	.05455	.00001	50	.01067	50	.03127	975	1.747	.1717	?	3233
3234	1432.14	382	163	.05440	.00001	50	.00001	50	.02404	1207	1.477	.3654	?	3234
3242	555.16	334	255	.06902	.00001	50	.00867	50	.03483	1026	2.062	.5254	?	3242
3243	609.95	388	126	.05456	.00001	50	.01404	50	.03390	1703	.845	.5054	?	3243
3244	1579.75	451	158	.07294	.00001	50	.01667	50	.03724	6508	2.140	.1440	?	3244
3245	1172.40	451	148	.06261	.00001	50	.02078	50	.02003	4083	1.557	.5605	?	3245
3251	1002.76	514	65	.06725	.00001	50	.01064	50	.01505	5516	1.720	.1802	/	3251
3254	130.46	425	117	.08036	.00001	50	.01674	50	.02667	2605	2.395	.2844	?	3254
3255	3740.65	492	135	.06025	.00001	50	.00889	50	.01541	7752	1.565	.2425	?	3255
3261	1025.55	483	128	.06220	.00001	50	.00001	50	.02140	4120	1.567	.2154	/	3261
3262	43.74	453	86	.08832	.00001	50	.00001	50	.10657	560	2.215	.5795	/	3262
3263	72.05	454	222	.07775	.00001	50	.00001	50	.04495	1159	1.676	.5356	/	3263
3271	1107.27	457	117	.06275	.00001	50	.00001	50	.01502	7537	1.527	.2445	?	3271
3272	181.46	408	66	.05536	.00001	50	.00001	50	.04576	1174	1.361	.5769	?	3272
3273	123.12	403	187	.04660	.00001	50	.01289	50	.02755	761	1.164	.7343	/	3273
3282	1550.31	434	81	.05156	.00001	50	.00001	50	.01542	7664	1.269	.3976	?	3282
3283	567.16	393	233	.07053	.00001	50	.00001	50	.04067	3267	1.632	.6213	?	3283
3291	1031.77	420	57	.06602	.00001	50	.02511	50	.01211	4237	1.431	.1731	?	3291
3294	40.25	446	410	.06656	.00001	50	.00001	50	.02054	710	1.477	.7304	?	3294
3295	150.45	447	128	.10864	.00001	50	.04292	50	.05324	2456	5.229	.5274	?	3295
3304	2755.69	446	44	.07772	.00001	50	.06392	50	.01667	4242	2.065	.2705	?	3304
3305	2945.60	458	184	.09424	.00001	50	.00001	50	.01495	4567	2.329	.3406	?	3305
3312	567.56	467	228	.06910	.00001	50	.01267	50	.02572	2510	1.625	.5220	?	3312
3313	515.50	464	155	.08425	.00001	50	.00001	50	.04264	2406	2.277	.6245	/	3313
3321	1160.22	408	9	.05454	.00001	50	.00001	50	.01382	4983	1.567	.3504	?	3321
3322	1646.56	471	331	.06265	.00001	50	.00001	50	.01701	4182	1.557	.3522	?	3322
3323	562.32	473	95	.07401	.00001	50	.00001	50	.02065	4049	1.542	.5402	/	3323
3332	156.32	450	334	.09633	.00001	50	.00001	50	.06322	1376	2.563	.4312	/	3332
3333	624.21	465	157	.08354	.00001	50	.00001	50	.02692	2971	2.459	.3596	/	3333
3342	665.62	467	245	.08451	.00001	50	.00001	50	.02695	2049	2.225	.4071	?	3342
3343	428.21	462	[illegible]	.07457	.00001	50	.00001	50	.02517	3608	2.072	.5167	?	3343
3352	425.25	480	229	.07007	.00001	50	.01933	50	.02435	2745	1.552	.4571	/	3352

[illegible]	[illegible]	[illegible]	88	.06668	.00001	[illegible]	.01128	50	.03014	[illegible]	1.[illegible]	.6[illegible]	?	[illegible]
3361	[illegible]	571	57	[illegible]	.00001	[illegible]	.00001	50	[illegible]	[illegible]	1.[illegible]	[illegible]	?	3361
3362	2322.27	515	235	.06241	.00001	50	.01067	50	.01411	5510	1.562	.2755	?	3362
3363	1124.20	514	84	.07070	.00001	50	.01978	50	.03322	3151	1.880	.5105	✓	3363
3372	645.[illegible]	487	[illegible]	.05520	.00001	[illegible]	.00001	50	.03617	[illegible]	1.[illegible]	[illegible]	?	3372
3373	1127.24	500	111	.06230	.00001	50	.00001	50	.01695	5259	1.500	.2092	✓	3373
3381	1117.80	509	330	.06660	.00001	50	.00001	50	.02664	5250	1.850	.3407	✓	3381
3382	2056.35	549	304	.06927	.00001	50	.02267	50	.03317	4695	1.753	.4523	✓	3382
3383	1333.25	542	85	.05556	.00001	50	.00001	50	.01705	5006	1.369	.4471	✓	3383
3391	1219.09	605	63	.09150	.00001	50	.00667	50	.00632	4998	2.466	.1632	✓	3391
3392	1936.71	535	324	.07456	.00001	50	.00001	50	.02432	6021	1.557	.3725	✓	3392
3393	5456.56	611	117	.12675	.00001	50	.00001	50	.07296	6022	3.559	.6405	?	3393
3402	269.56	475	11	.05751	.00001	50	.00001	50	.02525	2118	1.458	.2797	?	3402
340[illegible]	[illegible]	482	[illegible]	.09152	.00001	[illegible]	.00001	50	.0331[illegible]	1903	2.463	.6521	?	340[illegible]
3411	[illegible]	942	[illegible]	.05596	.00001	[illegible]	.04751	50	.0984[illegible]	7192	8.475	.6140	?	3411
3412	1625.39	622	12	.13556	.00001	50	.03956	50	.06906	6023	4.346	.5622	?	3412
341[illegible]	[illegible]	654	[illegible]	.14145	.00001	[illegible]	.00001	50	.10356	[illegible]	4.558	.6657	?	341[illegible]
3421	[illegible]	888	[illegible]	.22495	.00001	[illegible]	.05665	50	.12526	[illegible]	8.491	.1894	?	3421
3422	826.20	610	20	.15448	.00001	[illegible]	.09667	50	.08556	7708	4.459	.6557	?	3422
342[illegible]	[illegible].50	662	14[illegible]	.15906	.00001	[illegible]	.00001	50	.10595	4718	5.092	.6116	?	342[illegible]
[illegible]	[illegible]6.50	479	34	.07456	.00001	[illegible]	.00001	50	.0497[illegible]	1505	1.[illegible]	.6814	?	[illegible]
[illegible]	[illegible]9.05	450	187	.06025	.00001	[illegible]	.04178	50	.04566	1405	1.466	.7554	?	[illegible]
3441	1023.56	500	117	.09766	.00001	50	.04356	50	.06275	5515	2.317	.5641	✓	3441
3442	660.33	475	22	.07654	.00001	50	.01622	50	.02290	2801	1.667	.4870	✓	3442
3443	157.95	457	156	.06622	.00001	50	.01356	50	.03268	1050	1.673	.7244	✓	3443
3452	109.26	449	57	.04022	.00001	50	.00711	50	.00717	1174	1.281	.6904	✓	3452
3453	660.25	479	204	.06074	.00001	50	.00556	50	.01622	3636	1.335	.4085	✓	3453
3461	1778.76	787	58	.21157	.00001	50	.06533	50	.07846	8037	7.045	.4276	✓	3461
3462	372.60	495	57	.06914	.00001	50	.01667	50	.02612	2652	1.716	.5102	?	3462
3463	138.54	436	147	.06376	.00001	50	.00467	50	.05573	1177	1.666	.8375	?	3463
3471	[illegible]	[illegible]	[illegible]	.17702	.00001	[illegible]	.00001	50	.08571	6671	[illegible]	[illegible]	?	3471
3472	2372.79	603	43	.15447	.00001	50	.00001	50	.07525	3672	5.309	.4165	?	3472
3473	2482.65	651	176	.18345	.00001	50	.00001	50	.08716	3501	6.046	.2454	?	3473
3484	[illegible]	489	84	.08453	.00001	[illegible]	.00001	50	.03560	5584	2.[illegible]	.2405	?	3484
3485	[illegible]56.65	455	263	.07066	.00001	[illegible]	.02556	50	.05134	1775	2.060	.7960	?	3485
3491	1060.21	499	103	.07422	.00001	50	.00001	50	.04445	3492	2.370	.3927	?	3491
3494	738.35	469	[illegible]	.08187	.00001	[illegible]	.00001	50	.03951	4114	2.278	.5474	?	3494
349[illegible]	[illegible].86	474	187	.06716	.00001	[illegible]	.00001	50	.01582	4931	1.766	.2707	?	349[illegible]
3501	1045.71	627	126	.14760	.00001	50	.00001	50	.06613	5172	4.851	.5766	?	3501
3502	1008.56	406	30	.09757	.00001	50	.07209	50	.09282	2106	2.620	.4326	✓	3502
3503	2247.75	514	169	.10037	.00001	50	.00001	50	.08545	4129	3.030	.4135	✓	3503
3511	1021.03	390	119	.05316	.00001	50	.00001	50	.02222	5513	1.454	.3721	✓	3511
3512	65.06	352	51	.05450	.00001	50	.00001	50	.03547	1159	1.511	.6594	✓	3512
3513	34.02	353	208	.06156	.00001	50	.00001	50	.06732	432	1.608	.7422	✓	3513
3521	1032.76	375	118	.04322	.00001	50	.01956	50	.01633	6764	1.278	.3164	?	3521
3522	687.41	351	49	.03067	.00001	50	.00103	50	.00647	7027	.542	.2227	?	3522
3523	729.06	356	169	.03197	.00001	50	.00001	50	.00567	3871	.618	.4012	✓	3523
3532	1561.12	351	53	.03067	.00001	50	.00622	50	.00664	5053	.749	.3122	?	3532
3533	632.54	351	208	.04300	.00001	50	.00956	50	.01534	2571	1.140	.4289	?	3533
3543	375.34	366	61	.05027	.00001	50	.02356	50	.01107	6215	1.277	.2271	?	3543
[illegible]	[illegible]9.54	362	108	.06605	.00001	[illegible]	.00001	50	.00405	4573	1.[illegible]	.51[illegible]	?	[illegible]
[illegible]	[illegible].52	385	247	.08292	.00001	[illegible]	.04407	50	.00228	886	2.[illegible]	.6635	?	[illegible]
[illegible]	[illegible]	[illegible]	168	.05894	.00001	[illegible]	.00773	50	.04292	1121	1.468	.7732	?	[illegible]
[illegible]	[illegible]	416	46	.06502	.00001	[illegible]	.04224	50	.01730	8543	1.[illegible]	.2357	?	[illegible]
[illegible]	[illegible].61	502	323	.08374	.00001	[illegible]	.00001	50	.08062	814	2.[illegible]	.8720	?	[illegible]
3565	213.02	371	122	.06172	.00001	50	.01733	50	.03111	1401	1.428	.7861	✓	3565
[illegible]	[illegible].52	369	[illegible]	.08457	.00001	[illegible]	.01953	50	.02759	4112	2.[illegible]	[illegible]	?	[illegible]
[illegible]	640.64	370	182	.06022	.00001	[illegible]	.05156	50	.02602	2740	1.405	.2380	?	[illegible]
3581	1056.77	433	85	.06625	.00001	50	.00001	50	.01535	5210	1.774	.2104	✓	3581
3582	561.56	389	338	.05527	.00001	50	.00001	50	.02745	2642	1.376	.5200	✓	3582
3583	867.46	405	123	.07323	.00001	50	.00001	50	.02297	5460	1.565	.3721	✓	3583
3591	1001.97	451	63	.07522	.00001	50	.01267	50	.01410	5774	2.225	.0694	?	3591
3592	327.24	394	41	.08302	.00001	50	.00001	50	.03916	1623	2.130	.4032	?	3592
3593	849.62	405	172	.07754	.00001	50	.01844	50	.03106	3474	2.043	.4265	✓	3593
3602	1234.47	369	61	.05325	.00001	50	.00001	50	.02573	6857	1.253	.2864	?	3602
3603	906.61	377	243	.07709	.00001	50	.00001	50	.03027	4181	2.137	.3251	?	3603
[illegible]	[illegible].60	371	[illegible]	.05545	.00001	[illegible]	.04553	50	.02251	4290	1.4[illegible]	.5447	?	[illegible]
[illegible]	[illegible].46	366	168	.04550	.00001	[illegible]	.01511	50	.00760	4008	.[illegible]49	.2706	?	[illegible]
[illegible]	1.62	361	118	.00001	.00001	[illegible]	.00001	50	.00001	95	.040	.0554	?	[illegible]
[illegible]	[illegible]	348	54	.03218	.00001	[illegible]	.00001	50	.01446	5049	1.548	.2787	?	[illegible]
[illegible]	37.92	369	48	.11306	.00001	[illegible]	.00001	50	.00922	653	[illegible]41	.6806	?	[illegible]
3635	21.40	356	142	.01256	.00001	50	.01000	50	.01115	780	.370	.6120	?	3635
3642	617.06	355	40	.02865	.00001	50	.00001	50	.01631	2410	.722	.5022	✓	3642
364[illegible]	[illegible].31	367	269	.05033	.00001	[illegible]	.01156	50	.02758	7050	1.370	.5867	?	364[illegible]
3652	560.40	386	142	.06060	.00001	50	.09422	50	.01592	4201	1.129	.4652	?	3652
3655	536.66	390	127	.07642	.00001	50	.05400	50	.05802	3711	1.550	.5475	✓	3655
3661	1352.69	453	40	.06365	.00001	50	.00001	50	.02026	5119	1.877	.1565	✓	3661
3662	1169.95	416	306	.06617	.00001	50	.00001	50	.01585	2804	1.552	.5606	✓	3662
3663	928.02	449	59	.07650	.00001	50	.01644	50	.02747	6517	2.334	.4251	?	3663
3671	1077.00	473	30	.05003	.00001	50	.01572	50	.01040	8510	1.349	.2720	?	3671
3672	66.67	399	227	.05827	.00001	50	.00001	50	.06604	470	1.257	.6920	✓	3672

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
3552	355.24	572	235	.09915	.00001	50	.03001	50	.01855	5547	.726	.6356	?	3552
3553	265.15	330	7	.04441	.00001	50	.07644	50	.05228	2605	2.056	.5102	✓	3553
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
3721	1324.40	471	51	.25052	.00001	50	.00001	50	.02797	6406	1.485	.2633	✓	3721
3702	2320.25	429	162	.26765	.00001	50	.00911	50	.01453	7204	1.726	.1937	✓	3702
3703	1502.55	419	152	.26635	.00001	50	.02267	50	.03580	2245	1.303	.6606	✓	3703
3712	11.53	300	31	.25652	.00001	50	.00001	50	.02439	1525	1.875	.6030	✓	3712
3713	21.50	377	135	.25802	.00001	50	.00001	50	.03521	252	1.359	.7941	✓	3713
3722	954.56	409	5	.25986	.00001	50	.03622	50	.01183	5294	1.552	.2350	✓	3722
3723	621.61	405	151	.26564	.00001	50	.00001	50	.02564	1872	1.342	.5536	?	3723
3732	307.16	425	303	.25956	.00001	50	.01066	50	.01602	2959	1.023	.2354	?	3732
3742	569.64	474	18	.28535	.00001	50	.01036	50	.00003	2652	2.337	.2913	?	3742
3772	321.36	658	135	.26757	.00001	50	.05533	50	.26705	1532	8.025	.6328	✓	3772
3773	320.24	624	139	.26911	.00001	50	.00001	50	.12267	2177	9.278	.6366	✓	3773
3781	1117.60	672	162	.25742	.00001	50	.00001	50	.11201	6082	8.743	.5552	✓	3781
3782	640.74	650	16	.19073	.00001	50	.00001	50	.11737	3060	6.246	.5257	✓	3782
3783	571.46	659	128	.25367	.00001	50	.04600	50	.11465	4073	6.350	.7265	✓	3783
3792	2370.38	732	88	.22652	.00001	50	.00001	50	.06560	5357	7.543	.3455	✓	3792
3793	2169.43	701	138	.25301	.00001	50	.02207	50	.07533	3909	6.300	.3427	?	3793
3801	1389.31	979	91	.29582	.00001	50	.00001	50	.12214	6504	10.223	.3033	?	3801

[illegible]	60.45	219	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	761	11.097	.9494	?	[illegible]
[illegible]	[illegible]	[illegible]	48	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
4015	1204.49	060	294	.29255	.00001	50	.02244	50	.10109	6744	9.556	.4052	?	4015
4022	1259.55	050	328	.26065	.00001	50	.00001	50	.15003	5372	9.325	.6256	/	4022
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	.6345	?	[illegible]
4031	1270.69	1012	3	.26911	.00001	50	.04609	50	.10361	4061	9.369	.2012	/	4031
4032	122.31	075	391	.25212	.00001	50	.05070	50	.19592	1661	0.770	.7024	/	4032
4033	28.39	830	85	.24202	.00001	50	.00001	50	.20745	792	8.431	.8522	/	4033
4041	1020.50	1065	35	.20034	.00001	50	.00001	50	.00584	5657	9.739	.2626	/	4041
4042	63.41	861	351	.27959	.00001	50	.00001	50	.29581	600	9.262	.8393	/	4042
4043	640.54	938	149	.28111	.00001	50	.00001	50	.17425	2568	9.565	.6935	/	4043
4052	1050.26	931	76	.24871	.00001	50	.00001	50	.14213	3325	8.325	.6254	?	4052
4055	710.37	858	312	.30302	.00331	50	.00001	50	.17293	2975	10.316	.7026	?	4055
4061	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	4061
4062	[illegible]	979	[illegible]	[illegible]	.00001	50	.00001	50	.02455	[illegible]	[illegible]	[illegible]	?	4062
4063	30.77	885	379	.26263	.00001	50	.01756	50	.21522	1335	8.727	.9273	?	4063
[illegible]	[illegible]	947	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	8.960	[illegible]	?	[illegible]
[illegible]	492.92	983	[illegible]	[illegible]	.00001	50	.00828	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	362.44	839	450	[illegible]	.00001	50	.00001	50	[illegible]	1121	11.670	[illegible]	?	[illegible]
4081	[illegible]	846	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	10.[illegible]	[illegible]	?	4081
[illegible]	48.45	619	[illegible]	[illegible]	.00001	50	.00001	50	.00664	[illegible]	6.548	[illegible]	?	[illegible]
[illegible]	22.56	659	[illegible]	.22765	.00001	50	.00001	50	.00426	[illegible]	[illegible]	[illegible]	?	[illegible]
4091	1100.02	044	207	.23751	.00001	50	.02244	50	.09255	5310	7.551	.4366	/	4091
4093	203.31	705	152	.21253	.00001	50	.02222	50	.12701	2410	6.747	.6014	/	4093
4095	157.14	682	282	.18814	.00001	50	.00001	50	.12255	1897	5.776	.8041	/	4095
4102	509.03	420	153	.13850	.00001	50	.01756	50	.01211	4301	.816	.4260	/	4102
4103	447.12	418	262	.16543	.00001	50	.00867	50	.02245	1736	1.729	.5078	/	4103
4111	1010.86	589	145	.15262	.00001	50	.00001	50	.07232	7003	4.654	.4066	/	4111
4112	2008.74	517	126	.10672	.00001	50	.01644	50	.06240	7314	3.122	.4215	?	4112
4113	778.61	619	207	.05720	.00001	50	.00001	50	.05573	4122	1.428	.4613	?	4113

[illegible]	335.75	336	133	.11174	.00001	50	.11200	50	.10291	4092	[illegible]	.7292	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	.09144	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	179	[illegible]	.06094	.00001	50	.00001	50	[illegible]	91	1.448	[illegible]	?	[illegible]
4253	68.65	211	223	.09322	.00001	50	.00001	50	.06745	979	2.609	.8201	?	4253
[illegible]	[illegible]	252	97	.08925	.00001	50	.00001	50	.08115	[illegible]	2.198	[illegible]	?	[illegible]
[illegible]	[illegible]	223	[illegible]	.06094	.00001	50	[illegible]	50	[illegible]	[illegible]	1.466	[illegible]	?	[illegible]
[illegible]	[illegible]	198	[illegible]	.05095	.00001	50	.00211	50	[illegible]	[illegible]	1.469	[illegible]	?	[illegible]
[illegible]	861.76	174	[illegible]	.05555	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	191	[illegible]	.08005	.00001	50	.00001	50	[illegible]	[illegible]	2.511	[illegible]	?	[illegible]
[illegible]	47.75	156	[illegible]	[illegible]	.00001	50	[illegible]	50	.01565	1125	[illegible]	[illegible]	?	[illegible]
4265	26.73	157	135	.04066	.00001	50	.00001	50	.03405	560	1.244	.0750	/	4265
4352	2517.41	308	320	.15766	.00001	50	.00533	50	.01576	3530	4.739	.7000	/	4352
4353	2185.41	352	142	.19351	.00001	50	.05133	50	.13261	3331	6.067	.7252	/	4353
4403	2845.53	356	300	.16022	.00001	50	.04511	50	.05623	5501	4.271	.6276	/	4402
4405	3002.57	360	125	.11854	.00001	50	.00001	50	.03551	6230	3.436	.5026	/	4405
4412	2157.52	380	317	.16160	.00001	50	.00001	50	.08645	2636	4.223	.7356	/	4412
4415	3564.51	402	126	.10212	.00001	50	.06703	50	.09013	4793	3.605	.7664	?	4415
4422	2202.51	503	203	.19762	.00001	50	.01022	50	.04674	5099	5.372	.6934	?	4422
[illegible]	1885.76	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
4431	1006.62	679	7	.19200	.00001	50	.00001	50	.03241	0976	5.376	.2205	?	4431
4432	331.35	526	[illegible]	.35493	.00001	50	.00001	50	[illegible]	[illegible]	6.556	.8465	?	4432
[illegible]	[illegible]	549	[illegible]	[illegible]	.00001	50	.00111	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
4441	1002.[illegible]	618	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
4443	45.74	[illegible]	65	.29141	.00001	50	.00001	50	[illegible]	545	2.652	[illegible]	?	4443
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	1006.75	547	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
4452	25.52	551	253	.06316	.00001	50	.00001	50	.07052	210	2.259	.5657	?	4452
4455	53.06	568	137	.05441	.00001	50	.00001	50	.05050	1649	1.500	.6072	/	4455
4461	1010.07	524	161	.20440	.00001	50	.05222	50	.04105	6400	6.250	.4752	/	4461
4462	288.11	383	66	.13275	.00001	50	.00001	50	.17546	997	3.710	.6457	/	4462
4465	520.66	420	135	.17660	.00001	50	.00001	50	.00664	1085	5.339	.5257	/	4465
4471	1005.59	486	262	.20462	.00001	50	.05089	50	.03725	5779	6.153	.2756	/	4471
4472	272.57	308	135	.10025	.00001	50	.00001	50	.10075	2176	2.558	.8360	?	4472
4475	34.02	298	185	.07955	.00001	50	.07300	50	.12105	1132	1.516	.9001	?	4475
4482	1041.66	131	15	.06826	.00001	50	.00001	50	.10607	4036	1.759	.5474	/	4482
4485	951.47	168	173	.05046	.00001	50	.00001	50	.01745	4834	1.310	.4422	?	4485
4492	1245.74	288	3	.19245	.00001	50	.05170	50	.10506	2803	5.837	.6077	?	4492
4495	1176.72	137	183	.05152	.00001	50	.00462	50	.01717	0875	1.332	[illegible]	?	4495
[illegible]	[illegible]	166	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	187	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	743	[illegible]	.0174	?	[illegible]
[illegible]	[illegible]	268	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	214	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	1.648	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	1820	[illegible]	[illegible]	?	[illegible]
4525	1550.41	221	130	.07271	.00001	50	.00001	50	.01291	4973	2.050	.2064	/	4525
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	250	[illegible]	.08140	.00001	50	.00092	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
4542	1042.75	307	325	.15855	.00001	50	.00001	50	.11532	2167	4.019	.6125	/	4542
4543	1027.61	260	135	.06952	.00001	50	.00689	50	.02023	2642	1.553	.3662	/	4543
4552	1476.62	404	318	.18232	.00001	50	.00001	50	.08953	5951	5.746	.4541	/	4552
4555	456.54	259	101	.05581	.00001	50	.00001	50	.01582	2552	1.328	.3605	?	4555
4562	5048.10	431	213	.12260	.00001	50	.00001	50	.09303	3922	1.260	.7961	?	4562
4565	2760.72	279	125	.03521	.00001	50	.00001	50	.01375	3917	.537	.5220	/	4565
4572	374.22	366	295	.11564	.00001	50	.00001	50	.09723	5243	5.376	.7592	?	4572
4575	161.44	269	96	.02502	.00001	50	.00911	50	.01657	2292	.548	.5651	?	4575
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	224	[illegible]	[illegible]	.00001	50	.00001	50	.01295	[illegible]	.570	[illegible]	?	[illegible]
[illegible]	[illegible]	576	[illegible]	[illegible]	.00001	50	.00001	50	.07635	[illegible]	6.450	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	419	406	[illegible]	.00001	50	.00001	50	.08603	[illegible]	[illegible]	[illegible]	?	[illegible]
4502	6014.25	425	201	.13291	.00001	50	.00001	50	.00432	5644	5.925	.7570	?	4502
4505	3121.74	319	117	.04215	.00001	50	.00001	50	.02603	4009	1.013	.5250	/	4505
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	.06418	[illegible]	[illegible]	[illegible]	?	[illegible]
4512	1950.20	455	292	.11215	.00001	50	.04022	50	.07502	5624	5.140	.6901	?	4512
4515	1554.01	372	25	.06502	.00001	50	.01056	50	.02162	5951	1.502	.2022	/	4515
4522	589.56	336	325	.05424	.00001	50	.01232	50	.01504	2537	1.408	.4775	/	4522
4525	1533.77	348	128	.04635	.00001	50	.03644	50	.01646	5408	1.071	.5875	/	4525
4632	729.50	372	279	.06455	.00001	50	.02489	50	.03071	2891	1.544	.4443	?	4632
[illegible]	719.72	389	67	.07343	.00001	50	.00001	50	.01585	7536	1.667	.2224	?	[illegible]
4541	1149.35	672	317	.20272	.00001	50	.01333	50	.06022	5863	6.421	.4210	/	4541

4544	[illegible]	415	[illegible]	.09342	.00001	50	.01754	50	.02249	[illegible]	2.642	[illegible]	?	4544
4545	[illegible]	629	475	.15454	.00001	50	.05880	50	.09474	[illegible]	5.662	.9024	?	4545
4551	1355.61	557	311	.15016	.00001	50	.02156	50	.10272	5119	4.055	.5750	?	4551
4552	932.31	460	203	.10227	.00001	50	.00970	50	.00350	5656	2.659	.5771	/	4552
4554	851.[illegible]	448	5[illegible]	.09159	.00001	50	.05609	50	.02365	4509	1.549	[illegible]	?	4554
4561	1351.09	374	257	.05005	.00001	50	.01464	50	.02291	6067	1.455	.5755	/	4561
4565	1384.25	379	115	.05772	.00001	50	.00001	50	.03205	5204	1.425	.5642	/	4565
4571	1120.76	434	351	.06031	.00001	50	.00001	50	.01105	5920	1.504	.2925	/	4571
4572	931.50	427	300	.05930	.00001	50	.00001	50	.02245	5014	1.475	.3131	/	4572
4573	176.56	412	106	.06656	.00001	50	.00001	50	.03246	1252	2.266	.7653	/	4573
4661	1168.52	419	115	.04644	.00001	50	.00689	50	.01355	5430	1.145	.2342	/	4661
4662	255.52	396	208	.07610	.00001	50	.00001	50	.05223	1196	1.618	.7975	?	4662
4663	1000.58	419	120	.05935	.00001	50	.00001	50	.02224	6203	1.477	.3371	?	4663
4694	[illegible]	220	[illegible]	.01801	.00001	50	.00156	50	.00233	4043	.460	[illegible]	?	4694
[illegible]	[illegible]	296	[illegible]	.04580	.00001	50	[illegible]	50	.01551	6100	1.091	[illegible]	?	[illegible]
4702	2029.05	310	224	.04851	.00001	50	.00001	50	.02222	3107	1.210	.4560	/	4702
[illegible]	[illegible]	310	[illegible]	.05499	.00001	50	.00001	50	.02207	1666	1.342	[illegible]	?	[illegible]
4711	3002.64	[illegible]	397	.07446	.00001	50	.00001	50	.01540	6539	[illegible]	[illegible]	?	4711
4712	477.43	505	459	.05630	.00001	50	.00553	50	.01756	1667	.769	.6276	?	4712
[illegible]	58.20	292	114	.01685	.00001	50	.00667	50	.01391	[illegible]	.416	.6492	?	[illegible]
4722	425.30	500	467	.01944	.00001	50	.01564	50	.01876	4003	.440	.5648	?	4722
[illegible]	1465.42	542	147	.08964	.00001	50	.01000	50	.03240	6647	2.172	.2650	?	[illegible]
4731	1900.35	395	45	.06607	.00001	50	.00001	50	.01652	5990	1.562	.1775	/	4731
4732	1435.37	369	316	.05462	.00001	50	.00001	50	.02515	5496	1.268	.4855	/	4732
4733	2460.76	355	50	.05456	.00001	50	.05689	50	.02227	5681	1.273	.1725	/	4733
4742	302.04	328	25	.03046	.00001	50	.02222	50	.01569	4576	.715	.4570	/	4742
4743	122.31	320	155	.06546	.00001	50	.01770	50	.06303	1354	1.551	.7855	/	4743
4752	54.50	315	355	.02562	.00001	50	.00556	50	.02655	1084	.568	.5812	?	4752
4755	25.11	310	102	.00212	.00001	50	.00844	50	.03240	650	1.110	.7222	?	4755
4762	362.44	333	314	.05220	.00001	50	.00001	50	.03403	2112	1.395	.5907	?	4762
4764	470.37	346	[illegible]	.02560	.00001	50	.00001	50	.02570	[illegible]	1.510	[illegible]	?	4764
4772	207.30	363	259	.06352	.00001	50	.00001	50	.03124	2052	.520	.6227	?	4772
4773	51.00	329	105	.07001	.00001	50	.00800	50	.03440	973	.556	.8421	?	4773
4781	[illegible]	329	[illegible]	.02764	.00001	50	.00001	50	.01354	7633	1.570	[illegible]	?	4781
4782	408.96	553	269	.06054	.00001	50	.00001	50	.04484	7776	1.357	.8156	?	4782
4785	68.35	324	51	.05444	.00001	50	.01172	50	.04303	292	1.210	.8441	?	4785
4794	1460.34	562	[illegible]	.05268	.00001	50	.01829	50	.01611	4971	1.241	.5444	?	4794
[illegible]	2785.55	592	119	.06606	.00001	50	.02733	50	.00705	8555	1.209	.5060	?	[illegible]
4602	955.52	490	218	.06300	.00001	50	.00001	50	.02047	6840	1.565	.4462	?	4602
4603	123.12	375	122	.04461	.00001	50	.01067	50	.02244	1792	1.027	.7031	/	4603
4611	1352.76	412	28	.04161	.00001	50	.02889	50	.01542	5644	.972	.2642	/	4611
4612	1050.29	406	325	.06062	.00001	50	.00889	50	.01794	5029	1.502	.4337	/	4612
4615	320.42	391	121	.04041	.00001	50	.01353	50	.01874	3145	1.179	.5590	/	4615
4621	1157.45	429	102	.06046	.00001	50	.00001	50	.00815	5740	1.521	.3471	/	4621
4622	164.66	388	354	.05951	.00001	50	.00001	50	.03625	780	1.506	.5552	?	4622
4625	376.26	425	141	.07251	.00001	50	.00001	50	.03146	3747	2.118	.5016	?	4625
4631	1453.95	507	117	.09462	.00001	50	.00001	50	.05554	7183	2.619	.3460	/	4631
4632	354.47	407	71	.08356	.00001	50	.00001	50	.09673	1011	2.255	.4156	?	4632
4633	129.07	413	174	.07326	.00001	50	.00001	50	.04023	2519	1.605	.5903	?	4633
4643	1262.54	390	53	.07100	.00001	50	.00001	50	.02125	8475	1.601	.3474	?	4643
4644	238.97	359	[illegible]	.06451	.00001	50	.00001	50	.02374	2549	[illegible]	.6574	?	4644
4651	1399.76	569	[illegible]	.15184	.00001	50	.00001	50	.05474	5046	[illegible]	.6155	?	4651
4654	[illegible]	472	[illegible]	.08662	.00001	50	.00001	50	.02731	6882	2.412	.7754	?	4654
[illegible]	[illegible]	453	128	.07312	.00001	50	.00001	50	.01996	8841	2.066	.8574	?	[illegible]
4667	629.54	434	[illegible]	.15266	.00001	50	.00001	50	.09427	5240	4.552	.5055	?	4667
4665	1249.02	443	162	.14516	.00001	50	.00001	50	.05502	5342	4.259	.5035	/	4665
4674	146.34	447	[illegible]	.07955	.00001	50	.00001	50	.08841	7758	[illegible]	.8310	?	4674
4675	177.17	568	157	.06261	.00001	50	.01156	50	.03962	1556	1.509	.6018	?	4675
4682	119.07	463	320	.10015	.00001	50	.00001	50	.17407	1040	5.225	.9388	/	4682
4683	31.55	349	136	.06326	.00001	50	.00001	50	.04012	709	1.528	.8370	/	4683
4692	1005.21	475	224	.19124	.00001	50	.00001	50	.13512	2121	5.601	.8907	/	4692
4693	350.73	383	114	.04755	.00001	50	.00556	50	.01212	1466	1.259	.7451	?	4693
4502	256.46	503	330	.20502	.00001	50	.00001	50	.19292	3031	6.309	.9175	?	4502
4505	50.22	424	135	.10166	.00001	50	.01570	50	.08135	612	3.058	.9156	/	4505
4511	1002.76	614	46	.27515	.00001	50	.00001	50	.06721	7301	9.626	.4122	?	4511
4512	1319.05	566	334	.17896	.00001	50	.00001	50	.05205	5414	5.265	.5742	?	4512
[illegible]	779.83	566	[illegible]	.18095	.00001	50	.00001	50	.11201	4663	6.142	.6696	?	[illegible]
4521	1001.09	614	98	.22356	.00001	50	.02608	50	.06454	5130	[illegible]	.3840	?	4521
[illegible]	17.48	299	4	.20744	.00001	50	.00001	50	.17458	902	6.552	.9000	?	[illegible]
[illegible]	58.82	231	144	.20040	.00001	50	.00001	50	.17042	814	[illegible]	.8164	?	[illegible]
4531	1097.49	755	45	.30002	.00001	50	.00001	50	.11194	4738	10.[illegible]	[illegible]	?	4531
4532	912.89	535	21	.19626	.00001	50	.09667	50	.05276	7040	6.456	.5102	?	4532
4533	1266.26	550	165	.19054	.00001	50	.00001	50	.07695	5418	6.652	.5047	/	4533
4541	1443.46	428	[illegible]	.15406	.00001	50	.00001	50	.04185	5685	[illegible]	.5775	?	4541
4542	507.41	420	75	.08200	.00001	50	.05689	50	.04702	5258	2.556	.5302	?	4542
4545	127.17	356	176	.08326	.00001	50	.02911	50	.06381	904	2.244	.8528	/	4545
4552	710.37	379	51	.08644	.00001	50	.04733	50	.04496	4104	2.272	.3350	/	4552
4553	1112.94	458	172	.14956	.00001	50	.00001	50	.07235	5029	4.518	.5163	/	4553
4562	1164.25	519	73	.18696	.00001	50	.05689	50	.06740	5063	6.028	.2755	?	4562
4565	1127.37	510	163	.19111	.00001	50	.00001	50	.06517	6590	6.177	.6435	?	4565
4571	1023.02	742	62	.25960	.00001	50	.05356	50	.08202	7277	8.518	.2258	/	4571

4574	[illegible]	525	[illegible]	.22698	.00001	50	.00001	50	.27106	7755	[illegible]	.5461	?	4574
4575	1575.46	656	86	.25445	.00001	50	.07333	50	.09925	4605	8.045	.2054	?	4575
4581	1529.16	803	85	.30612	.00001	50	.01400	50	.10262	4601	10.465	.2252	?	4581
4583	464.12	581	1	.21450	.00001	50	.00001	50	.25659	1177	6.539	.7388	/	4583
4585	2045.45	683	158	.26236	.00001	50	.00001	50	.05777	5502	[illegible]	.5406	?	4585
4592	557.20	412	90	.09275	.00001	50	.00001	50	.00857	2215	2.720	.5127	/	4592
4593	320.58	449	256	.17525	.00001	50	.00001	50	.13261	2130	5.141	.7245	/	4593
5001	1047.22	686	115	.27655	.00001	50	.04467	50	.08222	6323	9.467	.3006	/	5001
5002	1006.03	593	51	.23566	.00001	50	.00001	50	.06541	4532	8.020	.3852	/	5002
5003	352.04	495	153	.17745	.00001	50	.00001	50	.06632	3294	5.208	.5901	/	5003
5012	358.02	433	123	.09775	.00001	50	.00001	50	.12456	2531	2.501	.6761	/	5012
5013	554.65	515	276	.21554	.00001	50	.00001	50	.14243	2472	6.649	.7957	?	5013
5021	1088.64	621	135	.25945	.00001	50	.00001	50	.07557	6121	8.060	.2126	?	5021
5024	148.29	531	18	.19146	.00001	50	.06209	50	.07086	908	[illegible]	[illegible]	?	5024
5025	119.52	501	129	.25548	.00001	50	.00001	50	.05544	777	7.611	[illegible]	?	5025
5032	807.52	482	109	.16777	.00001	50	.00001	50	.11002	2791	4.039	.7056	?	5032
[illegible]	1045.97	584	486	.21121	.00001	50	.01867	50	.12610	1738	6.626	.7260	?	[illegible]
5042	78.17	415	68	.06641	.00001	50	.04158	50	.06656	215	1.042	.6476	?	5042
5045	45.54	406	130	.08595	.00001	50	.04211	50	.07234	777	9.409	.9404	?	5045
5051	1142.51	649	94	.20875	.00001	50	.00001	50	.07770	4801	6.567	.1771	?	5051
5054	85.[illegible]	716	555	.22860	.00001	50	.00001	50	.16274	407	7.426	.8574	?	5054
5055	40.50	548	125	.17460	.00001	50	.00001	50	.03440	1405	5.675	.2007	?	5055
5062	257.56	501	52	.10775	.00001	50	.00001	50	.15561	1624	6.251	.6312	/	5062
5063	818.91	591	236	.21263	.00001	50	.02200	50	.07173	3306	7.468	.3951	/	5063
5072	2360.55	599	352	.20705	.00001	50	.13467	50	.11682	3983	6.626	.5974	/	5072
5075	2229.02	609	141	.15055	.00001	50	.00001	50	.07604	5940	5.125	.5352	/	5075
5081	1340.14	953	75	.23115	.00001	50	.00001	50	.06508	3923	7.370	.2984	/	5081
5082	1354.31	757	255	.28526	.00001	50	.01778	50	.09620	3660	9.478	.4853	/	5082
5091	1808.95	850	83	.26355	.00001	50	.00001	50	.09097	6422	8.509	.4472	?	5091
5092	1200.07	843	78	.25905	.00001	50	.00001	50	.10673	5151	8.647	.5026	?	5092
5094	85.60	665	18	.30564	.00001	50	.05209	50	.13037	703	9.632	.8501	?	5094
5095	115.02	670	176	.32225	.00001	50	.00001	50	.17627	702	10.624	.9403	?	5095
5102	77.74	432	87	.05975	.00001	50	.01133	50	.09546	215	.564	.5742	?	5102
5104	41.[illegible]	504	[illegible]	.35856	.00001	50	.00001	50	.17832	1015	7.465	.9338	?	5104
5112	472.[illegible]	462	[illegible]	.08616	.00001	50	.01000	50	.03946	4149	2.452	.7444	?	5112
5115	61.55	421	183	.10052	.00001	50	.01474	50	.03426	251	3.065	.8401	?	5115
5121	1038.45	746	8	.22665	.00001	50	.01422	50	.05235	7758	8.465	.1766	?	5121
5124	105.56	510	15	.10144	.00001	50	.01067	50	.08304	509	3.442	.6302	?	5124
5125	45.27	517	155	.11197	.00001	50	.00001	50	.09050	615	3.560	.8096	?	5125
5131	1015.74	630	153	.19056	.00001	50	.00001	50	.05627	5961	6.554	.1534	/	5131
5132	219.31	527	86	.10521	.00001	50	.00001	50	.07505	2797	3.467	.4750	/	5132
5133	133.65	551	133	.14072	.00001	50	.00001	50	.17072	1721	4.379	.9065	/	5133
5142	525.26	550	136	.11140	.00001	50	.00001	50	.06531	5197	3.327	.5026	/	5142
5143	140.23	554	271	.25274	.00001	50	.00001	50	.21185	1444	8.019	.9412	/	5143
5151	1626.20	753	176	.21102	.00001	50	.00001	50	.05027	6265	7.050	.1534	?	5151
5152	232.56	572	60	.15096	.00001	50	.00001	50	.12171	1941	4.670	.6187	?	5152
5153	505.44	619	187	.20356	.00001	50	.00001	50	.11375	3077	6.573	.5660	/	5153
5161	1153.41	596	188	.13949	.00001	50	.00001	50	.05577	4623	4.443	.1656	?	5161
5162	567.05	564	116	.16548	.00001	50	.07467	50	.10655	2843	4.162	.7261	?	5162
5163	830.25	589	332	.17172	.00001	50	.00001	50	.09533	3639	5.474	.6436	?	5163
[illegible]	1379.[illegible]	621	286	.17205	.00001	50	.00001	50	.05501	6047	5.410	.1710	?	[illegible]
[illegible]	1342.[illegible]	529	[illegible]	.20166	.00001	50	.00001	50	.08224	4545	[illegible]	.6540	?	[illegible]
[illegible]	[illegible]	623	[illegible]	.19441	.00001	50	.00001	50	.07493	1697	[illegible]	.6406	?	[illegible]
[illegible]	[illegible]	388	[illegible]	.06444	.00001	50	.01224	50	.02621	1895	[illegible]	.7380	?	[illegible]
[illegible]	[illegible]	220	285	.20256	.00001	50	.00001	50	.16605	1845	[illegible]	.9950	?	[illegible]
5191	1052.72	582	156	.14314	.00001	50	.00001	50	.09022	5067	4.223	.4145	/	5191
[illegible]	1401.49	554	[illegible]	.15455	.00001	50	.00001	50	.09197	4755	[illegible]	.6740	?	[illegible]
[illegible]	336.[illegible]	470	285	.16660	.00001	50	.00001	50	.14000	1600	5.252	.8626	?	[illegible]
5201	1005.55	400	165	.11077	.00001	50	.00001	50	.05212	4623	3.570	.1920	/	5201
5202	475.47	475	133	.14557	.00001	50	.00001	50	.05743	3117	4.539	.5545	/	5202
5203	353.56	490	217	.20314	.00001	50	.00001	50	.17274	1863	6.222	.9551	/	5203
5211	1331.57	452	129	.08246	.00001	50	.00001	50	.04662	6985	2.426	.4615	?	5211
5212	600.45	359	121	.05115	.00001	50	.03572	50	.02571	3141	1.358	.5030	?	5212
5213	46.50	325	211	.03861	.00001	50	.00001	50	.02651	907	1.033	.5075	/	5213
5221	1319.79	357	209	.05166	.00001	50	.00001	50	.01427	3109	1.265	.1425	?	5221
5222	1358.07	580	111	.06345	.00001	50	.00222	50	.02207	3992	1.635	.4933	?	5222
[illegible]	145.4[illegible]	575	[illegible]	.09954	.00001	50	.00001	50	.03904	1245	[illegible]	.5677	?	[illegible]
[illegible]	1727.50	459	[illegible]	.08742	.00001	50	.00001	50	.05116	4738	[illegible]	.5540	?	[illegible]
[illegible]	1640.44	550	54	.06260	.00001	50	.00001	50	.01444	4655	[illegible]	.2460	?	[illegible]
[illegible]	1305.[illegible]	507	124	.06096	.00001	50	.01333	50	.01662	3144	[illegible]	.5417	?	[illegible]
[illegible]	1112.[illegible]	502	75	.06410	.00001	50	.06600	50	.01605	6290	1.098	.7444	?	[illegible]
5245	1304.10	507	187	.05916	.00001	50	.01600	50	.01634	4620	.654	.4255	?	5245
5252	422.54	520	11	.03620	.00001	50	.00001	50	.01202	4548	.677	.3500	/	5252
[illegible]	115.[illegible]	592	189	.02946	.00001	50	.00001	50	.00095	1286	.440	.7448	?	[illegible]
5261	1001.16	564	115	.06774	.00001	50	.00001	50	.01666	5063	1.752	.3272	?	5261
5262	125.45	525	330	.04632	.00001	50	.00933	50	.03736	907	1.317	.7272	/	5262
5263	266.74	357	118	.06471	.00001	50	.01133	50	.03367	2133	1.117	.6535	/	5263
5272	1253.57	359	67	.08969	.00001	50	.05029	50	.02227	5352	2.524	.3362	/	5272
5273	865.55	354	153	.08724	.00001	50	.00001	50	.02712	4511	2.477	.5167	?	5273
5281	1146.15	500	117	.13349	.00001	50	.01511	50	.05471	6031	[illegible]	.3136	?	5281
5282	717.66	408	328	.14941	.00001	50	.02511	50	.04365	2644	4.509	.4250	/	5282

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5232	127.96	276	21	.35205	.00001	50	.01244	50	.01582	1935	.507	.6220	7	5232
[illegible]	97.20	274	200	.07566	.00001	50	.00001	50	.01546	1059	.517	.6447	7	[illegible]
5241	1010.66	320	[illegible]	.09566	.00001	50	[illegible]	50	.03743	6293	2.170	.1335	7	5241
5242	618.64	296	257	.05104	.00001	50	.01089	50	.01532	2291	.722	.4756	7	5242
[illegible]	1116.76	313	149	.04599	.00001	50	.00001	50	.02314	6479	1.[illegible]	.2796	7	[illegible]
5254	91.96	221	[illegible]	.05053	.00001	50	.01022	50	.03116	690	.761	.2814	7	5254
[illegible]	97.40	275	206	.09020	.00001	50	.00001	50	.03006	690	1.726	.0052	7	[illegible]
5361	1022.66	586	110	.08465	.00001	50	.00001	50	.03997	6901	2.395	.7164	7	5361
5364	533.50	516	33	.09006	.00001	50	.00001	50	.04034	1534	2.031	.5610	7	5364
[illegible]	445.66	547	[illegible]	.09764	.00001	50	.00001	50	.05667	1429	2.260	.6754	7	[illegible]
5372	2519.10	365	90	.09262	.00001	50	.00001	50	.04025	5355	2.370	.4453	/	5372
5373	2362.21	373	153	.10735	.00001	50	.00001	50	.01656	5324	3.035	.5376	/	5373
5382	659.29	400	258	.17565	.00001	50	.00001	50	.14265	1776	5.261	.7255	/	5382
5385	1083.26	453	135	.16861	.00001	50	.00001	50	.11665	6651	5.207	.5603	/	5385
5391	1063.53	443	58	.06314	.00001	50	.01400	50	.01675	5936	1.642	.0952	/	5391
5392	742.77	403	330	.07055	.00001	50	.01000	50	.01625	6170	2.050	.5836	/	5392
5393	728.16	408	128	.07260	.00001	50	.00001	50	.04525	1773	2.075	.7510	7	5393
5402	37.54	317	21	.12135	.00001	50	.03689	50	.04720	271	3.600	.2946	7	5402
[illegible]	19.66	367	[illegible]	.11105	.00001	50	.00001	50	.11454	560	2.[illegible]	.9606	7	[illegible]
5412	170.91	374	229	.11951	.00001	50	.02667	50	.08430	957	3.425	.7027	7	5412
[illegible]	178.82	333	154	.12845	.00001	50	.00001	50	.07437	2500	3.760	.5551	7	[illegible]
5424	442.70	434	[illegible]	.10753	.00001	50	.00001	50	.06654	1555	[illegible]	.8484	7	5424
[illegible]	1858.48	439	[illegible]	.08045	.00001	50	.00001	50	.03960	4747	2.[illegible]	.7002	7	[illegible]
5431	1066.77	529	113	.16823	.00001	50	.00001	50	.07516	7212	[illegible]	.4730	7	5431
5434	592.55	458	186	.15832	.00001	50	.00001	50	.09994	1555	[illegible]	.0973	7	5434
[illegible]	3508.92	577	135	.17812	.00001	50	.07800	50	.07104	2412	[illegible]	.5004	7	[illegible]
5441	1339.26	646	146	.19801	.00001	50	.02756	50	.09463	5574	5.526	.6654	7	5441
5442	870.75	507	101	.14743	.00001	50	.00001	50	.09578	5535	4.441	.5154	/	5442
5443	141.75	417	235	.08865	.00001	50	.02467	50	.04975	923	2.626	.6565	/	5443
5451	1321.41	613	146	.20056	.00001	50	.00001	50	.11225	4576	6.058	.6105	/	5451
5452	146.61	304	55	.07004	.00001	50	.00001	50	.03011	994	1.855	.5925	/	5452
5453	456.53	436	168	.13426	.00001	50	.00001	50	.07784	2434	3.551	.6546	/	5453
5461	1073.25	720	155	.22043	.00001	50	.00001	50	.09471	4575	6.757	.4737	7	5461
5462	320.70	459	50	.14264	.00001	50	.02400	50	.09537	1230	4.402	.5443	7	5462
5463	723.33	564	179	.21553	.00001	50	.04556	50	.15501	2981	6.521	.7105	/	5463
5471	1027.06	807	213	.21506	.00001	50	.00001	50	.07985	4871	6.534	.3045	7	5471
5472	1740.12	534	147	.21250	.00001	50	.05121	50	.08573	3075	6.352	.6566	7	5472
5473	361.58	575	729	.21255	.00001	50	.00001	50	.17352	1935	[illegible]	.8633	7	5473
5484	2556.48	304	[illegible]	.09665	.00001	50	.00001	50	.02511	9109	.558	[illegible]	7	5484
[illegible]	[illegible]	985	[illegible]	.04066	.00001	50	.00001	50	.01114	4281	[illegible]	.5245	7	[illegible]
5491	1006.80	602	[illegible]	.20350	.00001	50	.00001	50	.08905	6708	[illegible]	.7665	7	5491
5492	458.85	[illegible]	[illegible]	.09258	.00001	50	.01000	50	.02155	1099	[illegible]	.6016	7	5492
[illegible]	429.77	476	160	.11766	.00001	50	.00001	50	[illegible]	2950	[illegible]	.8644	7	[illegible]
5501	1011.65	449	155	.12657	.00001	50	.05156	50	.07640	5532	3.482	.7665	/	5501
5504	140.56	[illegible]	[illegible]	.09586	.00001	50	.00001	50	.03994	4126	[illegible]	.6700	7	5504
[illegible]	88.05	377	252	.06481	.00001	50	.02111	50	.04563	722	1.402	[illegible]	7	[illegible]
5511	1032.76	305	120	.04106	.00001	50	.02111	50	.01602	5373	.076	.3558	/	5511
5512	756.54	257	32	.04008	.00001	50	.00001	50	.01115	3530	.668	.3537	/	5512
5513	1146.15	274	157	.03825	.00001	50	.01667	50	.01324	5202	.510	.4354	/	5513
5521	1116.99	449	161	.14625	.00001	50	.00001	50	.07564	5805	4.125	.7537	7	5521
5522	1005.18	277	73	.04445	.00001	50	.00001	50	.01590	5527	1.127	.4298	7	5522
5523	2145.69	329	163	.07016	.00001	50	.00001	50	.07200	5091	1.532	.5612	/	5523
5532	28.86	207	43	.09865	.00001	50	.00001	50	.08242	380	3.174	.7851	7	5532
5533	16.20	230	218	.08162	.00001	50	.00001	50	.09544	252	2.008	.8537	7	5533
5541	1002.05	220	[illegible]	.09271	.00001	50	.00001	50	.01090	2068	1.[illegible]	.2847	7	5541
5544	[illegible]	246	[illegible]	.05013	.00001	50	.00005	50	.01302	1630	1.041	.5422	7	5544
[illegible]	50.04	273	[illegible]	.05063	.00001	50	.00558	50	.03557	623	1.[illegible]	.8418	7	[illegible]
5551	1062.80	196	[illegible]	.07715	.00001	50	.00001	50	.06533	6077	[illegible]	.6564	7	5551
5554	722.74	250	[illegible]	.06162	.00001	50	.00001	50	.02214	4211	1.306	.7354	7	5554
5555	1500.02	320	167	.09684	.00001	50	.00001	50	.09924	6051	2.564	.6150	7	5555
5562	1152.62	262	77	.06153	.00001	50	.00001	50	.01331	7705	1.529	.2321	/	5562
[illegible]	140.04	241	160	.08065	.00001	50	.01156	50	.02906	1576	2.[illegible]	.5710	7	[illegible]
5571	1031.07	352	130	.11106	.00001	50	.00001	50	.06095	5566	3.350	.5062	7	5571
5572	220.22	265	40	.07320	.00001	50	.00001	50	.02016	2171	1.556	.4461	/	5572
5573	677.90	354	147	.12223	.00001	50	.00001	50	.07502	4800	3.343	.7541	/	5573
5581	1157.45	336	135	.11066	.00001	50	.00001	50	.07032	5212	3.357	.6921	/	5581
5582	170.91	208	55	.05966	.00001	50	.00503	50	.02324	1500	.556	.4722	7	5582
5583	158.45	214	218	.04400	.00001	50	.01178	50	.02396	1842	1.119	.5540	7	5583
5591	1006.03	259	127	.03523	.00001	50	.01111	50	.01546	5343	.624	.3362	/	5591

5584	45.10	189	146	.06850	.00001	50	.00001	50	.05562	984	1.645	.6805	7	5584
[illegible]	65.58	190	[illegible]	.06262	.00001	50	.00001	50	.05332	1505	1.768	.6752	7	[illegible]
5592	1655.14	198	111	.04926	.00001	50	.01556	50	.01266	5545	1.255	.5005	7	5592
5593	543.14	191	251	.05265	.00001	50	.00000	50	.01446	4055	1.445	.4074	/	5593
5612	560.00	198	89	.04050	.00001	50	.00001	50	.03097	2136	1.441	.4255	7	5612
5613	1022.22	217	221	.04082	.00001	50	.00511	50	.00563	7078	1.010	.3242	/	5613
5622	1030.42	227	50	.04120	.00001	50	.01056	50	.01136	7145	.500	.2752	/	5622
5623	219.81	217	203	.06250	.00001	50	.01153	50	.03053	1556	1.526	.6017	/	5623
5631	1441.80	331	132	.10454	.00001	50	.00001	50	.06191	5007	2.522	.5164	/	5631
5632	218.70	250	335	.06816	.00001	50	.01244	50	.03123	1311	1.669	.7101	/	5632
5633	620.11	258	155	.04957	.00001	50	.01067	50	.02065	3505	1.257	.6255	/	5633
5642	306.16	226	139	.05963	.00001	50	.00001	50	.02627	2335	1.526	.5952	7	5642
5643	147.43	227	286	.04762	.00001	50	.00001	50	.01533	2683	1.006	.4215	7	5643
5651	1010.12	230	[illegible]	.09514	.00001	50	.00001	50	.03961	6168	[illegible]	.2460	7	5651
5654	455.15	255	28	.09198	.00001	50	.00001	50	.02864	3573	2.[illegible]	.2552	7	5654
5655	148.74	262	160	.07170	.00001	50	.00756	50	.03216	1956	2.241	.5871	7	5655
5664	62.60	216	176	.06455	.00001	50	.00001	50	.06334	613	1.[illegible]	.5174	7	5664
[illegible]	439.76	236	290	.05458	.00001	50	.01289	50	.02575	3252	1.[illegible]	.5947	7	[illegible]
5674	144.76	257	77	.08034	.00001	50	.01155	50	.02698	1944	2.720	.5715	7	5674
[illegible]	58.62	248	240	.02555	.00001	50	.01024	50	.03254	1115	2.419	.5052	7	[illegible]
5684	558.82	279	48	.09054	.00001	50	.00001	50	.05434	3806	2.362	.7720	7	5684
[illegible]	1176.21	308	126	.09955	.00001	50	.00001	50	.09255	5215	2.422	.5556	7	[illegible]
5692	378.27	279	15	.11968	.00001	50	.00001	50	.02390	4129	3.705	.3560	/	5692
5693	156.63	250	188	.10325	.00001	50	.00001	50	.05494	941	3.051	.8113	/	5693
5702	711.55	278	329	.08715	.00001	50	.01267	50	.02537	2585	2.469	.6100	/	5702
5703	586.44	293	145	.10365	.00001	50	.02400	50	.02605	3437	3.187	.4856	/	5703
5712	1570.52	356	311	.15476	.00001	50	.00001	50	.07655	3294	4.701	.6952	/	5712
5713	1227.15	318	112	.10514	.00001	50	.00001	50	.05375	4500	3.124	.4055	/	5713
5721	1017.20	666	96	.20261	.00001	50	.00001	50	.08295	3455	5.934	.2972	7	5721
5722	2775.30	459	759	.19426	.00001	50	.02711	50	.05732	6854	5.612	.7242	7	5722
[illegible]	5141.37	503	[illegible]	.15760	.00001	50	.00001	50	.07284	4140	[illegible]	.6963	7	[illegible]
5731	1001.10	658	11	.19420	.00001	50	.00001	50	.07457	3117	5.258	.2435	7	5731
5733	839.10	503	18	.18545	.00001	50	.00001	50	.10695	1776	5.378	.5663	7	5733
[illegible]	3345.43	553	126	.18956	.00001	50	.00001	50	.06744	4289	[illegible]	.7631	7	[illegible]
5741	1001.39	760	110	.16564	.00001	50	.00001	50	.06707	5888	7.641	.5007	7	5741
5743	32.40	283	5	.11035	.00001	50	.00001	50	.14315	143	5.342	.5863	7	5743
[illegible]	5[illegible]	331	[illegible]	.12856	.00001	50	.00001	50	.08616	3988	[illegible]	.6013	7	[illegible]
5751	1008.45	681	147	.21155	.00001	50	.00001	50	.06002	4791	6.[illegible]	.3547	7	5751
5752	650.36	278	65	.06625	.00001	50	.01256	50	.02502	2452	1.616	.4752	7	5752
5755	1632.28	402	139	.14876	.00001	50	.02667	50	.06775	5374	4.231	.6714	/	5755
5762	35.21	246	55	.12104	.00001	50	.00001	50	.12457	290	4.253	.6264	/	5762
5765	30.78	254	202	.13540	.00001	50	.00001	50	.12527	612	4.355	.8755	/	5765
5771	1001.37	550	127	.18921	.00001	50	.00001	50	.08454	5954	5.779	.7201	/	5771
5772	568.30	338	115	.10046	.00001	50	.00001	50	.06244	3846	2.521	.3855	/	5772
5773	471.42	290	197	.05906	.00001	50	.00001	50	.02777	2241	1.700	.4741	7	5773
5781	1034.40	460	146	.16055	.00001	50	.00703	50	.09565	3321	4.005	.6260	7	5781
5782	1640.55	332	129	.10655	.00001	50	.04289	50	.08145	5352	2.961	.5445	/	5782
5783	856.50	298	281	.07906	.00001	50	.00001	50	.01551	4418	2.459	.4255	7	5783
5791	1000.25	313	178	.06255	.00001	50	.05089	50	.03133	2591	1.705	.2724	7	5791
5793	1338.77	283	[illegible]	.06413	.00001	50	.00001	50	.02217	1995	1.970	.4404	7	5793
[illegible]	[illegible]	224	[illegible]	.09960	.00001	50	.00001	50	.01754	4568	2.542	.2944	7	[illegible]
5801	1002.56	225	212	.04540	.00001	50	.00002	50	.00514	5924	1.065	.1314	7	5801
5804	171.64	234	[illegible]	.06736	.00001	50	.01172	50	.06561	1975	1.666	.6931	7	5804
[illegible]	278.44	256	290	.05150	.00001	50	.00001	50	.02221	2101	1.330	.5440	7	[illegible]
5811	1001.78	258	67	.03746	.00001	50	.00001	50	.01734	4669	.641	.3146	7	5811
5812	1327.56	250	147	.03765	.00001	50	.00001	50	.01705	4567	.644	.5023	/	5812
[illegible]	[illegible]	214	246	.02672	.00001	50	.00001	50	.01562	1501	.567	.6554	7	[illegible]
5821	1001.76	214	67	.05008	.00001	50	.00001	50	.00584	4708	.560	.7254	7	5821
5822	805.14	214	154	.03054	.00001	50	.00911	50	.01122	3567	.556	.4705	/	5822
5823	580.82	212	312	.03255	.00001	50	.01133	50	.01075	2627	.752	.5435	/	5823
5831	1052.15	233	132	.03731	.00001	50	.00001	50	.01245	4781	1.113	.2055	/	5831
5832	51.51	158	100	.04935	.00001	50	.01022	50	.04772	597	1.162	.5110	7	5832
5833	308.17	192	233	.06202	.00001	50	.00001	50	.02443	2021	2.025	.5711	7	5833
5842	264.31	178	91	.06004	.00001	50	.01156	50	.02762	2021	1.872	.4822	/	5842
5843	164.43	154	277	.03251	.00001	50	.00001	50	.02035	1069	.775	.5141	7	5843
5852	1451.31	191	78	.03509	.00001	50	.00001	50	.00602	7292	.821	.1253	7	5852
[illegible]	119.32	180	218	.07446	.00001	50	.00001	50	.05002	1014	2.146	.6726	7	[illegible]
5861	1162.58	242	150	.05141	.00001	50	.00001	50	.00677	4507	.850	.2564	7	5861
5862	1608.80	209	89	.05605	.00001	50	.00624	50	.00545	4529	1.560	.2028	7	5862
[illegible]	189.37	203	411	.04426	.00001	50	.00001	50	.01791	1866	1.492	.2866	7	[illegible]
5871	1362.58	217	176	.09966	.00001	50	.00001	50	.00518	5555	.866	.1872	7	5871
5872	320.05	194	197	.04564	.00001	50	.00711	50	.02264	1591	1.227	.5708	7	5872
5873	354.24	176	365	.05356	.00001	50	.00070	50	.02620	1323	1.820	.4320	/	5873
5884	1120.52	187	149	.05048	.00001	50	.00211	50	.00077	6429	1.066	.5480	7	5884
5885	1370.62	177	271	.05207	.00001	50	.00001	50	.00495	7097	.760	.2832	7	5885
5891	1015.58	256	109	.02926	.00001	50	.03600	50	.00041	5722	.550	.2747	/	5891
5892	378.04	209	75	.03261	.00001	50	.00001	50	.01275	3216	.646	.4305	/	5892
5893	724.14	219	220	.03261	.00001	50	.00067	50	.01055	2009	1.002	.4742	/	5893
5901	1000.35	210	147	.02803	.00001	50	.00713	50	.00637	6975	.750	.2335	7	5901
5903	352.41	130	133	.04012	.00001	50	.01023	50	.02047	2005	1.072	.4569	7	5903
5905	2229.53	199	161	.03265	.00001	50	.00378	50	.00571	5068	.615	.1353	/	5905

5511	[illegible]	180	212	.02552	.00001	50	.00000	50	.00431	2298	.482	.1510	?	5511
5512	476.76	177	150	.02892	.00001	50	.01000	50	.01480	5584	.540	.5145	?	5512
5513	50.75	172	202	.05221	.00001	50	.00844	50	.02215	1137	.611	.6621	?	5513
5521	1155.44	189	150	.02054	.00001	50	.00001	50	.00255	5976	.459	.1325	/	5521
5522	1542.52	180	55	.02715	.00001	50	.00600	50	.00434	4012	.511	.0765	?	5522
5523	570.12	181	200	.03416	.00001	50	.00067	50	.01102	3071	.647	.3722	/	5523
5531	1322.73	176	133	.02717	.00001	50	.00556	50	.00663	5098	.511	.1025	/	5531
5532	222.36	155	33	.04775	.00001	50	.01311	50	.03509	597	1.252	.6251	/	5532
5533	261.66	154	170	.03512	.00001	50	.01311	50	.02003	2121	.670	.5252	/	5533
5542	1127.52	170	47	.03114	.00001	50	.00001	50	.00575	5991	.727	.2566	/	5542
5543	565.28	164	131	.03622	.00001	50	.00533	50	.01135	2531	.643	.3911	/	5543
5551	1045.26	167	93	.01722	.00001	50	.00001	50	.00502	5827	.359	.2151	?	5551
5552	362.32	176	9	.02757	.00001	50	.00001	50	.00524	1851	.619	.5026	?	5552
5553	1447.75	183	121	.02066	.00001	50	.00001	50	.00546	6753	.462	.0126	?	5553
5561	1458.45	188	178	.02155	.00001	50	.00071	50	.00457	6075	.497	.0547	?	5561
5562	240.55	174	79	.02566	.00001	50	.00289	50	.00991	1736	.500	.5216	?	5562
5563	666.47	180	227	.02196	.00001	50	.00333	50	.00433	4967	.491	.0622	?	5563
5571	1018.56	190	158	.02155	.00001	50	.01128	50	.00440	6155	.474	.1166	?	5571
5572	1097.54	172	62	.02955	.00001	50	.00001	50	.00672	5126	.549	.2085	?	5572
5573	48.02	171	217	.05296	.00001	50	.00728	50	.01666	1951	.462	.6422	?	5573
5581	1422.55	173	128	.05148	.00001	50	.00001	50	.00577	2635	.431	.2865	?	5581
5582	142.56	167	62	.05491	.00001	50	.00001	50	.02644	1676	.422	.5452	?	5582
5583	26.72	166	125	.04057	.00001	50	.00001	50	.03214	470	1.172	.5585	/	5583
5591	1146.15	180	127	.02316	.00001	50	.00001	50	.00643	7469	.535	.3334	/	5591
5592	176.58	151	53	.04454	.00001	50	.00001	50	.03446	889	1.012	.6327	/	5592
5593	301.04	156	251	.03937	.00001	50	.00001	50	.01562	1320	.764	.5057	/	5593
6001	1049.76	161	129	.02242	.00001	50	.00200	50	.00766	5790	.521	.3002	/	6001
6002	671.45	157	61	.03565	.00001	50	.00444	50	.00596	2785	.657	.3750	/	6002
6003	716.04	162	222	.04311	.00001	50	.01400	50	.01433	2129	1.132	.5416	?	6003
6011	1160.96	155	103	.02811	.00001	50	.00001	50	.00609	6802	.626	.2205	?	6011
6012	666.13	178	78	.02976	.00001	50	.00528	50	.00577	4601	.530	.1447	?	6012
6013	458.15	165	170	.03944	.00001	50	.00800	50	.01001	3639	.519	.1223	?	6013
6021	1371.03	170	113	.02372	.00001	50	.00644	50	.00603	8837	.758	.2436	?	6021
6022	258.75	177	19	.02766	.00001	50	.01128	50	.00516	2744	.648	.1400	?	6022
6023	565.31	174	148	.02609	.00001	50	.00001	50	.01634	1493	1.200	.6824	?	6023
6032	271.78	179	150	.04257	.00001	50	.00001	50	.02277	1793	.366	.5341	?	6032
6033	268.94	170	108	.02576	.00001	50	.00001	50	.00550	2286	.416	.2814	?	6033
6041	1017.36	194	50	.01266	.00001	50	.00001	50	.00314	5730	.415	.0550	?	6041
6042	926.64	151	21	.02762	.00001	50	.00956	50	.01500	1610	.610	.5517	?	6042
6043	874.80	157	175	.03005	.00001	50	.00001	50	.01571	1026	.946	.5605	/	6043
6051	1311.65	158	115	.02356	.00001	50	.00911	50	.00697	8526	.545	.2555	/	6051
6052	1304.10	152	53	.02451	.00001	50	.00001	50	.00502	9042	.558	.3101	/	6052
6053	107.72	139	210	.05054	.00001	50	.00378	50	.02126	650	.974	.7535	/	6053
6062	1355.12	143	46	.02400	.00001	50	.00511	50	.00675	4678	.557	.3750	/	6062
6063	449.55	139	181	.02622	.00001	50	.00867	50	.00757	2962	.609	.4906	?	6063
6071	1122.45	190	45	.01944	.00001	50	.00001	50	.00414	6792	.445	.0747	?	6071
6072	1162.60	170	66	.02426	.00001	50	.00156	50	.00771	5200	.544	.3862	/	6072
6073	538.35	155	169	.02762	.00001	50	.00001	50	.01215	2807	.614	.4310	?	6073
6081	1367.56	172	57	.02545	.00001	50	.00356	50	.00576	5205	.562	.2622	?	6081
6083	365.17	152	66	.02265	.00001	50	.00001	50	.01010	1317	.618	.5400	?	6083
6091	201.46	155	262	.02714	.00001	50	.00001	50	.01050	4895	.541	.2552	?	6091
6092	2141.02	161	65	.02822	.00001	50	.00001	50	.00744	5047	.545	.2204	?	6092
6093	1405.78	151	142	.02778	.00001	50	.00911	50	.00644	4100	.577	.3467	?	6093
6101	1009.30	129	57	.02342	.00001	50	.00511	50	.00411	8541	.531	.1360	?	6101
6102	140.70	154	55	.02275	.00001	50	.00644	50	.01112	1601	.461	.4355	?	6102
6103	135.27	157	160	.02605	.00001	50	.00378	50	.01155	1094	.373	.5556	/	6103
6111	1152.06	174	141	.02124	.00001	50	.00511	50	.00554	4865	.499	.1700	?	6111
6112	140.04	154	112	.02552	.00001	50	.00800	50	.01214	1501	.440	.2464	?	6112
6113	56.42	152	275	.02400	.00001	50	.00356	50	.01311	780	.514	.0201	/	6113
6121	1011.65	162	69	.03015	.00001	50	.00600	50	.00772	5426	.650	.2342	/	6121
6122	322.36	129	16	.05024	.00001	50	.00001	50	.01672	1938	1.205	.4456	/	6122
6123	153.55	127	167	.03725	.00001	50	.00001	50	.01243	1425	.506	.6325	?	6123
6131	1030.35	151	106	.02600	.00001	50	.00001	50	.00602	5603	.575	.2062	?	6131
6132	562.56	132	45	.03555	.00001	50	.00001	50	.00661	1941	.560	.3041	/	6132
6133	976.86	136	176	.03046	.00001	50	.00511	50	.01122	2646	.704	.3762	?	6133
6142	361.36	121	48	.10400	.00001	50	.00001	50	.03292	3038	2.540	.5914	?	6142
6143	475.04	130	258	.06231	.00001	50	.00001	50	.02356	4818	1.304	.6495	?	6143
6152	442.04	131	5	.02145	.00001	50	.00001	50	.01352	5553	1.645	.3066	?	6152
6153	745.16	176	153	.04462	.00001	50	.01356	50	.01101	2608	1.122	.5676	?	6153
6161	1822.47	156	116	.02261	.00001	50	.00001	50	.00574	9734	.502	.2261	?	6161
6162	500.61	154	19	.02222	.00001	50	.00333	50	.01402	1083	.529	.2352	?	6162
6163	156.33	153	168	.05164	.00001	50	.00644	50	.01660	1031	.776	.7245	?	6163
6171	1002.65	173	52	.02056	.00001	50	.00644	50	.00443	7068	.460	.1762	/	6171
6172	765.30	174	41	.02060	.00001	50	.00555	50	.00440	4903	.568	.3707	?	6172
6173	1041.66	165	178	.05045	.00001	50	.02000	50	.01276	3201	.715	.4054	?	6173
6182	2502.90	125	56	.04406	.00001	50	.00001	50	.01074	5107	1.076	.2075	/	6182
6183	3165.73	204	281	.11844	.00001	50	.00001	50	.05413	5740	3.319	.5540	/	6183
6192	25.11	102	59	.05961	.00001	50	.00844	50	.05857	693	1.275	.7670	/	6192
6193	6.20	91	226	.02454	.00001	50	.00001	50	.02503	162	.671	.9217	?	6193
6201	1006.83	179	53	.02756	.00001	50	.00800	50	.00526	6553	.617	.2877	?	6201
6202	1558.97	138	5	.02944	.00001	50	.00001	50	.00503	6339	.598	.2555	/	6202

6203	658.49	140	172	.02576	.00001	50	.00753	50	.00561	2902	.448	.1694	?	6203
6212	2809.74	145	76	.04306	.00001	50	.00800	50	.01274	5281	1.002	.2866	?	6212
6213	2550.62	151	212	.04442	.00001	50	.00001	50	.01277	4722	1.149	.2712	?	6213
6222	562.02	127	255	.04514	.00001	50	.01200	50	.01452	2910	1.150	.4627	/	6222
6223	590.40	149	156	.05066	.00001	50	.00001	50	.01965	2891	1.442	.4906	?	6223
6232	389.36	120	205	.02064	.00001	50	.00978	50	.01257	2264	.543	.5240	/	6232
6233	105.20	124	115	.03561	.00001	50	.00067	50	.02965	615	.771	.0144	/	6233
6241	1301.57	155	3	.02624	.00001	50	.00001	50	.00495	6802	.601	.0951	/	6241
6242	1406.16	147	209	.02072	.00001	50	.00778	50	.01035	4051	.552	.4132	/	6242
6243	332.35	144	92	.02436	.00001	50	.00756	50	.02086	1699	.767	.6771	/	6243
6251	1005.21	162	246	.02247	.00001	50	.00578	50	.00540	5592	.541	.2637	/	6251
6252	427.66	141	226	.02575	.00001	50	.00156	50	.01207	1593	.527	.6221	?	6252
6253	747.60	141	98	.02350	.00001	50	.00001	50	.00742	2000	.549	.4235	?	6253
6262	1078.56	149	29	.03188	.00001	50	.00001	50	.00649	4669	.460	.2507	?	6262
6263	630.69	149	427	.05795	.00001	50	.00800	50	.01500	1547	1.402	.2774	?	6263
6272	336.56	124	216	.06760	.00001	50	.00001	50	.02502	1644	1.626	.6242	?	6272
6273	860.47	131	172	.05671	.00001	50	.00001	50	.01164	3281	.651	.2922	?	6273
6282	42.15	119	178	.06462	.00001	50	.00001	50	.04448	505	1.272	.7164	?	6282
6283	4.06	108	196	.02263	.00001	50	.00067	50	.00733	35	.554	.5602	?	6283
6291	1009.46	149	138	.02140	.00001	50	.00489	50	.00457	4177	.508	.1841	?	6291
6292	152.43	149	406	.02725	.00001	50	.00474	50	.01967	2573	.621	.7484	?	6292
6293	126.56	152	97	.05784	.00001	50	.00600	50	.01635	1523	.546	.5605	?	6293
6302	335.74	116	335	.04020	.00001	50	.00001	50	.02245	1631	.920	.6233	/	6302
6303	265.24	124	189	.05427	.00001	50	.01311	50	.03179	1264	1.308	.7340	/	6303
6312	1144.52	130	208	.05546	.00001	50	.00001	50	.00546	2906	.622	.3656	/	6312
6313	1943.45	160	105	.04221	.00001	50	.00356	50	.00540	5040	1.183	.2723	/	6313
6321	1341.66	151	221	.01764	.00001	50	.00001	50	.00384	7826	.421	.2233	/	6321
6322	585.28	160	233	.03260	.00001	50	.00001	50	.02346	1627	.563	.2726	/	6322
6323	566.92	139	259	.02542	.00001	50	.00844	50	.00700	2472	.627	.2220	?	6323
6332	1351.39	101	320	.02521	.00001	50	.00001	50	.00549	7860	.552	.1907	?	6332
6333	152.42	131	142	.02535	.00001	50	.00756	50	.00460	1413	1.148	.7131	?	6333
6342	302.42	134	335	.03490	.00001	50	.00822	50	.01200	2077	.912	.5772	?	6342
6343	171.78	118	138	.07521	.00001	50	.00400	50	.01730	2401	1.159	.4750	?	6343
6352	488.09	123	227	.03048	.00001	50	.00667	50	.01432	3014	.724	.2810	?	6352
6353	500.12	129	95	.02561	.00001	50	.00623	50	.01112	4247	1.401	.3414	?	6353
6361	1145.36	161	312	.02432	.00001	50	.00001	50	.00675	7567	.572	.2525	?	6361
6362	879.72	146	266	.02405	.00001	50	.01024	50	.00794	1934	.436	.2540	?	6362
6363	241.76	178	75	.05924	.00001	50	.00244	50	.01557	2155	.742	.2727	?	6363
6372	120.51	126	298	.05205	.00001	50	.00001	50	.04224	705	1.245	.6427	?	6372
6373	541.52	152	106	.03040	.00001	50	.00844	50	.00535	5206	1.129	.2520	/	6373
6382	212.22	138	257	.06165	.00001	50	.00933	50	.03160	1125	1.558	.5445	/	6382
6383	123.52	135	92	.05457	.00001	50	.00933	50	.03515	867	1.330	.4350	/	6383
6392	200.17	166	250	.04146	.00001	50	.02156	50	.02065	1317	1.020	.5025	/	6392
6393	604.15	154	59	.03703	.00001	50	.00756	50	.00535	4905	1.004	.2966	/	6393
6401	1056.24	159	296	.02464	.00001	50	.00001	50	.00681	4607	.569	.3434	?	6401
6402	103.05	151	212	.02746	.00001	50	.00644	50	.01511	1023	.560	.4202	?	6402
6403	46.56	150	142	.02752	.00001	50	.00269	50	.01502	650	.756	.4225	/	6403
6411	1010.37	171	317	.02350	.00001	50	.00001	50	.00615	4034	.558	.2756	?	6411
6412	205.74	154	238	.02613	.00001	50	.00001	50	.01483	2069	.564	.5536	?	6412
6413	704.76	153	88	.02459	.00001	50	.00556	50	.00741	3749	.561	.3665	?	6413
6422	142.86	136	141	.02415	.00001	50	.01667	50	.01681	855	.550	.5914	?	6422
6423	576.35	155	112	.02106	.00001	50	.00528	50	.01134	4007	1.050	.5073	?	6423
6432	1319.53	142	107	.02204	.00001	50	.00511	50	.01287	4157	.477	.2852	?	6432
6433	2122.64	153	102	.02625	.00001	50	.00001	50	.00472	4035	1.097	.1222	?	6433
6442	60.72	146	418	.02216	.00001	50	.00001	50	.02435	957	1.075	.6225	?	6442
6443	19.44	144	144	.06756	.00001	50	.00001	50	.05252	432	1.516	.8861	/	6443
[illegible]	76.76	134	256	.03920	.00001	50	.01824	50	.03541	805	.959	.6663	?	[illegible]
[illegible]	17.07	149	52	.04106	.00001	50	.01800	50	.04144	540	1.006	.7826	?	[illegible]
6452	45.74	149	132	.03064	.00001	50	.00001	50	.02264	615	.500	.5354	/	6452
6453	11.14	149	339	.03814	.00001	50	.00001	50	.03133	252	1.314	.8856	/	6453
6471	1052.55	176	327	.02150	.00001	50	.00001	50	.00470	5938	.504	.2676	/	6471
6472	520.02	153	209	.01865	.00001	50	.00556	50	.00481	3335	.426	.2655	?	6472
6473	124.46	152	8	.02962	.00001	50	.03800	50	.01166	1267	.676	.5077	?	6473
6481	1040.04	175	229	.02154	.00001	50	.00689	50	.00512	7171	.503	.2405	/	6481
6482	45.76	134	265	.02405	.00001	50	.00001	50	.02450	650	.551	.5611	?	6482
6483	65.61	137	12	.02263	.00001	50	.01022	50	.01675	602	.504	.7020	?	6483
6491	1182.37	172	199	.01877	.00001	50	.01067	50	.00436	6795	.476	.1340	?	6491
6492	561.56	183	205	.02056	.00001	50	.00552	50	.00522	3831	.456	.1510	?	6492
6493	65.62	166	85	.02103	.00001	50	.00511	50	.00724	575	.406	.6017	?	6493
6503	500.14	151	111	.02903	.00001	50	.00667	50	.01644	1685	.678	.6195	?	6503
6511	1158.40	168	150	.02106	.00001	50	.00001	50	.00477	4575	1.142	.2446	?	6511
6512	458.18	156	291	.05442	.00001	50	.00644	50	.01684	2081	.720	.5971	?	6512
6513	1127.52	174	112	.05044	.00001	50	.00467	50	.00605	5215	1.326	.2325	/	6513
6522	10.57	116	175	.09066	.00001	50	.01500	50	.06043	135	.442	.2376	?	6522
6523	9.72	159	135	.09365	.00001	50	.01400	50	.09035	215	2.457	.9167	?	6523
6532	4.35	147	215	.02063	.00001	50	.01200	50	.06003	35	.517	.9551	/	6532
6533	6.46	150	336	.03664	.00001	50	.00711	50	.03111	435	.634	.9266	/	6533
6541	1007.64	177	236	.02152	.00001	50	.00689	50	.00612	7056	.473	.2624	/	6541
6542	52.24	160	136	.02141	.00001	50	.00001	50	.01614	1103	.551	.5264	?	6542
6543	37.76	150	334	.03726	.00001	50	.00001	50	.02523	734	.635	.8766	?	6543
6551	1031.54	163	338	.01960	.00001	50	.00667	50	.00566	5209	.449	.4742	/	6551

[illegible]	[illegible]	168	[illegible]	.01654	.00001	50	[illegible]	50	[illegible]	4658	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	178	20	.01251	.00001	50	.00553	50	.00415	4992	.416	.2256	7	[illegible]
6562	57.20	153	215	.05706	.00001	50	.00001	50	.03674	687	.769	.7062	7	6562
6565	734.55	176	135	.03584	.00001	50	.00001	50	.00651	5670	.523	.2821	/	6565
[illegible]	471.20	156	215	[illegible]	.00001	50	.00001	50	.01623	1922	[illegible]	.5065	7	[illegible]
6573	326.42	172	137	.05451	.00001	50	.01464	50	.01423	3006	1.450	.3757	/	6573
6582	124.74	157	236	.05851	.00001	50	.01933	50	.03625	960	1.350	.4152	/	6582
6583	563.14	182	100	.03810	.00001	50	.00001	50	.01205	4480	1.201	.3591	/	6583
6591	1362.57	169	237	.01722	.00001	50	.00378	50	.00475	5932	.437	.2652	/	6591
6592	1134.61	179	235	.02162	.00001	50	.00001	50	.00455	7632	.461	.2555	/	6592
6593	923.40	179	21	.02247	.00001	50	.00511	50	.00534	5197	.523	.3352	/	6593
6602	24.30	163	350	.03736	.00001	50	.00001	50	.04121	687	.712	.6011	7	6602
6603	39.10	169	111	.04867	.00001	50	.00953	50	.03426	830	1.245	.7702	7	6603
[illegible]	8.57	166	[illegible]	.02866	.00001	50	.01889	50	.02605	135	[illegible]	[illegible]	7	[illegible]
[illegible]	2.43	166	[illegible]	.01302	.00001	50	.00178	50	.00565	135	.192	.2744	7	[illegible]
6622	1280.57	187	221	.03055	.00001	50	.00001	50	.00593	3917	.606	.3452	7	6622
[illegible]	[illegible]	193	[illegible]	.02320	.00001	50	.00001	50	.00654	4929	.668	.3068	7	[illegible]
[illegible]	655.60	193	[illegible]	[illegible]	.00001	50	.00423	50	.00579	4927	.760	[illegible]	7	[illegible]
[illegible]	401.60	190	[illegible]	.04640	.00001	50	.00089	50	.01262	2149	1.220	.2644	7	[illegible]
[illegible]	962.50	194	256	.02645	.00001	50	.00003	50	.00449	4658	[illegible]	.0746	7	[illegible]
[illegible]	848.99	201	[illegible]	.05869	.00001	50	.00001	50	.00765	5635	.651	.3156	7	[illegible]
6661	1070.60	221	[illegible]	.01856	.00001	50	.00467	50	.00605	7501	.456	.2151	7	6661
6652	375.04	205	355	.05261	.00001	50	.00970	50	.01202	2351	.508	.5058	/	6652
6653	556.16	208	127	.02483	.00001	50	.00333	50	.00648	5517	.731	.3477	/	6653
6662	1276.94	217	56	.02525	.00001	50	.00467	50	.00647	6820	.659	.2822	/	6662
6663	823.77	211	170	.02425	.00001	50	.00001	50	.00790	6163	.837	.4455	/	6663
6671	1288.46	291	125	.06462	.00001	50	.00001	50	.02522	4669	1.701	.4371	/	6671
6672	2640.92	251	60	.03675	.00001	50	.01556	50	.01035	6789	.636	.2753	/	6672
6673	2012.85	246	164	.05422	.00001	50	.00844	50	.00797	5942	.754	.2927	7	6673
6681	1009.30	206	100	.02461	.00001	50	.00001	50	.00662	6743	.501	.3376	7	6681
[illegible]	[illegible]	217	59	.02604	.00001	50	.00528	50	.02802	5002	1.302	[illegible]	7	[illegible]
6683	60.16	220	219	.03951	.00001	50	.01622	50	.02177	702	1.347	.6717	7	6683
6691	1091.97	216	[illegible]	.02460	.00001	50	.00001	50	.00647	6643	.667	.1834	7	6691
[illegible]	46.14	192	7	.06850	.00001	50	.00005	50	.05935	1365	1.563	[illegible]	7	[illegible]
[illegible]	[illegible]	202	[illegible]	.05133	.00001	50	.00356	50	.00623	7017	.646	.5044	7	[illegible]
6701	1048.95	207	50	.02335	.00001	50	.00778	50	.00695	7171	.579	.1846	7	6701
[illegible]	[illegible]	182	41	.05655	.00001	50	.04156	50	.02483	1255	1.566	[illegible]	7	[illegible]
[illegible]	40.41	193	[illegible]	.05165	.00001	50	.00001	50	.03745	507	1.250	.7526	7	[illegible]
6714	577.16	199	10	.05575	.00001	50	.00267	50	.01204	2501	.555	.4023	7	6714
6715	1581.92	203	121	.02757	.00001	50	.00422	50	.00661	7140	.723	.3477	/	6715
6721	1253.57	263	125	.03722	.00001	50	.00001	50	.02517	5185	.660	.2502	/	6721
6722	1114.56	252	57	.02854	.00001	50	.00001	50	.00655	5144	.652	.3534	/	6722
6723	417.06	253	181	.05104	.00001	50	.00001	50	.02042	2600	.557	.6520	/	6723
6731	1001.16	266	123	.03805	.00001	50	.00711	50	.00565	5097	.561	.2356	/	6731
6732	72.90	215	115	.03165	.00001	50	.00001	50	.02532	867	.649	.7225	7	6732
6733	161.15	214	153	.02615	.00001	50	.00372	50	.01032	2261	.364	.3446	7	6733
6741	1325.46	264	120	.04757	.00001	50	.00001	50	.01144	5075	1.059	.2942	/	6741
6742	676.85	221	66	.03642	.00001	50	.01289	50	.01302	5914	.667	.4042	7	6742
6743	409.80	201	177	.02809	.00001	50	.00001	50	.00745	3593	.779	.5817	7	6743
6751	1009.76	266	173	[illegible]	.00001	50	.00001	50	.01081	6153	1.079	.2367	7	6751
[illegible]	[illegible]	207	60	[illegible]	.00001	50	.00806	50	.00227	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	191	160	.05165	.00001	50	.00001	50	[illegible]	[illegible]	.642	[illegible]	7	[illegible]
[illegible]	[illegible]	195	[illegible]	.02666	.00001	50	.01528	50	.01521	[illegible]	.661	[illegible]	7	[illegible]
[illegible]	[illegible]	181	50	.05434	.00001	50	.00111	50	[illegible]	[illegible]	.569	[illegible]	7	[illegible]
[illegible]	[illegible]	177	100	.04250	.00001	50	.00444	50	.01242	1063	1.072	.6240	7	[illegible]
6771	1057.55	221	100	.03036	.00001	50	.00001	50	.00565	6971	.717	.3784	/	6771
[illegible]	178.43	177	49	[illegible]	.00001	50	.00089	50	.01727	[illegible]	.509	[illegible]	7	[illegible]
[illegible]	[illegible]	183	[illegible]	.02855	.00001	50	.00001	50	.00755	4863	.662	.4002	7	[illegible]
6781	1094.34	220	106	.03242	.00001	50	.01400	50	.01113	5345	.718	.3027	/	6781
6782	353.97	181	31	.02574	.00001	50	.00001	50	.00695	2248	.550	.5248	/	6782
6783	537.01	180	143	.02115	.00001	50	.00001	50	.00695	3601	.545	.3426	/	6783
6792	228.42	153	39	.04562	.00001	50	.00556	50	.01645	1894	1.356	.5541	7	6792
6793	635.01	165	163	.05635	.00001	50	.00804	50	.01075	2149	.553	.4667	7	6793
6801	1156.37	261	106	.04135	.00001	50	.00001	50	.00584	5541	.578	.2615	/	6801
6802	1627.22	188	64	.03551	.00001	50	.00001	50	.00595	8983	.585	.2761	7	6802
6803	166.81	201	143	.05562	.00001	50	.00772	50	.02287	2111	.619	.6466	7	6803
[illegible]	[illegible]	161	68	[illegible]	.00001	50	.00556	50	.01253	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	183	236	.04702	.00001	50	.00001	50	.01224	[illegible]	.667	[illegible]	7	[illegible]
[illegible]	20.76	154	47	.01626	.00001	50	.00311	50	.01245	542	.408	[illegible]	7	[illegible]
[illegible]	49.60	169	[illegible]	.01915	.00001	50	.00001	50	.01741	[illegible]	.450	[illegible]	7	[illegible]
[illegible]	[illegible]	217	[illegible]	.02230	.00001	50	.00001	50	.01136	[illegible]	[illegible]	[illegible]	7	[illegible]
6632	126.46	175	67	.01924	.00001	50	.00001	50	.00686	2554	.420	.3756	7	6632
6633	15.30	173	121	.05137	.00001	50	.00001	50	.02020	342	.722	.9035	/	6633
[illegible]	[illegible]	263	[illegible]	.08660	.00001	50	.00001	50	.03002	5531	2.407	[illegible]	7	[illegible]
6642	1579.42	209	46	.06160	.00001	50	.00822	50	.01205	5448	.566	.3074	7	6642
6643	2139.16	234	142	.06021	.00001	50	.00001	50	.04527	4701	1.654	.5546	/	6643
6651	1033.56	178	120	.02307	.00001	50	.02264	50	.00788	6094	.523	.2702	/	6651
6652	44.55	160	139	.05676	.00001	50	.00001	50	.03773	522	1.510	.5246	/	6652
6653	38.32	156	251	.03766	.00001	50	.00001	50	.01920	997	1.269	.6057	7	6653
6661	1166.40	262	130	.10483	.00001	50	.00001	50	.04353	3048	5.040	.5825	7	6661
6662	1955.34	191	67	.03666	.00001	50	.00778	50	.01114	5093	.512	.3572	/	6662

7204	2?68.??	2??	1??	[illegible]	.00001	50	.00511	50	[illegible]	[illegible]	[illegible]	[illegible]	*	7204
7205	2055.40	224	[illegible]	.06724	.00001	50	.00001	50	.04147	4714	[illegible]	[illegible]	*	7205
7212	1575.02	371	350	.07265	.00001	50	.00001	50	.06745	5762	5.358	.6375	*	7212
7213	563.51	290	157	.09246	.00001	50	.01409	50	.05065	1770	2.212	.7352	✓	7213
7222	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	1074	5.444	.8647	*	7222
7223	136.45	307	133	.12506	.00001	50	.05111	50	.11705	560	3.720	.9627	✓	7223
7231	1306.03	408	336	.16046	.00001	50	.00867	50	.07402	5144	4.087	.5202	✓	7231
7232	31.35	314	269	.26004	.00001	50	.02933	50	.06522	615	1.623	.6665	✓	7232
7233	160.53	452	257	.20224	.00001	50	.00001	50	.16507	2192	5.046	.9015	✓	7233
7241	1162.35	482	331	.14381	.00001	50	.00001	50	.07642	5582	4.123	.6227	✓	7241
7242	313.67	433	257	.16356	.00001	50	.00001	50	.14534	2916	4.562	.7752	✓	7242
7243	176.56	355	130	.11343	.00001	50	.01911	50	.06515	1571	3.557	.7321	*	7243
7251	1162.00	559	123	.09650	.00001	50	.00022	50	.01614	7527	2.732	.3600	*	7251
7252	[illegible]	243	13	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	*	7252
7253	45.58	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	921	[illegible]	[illegible]	*	7253
7261	1368.25	526	117	.07766	.00001	50	.00001	50	.03005	3604	2.330	.2116	*	7261
7262	[illegible]	280	73	.10866	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	*	7262
7263	[illegible]	247	186	[illegible]	.00001	50	.02084	50	[illegible]	1879	[illegible]	[illegible]	*	7263
7272	256.40	218	55	[illegible]	.00001	50	.00001	50	[illegible]	1953	[illegible]	[illegible]	*	7272
7273	[illegible]	276	196	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	*	7273
7281	[illegible]	560	15	.06472	.00001	50	.00001	50	[illegible]	5504	1.501	[illegible]	*	7281
7282	1440.46	290	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	*	7282
7283	2549.51	351	160	.06357	.00001	50	.00001	50	.02507	5571	1.556	.5412	✓	7283
7291	1330.35	330	143	.05932	.00001	50	.01867	50	.02046	5371	1.473	.3458	✓	7291
7292	1556.01	295	59	.06700	.00001	50	.01778	50	.02630	5293	1.563	.4415	✓	7292
7293	1006.61	277	107	.07366	.00001	50	.01867	50	.02838	2766	2.220	.3852	✓	7293
7302	739.56	257	47	.28056	.00001	50	.01200	50	.03224	3145	2.303	.4681	✓	7302
7303	510.30	241	153	.28155	.00001	50	.00001	50	.04661	2776	2.447	.6153	✓	7303
7312	350.56	265	65	.26266	.00001	50	.03600	50	.02133	3812	1.777	.2426	✓	7312
7313	121.37	275	213	.28037	.00001	50	.03001	50	.03165	2171	2.155	.6084	✓	7313
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	*	[illegible]
7322	34.32	250	28	.26786	.00001	50	.01600	50	.07563	242	1.569	.5052	✓	7322
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	*	[illegible]
7343	620.85	237	275	.29712	.00001	50	.00809	50	.04322	4002	2.447	.6052	*	7343
7351	2305.21	305	118	.09652	.00001	50	.01111	50	.06820	5142	2.700	.6685	*	7351
7352	771.93	334	112	.10852	.00001	50	.03001	50	.05762	3220	3.558	.7312	✓	7352
7353	42.12	195	162	.13052	.00001	50	.03001	50	.03113	651	.616	.7252	✓	7353
7361	1105.85	273	123	.20753	.00001	50	.03001	50	.05206	5016	2.410	.6078	*	7361
7362	2550.66	259	135	.07350	.00001	50	.03266	50	.04514	5532	2.361	.6125	*	7362
7363	650.36	233	279	.10935	.00001	50	.02667	50	.04446	1904	5.157	.6156	*	7363
7372	2352.37	181	253	.28051	.00001	50	.03001	50	.01558	6037	2.335	.2254	*	7372
7373	853.43	171	137	.34855	.00001	50	.03001	50	.01382	3659	1.310	.4305	*	7373
7381	1341.66	276	55	.06557	.00001	50	.01915	50	.05562	5475	2.412	.5555	*	7381
7382	851.20	139	8	.07407	.00001	50	.03001	50	.03415	2700	2.116	.1952	*	7382
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	*	[illegible]
7411	1120.61	256	57	.10188	.00001	50	.03001	50	.03558	5490	2.057	.4324	✓	7411
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	*	[illegible]
7422	124.74	161	55	.20171	.00001	50	.01711	50	.04577	2354	2.350	.7558	✓	7422
7423	1330.03	138	218	.20661	.00001	50	.02867	50	.04215	5158	2.247	.6926	✓	7423
7431	2361.35	212	67	.07925	.00001	50	.03001	50	.03693	5194	3.234	.5537	✓	7431
7432	132.84	157	347	.27774	.00001	50	.03953	50	.03515	1481	2.228	.6525	✓	7432
7433	22.60	165	129	.39059	.00001	50	.03001	50	.07133	653	2.359	.8251	✓	7433
7442	60.04	154	62	.26645	.00001	50	.02489	50	.07026	975	2.360	.7146	*	7442
7443	68.08	161	233	.24542	.00001	50	.06022	50	.07305	575	1.511	.9352	*	7443
7452	477.90	151	20	.26937	.00001	50	.01200	50	.03073	2201	1.560	.5850	*	7452
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	*	[illegible]
7481	1585.32	451	9	.11040	.00001	50	.03001	50	.04120	7685	2.526	.2605	✓	7481
7482	2332.34	352	255	.15051	.00001	50	.03001	50	.07213	2763	3.056	.7575	✓	7482
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	*	[illegible]
7492	1568.94	271	212	.16852	.00001	50	.02756	50	.11542	3083	4.270	.7727	✓	7492
7493	1389.25	222	133	.16761	.00001	50	.01622	50	.01591	5920	1.526	.6027	✓	7493
7501	1010.88	216	305	.10002	.00001	50	.03001	50	.04546	3298	2.950	.4953	✓	7501
7502	1321.91	316	303	.15103	.00001	50	.01689	50	.03556	2956	1.566	.2334	✓	7502
7503	184.20	240	101	.26422	.00001	50	.03001	50	.03673	1157	1.370	.8052	*	7503
7512	1838.45	224	337	.12051	.00001	50	.03001	50	.03313	5737	1.351	.4377	*	7512
7513	2759.01	226	156	.06935	.00001	50	.02978	50	.03605	6287	1.351	.4751	✓	7513

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	*	[illegible]
[illegible]	[illegible]	[illegible]	88	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	*	[illegible]
7522	698.86	250	252	.07840	.00001	50	.01511	50	.02502	2460	2.100	.5812	*	7522
7533	29.16	208	56	.05855	.00001	50	.02464	50	.04155	470	.535	.0756	✓	7533
7541	1042.52	[illegible]	[illegible]	.10456	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	*	7541
7542	1355.78	326	206	.10602	.00001	50	.00001	50	.06295	5300	2.596	.7546	✓	7542
7543	451.70	274	72	.10113	.00001	50	.01044	50	.02747	2959	3.072	.4483	✓	7543
7552	2325.00	221	302	.06476	.00001	50	.00001	50	.02065	4213	1.707	.4251	✓	7552
7553	1450.42	279	113	.07556	.00001	50	.00001	50	.02671	3654	2.151	.5245	✓	7553
7561	1024.55	332	302	.06042	.00001	50	.03178	50	.05053	3237	2.127	.3823	✓	7561
7562	131.22	263	228	.06374	.00001	50	.00001	50	.03681	1031	1.558	.5474	✓	7562
7563	54.27	253	23	.07865	.00001	50	.00933	50	.04595	777	2.243	.7133	*	7563
7571	1127.30	124	60	.06227	.00001	50	.00001	50	.01533	3902	1.168	.2351	*	7571
[illegible]	[illegible]	297	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	1.158	.6355	*	[illegible]
[illegible]	[illegible]	105	49	[illegible]	.00001	50	.00822	50	[illegible]	1108	[illegible]	.6235	*	[illegible]
7583	771.81	351	21	.07383	.00001	50	.02067	50	.02532	2927	2.526	.4567	*	7583
[illegible]	[illegible]	254	[illegible]	.08954	.00001	50	[illegible]	50	[illegible]	[illegible]	2.492	[illegible]	*	[illegible]
[illegible]	[illegible]	259	[illegible]	.10842	.00001	50	.00001	50	.04734	[illegible]	2.810	[illegible]	*	[illegible]
[illegible]	[illegible]	260	[illegible]	[illegible]	.00001	50	.07600	50	[illegible]	[illegible]	[illegible]	[illegible]	*	[illegible]
[illegible]	1005.??	248	100	.07760	.00001	50	[illegible]	50	[illegible]	3093	[illegible]	.5534	*	[illegible]
[illegible]	2036.82	550	92	.11568	.00001	50	[illegible]	50	[illegible]	[illegible]	5.249	[illegible]	*	[illegible]
[illegible]	1055.56	549	[illegible]	.08852	.00001	50	[illegible]	50	[illegible]	4503	2.459	[illegible]	*	[illegible]
7612	825.20	325	208	.07043	.00001	50	.01244	50	.04241	2670	1.677	.7154	✓	7612
7613	389.61	323	117	.14766	.00001	50	.00001	50	.12358	1211	4.348	.8816	✓	7613
7621	1165.55	458	111	.15804	.00001	50	.06578	50	.06625	5610	4.456	.5733	✓	7621
7622	58.52	331	11	.07411	.00001	50	.01400	50	.05111	650	2.017	.6733	✓	7622
7623	451.17	420	199	.14132	.00001	50	.00222	50	.11842	4424	3.635	.8955	✓	7623
7631	1108.55	469	95	.16875	.00001	50	.00001	50	.06107	7174	4.514	.6315	✓	7631
7632	255.05	267	73	.09116	.00001	50	.06200	50	.04574	2025	2.617	.3152	*	7632
7633	458.96	352	133	.12950	.00001	50	.00001	50	.11631	3456	3.798	.6053	*	7633
[illegible]	[illegible]	579	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	.5104	*	[illegible]
7642	256.46	260	50	.09605	.00001	50	.00001	50	.03225	2807	2.734	.4245	*	7642
7643	378.66	269	333	.10171	.00001	50	.03972	50	.01976	2131	2.677	.7073	*	7643
[illegible]	[illegible]	266	[illegible]	[illegible]	.00001	50	.00001	50	.02173	[illegible]	[illegible]	.1509	*	[illegible]
[illegible]	186.66	253	57	[illegible]	.00001	50	.00001	50	.05564	2553	2.410	[illegible]	*	[illegible]
7653	61.36	210	323	.09444	.00001	50	.01911	50	.08414	994	2.610	.7774	*	7653
[illegible]	[illegible]	243	[illegible]	.06857	.00001	50	[illegible]	50	[illegible]	6941	[illegible]	.0887	*	[illegible]
[illegible]	[illegible]	236	[illegible]	[illegible]	.00001	50	.00001	50	.02466	2733	2.460	[illegible]	*	[illegible]
7663	217.06	233	181	.09512	.00001	50	.00001	50	.05506	1085	5.345	.5321	*	7663
7672	1120.81	183	35	.10325	.00001	50	.00001	50	.02441	4347	2.624	.3522	✓	7672
7673	2009.61	187	136	.07311	.00001	50	.00001	50	.01624	6535	2.134	.3003	✓	7673
7682	557.26	134	20	.07757	.00001	50	.01356	50	.03237	3654	2.263	.3861	✓	7682
7683	136.36	167	103	.08964	.00001	50	.01009	50	.06232	1140	2.350	.0720	✓	7683
7692	95.86	152	5	.09176	.00001	50	.02289	50	.08293	1013	2.713	.7262	✓	7692
7693	58.52	160	11	.08126	.00001	50	.01111	50	.02427	2273	2.454	.1624	*	7693
7701	1007.96	220	56	.07256	.00001	50	.02200	50	.01621	7022	2.276	.1120	*	7701
7702	133.05	156	299	.10162	.00001	50	.02778	50	.06687	1174	3.326	.6235	✓	7702
7703	53.46	195	84	.17023	.00001	50	.01800	50	.16445	342	6.454	.7824	*	7703
7711	1031.66	254	232	.08955	.00001	50	.00001	50	.02427	1650	2.012	.1776	*	7711
7713	1735.46	232	[illegible]	.07108	.00001	50	.00001	50	.02236	4107	2.275	.5773	*	7713
[illegible]	547.76	212	[illegible]	.14852	.00001	50	.04111	50	[illegible]	1987	2.668	[illegible]	*	[illegible]
[illegible]	1.52	127	[illegible]	.01040	.00001	54	.00001	0	.00007	0	.048	.0336	*	[illegible]
[illegible]	46.5?	148	[illegible]	.01697	.00001	50	.00222	50	[illegible]	575	.148	.1554	*	[illegible]
[illegible]	[illegible]	168	[illegible]	.11162	.00001	50	[illegible]	50	.05568	1444	5.415	.6944	*	[illegible]
[illegible]	826.?0	180	225	.16425	.00001	50	.00001	50	[illegible]	2087	[illegible]	.6145	*	[illegible]
7743	1153.16	170	155	.10885	.00001	50	.00001	50	.02435	2654	3.051	.5716	✓	7743
[illegible]	1048.?4	579	[illegible]	[illegible]	.00001	50	.00001	50	.02234	1457	[illegible]	[illegible]	*	[illegible]
[illegible]	[illegible]	264	[illegible]	.19005	.00001	50	.00001	50	[illegible]	1551	[illegible]	[illegible]	*	[illegible]
7753	720.09	282	115	.16704	.00001	50	.06067	50	.13516	1730	5.122	.8405	✓	7753
7762	553.22	216	319	.17699	.00001	50	.00001	50	.10197	2354	5.351	.7950	✓	7762
7763	1450.40	207	139	.13052	.00001	50	.00001	50	.04545	4659	3.534	.6247	✓	7763
7772	4008.65	165	206	.21021	.00001	50	.00001	50	.06781	7752	6.362	.7426	*	7772
7773	1610.33	227	120	.16655	.00001	50	.00001	50	.05636	4241	5.206	.4006	*	7773
7782	2628.72	301	204	.15578	.00001	50	.00001	50	.08774	5349	4.650	.5105	✓	7782
7783	2611.44	304	125	.14367	.00001	50	.00001	50	.08515	5132	4.529	.6945	*	7783
7792	3950.00	308	202	.12800	.00001	50	.00001	50	.09793	3054	4.036	.4262	*	7792
[illegible]	2745.06	296	[illegible]	.12491	.00001	50	.00001	50	[illegible]	6819	4.046	[illegible]	*	[illegible]
[illegible]	[illegible]	250	[illegible]	.15360	.00001	50	.07800	50	.10484	980	[illegible]	.6645	*	[illegible]
[illegible]	60.72	256	5	.19086	.00001	50	.05064	50	.06557	867	5.046	.8475	*	[illegible]
[illegible]	[illegible]	222	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	997	[illegible]	[illegible]	*	[illegible]
[illegible]	129.86	209	418	.16466	.00001	50	.00001	50	.12484	880	7.158	.9602	*	[illegible]
7821	1207.20	405	253	.15092	.00001	50	.01353	50	.08624	5846	4.424	.5057	*	7821
7822	55.51	334	139	.24765	.00001	50	.00001	50	.24532	507	8.252	.0666	✓	7822
[illegible]	55.66	516	298	[illegible]	.00001	50	.00001	50	.15476	447	[illegible]	[illegible]	*	[illegible]
7831	1200.42	594	259	.10804	.00001	50	.00001	50	.02184	5502	2.606	.1205	*	7831
7832	714.42	410	250	.16355	.00001	50	.00001	50	.11162	2770	4.573	.7451	✓	7832
7833	744.35	365	65	.16756	.00001	50	.02229	50	.06603	2678	5.366	.4216	✓	7833
7842	1564.52	358	287	.17075	.00001	50	.02889	50	.04555	5126	5.247	.4351	✓	7842
7843	709.76	122	110	.19902	.00001	50	.00001	50	.12410	2557	6.179	.6335	*	7843
7853	[illegible]	230	311	.18428	.00001	50	.00001	50	.10575	997	5.917	.7866	*	7853
7855	57.51	224	28	.10145	.00001	50	.00001	50	.08545	1249	2.732	.7315	✓	7855

7464	[illegible]	[illegible]	[illegible]	[illegible]	.00001	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	7464
7465	[illegible]	275	115	[illegible]	.00001	50	.00001	50	[illegible]	4650	[illegible]	[illegible]	?	7465
7472	56.70	257	229	.06700	.00001	50	.00001	50	.06702	904	1.577	.0046	?	7472
7475	13.77	254	79	.06611	.00001	50	.00001	50	.06445	700	2.140	.0171	✓	7475
7481	[illegible]	540	287	.06156	.00001	50	.00001	50	.01645	6026	1.547	.9656	?	7481
7482	512.73	324	149	.14054	.00001	50	.00001	50	.21614	670	4.526	.7721	✓	7482
7485	2526.32	332	365	.06051	.00001	50	.00001	50	.02232	5207	1.572	.4877	✓	7485
7492	601.02	293	309	.05112	.00001	50	.00001	50	.02255	4905	1.255	.5951	✓	7492
7495	211.41	304	117	.10021	.00001	50	.00001	50	.07532	2391	6.050	.0749	✓	7495
7502	472.23	301	365	.05982	.00001	50	.00001	50	.02795	4576	1.560	.6129	✓	7502
7505	47.75	270	76	.08117	.00001	50	.00001	50	.05602	758	2.065	.7729	✓	7505
7511	1248.21	372	305	.06351	.00001	50	.01533	50	.03263	5197	1.711	.3935	?	7511
7512	226.02	317	246	.07145	.00001	50	.01756	50	.03471	2552	2.202	.5209	?	7512
7514	80.79	293	196	.08052	.00001	50	.00001	50	.05102	1666	2.445	.6664	?	7514
7524	[illegible]	504	167	.09905	.00001	50	.04555	50	.05566	6866	1.321	.2471	?	7524
7525	781.37	505	131	.20667	.00001	50	.00001	50	.17442	1541	6.295	.7422	?	7525
7531	1006.02	546	196	.04576	.00001	50	.00001	50	.02977	6119	[illegible]	.6734	?	7531
7534	[illegible]	406	266	.11096	.00001	50	.04901	50	.10434	4045	[illegible]	.2830	?	7534
7545	[illegible]	550	445	.08469	.00001	50	.01156	50	.02454	6504	2.419	.5909	?	7545
7554	[illegible]	504	196	.08505	.00001	50	.00511	50	.01564	4011	2.40	.5947	?	7554
7555	[illegible]	745	193	.09556	.00001	50	.00005	50	.05239	5531	5.506	.6834	?	7555
7561	[illegible]	572	215	.09501	.00001	50	.00001	50	.05505	5607	5.569	.5624	?	7561
7552	1176.12	391	256	.10054	.00001	50	.00001	50	.04575	9604	3.270	.3016	✓	7552
7553	705.51	325	1	.09767	.00001	50	.00001	50	.03653	2462	3.133	.6276	✓	7553
7562	1330.55	439	265	.10952	.00001	50	.00001	50	.04636	9322	3.462	.4049	✓	7562
7565	789.50	410	137	.12134	.00001	50	.00001	50	.06552	3003	3.252	.7259	✓	7565
7571	1002.78	442	307	.13514	.00001	50	.05578	50	.04333	7078	4.156	.5209	✓	7571
7572	25.11	303	285	.08656	.00001	50	.03178	50	.12151	271	2.371	.6129	✓	7572
7575	41.31	336	7	.08462	.00001	50	.01444	50	.01103	520	2.605	.8936	?	7575
7582	1565.17	593	316	.10212	.00001	50	.00001	50	.06756	6092	5.332	.5210	?	7582
7584	[illegible]	521	179	.11059	.00001	50	.00001	50	.08066	1934	4.536	.7418	?	7584
7591	1369.90	466	212	.12794	.00001	50	.00001	50	.07577	6134	4.155	.6514	?	7591
7592	76.72	292	727	.05845	.00001	50	.03178	50	.12313	561	.572	.5867	?	7592
7594	324.09	334	167	.05660	.00001	50	.00001	50	.03564	1255	1.419	.7964	?	7594
8004	35.64	284	287	.05446	.00001	50	.01153	50	.02143	561	.629	.6536	?	8004
8005	28.07	283	68	.02334	.00001	50	.00400	50	.02181	525	.738	.6206	?	8005
8013	1030.05	555	8	.02456	.00001	50	.00001	50	.07514	4654	6.447	.7124	?	8013
8014	2447.55	578	449	.17904	.00001	50	.00001	50	.06450	6197	5.030	.5401	?	8014
8015	1526.46	566	75	.18876	.00001	50	.05111	50	.11265	6512	5.621	.5425	?	8015
8022	150.36	313	246	.06079	.00001	50	.00001	50	.04077	2931	1.757	.7319	✓	8022
8025	27.54	295	169	.02222	.00001	50	.02000	50	.03131	488	.457	.7525	✓	8025
8032	166.05	325	326	.07464	.00001	50	.00001	50	.11486	1519	1.576	.7463	✓	8032
8035	455.75	362	127	.07467	.00001	50	.00001	50	.03655	4464	1.532	.5401	✓	8035
8042	921.76	397	330	.13479	.00001	50	.00001	50	.10205	2627	3.736	.8561	✓	8042
8045	671.45	415	113	.12460	.00001	50	.00001	50	.06596	3735	3.605	.7395	?	8045
8051	1207.71	569	5	.19417	.00001	50	.04200	50	.08559	4502	5.306	.4437	?	8051
8052	166.30	457	233	.17634	.00001	50	.05267	50	.08026	2751	5.307	.4625	✓	8052
8055	46.17	435	29	.23830	.00001	50	.07756	50	.15621	975	7.446	.7655	?	8055
8062	378.37	462	343	.16020	.00001	50	.04622	50	.06653	2993	4.761	.5366	?	8062
8065	772.17	530	174	.27453	.00001	50	.00001	50	.16741	1555	8.135	.8367	?	8065
8073	[illegible]	714	58	.18325	.00001	50	.00001	50	.04547	7579	5.168	.3614	?	8073
8074	[illegible]	662	407	.17121	.00001	50	.00001	50	.12011	5968	4.541	.7564	?	8074
8075	1659.36	625	114	.17215	.00001	50	.00001	50	.13444	4788	5.048	.7474	?	8075
8084	1508.39	605	127	.20566	.00001	50	.00001	50	.09441	7838	6.214	.5776	?	8084
8085	1159.17	575	141	.21719	.00001	50	.00001	50	.05249	4143	6.520	.5906	?	8085
8091	1249.02	741	225	.19064	.00001	50	.01778	50	.06060	5520	5.615	.5157	✓	8091
8094	178.75	619	558	.20465	.00001	50	.00001	50	.19467	1011	6.141	.9992	?	8094
8095	70.16	588	167	.22348	.00001	50	.00001	50	.28582	352	9.557	.8620	?	8095
8101	1006.02	651	17	.15215	.00001	50	.00001	50	.05654	5524	4.400	.2535	✓	8101
8102	132.87	559	327	.14862	.00001	50	.00001	50	.17265	634	4.067	.7875	✓	8102
8105	240.67	589	125	.15643	.00001	50	.00001	50	.10026	1721	4.940	.7254	✓	8105
8112	852.65	434	341	.15155	.00001	50	.00001	50	.07757	3474	4.326	.6645	?	8112
8115	1045.41	412	146	.15457	.00001	50	.00001	50	.05926	5002	4.562	.6013	?	8115
8122	1060.54	565	328	.16945	.00001	50	.00001	50	.06715	4762	5.155	.5126	✓	8122
8125	548.00	430	152	.14510	.00001	50	.00001	50	.07615	3499	4.285	.6903	?	8125
8131	1055.55	611	255	.18254	.00001	50	.00001	50	.03076	9147	5.917	.2373	?	8131
8134	66.47	285	141	.22354	.00001	50	.02956	50	.16575	738	8.272	.8432	?	8134
8135	37.88	281	193	.30945	.00001	50	.00001	50	.50005	548	11.607	.8544	?	8135
8142	1575.89	519	5	.15615	.00001	50	.00001	50	.03625	8663	4.606	.3254	?	8142
8144	2768.46	552	145	.15186	.00001	50	.00001	50	.06494	5704	4.542	.5946	?	8144
8154	2807.00	557	409	.18472	.00001	50	.00001	50	.04432	7093	5.625	.5177	?	8154
8155	2325.57	552	129	.14160	.00001	50	.00001	50	.04675	5502	4.405	.5305	?	8155
8162	1233.02	554	224	.14655	.00001	50	.06000	50	.04670	5072	4.257	.6122	✓	8162
8165	1507.10	582	175	.17650	.00001	50	.00001	50	.08234	4779	5.476	.6417	?	8165
8171	1006.02	732	266	.19246	.00001	50	.01153	50	.06054	5905	5.719	.4214	?	8171
8172	717.66	613	150	.16666	.00001	50	.00001	50	.11622	2751	5.020	.6461	✓	8172
8175	2160.52	677	346	.18174	.00001	50	.00001	50	.06655	6234	5.384	.6475	✓	8175
8182	1652.02	557	300	.14367	.00001	50	.05756	50	.11174	3781	4.170	.7565	✓	8182
8185	2029.20	582	121	.13911	.00001	50	.00001	50	.07011	6405	4.225	.6374	?	8185
8193	.20	264	3	.00850	.00001	64	.00001	0	.00001	0	.028	1.0000	?	8193
8201	1053.00	739	20	.16852	.00001	50	.04133	50	.05615	4527	5.651	.1967	✓	8201

8204	[illegible]	621	164	.18675	.00001	50	.00001	50	.09148	4201	5.465	.5162	?	8204
8205	661.59	625	65	.29685	.00001	50	.02758	50	.15524	1885	9.224	.6474	?	8205
8211	1142.39	750	152	.21454	.00001	50	.00001	50	.05075	4921	7.162	.0914	?	8211
8212	4086.20	625	255	.15361	.00001	50	.01955	50	.02655	5464	4.752	.2042	✓	8212
8215	1882.64	596	129	.15875	.00001	50	.06000	50	.02625	6842	4.676	.2965	?	8215
8221	1550.67	756	131	.16868	.00001	50	.02956	50	.05744	4570	5.510	.0654	✓	8221
8222	616.40	650	58	.10155	.00001	50	.00001	50	.08676	3955	5.620	.5177	✓	8222
8225	509.65	617	184	.19754	.00001	50	.00001	50	.17523	2081	6.646	.6755	✓	8225
8232	721.42	551	52	.16544	.00001	50	.02533	50	.05795	3220	4.929	.3958	✓	8232
8235	268.08	521	165	.18333	.00001	50	.00001	50	.14597	1481	5.624	.7851	✓	8235
8242	351.22	615	137	.16915	.00001	50	.04800	50	.12156	2625	5.564	.7062	✓	8242
8245	1128.35	636	126	.16665	.00001	50	.03489	50	.07226	5712	5.159	.5171	?	8245
8251	1034.37	719	207	.18905	.00001	50	.00001	50	.06443	3743	6.228	.2465	?	8251
8254	[illegible]	656	145	.20444	.00001	50	.00001	50	.15545	1886	[illegible]	.7444	?	8254
8255	[illegible]	654	149	.20657	.00001	50	.04467	50	.11735	1661	[illegible]	.8176	?	8255
8261	1034.37	722	61	.15021	.00001	50	.00001	50	.06756	4437	4.636	.1745	?	8261
8264	[illegible]	657	[illegible]	.20975	.00001	50	.00001	50	.12477	1519	6.687	.6400	?	8264
8265	1477.49	702	178	.18342	.00001	50	.00001	50	.08735	2888	6.308	.6477	?	8265
8272	50.78	507	92	.22752	.00001	50	.00001	50	.06232	957	9.940	.5504	?	8272
8275	[illegible]	526	297	.18498	.00001	50	.00001	50	.09635	1205	6.447	.6470	?	8275
8281	1341.43	750	172	.16606	.00001	50	.00001	50	.05751	4837	5.369	.3728	?	8281
8282	406.52	625	95	.12649	.00001	50	.00001	50	.07600	3111	4.225	.6475	?	8282
8285	226.60	500	107	.16750	.00001	50	.00001	50	.11101	1615	5.417	.6051	✓	8285
8291	1013.31	618	236	.13963	.00001	50	.00001	50	.03515	3380	4.459	.1935	✓	8291
8292	63.42	546	126	.10443	.00001	50	.00001	50	.10565	1031	3.253	.7695	✓	8292
8295	46.26	570	232	.23567	.00001	50	.00001	50	.19255	612	7.057	.9364	✓	8295
8302	346.25	483	65	.14922	.00001	50	.00001	50	.08645	1649	4.538	.6856	✓	8302
8305	781.37	559	157	.17840	.00001	50	.00001	50	.07905	3129	5.457	.6824	✓	8305
8312	61.61	545	309	.21150	.00001	50	.04222	50	.20164	1205	6.407	.8226	?	8312
8315	12.15	482	166	.16406	.00001	50	.00001	50	.16177	380	5.028	.8086	?	8315
8321	[illegible]	661	[illegible]	.16677	.00001	50	.00001	50	.02957	6714	[illegible]	.3863	?	8321
8322	1316.36	591	231	.15926	.00001	50	.05000	50	.04753	3939	4.500	.2257	?	8322
8325	165.06	521	157	.12311	.00001	50	.00003	50	.06457	941	3.670	.7351	?	8325
8331	1005.76	568	117	.15940	.00001	50	.00001	50	.05550	4990	[illegible]	.3661	?	8331
8334	447.59	547	77	.12145	.00001	50	.00001	50	.05561	2088	3.446	.5429	?	8334
8335	162.37	561	167	.12434	.00001	50	.02128	50	.07032	2736	3.436	.7037	?	8335
8341	1002.04	639	460	.15791	.00001	50	.00001	50	.05751	4593	4.868	.3856	?	8341
8344	1007.09	634	150	.17866	.00001	50	.05211	50	.06633	5505	4.575	.3544	?	8344
8345	150.46	579	276	.19626	.00001	50	.05022	50	.17675	1571	6.255	.9206	?	8345
8351	1301.14	535	137	.15901	.00001	50	.00001	50	.03185	8505	4.526	.3310	✓	8351
8352	165.06	512	125	.16056	.00001	50	.00001	50	.09568	2556	5.246	.7125	✓	8352
8355	38.22	432	249	.16876	.00001	50	.00001	50	.13290	814	6.720	.5725	✓	8355
8361	1799.65	532	352	.15146	.00001	50	.00001	50	.02501	7246	3.554	.0661	✓	8361
8362	912.57	437	107	.14176	.00001	50	.00001	50	.09271	2642	4.210	.5756	✓	8362
8365	1646.66	480	259	.15254	.00001	50	.03356	50	.04286	6548	4.535	.4155	?	8365
8371	1301.57	442	357	.10329	.00001	50	.00001	50	.05242	5809	3.578	.3245	?	8371
8372	53.42	289	5	.07761	.00001	50	.02956	50	.08685	758	1.614	.7355	✓	8372
8375	157.55	545	127	.20322	.00001	50	.00001	50	.15161	1215	5.564	.9453	?	8375
8382	605.31	515	223	.16115	.00001	50	.00001	50	.15727	1084	4.738	.8361	?	8382
8385	376.35	332	118	.14771	.00001	50	.00001	50	.06743	3946	4.330	.2536	?	8385
8391	[illegible]	524	[illegible]	.15805	.00001	50	.00001	50	.07591	4087	[illegible]	.0067	?	8391
8392	555.23	416	333	.18267	.00001	50	.00001	50	.10145	1106	5.750	.8145	?	8392
8394	269.36	449	144	.22330	.00001	50	.01111	50	.19445	650	[illegible]	.9319	?	8394
8401	1061.35	786	70	.14345	.00001	50	.07022	50	.07652	4756	4.646	.1954	?	8401
8402	[illegible]	401	468	.10746	.00001	50	.04622	50	.10324	1029	2.572	.7072	?	8402
8405	1158.30	451	128	.14725	.00001	50	.00001	50	.06190	3900	4.285	.6146	✓	8405
8411	1496.76	596	144	.18377	.00001	50	.00001	50	.04773	6173	5.410	.3167	?	8411
8412	667.14	555	444	.15166	.00001	50	.00001	50	.10529	1321	4.809	.8325	?	8412
8415	357.71	361	136	.17053	.00001	50	.00001	50	.13348	1350	5.556	.0771	✓	8415
8421	1371.63	376	105	.17303	.00001	50	.00001	50	.04368	8725	5.262	.2765	✓	8421
8422	25.52	254	8	.06174	.00001	50	.00001	50	.06395	435	2.828	.5515	✓	8422
8425	12.56	274	138	.11912	.00001	50	.01267	50	.08606	252	4.139	.9135	?	8425
8432	829.14	320	18	.16500	.00001	50	.00001	50	.05031	6557	4.641	.1662	?	8432
8435	115.63	222	134	.05537	.00001	50	.02889	50	.07772	792	1.541	.5343	✓	8435
8442	1344.50	298	321	.18469	.00001	50	.03778	50	.09396	1953	5.526	.7155	?	8442
8445	2170.34	311	138	.10436	.00001	50	.00001	50	.07727	4710	3.152	.5953	?	8445
8454	45.36	256	[illegible]	.06545	.00001	50	.00001	50	.08567	597	1.466	.6197	?	8454
8455	[illegible]	226	87	.11304	.00001	50	.00001	50	.09677	899	5.600	.6734	?	8455
8457	49.47	286	440	.17840	.00001	50	.00001	50	.15785	265	5.742	.5664	?	8457
8464	26.95	244	174	.17202	.00001	50	.00001	50	.11414	474	5.065	.7867	?	8464
8471	1310.05	735	295	.19609	.00001	50	.00001	50	.02736	6901	5.426	.5536	?	8471
8472	64.24	557	150	.24154	.00001	50	.00001	50	.34405	290	8.565	.9415	?	8472
8475	200.66	550	215	.14620	.00001	50	.00844	50	.10530	1177	4.247	.9475	✓	8475
8481	1372.26	750	458	.19666	.00001	50	.00003	50	.02536	4836	5.667	.3744	?	8481
8482	50.22	529	315	.15920	.00001	50	.00001	50	.16456	544	5.570	.0225	?	8482
8485	25.02	344	112	.26915	.00001	50	.00001	50	.32563	435	10.281	.9552	✓	8485
8492	72.56	255	355	.07134	.00001	50	.01333	50	.05660	1050	1.567	.4400	✓	8492
8495	54.24	256	161	.07427	.00001	50	.01200	50	.06351	1157	2.037	.8355	✓	8495
8502	679.35	299	212	.15257	.00001	50	.03001	50	.09901	2500	3.556	.6031	?	8502
8505	335.66	301	136	.10305	.00001	50	.03844	50	.06003	1771	3.035	.6707	?	8505
8512	571.66	309	279	.12066	.00001	50	.03956	50	.09385	2413	3.811	.5931	✓	8512

[illegible]	[illegible]	[illegible]	96	.09564	.00001	50	[illegible]	50	.01564	[illegible]	3.111	[illegible]	7	[illegible]
8521	1093.15	456	311	.16140	.00001	50	.01466	50	.03244	9140	4.878	.4386	7	6521
8522	555.21	404	251	.12074	.00001	50	.00001	50	.03459	6541	3.552	.4025	7	6522
8525	43.74	334	340	.20224	.00001	50	.00001	50	.17715	667	6.331	.0656	/	6525
[illegible]	1834.55	412	105	.15580	.00001	50	.00001	50	.07420	4835	4.589	.4075	7	[illegible]
8535	2155.54	373	112	.09141	.00001	50	.00001	50	.05421	9262	2.556	.5521	/	6535
8542	1703.42	425	213	.10552	.00001	50	.00001	50	.12075	2000	5.551	.0610	/	6542
8543	2255.35	421	125	.10956	.00001	50	.00001	50	.07135	5535	3.209	.7435	/	6543
8551	1620.45	555	132	.13897	.00001	50	.00001	50	.08073	6032	3.351	.3357	/	6551
8552	1578.85	489	317	.14975	.00001	50	.00001	50	.04311	6942	4.532	.4156	/	6552
8553	1450.45	477	115	.11940	.00001	50	.00001	50	.07151	5920	3.459	.7603	/	6553
8562	249.45	392	45	.11745	.00001	50	.07232	50	.15351	1515	3.434	.7021	7	6562
8565	336.16	460	167	.17316	.00001	50	.00001	50	.10565	1301	5.160	.7524	7	6565
[illegible]	[illegible]	665	10	.19605	.00001	50	[illegible]	50	.08043	[illegible]	5.969	[illegible]	7	[illegible]
[illegible]	[illegible]	505	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	1561	[illegible]	.0601	7	[illegible]
8582	122.32	500	342	.19730	.00001	50	.00001	50	.20701	1502	5.838	.8062	7	6582
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	904	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	665	[illegible]	.17834	.00001	50	[illegible]	50	.06420	[illegible]	4.162	[illegible]	7	[illegible]
[illegible]	548.[illegible]	602	[illegible]	.18050	.00001	50	[illegible]	50	.15525	2264	[illegible]	.8024	7	[illegible]
[illegible]	[illegible]	558	[illegible]	[illegible]	.00001	50	.02976	50	.04758	[illegible]	4.885	[illegible]	7	[illegible]
[illegible]	[illegible]	503	58	.17544	.00001	50	[illegible]	50	[illegible]	[illegible]	4.709	[illegible]	7	[illegible]
[illegible]	[illegible]	502	[illegible]	[illegible]	.00001	50	[illegible]	50	.05340	[illegible]	[illegible]	[illegible]	7	[illegible]
8612	189.25	496	330	.21020	.00001	50	.04244	50	.22162	724	6.460	.7555	/	6612
8613	204.93	503	140	.13865	.00001	50	.00001	50	.08585	1916	4.273	.7514	/	6613
8621	1264.41	661	26	.11720	.00001	50	.04732	50	.04522	5535	3.594	.3223	/	6621
8622	667.75	577	326	.15345	.00001	50	.00001	50	.05555	3223	4.763	.3562	/	6622
8623	387.95	560	129	.14226	.00001	50	.03133	50	.07165	1951	4.513	.6795	/	6623
8631	1005.21	689	125	.15515	.00001	50	.00001	50	.06225	5150	4.782	.3012	/	6631
8632	724.67	582	49	.14755	.00001	50	.00976	50	.03120	4752	4.608	.2525	7	6632
8633	1325.33	659	140	.14911	.00001	50	.00001	50	.04511	9145	4.430	.5033	7	6633
[illegible]	49.16	[illegible]	[illegible]	.08955	.00001	50	.05800	50	.11194	342	3.065	.5501	7	[illegible]
8645	75.75	486	195	.14002	.00001	50	.00001	50	.09514	1245	4.614	.2202	7	6645
8651	1031.16	667	176	.15025	.00001	50	.00001	50	.04773	6654	[illegible]	.5205	7	6651
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	1462	4.812	[illegible]	7	[illegible]
8655	[illegible]	621	201	.17340	.00001	50	.02469	50	.08857	1340	4.888	.8056	7	6655
8661	[illegible]	669	142	.15112	.00001	50	.03078	50	.05657	2815	4.635	.4007	7	6661
8662	458.16	[illegible]	69	.17815	.00001	50	.02919	50	.10268	1385	[illegible]	.5546	7	6662
8665	607.54	550	221	.17826	.00001	50	.05869	50	.08459	2359	5.706	.4407	7	6665
8671	1014.02	617	122	.14041	.00001	50	.00001	50	.06225	4601	4.201	.1595	7	6671
8672	1143.72	545	58	.15046	.00001	50	.00001	50	.05530	3050	4.033	.4450	/	6672
8673	1033.56	551	261	.17865	.00001	50	.00001	50	.09532	2503	5.615	.5215	/	6673
8681	1001.97	687	226	.12246	.00001	50	.02244	50	.01517	7946	3.266	.1611	/	6681
8682	250.35	622	145	.20757	.00001	50	.00001	50	.15710	949	6.359	.8513	/	6682
8683	202.53	629	257	.20122	.00001	50	.00001	50	.28217	922	6.136	.8505	/	6683
8691	1026.83	464	110	.15526	.00001	50	.00001	50	.08750	5464	3.972	.6935	7	6691
8692	18.63	514	56	.08943	.00001	50	.00001	50	.14108	102	3.101	.5213	7	6692
8693	81.56	340	155	.08763	.00001	50	.00001	50	.06254	1320	2.381	.7591	/	6693
8702	352.32	331	6	.07342	.00001	50	.00001	50	.03514	2655	2.053	.5424	7	6702
8703	366.33	361	165	.07950	.00001	50	.01756	50	.03203	6022	2.101	.5053	7	6703
8711	1001.55	520	73	.12160	.00001	50	.00001	50	.04773	4537	3.636	.3133	7	6711
[illegible]	[illegible]	486	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	3.686	[illegible]	7	[illegible]
[illegible]	[illegible]	421	[illegible]	[illegible]	.00001	50	.06022	50	[illegible]	4096	2.180	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	6752	2.760	.2503	7	[illegible]
[illegible]	[illegible]	581	[illegible]	.06706	.00001	50	[illegible]	50	[illegible]	6001	1.808	[illegible]	7	[illegible]
[illegible]	[illegible]	566	[illegible]	.06066	.00001	50	[illegible]	50	[illegible]	9476	[illegible]	[illegible]	7	[illegible]
8731	1535.32	374	56	.05965	.00001	50	.02867	50	.02427	6457	1.560	.2755	/	6731
[illegible]	[illegible]	[illegible]	42	[illegible]	.00001	50	.01300	50	[illegible]	[illegible]	1.895	[illegible]	7	[illegible]
[illegible]	[illegible]	326	[illegible]	[illegible]	.00001	50	[illegible]	50	.05598	1556	2.562	.6680	7	[illegible]
8741	1590.05	304	212	.07750	.00001	50	.00001	50	.03430	7702	1.980	.1417	/	6741
8742	290.82	330	50	.06633	.00001	50	.00844	50	.03816	1211	1.911	.4536	/	6742
8743	627.75	371	155	.09259	.00001	50	.04511	50	.05645	4569	2.791	.4694	/	6743
8751	1016.55	442	119	.12347	.00001	50	.00001	50	.07334	3825	3.523	.1683	7	6751
8752	826.72	354	50	.12936	.00001	50	.00001	50	.05414	5360	3.918	.5397	7	6752
8753	757.35	371	150	.13826	.00001	50	.00001	50	.09762	3364	4.139	.5655	/	6753
8761	1016.12	452	75	.14975	.00001	50	.00001	50	.06356	5011	4.110	.2221	7	6761
8762	178.27	502	8	.16217	.00001	50	.01200	50	.11491	1795	4.951	.0036	7	6762
[illegible]	[illegible]	585	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	.07030	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	46.44	307	[illegible]	.10764	.00001	50	.05232	50	[illegible]	240	[illegible]	.6064	7	[illegible]
[illegible]	32.40	444	[illegible]	.11455	.00001	50	.01437	50	.07391	256	3.865	.7264	7	[illegible]
[illegible]	[illegible]	178	2	[illegible]	.00001	50	[illegible]	50	[illegible]	3132	.865	[illegible]	7	[illegible]
8785	1041.63	220	207	.12025	.00001	50	.00001	50	.01466	6030	4.105	.1657	7	6785
8791	1106.45	291	75	.10510	.00001	50	.00001	50	.05515	6120	3.305	.3275	/	6791
[illegible]	[illegible]	220	[illegible]	.16363	.00001	50	[illegible]	50	[illegible]	851	[illegible]	[illegible]	7	[illegible]
8795	547.53	213	115	.10252	.00001	50	.00001	50	.04569	2245	3.397	.6685	7	6795
8802	124.74	172	27	.09262	.00001	50	.01600	50	.05585	1666	2.808	.4625	/	6802
8803	1161.75	262	137	.10611	.00001	50	.00001	50	.04266	6171	3.339	.4065	/	6803
8811	1006.43	312	110	.11362	.00001	50	.00001	50	.03701	6129	3.353	.4556	/	6811
8812	55.56	200	223	.16173	.00001	50	.02844	50	.00211	301	5.535	.7237	7	6812
[illegible]	141.07	273	110	.12770	.00001	50	.00001	50	.11718	2924	4.010	.7693	7	[illegible]
8822	259.70	248	41	.21200	.00001	50	.02335	50	.16154	2222	6.630	.7564	/	6822

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
6851	405.13	202	166	.16572	.00001	50	.00001	50	.04995	2548	5.496	.4531	P	8851
6842	5310.33	283	109	.14050	.00001	50	.00001	50	.04550	9552	4.443	.2674	P	8842
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
6051	1111.33	373	322	.12153	.00001	50	.00001	50	.06618	5225	2.352	.2865	P	8051
6052	690.31	316	201	.10135	.00001	50	.03358	50	.07340	5224	3.408	.6857	P	8052
6053	201.69	271	42	.13787	.00001	50	.00001	50	.12515	1606	4.230	.7160	P	8053
6052	710.17	226	152	.09055	.00001	50	.00001	50	.07321	4455	2.504	.5597	P	8052
6853	302.13	204	133	.15737	.00001	50	.00001	50	.06736	1562	5.141	.5065	P	8853
6872	473.11	297	120	.14478	.00001	50	.00001	50	.12549	3574	4.390	.7389	P	8872
6873	324.13	204	151	.09218	.00001	50	.00001	50	.07272	2527	2.321	.2356	P	8873
6882	2767.31	332	109	.13133	.00001	50	.00001	50	.05115	6612	3.952	.0658	P	8882
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
6893	179.53	380	121	.09503	.00001	50	.00001	50	.04626	3034	2.110	.0501	P	8893
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
6912	171.24	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	8912
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
6922	1114.59	347	201	.07565	.00001	50	.00001	50	.04300	6172	2.099	.4247	P	8922
6923	1204.67	391	58	.10155	.00001	50	.03758	50	.02502	8561	3.181	.2640	P	8923
6932	65.51	354	351	.10233	.00001	50	.00001	50	.06714	687	2.614	.7450	P	8932
6933	67.85	276	171	.11165	.00001	50	.00001	50	.05025	1422	2.452	.7570	P	8933
6942	511.92	303	113	.10566	.00001	50	.00001	50	.07165	2056	3.031	.6279	P	8942
6943	474.56	302	130	.09667	.00001	50	.00001	50	.06783	2625	3.021	.7319	P	8943
6952	382.51	335	115	.11014	.00001	50	.00001	50	.07429	3160	3.407	[illegible]	P	8952
6953	350.15	302	138	.09681	.00001	50	.00001	50	.04735	1656	2.876	.7451	P	8953
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
6963	200.88	317	132	.09182	.00001	50	.03022	50	.05357	2205	2.599	.7380	P	8963
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
6983	71.28	351	68	.10208	.00001	50	.00001	50	.06015	558	3.001	[illegible]	P	8983
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
6993	120.53	389	97	.09151	.00001	50	.00001	50	.05277	1211	2.767	.7011	P	8993
7001	1060.13	520	90	.14152	.00001	50	.03511	50	.04320	5415	4.115	.2377	P	3001
7002	462.51	405	316	.10084	.00001	50	.00522	50	.05550	1255	3.071	.7215	P	3002
7003	1022.22	417	106	.07755	.00001	50	.00001	50	.04136	4455	2.271	.5890	P	3003
7011	1047.53	525	10	.15513	.00001	50	.03256	50	.05315	5257	4.076	.2314	P	3011
7012	1415.07	435	147	.13136	.00001	50	.00001	50	.03757	6542	4.021	.2470	P	3012
7013	2227.94	450	130	.10265	.00001	50	.00001	50	.02168	4452	2.913	.5194	P	3013
7021	1106.89	411	95	.07481	.00001	50	.00001	50	.01720	6405	2.095	.1504	P	3021
7022	137.88	341	139	.10651	.00001	50	.00001	50	.06635	563	2.561	.4579	P	3022
7023	355.98	364	116	.11682	.00001	50	.00001	50	.04446	1336	3.455	.5169	P	3023
7031	1053.33	395	112	.07036	.00001	50	.00165	50	.02374	5062	1.901	.1510	P	3031
7032	137.17	326	45	.10073	.00001	50	.03238	50	.05167	1045	3.016	.6767	P	3032
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
7052	511.85	315	46	.13576	.00001	50	.00001	50	.05542	2701	4.466	.4226	P	3052
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
7062	120.33	272	57	.10171	.00001	50	.03022	50	.04776	1405	2.504	.5419	P	3062
7063	124.74	281	180	.11027	.00001	50	.00001	50	.07985	1552	3.000	.7095	P	3063
7072	660.96	272	151	.13036	.00001	50	.01556	50	.04761	3661	4.176	.4250	P	3072
7073	499.77	245	170	.10185	.00001	50	.00001	50	.04625	3815	3.144	.6515	P	3073
7082	770.11	301	20	.02265	.00001	50	.00723	50	.02548	5610	2.503	.4258	P	3082
7083	47.29	196	176	.11632	.00001	50	.00001	50	.06778	1205	3.111	.6964	P	3083
7092	419.55	225	16	.12275	.00001	50	.00511	50	.04653	3622	3.993	.4645	P	3092
7093	502.13	212	180	.09672	.00001	50	.00001	50	.03722	2531	3.273	.5402	P	3093
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
7123	350.75	284	100	.21152	.00001	50	.00001	50	.12545	1004	6.161	.7550	P	3123
7131	1061.13	306	208	.09657	.00001	50	.00001	50	.02515	5355	3.060	.1196	P	3131
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
7133	783.27	320	142	.11120	.00001	50	.00001	50	.06856	5022	3.016	.5540	P	3133
7142	561.59	252	120	.00113	.00001	50	.00001	50	.06490	4140	2.529	.5099	P	3142
7143	331.19	314	127	.21078	.00001	50	.00001	50	.15357	2052	6.601	.5260	P	3143
7151	1010.37	196	109	.13571	.00001	50	.00001	50	.02852	5735	4.387	.2749	P	3151
7152	241.26	275	287	.02031	.00001	50	.00001	50	.04462	3132	2.600	.7390	P	3152
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
7162	1007.56	296	130	.09536	.00001	50	.00001	50	.04752	5343	2.006	.5616	P	3162

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
9175	52.24	245	115	.20070	.00001	50	.02209	50	.10000	615	6.992	.8061	P	9175
9181	1091.57	400	277	.14056	.00001	50	.00001	50	.03403	6605	4.592	.2211	✓	9181
9182	45.48	[illegible]	[illegible]	.10951	.00001	50	.00001	50	.00543	[illegible]	[illegible]	[illegible]	P	9182
9183	91.28	278	7	.11145	.00001	50	.02467	50	.05227	1317	4.180	.6411	✓	9183
9192	179.31	236	315	.30236	.00001	50	.00001	50	.06403	1832	2.175	.5658	✓	9192
9193	69.19	305	125	.33051	.00001	50	.00001	50	.25506	562	10.794	.9785	✓	9193
9201	1336.62	692	354	.24835	.00001	50	.00001	50	.05365	9118	7.331	.2792	✓	9201
9202	1177.74	425	373	.15565	.00001	50	.02244	50	.04741	4561	5.336	.3394	✓	9202
9203	747.62	434	3	.18024	.00001	50	.05222	50	.09112	4452	6.792	.5636	✓	9203
9212	1053.75	265	330	.09735	.00001	50	.03333	50	.05505	5070	3.150	.6005	P	9212
9213	889.36	350	122	.26084	.00001	50	.04844	50	.09358	4335	7.391	.7397	P	9213
9221	[illegible]	295	[illegible]	.21480	.00001	50	.06487	50	.08768	5025	[illegible]	.4836	P	9221
9222	168.10	305	240	.12564	.00001	50	.00001	50	.09452	2711	4.111	.7296	P	9222
9223	68.80	271	18	.15130	.00001	50	.32974	50	.09264	652	4.376	.8937	P	9223
9232	848.60	280	[illegible]	.10468	.00001	50	.00001	50	.07620	5957	5.397	.5594	P	9232
9233	711.44	358	[illegible]	.19535	.00001	50	.00001	50	.07224	4024	6.387	.5060	P	9233
9241	1055.15	473	325	.18550	.00001	50	.00001	50	.10450	6449	6.155	.4835	P	9241
9242	156.09	305	262	.10675	.00001	50	.05256	50	.04954	2606	3.086	.8070	P	9242
9243	45.38	273	4	.07665	.00001	50	.00732	50	.01708	279	3.151	.9040	P	9243
9252	491.78	273	218	.08524	.00001	50	.02256	50	.03097	4391	2.540	.6273	P	9252
9253	727.12	391	112	.25614	.00001	50	.00001	50	.08656	3732	8.516	.3157	✓	9253
9262	126.36	376	257	.09633	.00001	50	.02956	50	.04211	2133	2.957	.4692	✓	9262
9263	8.91	267	57	.22270	.00001	50	.00001	50	.18652	306	8.559	.7834	✓	9263
9271	1125.94	602	311	.23006	.00001	50	.02400	50	.11575	5154	8.529	.4551	✓	9271
9272	109.38	322	246	.12945	.00001	50	.03085	50	.10443	1050	4.176	.7368	✓	9272
9273	69.10	316	13	.14329	.00001	50	.00001	50	.09177	652	4.375	.8515	✓	9273
9281	1352.72	619	231	.18970	.00001	50	.00001	50	.09703	5126	6.331	.6757	P	9281
9282	1310.14	559	211	.12860	.00001	50	.06623	50	.10162	5624	3.884	.7691	P	9282
9283	856.64	408	47	.17894	.00001	50	.05663	50	[illegible]	[illegible]	4.779	.3306	P	9283
9292	727.36	327	202	.28313	.00001	50	.01267	50	.10469	2335	9.067	.7476	P	9292
9293	1656.47	469	137	.31933	.00001	50	.00001	50	.07693	7024	10.735	.5787	P	9293
9301	1042.86	667	357	.21044	.00001	50	.00001	50	.09909	[illegible]	7.082	.4913	P	9301
9302	3740.42	723	268	.17450	.00001	50	.04793	50	.08774	7709	6.076	.4667	P	9302
9303	747.63	462	48	.21124	.00001	50	.05467	50	.11330	1773	7.178	.6373	P	9303
9312	1197.79	725	380	.10535	.00001	50	.05485	50	.05665	6073	3.457	.5566	P	9312
9313	140.34	380	140	.10443	.00001	50	.00001	50	.06461	1956	3.359	.8542	P	9313
9322	956.15	295	315	.07224	.00001	50	.04332	50	.06402	5526	2.515	.6661	P	9322
9323	0.13	265	65	.00001	.00001	50	.00001	50	.00001	25	.052	1.0000	✓	9323
9331	1016.12	412	251	.15850	.00001	50	.00001	50	.04571	7680	5.165	.4185	✓	9331
9332	239.75	255	329	.03758	.00001	50	.02067	50	.03028	1941	1.127	.8336	✓	9332
9333	151.15	359	255	.02462	.00001	50	.00001	50	.02445	2772	.723	.8672	✓	9333
9342	40.52	265	39	.00001	.00001	50	.00001	50	.00001	1541	.029	.9621	✓	9342
9343	844.02	289	105	.06509	.00001	50	.00001	50	.03330	7407	1.818	.7071	P	9343
9352	208.92	254	329	.02640	.00001	50	.00600	50	.02671	2370	.819	.8465	P	9352
9353	176.96	267	52	.01249	.00001	50	.00001	50	.00001	2503	.409	.8647	✓	9353
9362	660.96	324	263	.09369	.00001	50	.00001	50	.06157	4551	2.798	.5752	P	9362
9363	367.53	292	359	.05146	.00001	50	.00489	50	.03243	1220	1.239	.9095	P	9363
9371	1001.16	675	353	.25175	.00001	50	.05311	50	.09678	5381	8.855	.3830	P	9371
9372	[illegible]	299	[illegible]	.25745	.00001	50	.00001	50	.11456	[illegible]	[illegible]	.5484	P	9372
9373	55.15	306	251	.12649	.00001	50	.07156	50	.14052	755	4.375	.9174	P	9373
9381	[illegible]	653	336	.21112	.00001	50	.00001	50	.11151	5082	7.590	.6536	P	9381
9382	241.47	706	381	.11766	.00001	50	.00001	50	.09564	5092	3.272	.6606	P	9382
9383	120.65	568	33	.06575	.00001	50	.00001	50	.06493	[illegible]	2.190	.9115	P	9383
9393	25.21	240	73	.03257	.00001	50	.00001	50	.01752	2222	.790	.6358	✓	9393
9402	196.49	254	327	.02115	.00001	50	.00365	50	.01729	2645	.722	.8271	P	9402
9403	142.27	245	39	.00556	.00001	50	.00001	50	.00001	2174	.356	.7500	P	9403
9411	1187.77	431	220	.12751	.00001	50	.00001	50	.07641	6661	4.257	.4667	✓	9411
9412	734.05	283	272	.07155	.00001	50	.00756	50	.02561	1685	2.050	.5768	✓	9412
9413	502.63	283	3	.06555	.00001	50	.02533	50	.02612	2427	1.758	.4405	✓	9413
9422	2349.03	391	252	.12156	.00001	50	.00001	50	.09362	7146	4.130	.5236	P	9422
9423	366.58	214	23	.09002	.00001	50	.02150	50	.03318	5141	2.532	.6260	P	9423
9431	1018.17	642	326	.25016	.00001	50	.00001	50	.07577	5306	8.200	.3792	✓	9431
9432	1426.56	557	259	.22155	.00001	50	.00001	50	.10477	6745	7.970	.5496	P	9432
9433	31.53	370	37	.22036	.00001	50	.00001	50	.10666	552	8.316	.7336	P	9433
9442	[illegible]	583	339	.15035	.00001	50	.06910	50	.13336	5393	5.164	.7532	P	9442
9443	3460.18	504	133	.26052	.00001	50	.00001	50	.14297	5326	8.720	.2970	P	9443
9451	[illegible]	663	[illegible]	.28652	.00001	50	.00001	50	.09519	4423	10.306	.1696	P	9451
9452	[illegible]	558	[illegible]	.26182	.00001	50	.06176	50	.14721	2723	9.875	.6471	P	9452
9453	[illegible]	285	8	.28744	.00001	50	.00001	50	.04775	2090	9.292	.8877	P	9453
9462	756.64	410	211	.16803	.00001	50	.07333	50	.15269	3111	5.576	.6641	P	9462
9463	353.37	521	111	.24098	.00001	50	.00001	50	.00427	4012	8.373	.5656	✓	9463
9471	1001.97	679	378	.32075	.00001	50	.02743	50	.08799	5042	11.175	.1544	P	9471
9472	159.20	442	286	.24300	.00001	50	.00001	50	.23725	1515	7.558	.8255	P	9472
9473	332.13	575	357	.20836	.00001	50	.00001	50	.22567	2145	10.325	.7160	✓	9473
9482	464.36	443	306	.16426	.00001	50	.07556	50	.14379	3241	5.509	.7334	✓	9482
9483	469.24	504	115	.22164	.00001	50	.00001	50	.11722	3456	7.112	.7336	✓	9483
9491	1124.26	720	322	.20546	.00001	50	.03311	50	.09759	4120	10.495	.1566	P	9491
9492	[illegible]	555	340	.27778	.00001	50	.00001	50	.21717	2370	9.789	.7417	P	9492
9493	259.20	527	13	.29977	.00001	50	.00001	50	.19511	1826	10.087	.8087	✓	9493

9502	[illegible]	315	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	9502
9503	[illegible]	329	110	[illegible]	.00001	50	.01044	50	[illegible]	[illegible]	[illegible]	1.0000	P	9503
9512	1580.51	492	315	.20419	.00001	50	.00001	50	.15351	3950	9.093	.7487	P	9512
9513	1371.55	595	124	.26680	.00001	50	.00001	50	.10687	5124	8.661	.6062	P	9513
9521	1064.70	736	[illegible]	.25268	.00001	50	.00001	50	.09500	[illegible]	8.868	.3665	P	9521
9522	1535.75	497	311	.27245	.00001	50	.02222	50	.07143	5610	9.160	.2556	P	9522
9523	402.57	540	6	.29230	.00001	50	.00265	50	.23956	1592	9.674	.6471	P	9523
9532	2008.60	551	107	.22049	.00001	50	.00001	50	.06756	6135	7.687	.5507	P	9532
9533	1599.75	616	120	.25565	.00001	50	.00001	50	.11070	4035	8.374	.6696	P	9533
9542	5.57	375	132	.05279	.00001	50	.02355	50	.07250	161	1.121	.6034	P	9542
9543	5.57	406	91	.23370	.00001	50	.09176	50	.31866	215	7.391	.5295	P	9543
9551	1009.21	760	300	.29319	.00001	50	.01244	50	.10259	4255	10.020	.2471	P	9551
9552	182.75	525	225	.26369	.00001	50	.05576	50	.19261	1145	8.205	.7557	P	9552
9553	299.20	594	[illegible]	.28509	.00001	50	.00001	50	.16590	[illegible]	9.853	[illegible]	P	9553
9562	[illegible]	524	[illegible]	.15843	.00001	50	.07494	50	.15061	3754	5.228	.7466	P	9562
9563	219.58	512	100	.23238	.00001	50	.02156	50	.13130	1639	7.223	.6542	P	9563
9571	[illegible]	773	[illegible]	.28537	.00001	50	.00001	50	.10709	[illegible]	[illegible]	.2552	P	9571
9572	132.87	540	442	.18936	.00001	50	.04726	50	[illegible]	1457	5.914	[illegible]	P	9572
9573	162.59	592	551	.25034	.00001	50	.00001	50	.16740	1055	9.054	.5592	P	9573
9581	1003.59	775	401	.23537	.00001	50	.01511	50	[illegible]	6035	8.028	.2550	P	9581
9582	757.70	561	408	.13037	.00001	50	.04544	50	.13405	4484	4.553	.5448	P	9582
9583	504.87	550	72	.15298	.00001	50	.06444	50	.06805	5174	4.011	.2662	P	9583
9592	1466.13	512	302	.12676	.00001	50	.04555	50	.06021	5442	5.765	.7264	P	9592
9593	2760.02	666	128	.21162	.00001	50	.00001	50	.05920	7842	6.830	.5678	P	9593
9602	210.60	485	217	.08579	.00001	50	.02867	50	.04563	2165	2.286	.4521	P	9602
9603	870.75	645	315	.18031	.00001	50	.00001	50	.10029	5743	6.396	.5250	P	9603
9611	1064.36	760	286	.23186	.00001	50	.00001	50	.09505	7447	7.760	.4026	P	9611
9612	55.08	551	146	.16261	.00001	50	.00001	50	.15217	544	4.976	.6776	P	9612
9613	54.02	527	331	.10240	.00001	50	.00001	50	.07734	1021	3.209	.5745	P	9613
9621	1001.16	981	291	.22177	.00001	50	.00001	50	.12770	4421	5.705	.1900	P	9621
9622	[illegible]	695	232	.26710	.00001	50	.05669	50	.06061	[illegible]	8.078	.4718	P	9622
9623	341.82	745	5	.31738	.00001	50	.00001	50	.22601	1750	11.022	.6255	P	9623
9632	3496.77	667	302	.19874	.00001	50	.03207	50	.07354	9467	6.919	.4600	P	9632
9633	4195.86	656	127	.17967	.00001	50	.08578	50	.05770	7419	[illegible]	.5087	P	9633
9641	1018.17	739	405	.23444	.00001	50	.00001	50	.06675	7945	8.753	.3465	P	9641
9642	50.28	465	127	.05915	.00001	50	.01007	50	.03456	470	1.117	.6099	P	9642
9643	50.28	504	90	.15752	.00001	50	.00001	50	.11780	504	5.254	.8452	P	9643
9652	1675.17	556	410	.13480	.00001	50	.00001	50	.06443	6041	4.528	.4583	P	9652
9653	2009.91	625	120	.16269	.00001	50	.02222	50	.08041	5641	5.199	.6101	P	9653
9661	1091.89	815	313	.23671	.00001	50	.00001	50	.11117	5066	6.608	.4301	P	9661
9662	1393.20	767	267	.21211	.00001	50	.00001	50	.08612	6662	7.497	.4569	P	9662
9663	265.58	565	19	.14396	.00001	50	.01776	50	.07258	1062	4.735	.6569	P	9663
9672	120.57	504	306	.06185	.00001	50	.02511	50	.06377	1522	1.650	.5700	P	9672
9673	699.64	702	112	.22626	.00001	50	.00001	50	.10126	4257	7.363	.5692	P	9673
9681	1006.85	774	302	.20633	.00001	50	.00001	50	.07727	7613	7.210	.4716	P	9681
9682	522.12	605	285	.12581	.00001	50	.07511	50	.06909	3142	4.449	.5057	P	9682
9683	186.50	562	20	.13262	.00001	50	.03156	50	.05611	1661	4.256	.6521	P	9683
9692	389.61	554	302	.10286	.00001	50	.02067	50	.02950	3605	3.494	.4563	P	9692
9693	143.37	529	125	.12016	.00001	50	.00001	50	.02024	1095	3.700	.6555	P	9693
9701	1163.77	833	317	.24338	.00001	50	.00001	50	.11131	5550	8.683	.4799	P	9701
9702	494.96	603	461	.10611	.00001	50	.00001	50	.06848	[illegible]	[illegible]	.6466	P	9702
9703	191.28	601	36	.27735	.00001	50	.03222	50	.35570	[illegible]	8.050	.6705	P	9703
9712	54.11	515	452	.08547	.00001	50	.00001	50	.11031	366	2.919	.6462	P	9712
9713	601.68	714	115	.24118	.00001	50	.01244	50	.09098	5544	7.863	.4026	P	9713
9721	811.59	652	435	.14557	.00001	50	.00001	50	.05546	6477	5.013	.3477	P	9721
9722	130.59	556	260	.12513	.00001	50	.03333	50	.05095	857	3.959	.7746	P	9722
9723	51.87	562	65	.19011	.00001	50	.01556	50	.17846	[illegible]	5.512	.8546	P	9723
9732	645.97	571	575	.09575	.00001	50	.00001	50	.03505	4078	3.144	.4462	P	9732
9733	2037.15	742	100	.21096	.00001	50	.00001	50	.06760	6749	6.971	.4561	P	9733
9741	1006.52	1002	298	.30951	.00001	50	.00001	50	.10776	5365	11.009	.3524	P	9741
9742	2783.37	774	291	.18759	.00001	50	.00001	50	.06626	7612	6.782	.5144	P	9742
9743	1769.85	705	356	.14591	.00001	50	.00001	50	.03562	8225	5.247	.2734	P	9743
9752	1185.86	567	305	.11525	.00001	50	.03044	50	.05211	2466	3.801	.6348	P	9752
9753	1742.51	715	121	.25577	.00001	50	.00001	50	.06907	3722	8.490	.6252	P	9753
9761	1009.45	895	302	.18492	.00001	50	.00001	50	.07947	8546	6.203	.5313	P	9761
9762	1110.51	662	290	.11579	.00001	50	.00001	50	.02735	6663	3.967	.2307	P	9762
9763	123.91	628	20	.04514	.00001	50	.00001	50	.05675	[illegible]	[illegible]	.6828	P	9763
9772	510.28	639	489	.08570	.00001	50	.00001	50	.04085	2880	3.000	.4262	P	9772
9773	600.17	756	101	.24226	.00001	50	.02188	50	.05780	3424	8.060	.5048	P	9773
9781	1001.15	911	119	.29611	.00001	50	.00001	50	.06871	[illegible]	9.958	.4761	P	9781
9782	4603.97	810	506	.17752	.00001	50	.04722	50	.07550	8544	6.013	.5467	P	9782
9783	921.78	735	99	.16651	.00001	50	.00001	50	.05505	3242	5.474	.5295	P	9783
9791	1041.55	797	55	.10426	.00001	50	.00001	50	.06239	4241	6.520	.0409	P	9791
9792	1776.55	780	510	.17688	.00001	50	.04517	50	.07001	2040	6.541	.5455	P	9792
9793	2666.58	776	121	.19759	.00001	50	.06711	50	.06555	5568	6.502	.4578	P	9793
9801	1002.78	647	72	.27631	.00001	50	.06155	50	.05070	5218	9.328	.1351	P	9801
9802	127.17	544	70	.24531	.00001	50	.02333	50	.14211	2064	8.759	.6514	P	9802
9803	57.51	516	157	.35385	.00001	50	.00001	50	.34563	724	11.220	.6507	P	9803
9812	400.82	261	354	.03236	.00001	50	.01022	50	.02721	3595	.559	.5407	P	9812
9813	464.17	276	115	.06717	.00001	50	.00001	50	.02712	3164	1.878	.4325	P	9813
9823	2.63	246	105	.00617	.00001	50	.00202	50	.00640	125	.076	.3390	P	9823

9831	[illegible]	568	378	.12249	.00001	50	.00001	50	.05154	6275	[illegible]	.5366	7	9831
9832	[illegible]	902	[illegible]	[illegible]	.00001	50	.00669	50	.04365	1922	2.775	.6234	7	9832
9835	28.26	250	129	.01381	.00001	50	.01556	50	.02519	251	.565	.6454	7	9835
9842	21.67	247	311	.00981	.00001	50	.00882	50	.01278	358	.226	.7162	/	9842
9845	11.24	367	158	[illegible]	.00001	50	.00422	50	.06463	305	.181	[illegible]	7	9845
9852	1524.25	357	317	.14650	.00001	50	.00001	50	.00970	5762	4.631	.6452	/	9852
9853	1250.25	295	112	.00074	.00001	50	.00001	50	.03378	3977	2.592	.5955	/	9853
9861	1014.12	501	225	.21104	.00001	50	.07689	50	.10127	5600	6.785	.5007	/	9861
9862	500.56	678	207	.21824	.00001	50	.00001	50	.12246	4464	7.531	.6050	/	9862
9863	55.65	307	66	.12575	.00001	50	.00001	50	.09412	923	3.914	.7662	/	9863
9872	49.41	202	21	.12956	.00001	50	.00001	50	.13458	666	3.378	[illegible]	/	9872
9873	163.57	321	189	.09670	.00001	50	.00001	50	.04139	2766	3.189	.4601	7	9873
9881	1010.52	501	325	.10765	.00001	50	.05376	50	.07736	7131	4.125	.5736	7	9881
9882	[illegible]	528	304	.10048	.00001	50	.05444	50	.10959	740	[illegible]	[illegible]	7	9882
9885	[illegible]	[illegible]	48	[illegible]	.00001	50	.00001	50	.06576	1202	4.288	[illegible]	7	9885
9892	8.10	264	77	.00960	.00001	50	.00376	50	.00567	121	.121	.5685	7	9892
9895	[illegible]	276	[illegible]	[illegible]	.00001	50	[illegible]	50	.09671	351	[illegible]	.9626	7	9895
9901	[illegible]	559	[illegible]	.10436	.00001	50	[illegible]	50	[illegible]	6752	[illegible]	[illegible]	7	9901
9902	[illegible]	555	18	.09849	.00001	50	.00069	50	.03548	5582	3.162	.4596	7	9902
9905	[illegible]	513	168	.18048	.00001	50	.00001	50	.15959	552	7.149	[illegible]	7	9905
9912	[illegible]	534	[illegible]	.12026	.00001	50	.00001	50	.03246	2172	4.487	[illegible]	7	9912
9915	[illegible]	409	151	.16166	.00001	50	.05065	50	.08847	6002	4.408	[illegible]	7	9915
9922	62.52	357	207	.16025	.00001	50	.02822	50	.15029	1376	4.512	.6702	/	9922
9923	27.54	209	118	.00314	.00001	50	.00376	50	.00256	1631	.366	.7365	/	9923
9932	253.52	337	302	.12422	.00001	50	.03669	50	.10766	1500	3.547	.7095	/	9932
9935	170.51	325	80	.10101	.00001	50	.00001	50	.06023	1315	3.105	.6751	/	9935
9942	528.65	332	206	.09352	.00001	50	.00001	50	.03527	4440	2.310	.1651	/	9942
9943	69.65	318	25	.06856	.00001	50	.00001	50	.04206	1735	1.962	.5675	/	9943
9951	1121.04	561	231	.19536	.00001	50	.00001	50	.06650	8132	6.241	.2491	7	9951
9952	164.72	564	277	.09860	.00001	50	.00001	50	.05148	2427	3.397	.5592	7	9952
9955	[illegible]	558	[illegible]	.08885	.00001	50	.02156	50	.04349	[illegible]	3.992	[illegible]	7	9955
9962	2807.72	492	339	.19135	.00001	50	.00001	50	.02400	6026	6.129	.4576	7	9962
9965	1972.37	478	139	.16813	.00001	50	.00001	50	.04504	7405	5.305	[illegible]	7	9965
9971	[illegible]	768	[illegible]	.16564	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	9971
9972	[illegible]	617	404	[illegible]	.00001	50	.00001	50	.03463	5445	[illegible]	.5584	7	9972
9975	841.55	760	5	.19740	.00001	50	.00001	50	.07043	5200	6.166	[illegible]	7	9975
9981	[illegible]	626	[illegible]	.18325	.00001	50	.02385	50	.08551	5616	[illegible]	[illegible]	7	9981
9982	[illegible]	566	[illegible]	.14360	.00001	50	.00001	50	[illegible]	5522	[illegible]	.0754	7	9982
9985	1700.20	500	127	.16592	.00001	50	.00001	50	.09695	4302	5.016	.6616	7	9985
9992	5906.52	463	115	.16115	.00001	50	.00001	50	.08444	5337	5.550	.5252	/	9992
9993	4650.35	502	123	.18525	.00001	50	.00001	50	.06456	8125	5.509	.7175	/	9993
10001	1117.85	597	115	.16936	.00001	50	.00001	50	.07555	5256	5.305	.3664	/	10001
10002	637.65	405	220	.14917	.00001	50	.00001	50	.07765	1951	5.011	.5152	/	10002
10003	721.71	497	36	.13062	.00001	50	.03422	50	.03260	4321	4.607	.4161	/	10003
10012	1169.64	477	316	.10232	.00001	50	.04222	50	.03155	5162	3.176	.4511	7	10012
10013	1374.06	510	119	.14239	.00001	50	.00001	50	.09461	4576	4.198	.6991	7	10013
10022	13.77	453	219	.10826	.00001	50	.00001	50	.15224	476	3.380	.9401	/	10022
10023	4.25	437	16	.02612	.00001	50	.01222	50	.02513	252	.572	.9152	7	10023
10031	1336.52	784	233	.13262	.00001	50	.00001	50	.03416	6952	3.857	.1211	7	10031
10032	959.54	629	155	.19500	.00001	50	.04869	50	.09154	2352	6.138	.4835	7	10032
10035	[illegible]	707	147	[illegible]	.00001	50	.00001	50	[illegible]	6516	5.201	.4081	7	10035
10042	[illegible]	473	265	.11045	.00001	50	.02444	50	.04165	2050	3.201	.4294	7	10042
10045	[illegible]	671	120	.02146	.00001	50	.00082	50	.01769	954	.509	.8466	7	10045
10051	[illegible]	786	176	.15158	.00001	50	.00001	50	.05541	5032	4.562	.3854	7	10051
10052	466.87	650	268	.19158	.00001	50	.05132	50	.04125	3534	6.155	.5457	7	10052
10053	511.55	637	21	.19925	.00001	50	.00001	50	.11467	2061	6.354	.5504	/	10053
10062	[illegible]	673	105	[illegible]	.00001	50	.06956	50	.08086	2545	2.082	.4431	7	10062
10065	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	10065
10072	500.58	662	253	.24647	.00001	50	.04406	50	.20326	2006	8.221	.7492	/	10072
10075	56.42	517	136	.21625	.00001	50	.02156	50	.17506	557	6.951	.6496	/	10075
10082	377.45	566	235	.18572	.00001	50	.02976	50	.12582	1575	6.186	.6657	/	10082
10085	1362.15	622	111	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	/	10085
10092	247.20	663	[illegible]	.17134	.00001	50	.02376	50	.10665	2545	5.856	.6212	/	10092
10093	320.17	664	316	.20755	.00001	50	.04385	50	.16769	1931	6.555	.8252	/	10093
10101	1350.64	760	250	.17654	.00001	50	.00001	50	.04832	5747	5.662	.3303	/	10101
10102	326.37	714	199	.17476	.00001	50	.00001	50	.10157	1334	5.352	.8170	/	10102
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
10135	222.17	600	119	.13113	.00001	50	.00001	50	.07255	2252	3.227	.7272	/	10135
10141	1301.07	610	270	.13022	.00001	50	.00001	50	.06186	5084	7.164	.1532	/	10141
10142	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	/	10142
10145	200.67	728	117	.21030	.00001	50	.00001	50	.14257	2252	6.591	.8992	/	10145
10152	70.47	592	125	.16021	.00001	50	.02422	50	.10265	749	6.359	.7672	/	10152
10155	25.95	577	122	.15964	.00001	50	.00001	50	.15571	724	4.738	.8526	/	10155
10162	31.55	562	126	.16936	.00001	50	.00001	50	.14268	525	7.666	.8126	/	10162
10165	55.71	577	131	.15932	.00001	50	.00001	50	.12259	263	4.761	.2855	/	10165
10172	46.13	600	253	.16477	.00001	50	.07085	50	[illegible]	[illegible]	[illegible]	[illegible]	/	10172
10173	26.72	608	77	.21669	.00001	50	.05600	50	.40557	305	11.357	.6525	/	10173

[illegible]	[illegible]	843	407	[illegible]	.00001	50	[illegible]	50	[illegible]	4947	5.975	[illegible]	P	[illegible]
13182	263.17	752	298	.22970	.00001	50	.00001	50	.13749	2357	5.144	.4691	P	13182
13183	197.56	760	356	.32035	.00001	50	.00001	50	.12728	2156	11.119	.3447	P	13183
13192	1041.04	760	203	.21555	.00001	50	.02259	50	.07547	4227	6.979	.4510	F	13192
13193	2824.19	770	98	.21532	.00001	50	.00001	50	.06667	5749	5.365	.2640	P	13193
13202	73.71	736	226	.16435	.00001	50	.04200	50	.14682	575	5.256	.7160	F	13202
13203	42.05	732	40	.20585	.00001	50	.00001	50	.11305	687	7.014	.7206	F	13203
13211	1025.66	825	241	.15115	.00001	50	.00001	50	.04529	6072	4.672	.2275	F	13211
13212	76.05	746	166	.12631	.00001	50	.00001	50	.10253	1254	3.972	.7570	F	13212
13213	159.37	729	303	.19231	.00001	50	.00001	50	.10726	1551	6.156	.5944	F	13213
13221	1314.55	826	15	.12528	.00001	50	.04622	50	.04359	5355	3.687	.1118	F	13221
13222	1860.82	801	312	.15667	.00001	50	.03256	50	.06518	3421	4.641	.4616	P	13222
13223	556.17	775	127	.19238	.00001	50	.01175	50	.07829	1050	6.003	.5000	P	13223
13232	[illegible]	779	[illegible]	.17008	.00001	50	.00001	50	[illegible]	[illegible]	3.621	.7474	P	13232
13233	[illegible]	762	122	.09419	.00001	50	.00001	50	.02405	1457	[illegible]	[illegible]	P	13233
13241	1003.02	934	112	.14269	.00001	50	.00001	50	.02806	5041	4.169	.4506	P	13241
13242	775.17	775	119	.13482	.00001	50	.00001	50	.05141	3547	4.086	.6760	P	13242
13243	[illegible]	873	112	.13505	.00001	50	.01159	50	.04148	5160	3.924	[illegible]	P	13243
13251	1163.15	895	112	.21237	.00001	50	.00001	50	.06475	6357	6.687	.3592	P	13251
13252	90.27	751	32	.17716	.00001	50	.07554	50	.24136	537	5.210	.6748	P	13252
13253	201.95	803	160	.21622	.00001	50	.00001	50	.13929	1450	6.920	.8066	P	13253
13262	1569.15	755	148	.24715	.00001	50	.00001	50	.04650	6956	7.750	.3050	P	13262
13263	1476.55	725	136	.23635	.00001	50	.00001	50	.07550	4122	7.659	.5570	F	13263
13272	1070.82	787	325	.18547	.00001	50	.05600	50	.06130	5312	5.759	.3677	F	13272
13273	231.66	672	123	.13244	.00001	50	.00001	50	.05121	2664	3.921	.7518	F	13273
13282	1628.01	801	515	.23165	.00001	50	.00001	50	.11357	4657	7.444	.6564	F	13282
13283	1035.18	804	127	.22576	.00001	50	.00001	50	.12462	3653	6.983	.7414	F	13283
13292	2297.15	912	312	.21535	.00001	50	.00001	50	.10222	5250	7.214	.5440	F	13292
13293	1121.04	279	128	.21469	.00001	50	.00001	50	.11001	3051	6.552	.6405	P	13293
13302	229.59	267	108	.17561	.00001	50	.00001	50	.11612	3361	5.509	.6295	P	13302
13303	[illegible]	843	150	.25479	.00001	50	.00001	50	.14139	1461	8.183	.6367	P	13303
13311	1342.98	972	112	.19518	.00001	50	.00001	50	.06015	6262	6.602	.4291	P	13311
13312	[illegible]	790	250	.15537	.00001	50	.05222	50	.33735	367	5.007	.5585	P	13312
13313	[illegible]	816	46	.20747	.00001	50	.00001	50	.28097	[illegible]	5.584	.5774	P	13313
13322	[illegible]	865	552	.11477	.00001	50	.00001	50	.03488	1157	3.563	.6467	P	13322
13321	1679.34	925	121	.17493	.00001	50	.00001	50	.04605	5290	5.558	.5718	P	13321
13331	1321.44	1016	120	.18407	.00001	50	.04493	50	.09716	6062	5.974	.4506	P	13331
13332	65.57	853	476	.12457	.00001	50	.00001	50	.14627	862	3.753	.7462	P	13332
13333	30.78	862	75	.25054	.00001	50	.03000	50	.24604	451	8.052	.0051	P	13333
13341	1009.25	902	97	.15059	.00001	50	.00001	50	.06932	5507	4.790	.2090	F	13341
13342	528.91	885	327	.16219	.00001	50	.04511	50	.10715	1536	5.352	.5771	F	13342
13343	826.20	936	130	.13511	.00001	50	.00001	50	.06850	5224	4.293	.7461	F	13343
13352	352.55	842	37	.20515	.00001	50	.03595	50	.14251	1765	6.042	.6650	F	13352
13353	763.85	940	205	.25357	.00001	50	.00001	50	.16950	4620	7.899	.6274	F	13353
13362	132.86	896	346	.22525	.00001	50	.00001	50	.20728	1631	7.078	.5175	P	13362
13363	54.95	780	177	.05021	.00001	50	.01460	50	.05931	470	1.115	.6151	P	13363
13371	1125.90	976	39	.14628	.00001	50	.00001	50	.06879	3550	4.563	.2034	F	13371
13372	2012.85	936	121	.15485	.00001	50	.06044	50	.06925	4157	4.515	.7736	F	13372
13373	1066.91	924	120	.14582	.00001	50	.00001	50	.10025	3170	4.507	.6770	F	13373
13381	1054.57	921	149	.15256	.00001	50	.00001	50	.05752	6000	5.017	.3574	P	13381
13382	666.61	885	107	.13861	.00001	50	.00001	50	.06940	[illegible]	3.724	.7716	P	13382
13383	260.57	810	189	.09655	.00001	50	.02080	50	.03520	3564	2.505	.4528	P	13383
13391	1075.68	965	446	.17860	.00001	50	.04093	50	.10038	5041	5.617	.3585	P	13391
13392	587.18	864	158	.11976	.00001	50	.00001	50	.05771	4341	3.719	.4477	P	13392
13393	143.57	876	256	.16597	.00001	50	.06623	50	.17225	2117	4.886	.6690	P	13393
13401	1096.76	1075	167	.23709	.00001	50	.00001	50	.12200	4065	8.126	.2200	F	13401
13402	256.20	946	38	.20538	.00001	50	.00001	50	.18525	1466	10.224	.3471	P	13402
13403	386.76	932	197	.26616	.00001	50	.00001	50	.24757	1258	11.612	.6558	F	13403
13411	1004.53	1056	167	.23055	.00001	50	.00001	50	.05844	5075	7.505	.4170	F	13411
13412	162.05	801	63	.25685	.00001	50	.04733	50	.15872	1605	7.966	.7001	F	13412
13413	152.26	796	176	.28242	.00001	50	.04222	50	.16145	554	5.374	.8528	F	13413
13421	1009.26	915	135	.22622	.00001	50	.04022	50	.10708	5561	7.142	.5435	P	13421
13422	45.17	602	66	.07556	.00001	50	.01607	50	.00364	470	1.594	.7175	P	13422
13423	93.95	722	172	.26381	.00001	50	.00001	50	.15560	1265	8.204	.6626	F	13423
13431	1173.59	1150	78	.25475	.00001	50	.01556	50	.06958	6125	8.323	.3131	F	13431
13432	1913.22	816	20	.22163	.00001	50	.00001	50	.07941	6277	6.921	.4066	F	13432
13433	[illegible]	897	147	[illegible]	.00001	50	.00001	50	.10739	[illegible]	[illegible]	[illegible]	P	13433
13441	[illegible]	1002	116	.23563	.00001	50	[illegible]	50	.06808	[illegible]	7.603	.2618	P	13441
13442	1516.12	763	40	.22559	.00001	50	.00001	50	.05770	4656	7.083	[illegible]	P	13442
13443	1192.43	772	121	.24599	.00001	50	.00001	50	.05772	[illegible]	7.858	.5095	P	13443
13451	604.50	702	85	.21614	.00001	50	.03542	50	.05676	5104	6.669	.3985	P	13451
13452	254.39	682	345	.24326	.00001	50	.00001	50	.12951	1402	7.770	.6509	P	13452
13453	291.50	676	127	.19155	.00001	50	.00001	50	.12519	2055	6.705	.5563	F	13453
13461	[illegible]	425	155	.24556	.00001	50	.00001	50	.06605	6294	8.173	.6602	P	13461
13462	608.51	615	70	.20675	.00001	50	.04076	50	.07924	4725	6.002	.2514	P	13462
13463	270.45	635	104	.24655	.00001	50	.00001	50	.10645	3160	7.885	.4136	F	13463
13471	1014.12	953	105	.20061	.00001	50	.00001	50	.05260	5755	6.097	.4450	F	13471
13472	1701.81	681	327	.21032	.00001	50	.00001	50	.06611	5237	6.911	.6270	F	13472
13473	2577.77	764	125	.20042	.00001	50	.00001	50	.10256	4370	6.014	.5122	P	13473
13482	3153.57	385	50	.09533	.00001	50	.00001	50	.03311	9535	2.920	.4410	P	13482
13483	507.05	287	157	.02521	.00001	50	.03263	50	.01341	4452	.593	.5525	F	13483

10492	[illegible]	726	5	.17448	.00001	50	.09888	50	.0777	6356	5.606	.5030	?	10492
10495	772.57	542	151	.19796	.00001	50	.00001	50	.06025	1352	4.172	.4080	?	10495
10501	1516.25	756	104	.19754	.00001	50	.00001	50	.07525	5806	6.156	.5100	?	10501
10502	4275.55	553	205	.20275	.00001	50	.00001	50	.05220	6515	9.870	.4792	✓	10502
10505	5577.15	600	112	.25160	.00001	50	.00001	50	.09095	6492	8.149	.5872	?	10505
10512	955.35	506	50	.29012	.00001	50	.04244	50	.14058	3071	9.066	.5037	✓	10512
10513	2035.56	550	165	.23751	.00001	50	.01711	50	.00078	5917	7.356	.5835	✓	10513
10522	5743.71	674	306	.30750	.00001	50	.00001	50	.13647	5152	10.525	.5812	✓	10522
10525	5581.24	760	121	.25342	.00001	50	.00001	50	.11241	0050	8.570	.5668	✓	10525
10532	745.22	727	254	.32536	.00001	50	.00001	50	.14672	4532	10.981	.6234	✓	10532
10533	465.75	620	121	.23575	.00001	50	.00001	50	.19776	1953	7.758	.8652	✓	10533
10541	1759.01	765	250	.20667	.00001	50	.00001	50	.10140	5802	5.999	.4567	?	10541
10542	24.62	572	223	.26457	.00001	50	.27444	50	.55156	470	2.392	.6765	?	10542
10545	[illegible]	603	156	.17820	.00001	50	.00001	50	.13669	[illegible]	10.971	.9662	?	10545
10552	475.76	667	110	.10744	.00001	50	.00001	50	.26722	1192	9.292	.8212	?	10552
10555	619.62	713	117	.27216	.00001	50	.05067	50	.14035	4014	9.189	.6715	?	10555
10561	1066.77	779	110	.17282	.00001	50	.00001	50	.11702	7704	1.995	.5021	?	10561
10562	1195.31	722	151	.16272	.00001	50	.06700	50	.09692	7265	4.678	.4462	?	10562
10565	141.77	645	61	.25360	.00001	50	.00001	50	.20542	1272	8.715	.7234	?	10565
10572	461.22	656	211	.19018	.00001	50	.05566	50	.21551	1024	9.100	.6690	?	10572
10575	3042.15	763	126	.27448	.00001	50	.00001	50	.13525	7796	8.005	.5617	?	10575
10581	1164.05	807	275	.21141	.00001	50	.00001	50	.09567	7148	7.048	.5094	?	10581
10582	1635.32	812	315	.16936	.00001	50	.00001	50	.00585	5872	5.157	.6565	✓	10582
10585	19.44	640	49	.40246	.00001	50	.38867	50	.46523	365	13.267	.7251	✓	10585
10592	546.65	655	215	.29157	.00001	50	.00001	50	.18723	1035	9.193	.8466	✓	10592
10595	2550.36	916	116	.25142	.00001	50	.00001	50	.10177	0037	7.423	.5033	✓	10595
10602	3657.85	846	309	.26267	.00001	50	.07911	50	.11325	5911	9.099	.5342	✓	10602
10605	3225.42	943	125	.26333	.00001	50	.02111	50	.12478	6356	8.531	.6247	✓	10605
10611	1138.23	957	222	.26627	.00001	50	.00001	50	.13336	5066	9.385	.4791	?	10611
10612	25.21	734	227	.27291	.00001	50	.07776	50	.34124	422	9.561	.7277	?	10612
10615	52.42	751	16	.25757	.00001	50	.00001	50	.23847	535	11.578	.8546	?	10615
10622	321.04	872	212	.26474	.00001	50	.00001	50	.14419	4506	9.626	.6135	?	10622
10625	352.77	875	117	.26245	.00001	50	.02756	50	.17578	2636	9.101	.8036	?	10625
10632	462.37	850	110	.25007	.00001	50	.06885	50	.11009	5615	8.272	.6744	?	10632
10635	151.17	776	124	.29374	.00001	50	.00001	50	.18456	1125	10.570	.8066	?	10635
10641	1155.23	1048	331	.21433	.00001	50	.01433	50	.10326	7852	8.312	.4560	?	10641
10642	1374.22	981	269	.24321	.00001	50	.00001	50	.13879	5856	8.558	.5590	?	10642
10645	158.95	855	49	.25022	.00001	50	.02669	50	.06739	1220	8.212	.6312	?	10645
10652	1625.63	917	214	.26912	.00001	50	.05076	50	.13761	4342	9.269	.5455	?	10652
10655	384.13	911	118	.29373	.00001	50	.03222	50	.18012	2388	9.723	.8219	✓	10655
10661	1241.73	1059	71	.20315	.00001	50	.05156	50	.05279	4662	6.851	.1602	✓	10661
10662	1107.27	974	201	.26935	.00001	50	.00001	50	.12243	4374	8.726	.7512	✓	10662
10665	1010.88	995	119	.26431	.00001	50	.05132	50	.14025	2661	9.150	.8267	✓	10665
10672	151.97	956	18	.33554	.00001	50	.01533	50	.24175	1457	10.570	.7712	✓	10672
10675	140.22	961	151	.41927	.00001	50	.02422	50	.26163	1305	13.160	.9105	?	10675
10681	1027.85	1213	59	.17105	.00001	50	.00001	50	.04301	5249	5.272	.2685	?	10681
10682	2722.12	1101	316	.20566	.00001	50	.00001	50	.06355	3220	6.459	.4227	✓	10682
10685	4795.56	1115	127	.20455	.00001	50	.00001	50	.04650	6426	6.750	.2570	?	10685
10691	1001.10	1125	133	.22470	.00001	50	.00001	50	.05140	5470	7.801	.1552	?	10691
10692	36.14	940	68	.29472	.00001	50	.07956	50	.33614	428	9.769	.5573	?	10692
10695	441.05	1050	228	.22055	.00001	50	.00001	50	.08464	2357	7.565	.2625	?	10695
10702	576.04	961	165	.27772	.00001	50	.00001	50	.09660	4005	9.078	.5475	?	10702
10705	406.64	913	111	.39550	.00001	50	.00001	50	.24057	1072	13.140	.7275	?	10705
10712	30.76	894	108	.40335	.00001	50	.06432	50	.45630	541	12.841	.8444	?	10712
10715	13.34	852	151	.41074	.00001	50	.09856	50	.50565	276	12.577	.8585	?	10715
10721	1005.21	1151	59	.22575	.00001	50	.00001	50	.05820	6512	7.576	.3250	✓	10721
10722	402.26	1097	16	.16547	.00001	50	.00001	50	.05660	2709	5.492	.3384	?	10722
10725	41.57	952	152	.40326	.00001	50	.00001	50	.41045	472	15.479	.8454	?	10725
10732	102.05	911	25	.35022	.00001	50	.00001	50	.35050	544	11.120	.6555	✓	10732
10735	147.42	965	166	.32850	.00001	50	.02133	50	.18256	1447	11.314	.7765	✓	10735
10741	1014.97	1148	180	.21565	.00001	50	.00001	50	.06566	4306	7.361	.0375	✓	10741
10742	176.15	1062	36	.37565	.00001	50	.01532	50	.37245	777	12.371	.8172	?	10742
10745	110.16	1060	330	.40925	.00001	50	.00001	50	.35523	720	14.156	.9250	?	10745
10751	1108.85	1238	258	.13121	.00001	50	.00001	50	.07246	4856	3.788	.3377	✓	10751
10752	1318.65	1134	120	.20062	.00001	50	.00001	50	.05565	2754	6.382	.4166	?	10752
10755	355.26	1101	262	.31134	.00001	50	.00356	50	.27050	650	10.890	.2284	?	10755
10761	746.38	1074	149	.17866	.00001	50	.05711	50	.07074	6964	5.663	.3569	?	10761
10762	47.72	828	82	.28142	.00001	50	.07582	50	.31596	592	10.573	.7467	?	10762
10765	76.44	908	245	.23126	.00001	50	.00001	50	.51675	702	11.278	.8594	?	10765
10771	1036.30	1110	158	.25134	.00001	50	.01111	50	.15674	7566	7.882	.5102	?	10771
10772	130.87	758	48	.22660	.00001	50	.00001	50	.16466	721	8.220	.7348	?	10772
10775	185.26	910	159	.27525	.00001	50	.00001	50	.21527	2456	8.954	.7654	?	10775
10782	373.41	657	6	.25170	.00001	50	.00001	50	.14018	2042	7.554	.7222	✓	10782
10785	579.98	683	155	.25843	.00001	50	.02844	50	.10590	2525	7.706	.7274	?	10785
10791	1112.13	1104	139	.26220	.00001	50	.01844	50	.07509	6504	8.250	.4265	?	10791
10792	1305.21	797	221	.25739	.00001	50	.00001	50	.06051	3720	7.372	.7165	✓	10792
10795	1288.71	956	111	.31642	.00001	50	.03333	50	.18009	3362	10.502	.7238	✓	10795
10802	242.15	821	55	.29444	.00001	50	.00001	50	.20585	3156	9.885	.7095	✓	10802
10805	38.07	541	231	.15106	.00001	50	.05022	50	.02456	1005	4.457	.7320	?	10805
10812	330.34	791	38	.30503	.00001	50	.07644	50	.20486	2835	9.946	.7175	?	10812
10813	513.95	811	132	.20036	.00001	50	.00001	50	.23122	2453	9.550	.8556	✓	10813

10822	1222.57	815	142	.28617	.00001	50	.03711	50	.16431	4234	9.658	.4456	P	10822
10825	402.14	863	149	.25055	.00001	50	.05744	50	.14575	3474	13.086	.6701	P	10825
10831	1150.55	1242	515	.14258	.00001	50	.00001	50	.06557	5340	4.225	.2405	P	10831
10832	2795.45	1094	300	.26655	.00001	50	.00001	50	.17927	3157	8.494	.7411	P	10832
10833	1564.06	1060	162	.31155	.00001	50	.00001	50	.12566	1662	10.862	.5717	P	10833
10841	1277.37	1030	347	.21450	.00001	50	.02622	50	.08622	5324	7.299	.0651	P	10841
10842	144.00	852	351	.20091	.00001	50	.02222	50	.24682	1155	6.057	.7347	P	10842
10843	917.59	954	135	.35500	.00001	50	.06422	50	.12978	3527	12.332	.5318	P	10843
10851	1012.50	902	117	.26071	.00001	50	.04211	50	.10611	5526	8.600	.2126	P	10851
10852	126.35	780	23	.40332	.00001	50	.06467	50	.44538	557	12.939	.7538	P	10852
10853	1169.05	984	206	.32207	.00001	50	.00001	50	.15426	4651	11.081	.4415	P	10853
10861	1000.35	1251	131	.28547	.00001	50	.02022	50	.10235	5455	9.283	.3130	P	10861
10862	1005.55	950	107	.31001	.00001	50	.01000	50	.13329	5491	10.326	.5600	P	10862
10863	1953.97	1013	410	.27441	.00001	50	.01000	50	.10742	6571	9.290	.4487	P	10863
10872	555.16	505	108	.18515	.00001	50	.00001	50	.11359	3400	6.101	.5306	P	10872
10873	116.66	555	269	.24155	.00001	50	.07522	50	.20522	2132	7.903	.6561	P	10873
10881	1061.97	866	102	.22834	.00001	50	.01443	50	.13865	5746	5.124	.4521	P	10881
10882	75.27	452	40	.15544	.00001	50	.00001	50	.16431	425	5.915	.5460	P	10882
10885	90.76	476	159	.20392	.00001	50	.00001	50	.10140	3420	6.609	.6096	P	10885
10892	610.24	585	112	.21758	.00001	50	.00001	50	.14872	3464	5.227	.5014	P	10892
10893	291.90	482	492	.24597	.00001	50	.00001	50	.01445	2256	8.018	.5486	P	10893
10901	896.78	923	174	.26292	.00001	50	.03662	50	.12071	5574	8.404	.4505	P	10901
10902	200.37	667	77	.21656	.00001	50	.00001	50	.12150	3202	7.266	.6790	P	10902
10903	42.93	562	176	.28199	.00001	50	.04403	50	.37253	355	9.259	.5542	P	10903
10911	1181.79	729	117	.17625	.00001	50	.00001	50	.11652	6177	5.453	.2491	P	10911
10912	400.35	502	110	.15880	.00001	50	.00001	50	.12805	2481	4.745	.7222	P	10912
10913	679.59	651	280	.19036	.00001	50	.02466	50	.11217	3071	5.575	.5567	P	10913
10921	1050.57	396	118	.09565	.00001	50	.00001	50	.07661	6075	2.638	.4560	P	10921
10922	112.94	305	41	.04722	.00001	50	.02203	50	.05135	1033	.997	.5765	P	10922
10923	200.85	326	201	.07220	.00001	50	.00522	50	.04825	1400	1.706	.6790	P	10923
10932	671.98	315	101	.04289	.00001	50	.00001	50	.02779	3594	1.167	.4322	P	10932
10933	1091.88	426	236	.15677	.00001	50	.05222	50	.06261	5534	5.040	.5042	P	10933
10941	1008.77	404	102	.14775	.00001	50	.01667	50	.06656	6515	5.760	.5167	P	10941
10942	1594.84	405	77	.19774	.00001	50	.04556	50	.05938	6711	7.964	.4708	P	10942
10943	252.28	445	185	.15685	.00001	50	.00001	50	.05882	857	7.415	.5950	P	10943
10952	45.17	306	130	.03518	.00001	50	.01333	50	.04697	1174	.750	.7467	P	10952
10953	23.39	312	496	.17741	.00001	50	.00001	50	.13446	147	5.555	.8767	P	10953
10961	1272.93	404	122	.08072	.00001	50	.00001	50	.02570	7164	2.517	.3560	P	10961
10962	257.55	336	36	.06500	.00001	50	.01511	50	.05050	1454	1.713	.5045	P	10962
10963	370.27	352	171	.08095	.00001	50	.05000	50	.05557	3455	2.475	.5506	P	10963
10972	775.98	352	132	.07157	.00001	50	.00001	50	.02525	5466	2.143	.4140	P	10972
10973	658.28	527	287	.20656	.00001	50	.05044	50	.11819	3578	6.595	.6355	P	10973
10982	146.51	343	49	.08147	.00001	50	.02422	50	.06539	1444	2.171	.7500	P	10982
10983	67.25	332	211	.10467	.00001	50	.01844	50	.06811	612	3.083	.8521	P	10983
10991	1008.65	906	94	.20517	.00001	50	.00001	50	.10059	6057	6.192	.5277	P	10991
10992	2143.25	485	33	.13045	.00001	50	.00001	50	.02657	4022	3.851	.4709	P	10992
10993	4581.35	615	131	.17275	.00001	50	.01211	50	.07455	8172	5.096	.4229	P	10993
11002	1475.01	466	70	.14452	.00001	50	.00001	50	.05277	3635	4.202	.5224	P	11002
11003	2947.05	500	195	.15108	.00001	50	.03333	50	.05785	4625	4.866	.2109	P	11003
11011	1095.13	811	118	.20431	.00001	50	.00001	50	.06566	5511	6.223	.4788	P	11011
11012	560.57	585	126	.15690	.00001	50	.00001	50	.05118	2264	4.580	.5561	P	11012
11013	1560.87	670	175	.16995	.00001	50	.00444	50	.10001	5565	5.174	.6002	P	11013
11021	1057.61	801	122	.20766	.00001	50	.01556	50	.06171	5966	6.196	.5605	P	11021
11022	119.07	527	97	.10444	.00001	50	.00001	50	.11152	440	3.103	.4407	P	11022
11023	656.97	614	180	.13175	.00001	50	.00465	50	.02479	4677	3.767	.2205	P	11023
11031	1110.51	461	241	.14520	.00001	50	.02405	50	.07451	6650	4.013	.1020	P	11031
11032	527.17	374	117	.08676	.00001	50	.00001	50	.04426	2364	3.074	.5111	P	11032
11033	1411.78	504	270	.17755	.00001	50	.00001	50	.05570	5020	5.906	.5457	P	11033
11041	1003.50	305	02	.12085	.00001	50	.00001	50	.06525	7621	3.040	.2350	P	11041
11042	174.95	275	27	.08663	.00001	50	.00001	50	.03012	1551	2.400	.5022	P	11042
11043	202.53	286	149	.07736	.00001	50	.02511	50	.03351	1755	2.096	.6021	P	11043
11051	1003.59	547	128	.22650	.00001	50	.00001	50	.07346	5122	7.069	.4761	P	11051
11052	1292.85	442	99	.15833	.00001	50	.00001	50	.07239	7331	4.796	.4557	P	11052
11053	1229.58	356	166	.10155	.00001	50	.00001	50	.05941	4622	2.793	.4196	P	11053
11061	1034.37	335	125	.11944	.00001	50	.00001	50	.05532	4653	3.059	.5386	P	11061
11062	187.32	256	35	.03333	.00001	50	.00001	50	.02216	1571	.833	.7273	P	11062
11063	273.74	261	118	.04134	.00001	50	.00001	50	.02401	2056	.984	.6628	P	11063
11072	17.37	348	135	.00557	.00001	50	.00001	50	.00001	1138	.029	.8543	P	11072
11073	23.76	276	180	.06607	.00001	50	.01444	50	.05731	1575	1.474	.8565	P	11073
11082	597.27	365	80	.04874	.00001	50	.00001	50	.03735	3274	1.564	.6321	P	11082
11083	770.77	375	156	.04673	.00001	50	.00001	50	.01841	3057	1.573	.6060	P	11083
11091	1005.21	527	95	.17692	.00001	50	.00001	50	.06205	5575	5.471	.2545	P	11091
11092	610.06	395	356	.13450	.00001	50	.00001	50	.06276	3026	3.024	.6266	P	11092
11093	880.17	416	139	.14677	.00001	50	.06444	50	.10094	2456	4.794	.6650	P	11093
11101	1200.55	546	81	.21291	.00001	50	.00001	50	.06146	6725	7.102	.3100	P	11101
11102	733.05	396	96	.11738	.00001	50	.03511	50	.05557	6242	3.500	.5415	P	11102
11103	117.65	315	190	.07432	.00001	50	.00001	50	.06521	634	1.906	.7562	P	11103
11112	331.23	294	104	.07138	.00001	50	.00001	50	.02119	3545	2.059	.4172	P	11112
11113	469.85	336	254	.15565	.00001	50	.04644	50	.07755	4244	4.800	.5066	P	11113
11121	1794.83	427	117	.13643	.00001	50	.04775	50	.05872	7561	3.966	.5288	P	11121
11122	922.53	329	75	.05634	.00001	50	.03575	50	.03175	8521	1.482	.2417	P	11122

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	1.491	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11132	2131.05	568	129	.09922	.00001	50	.04685	50	.05655	8412	2.947	.4591	7	11132
11135	301.53	305	202	.14536	.00001	50	.00001	50	.11160	3974	4.456	.0645	/	11135
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11145	221.13	343	153	.20032	.00001	50	.00001	50	.23231	1323	9.059	.8122	/	11145
11152	2352.51	357	323	.15412	.00001	50	.00001	50	.08157	5144	5.325	.5597	/	11152
11155	2454.50	288	137	.08735	.00001	50	.00956	50	.01628	5362	2.777	.3362	/	11155
11161	1006.02	366	226	.12052	.00001	50	.00001	50	.03526	6306	4.166	.2125	/	11161
11162	562.63	398	257	.16745	.00001	50	.00001	50	.04535	5551	5.455	.3462	/	11162
11163	18.63	292	57	.17357	.00001	50	.00001	50	.10447	360	6.709	.9696	/	11163
11171	1725.35	462	91	.13120	.00001	50	.00001	50	.05368	9316	4.269	.4455	7	11171
11172	2321.76	552	218	.12417	.00001	50	.00001	50	.05153	5635	3.962	.4313	7	11172
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11182	330.70	503	141	.10330	.00001	50	.00001	50	.04703	3367	3.136	.5700	7	11182
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11203	571.40	330	226	.17717	.00001	50	.00001	50	.06115	5750	5.593	.4015	/	11203
11212	653.25	271	35	.12979	.00001	50	.04333	50	.06167	5374	3.879	.4795	/	11212
11215	954.15	223	203	.09326	.00001	50	.01244	50	.02126	5765	3.019	.3213	/	11215
11222	327.24	198	335	.08061	.00001	50	.05209	50	.05552	2959	2.727	.4652	/	11222
11225	36.45	170	173	.03893	.00001	50	.03485	50	.02706	612	1.279	.7587	/	11225
11231	2005.55	297	55	.10148	.00001	50	.00778	50	.02151	6525	3.165	.1075	/	11231
11232	1231.22	283	323	.15765	.00001	50	.00001	50	.13609	2664	4.481	.2514	7	11232
11235	1735.26	200	111	.09161	.00001	50	.00685	50	.02700	5734	2.889	.4237	7	11235
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11245	1471.35	224	155	.08717	.00001	50	.00001	50	.02359	5206	2.709	.4651	7	11245
11251	1331.13	263	343	.09136	.00001	50	.01544	50	[illegible]	5366	2.972	.3143	7	11251
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11262	75.32	198	31	.09947	.00001	50	.00001	50	.09327	957	3.158	.6234	7	11262
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11275	641.42	350	166	.11154	.00001	50	.01733	50	.04191	5794	3.507	.5214	7	11275
11282	187.11	237	310	.23206	.00001	50	.00001	50	.22555	777	7.252	.0417	/	11282
11285	555.75	222	123	.08652	.00001	50	.00001	50	.03347	3349	2.096	.5465	/	11285
11292	152.25	257	302	.25530	.00001	50	.00001	50	.30646	669	7.980	.7231	/	11292
11295	254.34	214	120	.09015	.00001	50	.00001	50	.03512	2025	2.774	.7173	/	11295
11302	1.62	179	340	.00936	.00001	50	.00001	50	.00001	51	.030	.8632	/	11302
11312	10.53	161	245	.05126	.00001	50	.01511	50	.03341	161	.432	.6222	7	11312
11315	5.24	180	330	.06152	.00001	50	.02311	50	.04223	271	1.924	.9395	7	11315
11321	1306.02	268	306	.09851	.00001	50	.00001	50	.02420	6460	3.157	.1477	/	11321
11322	51.03	221	159	.16616	.00001	50	.00001	50	.16507	470	5.094	.7014	7	11322
11325	160.36	227	250	.07664	.00001	50	.00001	50	.03592	2245	2.580	.4517	7	11325
11331	1107.37	275	315	.09505	.00001	50	.05644	50	.03734	5731	3.078	.3416	7	11331
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11352	42.12	196	227	.05777	.00001	50	.00001	50	.00452	570	1.173	.7420	/	11352
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11365	505.15	225	137	.07456	.00001	50	.00001	50	.02765	3905	2.302	.4554	/	11365
11372	3520.75	277	315	.10400	.00001	50	.00001	50	.03739	7974	3.461	.4461	/	11372
11375	2556.06	249	116	.09154	.00001	50	.00001	50	.02362	7068	2.865	.3597	/	11375
11382	274.55	238	335	.08566	.00001	50	.02756	50	.02554	3326	2.537	.4195	7	11382
11385	149.20	250	150	.08135	.00001	50	.01295	50	.04321	1024	2.375	.6691	7	11385
11392	1758.20	286	255	.10014	.00001	50	.00001	50	.04166	6836	3.362	.4456	/	11392
11395	543.51	252	67	.07235	.00001	50	.00001	50	.03752	2351	2.145	.5765	7	11395
11401	1100.76	276	217	.06945	.00001	50	.01756	50	.01253	5193	1.965	.2566	7	11401
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11425	1810.45	286	129	.09967	.00001	50	.00001	50	.02422	7335	3.155	.4082	7	11425
11432	2650.35	356	226	.12978	.00001	50	.00001	50	.04411	12256	5.309	.3133	/	11432
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11442	1556.52	444	317	.24255	.00001	50	.01657	50	.10251	4244	7.597	.0282	7	11442
11445	2250.44	364	127	.12950	.00001	50	.00001	50	.03522	7065	4.307	.4207	/	11445
11452	17.01	282	383	.02668	.00001	50	.01133	50	.03329	613	.659	.5462	/	11452
11455	8.13	297	55	.17212	.00001	50	.05956	50	.24262	215	5.384	.9054	/	11455
11462	1339.02	527	252	.24330	.00001	50	.00001	50	.02158	5962	7.979	.3570	7	11462
[illegible]	[illegible]	518	109	.07314	.00001	50	.00001	50	[illegible]	1343	1.932	.0667	7	[illegible]
11472	646.43	473	313	.18671	.00001	50	.00001	50	.07776	4464	5.856	.6755	/	11472

[illegible]	[illegible]	344	126	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	.2499	P	[illegible]
[illegible]	[illegible]	474	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11482	2097.66	486	297	.16545	.00001	50	.00001	50	.07745	6411	5.295	.5066	P	11482
11485	2217.73	394	100	.09135	.00001	50	.00001	50	.01985	7265	2.023	.2793	F	11485
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11492	991.66	443	29	.12065	.00001	50	.01155	50	.04975	6044	2.659	.3500	F	11492
11493	869.96	406	152	.11697	.00001	50	.00001	50	.06157	4141	3.450	.6034	F	11493
11502	1679.96	511	8	.17379	.00001	50	.00001	50	.03146	5656	5.242	.4322	F	11502
11503	2576.50	522	153	.17960	.00001	50	.00001	50	.08052	5667	4.979	.5455	F	11503
11511	1156.58	706	121	.19507	.00001	50	.00001	50	.05872	6547	5.969	.3559	F	11511
11512	103.58	562	316	.23389	.00001	50	.00001	50	.26572	634	7.014	.5456	F	11512
11513	771.93	728	106	.21288	.00001	50	.02555	50	.05760	5655	6.650	.5282	P	11513
11521	1185.13	710	142	.18738	.00001	50	.00001	50	.05109	4502	5.682	.2629	P	11521
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11531	1060.85	553	117	.17068	.00001	50	.00001	50	.06765	6040	5.074	.5278	P	11531
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11553	579.15	325	105	.12215	.00001	50	.02222	50	.05254	1641	2.996	.6529	F	11553
11561	1100.79	555	116	.19388	.00001	50	.00001	50	.07461	7621	5.785	.5705	F	11561
11562	947.77	418	338	.12515	.00001	50	.00001	50	.05353	4474	4.072	.5810	F	11562
11563	1313.55	472	129	.16605	.00001	50	.00001	50	.07659	6706	5.110	.4050	F	11563
11571	1044.09	460	125	.16135	.00001	50	.01603	50	.05458	6879	4.756	.4496	F	11571
11572	81.33	341	16	.15676	.00001	50	.03111	50	.10418	831	5.156	.7015	F	11572
11573	184.68	357	180	.13531	.00001	50	.00001	50	.06145	1501	4.487	.5686	P	11573
11581	1124.81	470	115	.16526	.00001	50	.00001	50	.05377	7015	4.867	.3379	P	11581
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11583	2491.13	345	146	.12032	.00001	50	.01723	50	.02386	5047	3.792	.4097	P	11583
11591	1105.65	327	162	.10710	.00001	50	.00001	50	.03382	7217	3.486	.2121	P	11591
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11601	1001.16	383	72	.10378	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	.2000	P	11601
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11612	326.45	234	39	.07215	.00001	50	.01244	50	.02657	1646	2.105	.5501	P	11612
11613	553.70	263	109	.11105	.00001	50	.00001	50	.05513	2571	3.409	.5750	F	11613
11621	1049.26	357	77	.11655	.00001	50	.00001	50	.05108	5542	3.420	.1521	F	11621
11622	962.15	295	324	.12450	.00001	50	.00001	50	.08958	2555	4.000	.6555	F	11622
11623	2032.39	332	120	.13687	.00001	50	.00001	50	.06557	6257	4.072	.6239	F	11623
11631	1009.45	366	133	.12009	.00001	50	.00001	50	.06557	4231	3.505	.2300	F	11631
11632	343.44	306	117	.12354	.00001	50	.00001	50	.07632	4466	3.480	.5596	P	11632
11633	62.37	382	241	.11566	.00001	50	.04222	50	.10530	1211	2.704	.5307	P	11633
11641	1043.26	295	96	.11329	.00001	50	.00001	50	.06465	4155	3.181	.1531	F	11641
11642	660.96	246	12	.09421	.00001	50	.00001	50	.05277	2251	3.062	.5545	P	11642
11643	2057.13	289	161	.12143	.00001	50	.00001	50	.03928	4012	3.631	.4568	P	11643
11651	1070.87	303	121	.14582	.00001	50	[illegible]	50	.03776	7017	4.629	.1456	P	11651
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11672	3.26	174	220	.01460	.00001	50	.00644	50	.00352	271	.171	.5014	F	11672
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11692	447.12	231	72	.14457	.00001	50	.00001	50	.16342	1785	4.364	.4585	F	11692
11693	663.39	206	196	.03418	.00001	50	.01723	50	.02270	3106	.720	.6530	F	11693
11702	789.75	255	129	.20152	.00001	50	.06665	50	.12950	2111	6.009	.6067	F	11702
11703	1477.66	296	127	.13592	.00001	50	.01067	50	.06134	3556	3.659	.6530	P	11703
11712	2016.06	307	110	.12633	.00001	50	.00550	50	.05165	4734	5.992	.5567	P	11712
11713	4441.23	363	130	.12573	.00001	50	.00001	50	.08241	7543	3.692	.6595	F	11713
11722	1914.86	343	139	.18558	.00001	50	.00001	50	.05487	7335	5.603	.6546	P	11722
11723	667.16	295	135	.23530	.00001	50	.00001	50	.13379	1651	7.564	.7629	P	11723
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11752	47.79	315	25	.20395	.00001	50	.00001	50	.15010	1064	6.696	.5570	P	11752
11753	12.39	285	205	.29093	.00001	50	.00001	50	.26195	432	8.603	.5765	F	11753
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	[illegible]
11762	5045.40	504	315	.21722	.00001	50	.00001	50	.04735	6155	6.698	.5391	P	11762
11763	10191.6	546	122	.19051	.00001	50	.04222	50	.05267	6357	6.021	.6206	F	11763
11772	1085.60	431	64	.23395	.00001	50	.00001	50	.08950	5551	7.494	.4716	F	11772
11773	1131.57	427	192	.19433	.00001	50	.00001	50	.06849	4524	6.090	.6557	F	11773
11782	1240.92	572	24	.21701	.00001	50	.00001	50	.10958	5002	6.522	.5551	P	11782
11783	[illegible]	372	317	.24578	.00001	50	.00001	50	.13338	1774	[illegible]	.6320	P	11783
11792	879.56	551	337	.20087	.00001	50	.00001	50	.10518	4646	6.003	.5508	F	11792

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	1995	[illegible]	[illegible]	7	[illegible]
11802	[illegible]	418	240	[illegible]	.00001	50	.00001	50	.24564	1306	8.121	[illegible]	7	11802
11805	112.58	572	140	.16857	.00001	50	.00001	50	.15576	1156	4.586	.9022	7	11805
11811	1049.75	712	216	.13703	.00001	50	.00001	50	.04581	7750	3.450	.4570	/	11811
[illegible]	[illegible]	561	[illegible]	.20206	.00001	50	.00001	50	.15475	[illegible]	[illegible]	[illegible]	7	[illegible]
11813	157.55	499	65	.20736	.00001	50	.00001	50	.31755	634	10.112	.8515	/	11813
11822	53.55	500	7	.20000	.00001	50	.00001	50	.44554	432	9.245	.7627	/	11822
11823	355.57	487	175	.19977	.00001	50	.00001	50	.14455	2500	5.660	.9270	/	11823
11832	351.22	454	275	.20645	.00001	50	.00001	50	.11356	2300	6.335	.6216	/	11832
11833	352.27	452	83	.18747	.00001	50	.32844	50	.12360	2261	5.652	.6557	/	11833
11842	1308.15	563	316	.15550	.00001	50	.00001	50	.07571	5601	4.463	.5735	/	11842
11843	252.44	473	132	.19964	.00001	50	.00001	50	.12567	2225	5.279	.7226	7	11843
11852	92.56	501	379	.16076	.00001	50	.32225	50	.12225	1402	4.676	.8135	7	11852
[illegible]	[illegible]	517	63	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11861	[illegible]	761	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	11861
11862	869.36	670	380	.15135	.00001	50	.00001	50	.06328	5315	4.169	.5016	7	11862
[illegible]	[illegible]	583	2	[illegible]	.00001	50	[illegible]	50	.13340	1665	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	549	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11881	[illegible]	765	112	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	11881
[illegible]	[illegible]	681	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	640	[illegible]	[illegible]	.00001	50	.01422	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
11892	624.97	542	257	.20472	.00001	50	.01000	50	.08851	2041	6.389	.5605	/	11892
11893	525.65	605	136	.18180	.00001	50	.02111	50	.12585	2805	5.576	.6585	/	11893
11902	848.45	621	334	.20056	.00001	50	.01467	50	.08553	3275	6.055	.4767	/	11902
11903	626.07	500	142	.22010	.00001	50	.00001	50	.22112	1150	7.356	.7000	/	11903
11912	53.48	555	311	.20623	.00001	50	.00001	50	.26067	761	5.594	.6955	/	11912
11913	122.31	627	128	.22820	.00001	50	.00001	50	.17662	1271	6.910	.9515	/	11913
11922	685.75	675	236	.15046	.00001	50	.05222	50	.05512	3665	4.261	.4432	7	11922
11925	566.92	620	41	.20335	.00001	50	.00711	50	.11031	1933	6.179	.8130	7	11925
11931	[illegible]	815	299	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	11931
11932	741.96	756	228	.10717	.00001	50	.02644	50	.05248	3415	2.685	.4595	7	11932
[illegible]	[illegible]	703	39	.18134	.00001	50	.00001	50	.14054	772	5.169	.8777	7	[illegible]
11942	[illegible]	725	178	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	11942
11945	[illegible]	753	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	11945
11951	[illegible]	956	11	.07132	.00001	50	.00001	50	.01551	5553	1.656	.4303	7	11951
11952	[illegible]	869	298	.08022	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	11952
11955	[illegible]	877	82	.09555	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	11955
11961	1012.94	858	19	.06519	.00001	50	.01776	50	.02455	6552	1.550	.4055	7	11961
11962	51.55	741	200	.11245	.00001	50	.00001	50	.11429	761	2.019	.6272	/	11962
11963	253.50	803	63	.10617	.00001	50	.00001	50	.04561	3108	2.765	.5480	/	11963
11972	1656.85	757	6	.13324	.00001	50	.00001	50	.03669	8109	3.556	.3680	/	11972
11975	1227.71	762	121	.12574	.00001	50	.01467	50	.06226	6766	3.483	.5852	/	11975
11982	213.03	693	212	.23622	.00001	50	.00001	50	.17683	1357	7.089	.7201	/	11982
11985	552.85	758	120	.15296	.00001	50	.00001	50	.05267	4576	4.492	.4415	7	11985
11992	621.95	775	215	.16665	.00001	50	.00001	50	.08261	2957	4.791	.5195	7	11992
11993	162.00	725	125	.21726	.00001	50	.00822	50	.13021	1266	6.988	.7625	/	11993
12002	1814.43	816	272	.09421	.00001	50	.00001	50	.02526	4077	2.615	.4525	7	12002
12005	1372.21	850	67	.08425	.00001	50	.00011	50	.02226	5221	2.261	.5000	7	12005
12011	1065.96	909	16	.06437	.00001	50	.01400	50	.01707	6113	[illegible]	.3361	7	12011
12012	[illegible]	857	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	7324	[illegible]	[illegible]	7	12012
12015	55.76	867	43	.10564	.00001	50	[illegible]	50	.10642	485	[illegible]	[illegible]	7	12015
12022	[illegible]	963	111	[illegible]	.00001	50	[illegible]	50	[illegible]	6683	1.366	[illegible]	7	12022
12025	[illegible]	991	66	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	12025
12031	[illegible]	1052	73	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	12031
12032	409.05	1037	275	.25685	.00001	50	.01444	50	.03445	3235	1.170	.7594	/	12032
12035	[illegible]	1007	57	[illegible]	.00001	50	.01344	50	[illegible]	780	[illegible]	[illegible]	7	12035
12041	[illegible]	1154	28	[illegible]	.00001	50	[illegible]	50	.04560	[illegible]	[illegible]	[illegible]	7	12041
12042	1829.73	1069	310	.06085	.00001	50	.00001	50	.03150	6365	1.352	.4517	/	12042
12043	1012.19	1093	116	.07936	.00001	50	.00001	50	.04735	4384	1.785	.6355	/	12043
12052	424.16	764	309	.13956	.00001	50	.00001	50	.10566	1666	3.742	.8055	/	12052
12053	567.00	781	120	.12380	.00001	50	.00332	50	.07121	2425	3.598	.7405	7	12053
12061	1261.00	955	300	.05947	.00001	50	.00576	50	.03157	5302	1.278	.4132	7	12061
12062	603.52	856	311	.09072	.00001	50	.01400	50	.04550	4260	2.301	.4076	/	12062
12063	526.93	874	55	.10127	.00001	50	.00001	50	.04592	2406	2.936	.5454	7	12063
12072	110.07	816	3	.15894	.00001	50	.00001	50	.07763	2471	4.365	.7641	7	12072
12075	[illegible]	804	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	12075
12082	[illegible]	785	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	1.705	[illegible]	7	12082
12085	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	1121	[illegible]	[illegible]	7	12085
12092	[illegible]	811	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	2031	[illegible]	[illegible]	7	12092
12095	[illegible]	777	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	2351	[illegible]	[illegible]	7	12095
12102	55.92	771	215	.16539	.00001	50	.00001	50	.16426	761	4.550	.6591	7	12102
12105	76.14	798	55	.10617	.00001	50	.01753	50	.15060	941	5.655	.8576	/	12105
12111	[illegible]	905	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	12111
12112	42.05	814	167	.14656	.00001	50	.01732	50	.11157	795	4.186	.7194	7	12112
12115	29.60	840	320	.17188	.00001	50	.02570	50	.12118	1155	5.227	.9282	/	12115
12121	1186.63	987	346	.06883	.00001	50	.00001	50	.02535	5172	1.522	.4073	/	12121
12122	357.15	888	339	.09593	.00001	50	.00933	50	.05442	2957	2.441	.6536	/	12122
12125	229.20	891	71	.12745	.00001	50	.00001	50	.02061	1559	3.971	.7077	7	12125
12132	61.43	777	337	.17465	.00001	50	.00972	50	.10515	1336	4.335	.6517	7	12132
12135	625.25	793	168	.06480	.00001	50	.00001	50	.02552	3310	1.599	.1632	/	12135

12142	[illegible]	894	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12142
12144	251.55	806	112	.11068	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	.4671	F	12144
12152	110.15	802	531	.07259	.00001	50	.00576	50	.04145	1221	1.669	.7096	F	12152
12153	51.05	865	140	.10561	.00001	50	.00001	50	.07011	1021	3.037	.6820	F	12153
12162	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	4665	[illegible]	.5402	F	12162
12163	443.00	844	120	.09763	.00001	50	.00001	50	.01686	4097	2.598	.3500	F	12163
12171	1001.15	956	520	.09508	.00001	50	.02155	50	.02052	6281	2.471	.3331	F	12171
12172	54.27	845	260	.11025	.00001	50	.00001	50	.05325	624	2.669	.6596	F	12172
12173	497.56	921	351	.11717	.00001	50	.00001	50	.04565	4264	3.149	.3553	F	12173
12181	1310.58	927	29	.11501	.00001	50	.00001	50	.03270	5364	3.359	.1216	F	12181
12182	810.81	902	339	.12616	.00001	50	.00001	50	.02862	3765	3.579	.5104	F	12182
12183	343.44	851	151	.09322	.00001	50	.00001	50	.06156	1571	2.454	.7117	F	12183
12191	1001.97	882	116	.13161	.00001	50	.00001	50	.02619	6265	3.709	.2316	F	12191
12192	[illegible]	825	148	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12192
12195	[illegible]	859	142	[illegible]	.00001	50	[illegible]	50	[illegible]	4406	[illegible]	[illegible]	F	12195
12201	1210.14	845	145	.11660	.00001	50	.00001	50	.02660	5552	2.179	.2695	F	12201
12202	[illegible]	790	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12202
12205	[illegible]	802	422	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12205
12211	[illegible]	844	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12211
12212	[illegible]	772	32	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12212
12215	[illegible]	784	198	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12215
12221	[illegible]	839	[illegible]	[illegible]	.00001	50	[illegible]	50	.04648	[illegible]	[illegible]	[illegible]	F	12221
12222	165.24	772	21	.11771	.00001	50	.01602	50	.06827	1047	3.170	.7203	F	12222
12223	368.35	791	190	.08590	.00001	50	.00222	50	.04150	2627	2.292	.5502	F	12223
12231	1260.35	830	192	.08351	.00001	50	.02222	50	.02358	4466	2.041	.2238	F	12231
12232	1017.35	822	109	.09107	.00001	50	.00001	50	.02986	4636	2.250	.3375	F	12232
12233	466.81	812	252	.06881	.00001	50	.01667	50	.03156	3671	1.666	.5918	F	12233
12241	1027.36	851	129	.08313	.00001	50	.00001	50	.03158	6157	1.888	.3142	F	12241
12242	1447.47	834	106	.10121	.00001	50	.00776	50	.02727	7132	2.592	.2190	F	12242
12243	263.25	775	196	.14533	.00001	50	.01023	50	.02876	1324	4.002	.7457	F	12243
12252	[illegible]	720	42	[illegible]	.00001	50	[illegible]	50	[illegible]	54	[illegible]	.2018	F	12252
12253	157.93	736	207	.17927	.00001	50	.00001	50	.12627	1222	5.202	.5210	F	12253
12261	[illegible]	812	141	.02716	.00001	50	.00001	50	.04619	4567	2.054	.4714	F	12261
12262	[illegible]	774	31	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12262
12263	[illegible]	751	104	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12263
12271	1057.61	865	174	.08775	.00001	50	.00001	50	.05369	4175	[illegible]	.5061	F	12271
12272	208.88	789	101	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12272
12275	[illegible]	785	445	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12275
12281	1217.65	826	130	.10259	.00001	50	.00644	50	.04024	7242	2.606	.4571	F	12281
12282	120.70	654	32	.21120	.00001	50	.03155	50	.13789	1052	6.140	.7010	F	12282
12283	252.72	683	183	.17652	.00001	50	.00001	50	.11353	1772	5.197	.6461	F	12283
12291	1206.90	805	137	.13251	.00001	50	.01444	50	.06221	5855	3.628	.4675	F	12291
12292	901.72	765	64	.14265	.00001	50	.01422	50	.06151	5644	3.940	.4029	F	12292
12293	828.63	714	176	.13625	.00001	50	.00001	50	.06360	5216	3.819	.5799	F	12293
12301	1015.76	739	125	.14535	.00001	50	.01200	50	.04861	7522	3.976	.3365	F	12301
12302	64.80	545	54	.17283	.00001	50	.00001	50	.16435	575	5.511	.7142	F	12302
12303	102.67	576	164	.21235	.00001	50	.01265	50	.15182	1260	6.562	.9237	F	12303
12311	1023.86	785	135	.11267	.00001	50	.00001	50	.05550	6125	2.933	.4500	F	12311
12312	269.72	558	35	.16569	.00001	50	.01022	50	.13017	1207	4.780	.6260	F	12312
12313	367.58	567	159	.17085	.00001	50	.00001	50	.13165	1437	4.956	.6876	F	12313
12321	[illegible]	784	103	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12321
12322	82.57	451	50	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12322
12323	[illegible]	565	168	[illegible]	.00001	50	[illegible]	50	.17081	[illegible]	[illegible]	[illegible]	F	12323
12332	[illegible]	380	45	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12332
12333	509.06	502	205	[illegible]	.00001	50	[illegible]	50	[illegible]	2642	[illegible]	[illegible]	F	12333
12342	691.76	562	37	.28051	.00001	50	.00001	50	.16760	2140	8.460	.7590	F	12342
12343	[illegible]	657	170	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12343
12352	91.55	582	354	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12352
12353	94.77	592	149	.24461	.00001	50	.00001	50	.22520	1024	7.257	.5715	F	12353
12361	1017.36	829	351	.14130	.00001	50	.01065	50	.03878	6762	3.780	.3681	F	12361
12362	1191.51	746	329	.26610	.00001	50	.00001	50	.15863	1366	8.264	.6511	F	12362
12363	2271.39	744	136	.14495	.00001	50	.00001	50	.02363	7327	4.411	.2355	F	12363
12371	1219.18	792	97	.15216	.00001	50	.00001	50	.02365	5416	4.991	.0567	F	12371
12372	1052.18	681	57	.22207	.00001	50	.00001	50	.06152	4771	7.395	.4200	F	12372
12373	1093.50	696	199	.21570	.00001	50	.03665	50	.06520	3220	7.363	.4225	F	12373
12382	920.00	642	102	.22007	.00001	50	.00001	50	.05278	6242	7.353	.3658	F	12382
12383	[illegible]	606	406	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12383
[illegible]	67.4[illegible]	572	62	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	[illegible]
[illegible]	55.38	557	104	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	[illegible]
12401	[illegible]	752	136	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12401
12402	[illegible]	565	98	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12402
12403	110.97	625	185	.32605	.00001	50	.04244	50	.22776	682	11.465	.0216	F	12403
12411	1266.06	757	155	.17130	.00001	50	.00001	50	.05626	4638	5.203	.1411	F	12411
12412	[illegible]	656	78	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	12412
12413	753.05	682	235	.23259	.00001	50	.00001	50	.05956	2650	7.909	.5787	F	12413
12422	1057.89	676	142	.21130	.00001	50	.01516	50	.04820	6404	6.940	.2818	F	12422
12423	1500.93	716	314	.21111	.00001	50	.00001	50	.05930	6234	6.840	.4450	F	12423
12431	1018.38	805	200	.12522	.00001	50	.00001	50	.01887	7626	3.428	.1270	F	12431
12432	754.11	732	30	.20567	.00001	50	.00001	50	.07350	2042	6.502	.4595	F	12432
12433	769.30	722	199	.20578	.00001	50	.00001	50	.05371	2535	7.251	.5328	F	12433
12442	1806.30	724	158	.17552	.00001	50	.00001	50	.04125	7028	5.830	.2538	F	12442

[illegible]	[illegible]	695	10	[illegible]	.00001	50	.00001	50	.11548	2546	8.801	[illegible]	P	[illegible]
12451	[illegible]	774	190	.11829	.00001	50	.00001	50	.02505	5267	3.402	.1666	P	12451
12452	851.00	741	155	.16671	.00001	50	.01085	50	.04579	4654	5.386	.3220	P	12452
12453	605.00	722	275	.21056	.00001	50	.00001	50	.09715	1965	7.379	.8513	✓	12453
12462	[illegible]	661	209	.21160	.00001	50	.00001	50	.15425	1126	9.189	.6694	P	12462
12463	150.57	710	5	.20795	.00001	50	.02844	50	.16572	1155	9.650	.7790	✓	12463
12472	942.84	750	135	.13002	.00001	50	.00001	50	.04628	3155	4.627	.4285	✓	12472
12473	528.65	761	205	.21914	.00001	50	.00001	50	.14156	1317	7.122	.9605	✓	12473
12481	1524.28	701	219	.08874	.00001	50	.00001	50	.01508	5957	2.512	.0777	✓	12481
12482	106.52	750	72	.14597	.00001	50	.00001	50	.11635	830	4.389	.7314	✓	12482
12483	61.00	753	237	.15506	.00001	50	.01911	50	.08663	867	3.900	.7513	✓	12483
12491	1005.21	623	256	.10455	.00001	50	.00001	50	.01970	8174	2.881	.2152	P	12491
12492	750.50	767	152	.09905	.00001	50	.01332	50	.03056	2779	2.931	.4471	P	12492
12493	[illegible]	744	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	2629	3.900	[illegible]	P	12493
12501	[illegible]	800	266	[illegible]	.00001	50	.00001	50	[illegible]	9555	3.201	[illegible]	P	12501
12502	61.50	703	331	.27172	.00001	50	.00001	50	.28356	777	9.521	.7772	P	12502
12503	[illegible]	744	146	[illegible]	.00001	50	.00001	50	.05750	4061	5.470	[illegible]	P	12503
12511	[illegible]	647	168	[illegible]	.00001	50	.00001	50	.05577	6495	3.187	.4492	P	12511
12512	[illegible]	402	142	.19945	.00001	50	.04465	50	.22467	251	6.652	[illegible]	P	12512
12513	46.59	788	331	.17444	.00001	50	.03844	50	.14670	1590	[illegible]	[illegible]	P	12513
12522	866.56	792	152	[illegible]	.00001	50	.00001	50	.00865	5915	4.068	.4383	P	12522
12523	546.65	665	266	[illegible]	.00001	50	.00001	50	.11739	2136	[illegible]	[illegible]	P	12523
12531	1202.85	752	140	.13251	.00001	50	.00001	50	.07761	4727	3.216	.6251	✓	12531
12532	722.59	569	63	.16002	.00001	50	.03267	50	.08265	3741	3.860	.6412	✓	12532
12533	278.64	540	212	.22921	.00001	50	.03933	50	.18521	1230	7.109	.8657	✓	12533
12542	314.20	409	127	.15951	.00001	50	.00001	50	.05467	2057	4.557	.6825	✓	12542
12543	776.79	575	257	.16867	.00001	50	.00001	50	.08247	4837	5.056	.6287	✓	12543
12552	851.31	573	145	.15456	.00001	50	.00001	50	.06546	5641	4.350	.4256	✓	12552
12553	202.53	520	204	.22430	.00001	50	.01225	50	.15750	1524	6.787	.9180	P	12553
12561	1332.77	720	141	.12973	.00001	50	.00001	50	.05627	5956	3.507	.5717	P	12561
12562	[illegible]	584	[illegible]	[illegible]	.00001	50	.00001	50	.11656	2529	4.206	[illegible]	P	12562
12565	154.66	567	232	.21512	.00001	50	.00001	50	.15346	1177	6.587	.8652	P	12565
12572	659.93	586	145	.15815	.00001	50	.03111	50	.11340	2765	5.188	.7237	P	12572
12573	[illegible]	675	[illegible]	[illegible]	.00001	50	.00001	50	.05950	6146	[illegible]	[illegible]	P	12573
12581	[illegible]	774	[illegible]	[illegible]	.00001	50	.00001	50	.05478	6436	3.882	.3576	P	12581
12582	100.44	585	62	.19616	.00001	50	.00001	50	.17218	1024	6.357	.2657	P	12582
12585	[illegible]	575	270	[illegible]	.00001	50	.05356	50	.20970	439	6.582	[illegible]	P	12585
12592	[illegible]	673	122	.13360	.00001	50	.02332	50	.05205	5560	3.080	.5254	P	12592
12595	1846.37	673	215	.14059	.00001	50	.01378	50	.05245	6454	3.075	.5129	P	12595
12602	149.85	556	121	.07056	.00001	50	.00001	50	.05373	1425	2.105	.4002	✓	12602
12603	127.77	569	288	.09832	.00001	50	.01911	50	.07571	1100	2.601	.8394	✓	12603
12611	1552.49	763	129	.11060	.00001	50	.00001	50	.04575	6817	2.795	.5117	✓	12611
12612	110.97	575	56	.09546	.00001	50	.00001	50	.08165	1407	2.236	.7195	✓	12612
12613	51.96	562	150	.06459	.00001	50	.00001	50	.04655	1106	1.559	.8182	✓	12613
12621	1001.16	751	172	.09765	.00001	50	.00001	50	.06352	4565	2.400	.6726	P	12621
12622	1520.21	677	121	.10349	.00001	50	.00001	50	.04570	6954	2.502	.5934	P	12622
12623	1229.58	600	278	.08842	.00001	50	.01422	50	.02135	3657	2.127	.4250	✓	12623
12631	1041.66	724	257	.10254	.00001	50	.00001	50	.04425	5457	2.367	.5095	P	12631
12632	128.79	581	161	.08244	.00001	50	.00001	50	.05758	1211	2.026	.5746	P	12632
12633	585.63	676	310	.12346	.00001	50	.03372	50	.06757	2595	3.825	.7168	P	12633
12641	[illegible]	693	261	.17832	.00001	50	.00844	50	.06667	5977	[illegible]	.4808	P	12641
12642	[illegible]	486	252	.10662	.00001	50	.07917	50	.11671	660	[illegible]	.8500	P	12642
12645	45.36	681	132	.21876	.00001	50	.00001	50	.12576	602	6.277	.9664	P	12645
12651	[illegible]	677	266	.17136	.00001	50	.00001	50	.05498	7257	5.842	.5424	P	12651
12652	58.00	434	135	.24955	.00001	50	.00001	50	.19279	914	6.158	.7742	P	12652
12653	125.59	436	250	.21216	.00001	50	.00001	50	.15056	1605	6.156	.8509	✓	12653
12661	[illegible]	798	134	.16865	.00001	50	.00001	50	.11153	5466	5.241	.5215	P	12661
12662	840.76	458	125	.23366	.00001	50	.00001	50	.09978	6207	7.165	.6784	P	12662
12663	41.31	290	276	.26580	.00001	50	.00022	50	.28515	578	8.507	.7688	✓	12663
12671	1371.33	476	136	.17156	.00001	50	.00844	50	.08276	6767	5.123	.6032	✓	12671
12672	153.06	289	344	.22152	.00001	50	.05644	50	.07556	960	6.555	.5273	✓	12672
12675	1377.33	461	130	.17151	.00001	50	.00001	50	.09612	6012	5.292	.7476	P	12675
12681	1159.61	480	116	.17471	.00001	50	.01444	50	.08323	6276	5.281	.5776	P	12681
12682	146.61	234	50	.04846	.00001	50	.00001	50	.04155	1555	1.134	.6535	✓	12682
12685	1163.41	559	141	.15178	.00001	50	.01867	50	.08249	6726	4.365	.5121	P	12685
12692	67.23	193	68	.04303	.00001	50	.02556	50	.02775	650	1.367	.3772	P	12692
12695	[illegible]	205	246	.10832	.00001	50	.00001	50	.04738	2958	3.405	[illegible]	P	12695
12702	[illegible]	227	[illegible]	.07927	.00001	50	.00001	50	.15766	1591	8.708	.6685	P	12702
12705	[illegible]	504	163	.25550	.00001	50	.00001	50	.13470	2226	7.250	[illegible]	P	12705
12711	[illegible]	668	117	.11704	.00001	50	.00001	50	.03871	5169	3.140	.4772	P	12711
12712	1601.66	751	145	.10744	.00001	50	.02222	50	.00465	2563	5.402	.7050	P	12712
12715	2107.37	404	127	.17855	.00001	50	.01805	50	.08201	5401	5.527	.4444	P	12715
12722	330.95	255	110	.15821	.00001	50	.00001	50	.14207	1137	3.656	.6205	✓	12722
12725	487.37	525	267	.25047	.00001	50	.00001	50	.13345	3024	8.572	.6651	P	12725
12732	1100.05	581	22	.19646	.00001	50	.04829	50	.11246	5760	6.097	.4750	P	12732
12733	707.98	610	170	.22454	.00001	50	.00001	50	.14257	3066	7.150	.6751	✓	12733
12742	116.21	468	335	.16456	.00001	50	.00001	50	.14454	2732	3.705	.9159	✓	12742
12743	59.94	591	152	.16754	.00001	50	.00001	50	.16325	851	4.593	.9751	✓	12743
12751	1005.59	570	241	.15975	.00001	50	.01244	50	.04204	5157	4.501	.3675	P	12751
12752	162.49	483	309	.14766	.00001	50	.05733	50	.14502	3421	3.368	.9307	P	12752
12753	35.64	404	55	.22813	.00001	50	.00001	50	.18523	576	7.220	.9516	✓	12753

12762	[illegible]	441	9	.17558	.00001	50	.03543	50	.13839	2936	4.556	[illegible]	P	12762
12763	[illegible]	440	165	.12088	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12763
12771	1157.26	672	137	.13078	.00001	50	.00001	50	.05968	5652	3.558	.4567	P	12771
12772	856.75	532	329	.13040	.00001	50	.02559	50	.06325	3121	3.452	.6274	P	12772
12773	[illegible]	535	151	.14855	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12773
12781	1560.07	624	119	.15555	.00001	50	.00001	50	.08587	5162	4.273	.5408	P	12781
12782	14.32	417	77	.10475	.00001	50	.00001	50	.15380	524	2.760	.4750	P	12782
12783	72.83	470	185	.12252	.00001	50	.00001	50	.11361	1530	3.216	.5277	P	12783
12791	1100.73	641	151	.13287	.00001	50	.00001	50	.05513	6742	3.616	.4360	P	12791
12792	1256.48	541	117	.14476	.00001	50	.00001	50	.07051	6326	4.059	.5591	✓	12792
12793	1008.65	502	242	.14546	.00001	50	.00001	50	.07755	3744	4.012	.7067	P	12793
12802	2111.57	350	121	.14322	.00001	50	.00001	50	.06964	5252	4.513	.6281	P	12802
12803	1027.65	345	160	.10538	.00001	50	.00001	50	.11340	2520	5.663	.7666	P	12803
12812	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12812
12813	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12813
12821	1053.81	545	28	.11797	.00001	50	.00001	50	.07248	5032	3.606	.2399	P	12821
12822	[illegible]	491	310	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12822
12823	[illegible]	460	121	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12823
12831	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12831
12832	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12832
12833	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12833
12842	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12842
12843	1116.70	448	207	.10155	.00001	50	.00001	50	.11330	3651	5.306	.7030	P	12843
12852	564.57	415	19	.19582	.00001	50	.00001	50	.06704	3262	5.172	.5335	P	12852
12853	1340.58	367	174	.14114	.00001	50	.00001	50	.07508	6372	3.467	.5214	P	12853
12861	1209.53	552	99	.13055	.00001	50	.00001	50	.05505	5505	3.525	.5330	P	12861
12862	115.85	507	118	.17256	.00001	50	.00001	50	.15231	1451	4.497	.5256	P	12862
12863	25.81	432	126	.12131	.00001	50	.03576	50	.13125	557	3.364	.6256	P	12863
12872	283.36	521	15	.20419	.00001	50	.00001	50	.10377	2056	6.026	.5591	P	12872
12873	569.51	590	109	.23135	.00001	50	.00001	50	.12760	2772	6.065	.5370	P	12873
12881	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12881
12882	1963.44	640	135	.10558	.00001	50	.01611	50	.03069	10254	3.185	.4107	P	12882
12883	[illegible]	580	158	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12883
12891	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12891
12892	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12892
12893	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12893
12902	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12902
12903	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12903
12911	1051.65	605	141	.15055	.00001	50	.00001	50	.05559	7012	5.020	.2556	P	12911
12912	93.15	401	85	.21105	.00001	50	.00001	50	.12325	1088	7.207	.7030	P	12912
12913	25.73	354	195	.19017	.00001	50	.00001	50	.17839	671	5.453	.8203	P	12913
12922	422.82	391	126	.22559	.00001	50	.00001	50	.12111	556	7.159	.5149	P	12922
12923	1017.56	517	103	.20145	.00001	50	.00001	50	.06505	5151	5.404	.5530	P	12923
12931	1005.21	454	70	.19572	.00001	50	.00001	50	.05256	6526	6.049	.3565	P	12931
12932	446.51	527	88	.23247	.00001	50	.00001	50	.11526	3075	7.195	.5371	P	12932
12933	214.53	504	210	.20268	.00001	50	.32.76	50	.06771	1215	6.014	.5157	P	12933
12942	279.45	417	131	.13718	.00001	50	.00001	50	.10245	2045	4.307	.5549	P	12942
12943	303.75	452	167	.20150	.00001	50	.37644	50	.16565	1656	6.210	.6264	P	12943
12951	1363.32	625	90	.13181	.00001	50	.01403	50	.03522	5951	2.758	.3600	P	12951
12952	[illegible]	560	25	.14553	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12952
12953	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12953
12961	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12961
12962	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12962
12963	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12963
12971	[illegible]	364	140	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12971
12972	257.58	327	142	.16485	.00001	50	.00001	50	.15025	1276	4.769	.7626	P	12972
12973	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12973
12982	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	12982
12983	1024.12	301	209	.16002	.00001	50	.00001	50	.05552	5306	5.262	.4760	P	12983
12992	1030.52	267	128	.11487	.00001	50	.00001	50	.06510	4530	3.465	.4000	P	12992
12993	191.15	236	295	.09214	.00001	50	.03111	50	.07125	554	2.709	.7391	P	12993
13001	1086.76	395	132	.17286	.00001	50	.00001	50	.05341	5627	5.100	.5115	P	13001
13002	359.23	285	105	.15513	.00001	50	.00001	50	.10161	1572	4.227	.6226	P	13002
13003	208.17	281	188	.16191	.00001	50	.00001	50	.11713	1541	5.074	.6649	P	13003
13012	119.37	334	137	.07115	.00001	50	.32.56	50	.06354	455	1.953	.6160	P	13012
13013	430.12	275	297	.13558	.00001	50	.00001	50	.06151	3145	4.284	.4235	P	13013
13022	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	13022
13023	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	13023
13031	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	13031
13032	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	13032
13033	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	13033
13042	263.55	342	120	.12032	.00001	50	.32159	50	.06521	2025	2.610	.5659	P	13042
13043	923.43	430	297	.15733	.00001	50	.35259	50	.10352	3448	4.909	.7405	P	13043
13051	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	13051
13052	1580.51	446	121	.13451	.00001	50	.00001	50	.05961	4052	2.697	.5916	P	13052
13053	468.33	350	234	.17256	.00001	50	.35559	50	.05382	3775	5.009	.3775	P	13053
13062	484.56	391	136	.15552	.00001	50	.00001	50	.07002	2216	5.075	.5635	P	13062
13063	2050.11	486	296	.16747	.00001	50	.00001	50	.07941	5151	4.907	.7335	P	13063
13071	1061.58	523	119	.10223	.00001	50	.00001	50	.05465	7471	4.782	.5271	P	13071
13072	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	13072
13073	1805.49	462	285	.14636	.00001	50	.00001	50	.06126	5582	4.035	.6257	P	13073

13081	[illegible]	[illegible]	294	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	13081
13082	45.74	597	185	.15724	.00001	50	.00001	50	.14493	694	4.157	[illegible]	?	13082
13083	97.51	403	208	.10654	.00001	50	.01600	50	.09265	1064	2.526	.9595	?	13083
13091	1066.21	403	237	.14746	.00001	50	.03532	50	.03565	4856	4.085	.1065	✓	13091
13092	1299.44	440	147	.18059	.00001	50	.05578	50	.14478	9344	5.448	.6136	?	13092
13093	1204.47	435	300	.13171	.00001	50	.00001	50	.05201	4252	3.079	.6151	✓	13093
13101	1014.12	356	202	.15747	.00001	50	.05311	50	.04785	5756	5.184	.2200	✓	13101
13102	255.55	269	195	.14024	.00001	50	.04333	50	.07515	1575	4.561	.4555	✓	13102
13103	751.56	323	311	.10116	.00001	50	.00001	50	.00209	3421	6.270	.3252	✓	13103
13111	1534.14	427	256	.13467	.00001	50	.02600	50	.03594	6745	3.615	.2406	✓	13111
13112	1219.35	379	135	.19332	.00001	50	.02432	50	.05563	5046	6.037	.6580	✓	13112
13113	553.72	326	259	.23124	.00001	50	.02956	50	.12146	1335	7.552	.9125	?	13113
13122	22.40	194	130	.38126	.00001	50	.00001	50	.09051	470	2.112	.5292	?	13122
13125	[illegible]	247	[illegible]	[illegible]	.00001	50	.02844	50	.05550	1444	3.802	.7694	?	13125
13131	[illegible]	565	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	2156	4.964	.8295	?	13131
13132	117.40	234	133	.09550	.00001	50	.00001	50	.07121	617	2.575	.5192	?	13132
13135	85.86	243	[illegible]	[illegible]	.00001	50	.00001	50	.14453	705	5.162	.8130	?	13135
13141	[illegible]	288	[illegible]	.14486	.00001	50	.00001	50	.04583	6164	[illegible]	.3587	?	13141
13142	[illegible]	250	[illegible]	.14267	.00001	50	[illegible]	50	[illegible]	862	4.121	.7244	?	13142
13145	[illegible]	214	102	.15116	.00001	50	[illegible]	50	.11060	366	5.193	.9930	?	13145
13155	2.44	167	206	.05705	.00001	50	.01111	50	.05555	25	[illegible]	.9565	?	13155
13161	1164.77	492	284	.15060	.00001	50	.00001	50	.04504	6626	4.082	.3554	?	13161
13162	756.23	252	85	.09412	.00001	50	.00001	50	.04062	1376	2.505	.5515	✓	13162
13163	1474.20	322	236	.12261	.00001	50	.00001	50	.09240	3871	3.453	.5675	✓	13163
13171	1309.15	361	142	.13971	.00001	50	.00001	50	.07163	5973	4.325	.5260	✓	13171
13172	1124.00	264	136	.09285	.00001	50	.02467	50	.07276	4464	2.536	.6255	✓	13172
13173	350.45	227	261	.11926	.00001	50	.00001	50	.05952	1503	3.714	.6265	✓	13173
13182	159.25	203	133	.08335	.00001	50	.00933	50	.04549	1770	2.552	.5971	✓	13182
13185	114.21	221	273	.15200	.00001	50	.00001	50	.09456	1437	4.801	.2692	?	13185
13191	1050.20	265	107	.07114	.00001	50	.00022	50	.02167	4977	2.160	.2027	?	13191
13192	[illegible]	221	[illegible]	.09476	.00001	50	.00001	50	[illegible]	1441	2.915	[illegible]	?	13192
13193	264.01	221	163	.11455	.00001	50	.00001	50	.05726	1437	3.726	.4287	?	13193
13202	805.89	217	[illegible]	.12166	.00001	50	.02756	50	.03751	1954	3.829	.2647	?	13202
13205	[illegible]	264	228	[illegible]	.00001	50	.02465	50	.05323	2096	5.087	.5209	?	13205
13212	1426.86	511	58	.11565	.00001	50	.05533	50	.06477	6024	3.552	.4355	?	13212
13215	1819.30	294	275	.14332	.00001	50	.01511	50	.06215	5211	4.275	.5102	?	13215
13221	[illegible]	601	64	.13966	.00001	50	.00001	50	.05066	[illegible]	4.112	[illegible]	?	13221
13222	1045.97	574	444	.20165	.00001	50	.00001	50	.05765	5061	6.485	.4437	?	13222
13225	1024.12	558	120	.15016	.00001	50	.02756	50	.04629	6252	4.895	.3592	?	13225
13232	220.42	259	120	.10875	.00001	50	.05711	50	.11265	1522	2.835	.3043	✓	13232
13235	518.40	333	301	.16065	.00001	50	.00001	50	.12751	2416	5.530	.7730	✓	13235
13242	2567.14	372	100	.13817	.00001	50	.00001	50	.04776	6862	4.186	.5537	✓	13242
13243	2457.56	471	251	.19508	.00001	50	.00001	50	.05461	7541	4.575	.4577	✓	13243
13251	1137.24	482	139	.18032	.00001	50	.00001	50	.06266	5792	5.275	.4362	✓	13251
13252	48.60	592	329	.22602	.00001	50	.00001	50	.28715	595	6.390	.7534	?	13252
13255	651.14	473	133	.13705	.00001	50	.01576	50	.09522	4151	3.764	.7079	?	13255
13261	1560.03	614	201	.15725	.00001	50	.00001	50	.07075	5932	4.612	.6100	✓	13261
13262	441.45	494	142	.14056	.00001	50	.00001	50	.09585	4416	3.953	.7262	?	13262
13265	96.50	573	273	.37432	.00001	50	.00001	50	.05051	724	1.938	.8610	?	13265
13272	235.61	275	176	.12377	.00001	50	.00001	50	.09557	1055	3.832	.5387	?	13272
13275	480.74	[illegible]	[illegible]	.17516	.00001	50	.00001	50	[illegible]	2559	4.585	.6409	?	13275
13281	1374.65	482	[illegible]	.14206	.00001	50	.00001	50	[illegible]	5015	4.015	.3012	?	13281
13282	41.01	298	47	.10555	.00001	50	.06111	50	.28654	522	4.902	.9468	?	13282
13285	190.45	507	166	.20649	.00001	50	.00001	50	.11040	1161	6.477	.6974	?	13285
13292	548.26	500	120	.15446	.00001	50	.00001	50	.06558	2924	3.373	.6676	?	13292
13295	350.75	348	257	.13046	.00001	50	.04622	50	.08210	2365	4.335	.7722	✓	13295
13301	1311.11	456	114	.17836	.00001	50	.02111	50	.05000	5925	3.876	.4545	?	13301
13302	1892.06	461	114	.20019	.00001	50	.00001	50	.06457	5754	3.689	.6418	?	13302
13303	165.07	371	275	.29352	.00001	50	.05576	50	.16201	621	9.304	.7227	✓	13303
13312	521.92	327	112	.16065	.00001	50	.05556	50	.14002	1351	4.754	.7125	✓	13312
13313	1547.01	378	269	.12756	.00001	50	.02176	50	.04205	5526	3.947	.5426	✓	13313
13322	364.50	347	111	.15065	.00001	50	.05556	50	.10232	1725	4.429	.4686	?	13322
13325	333.72	342	283	.10407	.00001	50	.00932	50	.08763	1785	3.085	.2474	?	13325
13332	154.71	335	139	.09809	.00001	50	.04069	50	.09301	1765	2.793	.5507	✓	13332
13333	220.04	366	257	.11016	.00001	50	.04376	50	.05665	2275	3.499	.7066	?	13333
13341	1130.75	529	129	.17810	.00001	50	.00001	50	.04515	5365	5.268	.4424	?	13341
13342	[illegible]	525	114	.15955	.00001	50	.00933	50	.05454	6442	4.606	.4606	?	13342
13345	407.44	405	245	.21466	.00001	50	.00001	50	.14555	955	7.376	.3977	?	13345
13351	[illegible]	426	248	.10209	.00001	50	.00001	50	.02765	5504	2.905	.3560	?	13351
13352	425.97	582	136	.17944	.00001	50	.00001	50	.09562	1444	4.398	.7577	?	13352
13355	1144.54	403	301	.09804	.00001	50	.01755	50	.03014	5471	3.975	.5677	?	13355
13362	254.34	588	178	.16352	.00001	50	.00001	50	.05437	2456	4.650	.4042	?	13362
13363	537.02	387	219	.13352	.00001	50	.05711	50	.08465	1655	4.320	.5565	✓	13363
13371	1047.22	444	220	.05746	.00001	50	.00455	50	.01548	7451	1.660	.1094	?	13371
13372	521.35	416	124	.08772	.00001	50	.00001	50	.05223	2366	2.520	.6570	?	13372
13373	419.56	428	260	.10002	.00001	50	.01622	50	.03597	3077	2.565	.6657	✓	13373
13381	1062.50	453	274	.10816	.00001	50	.00001	50	.01742	6845	3.227	.1036	✓	13381
13382	394.50	441	262	.09537	.00001	50	.00001	50	.03169	5231	2.991	.4656	✓	13382
13385	275.24	425	224	.10220	.00001	50	.22267	50	.03658	5310	3.260	.4962	?	13385
13391	1078.11	415	251	.09754	.00001	50	.02844	50	.01113	4820	3.036	.3353	?	13391
13392	65.05	347	222	.14866	.00001	50	.03756	50	.11553	957	4.357	.7361	✓	13392

13393	84.47	356	158	.10610	.00001	50	.00001	50	.14222	862	5.558	.8419	?	13393
13401	1317.44	325	279	.08600	.00001	50	.00001	50	.02820	2454	2.716	.2764	?	13401
13402	1164.78	296	137	.08603	.00001	50	.03533	50	.02819	6515	2.809	.4547	?	13402
13403	765.65	281	279	.09557	.00001	50	.00001	50	.04251	5252	3.470	.4535	✓	13403
13411	1044.80	346	235	.10544	.00001	50	.00001	50	.04225	9524	3.162	.2015	?	13411
13412	12.15	180	166	.09454	.00001	50	.03285	50	.21756	125	1.297	.8276	✓	13412
13413	28.55	220	200	.21093	.00001	50	.00001	50	.16112	557	6.657	.5420	✓	13413
13421	1228.77	316	173	.11475	.00001	50	.04067	50	.05308	6136	3.447	.4021	✓	13421
13422	174.15	205	20	.11526	.00001	50	.05044	50	.01050	614	2.670	.7020	✓	13422
13423	456.03	243	183	.12835	.00001	50	.00001	50	.05332	3351	4.013	.4831	✓	13423
13432	1468.28	251	76	.12627	.00001	50	.00001	50	.05964	5546	4.026	.4056	✓	13432
13433	2292.53	226	180	.12429	.00001	50	.00001	50	.04940	6470	4.009	.3598	?	13433
13442	221.56	191	159	.17231	.00001	50	.00001	50	.15721	1505	5.259	.7026	?	13442
13443	214.64	381	166	.13434	.00001	50	.00001	50	.07445	1511	4.695	.6486	?	13443
13451	1001.97	406	218	.13382	.00001	50	.00001	50	.05092	6137	3.809	.4452	?	13451
13452	762.63	371	318	.14517	.00001	50	.00001	50	.10937	2226	6.743	.6036	?	13452
13453	258.91	326	125	.16604	.00001	50	.00001	50	.14768	956	5.174	.8616	?	13453
13462	41.27	362	32	.17476	.00001	50	.03656	50	.17961	560	5.859	.9719	?	13462
13463	25.37	258	410	.17860	.00001	50	.03783	50	.15021	470	5.052	.8605	?	13463
13471	1016.37	306	55	.07600	.00001	50	.01756	50	.02409	4420	2.204	.1192	?	13471
13472	254.30	396	337	.17258	.00001	50	.00001	50	.06545	1156	5.526	.5802	?	13472
13473	914.49	342	120	.09526	.00001	50	.00001	50	.03564	8224	3.080	.4475	?	13473
13482	443.08	201	106	.07285	.00001	50	.00001	50	.02352	4650	2.354	.2562	✓	13482
13483	68.29	274	271	.14761	.00001	50	.00001	50	.12517	1647	4.475	.8465	✓	13483
13491	1121.06	381	114	.13137	.00001	50	.00001	50	.04975	5110	4.101	.3522	✓	13491
13492	242.10	275	31	.10155	.00001	50	.01222	50	.02220	1021	3.301	.5272	✓	13492
13493	686.88	312	152	.08578	.00001	50	.00001	50	.05121	5514	2.839	.5172	✓	13493
13502	240.57	277	122	.07371	.00001	50	.00001	50	.02935	2065	2.270	.5620	✓	13502
13503	205.71	294	293	.12213	.00001	50	.00001	50	.07763	1001	3.987	.6206	?	13503
13511	1005.21	335	125	.08772	.00001	50	.00001	50	.04065	5422	3.603	.5067	?	13511
13512	23.14	321	48	.07547	.00001	50	.01511	50	.05216	560	1.999	.9111	?	13512
13513	20.75	275	185	.11585	.00001	50	.00001	50	.06919	432	4.092	.5156	?	13513
13533	255.95	284	107	.06759	.00001	50	.00001	50	.03470	2046	1.960	.5366	?	13533
13523	558.74	316	479	.11466	.00001	50	.00325	50	.03177	4365	3.424	.5720	?	13523
13531	1014.94	335	108	.13417	.00001	50	.00001	50	.03355	6062	3.800	.2138	?	13531
13532	197.67	306	76	.06706	.00001	50	.00001	50	.02710	2333	1.903	.5702	?	13532
13533	123.91	306	195	.09781	.00001	50	.00001	50	.06026	1094	2.903	.5595	?	13533
13541	1114.25	392	170	.13411	.00001	50	.00001	50	.04526	5564	3.756	.3525	?	13541
13542	954.18	337	117	.07614	.00001	50	.00001	50	.04958	4781	2.262	.5055	?	13542
13543	660.25	332	374	.09035	.00001	50	.00001	50	.03952	3234	3.104	.5750	✓	13543
13551	1021.61	355	272	.09586	.00001	50	.00001	50	.02667	6010	2.916	.2517	✓	13551
13552	186.33	286	118	.09655	.00001	50	.00001	50	.06469	1626	3.165	.5566	✓	13552
13553	261.93	322	253	.14552	.00001	50	.00001	50	.16507	1033	4.502	.7272	✓	13553
13562	2030.57	230	120	.12623	.00001	50	.00001	50	.02434	3235	4.164	.2405	✓	13562
13563	1252.26	265	292	.17565	.00001	50	.00001	50	.13625	2313	5.562	.6519	?	13563
13572	220.12	236	39	.06238	.00001	50	.00001	50	.04421	2355	1.748	.5208	?	13572
13573	188.03	267	206	.12761	.00001	50	.03775	50	.05063	2676	4.050	.5521	✓	13573
13581	1096.76	330	116	.08065	.00001	50	.00001	50	.04519	5335	2.291	.4616	?	13581
13582	607.30	283	12	.09634	.00001	50	.02022	50	.02207	3571	2.990	.3271	?	13582
13583	190.33	361	159	.10687	.00001	50	.00001	50	.00066	1010	3.029	.7056	?	13583
13592	1071.41	374	66	.08567	.00001	50	.00001	50	.03842	4941	2.525	.4426	?	13592
13593	2088.18	326	200	.11255	.00001	50	.00001	50	.04648	7468	3.593	.2594	?	13593
13601	1015.77	335	120	.09447	.00001	50	.00001	50	.03877	4931	2.957	.3875	?	13601
13602	994.68	335	142	.11340	.00001	50	.00001	50	.05761	4537	3.554	.5789	?	13602
13603	592.86	403	130	.07284	.00001	50	.00001	50	.04198	2624	2.452	.6856	?	13603
13612	190.25	265	92	.11013	.00001	50	.00001	50	.07146	659	3.742	.5178	✓	13612
13613	205.68	285	461	.12591	.00001	50	.04222	50	.05278	1546	3.808	.5529	?	13613
13621	1012.53	425	159	.13468	.00001	50	.00001	50	.04571	6571	4.066	.2142	?	13621
13622	2261.35	357	100	.11213	.00001	50	.04422	50	.02954	6550	3.472	.3073	✓	13622
13623	983.71	334	235	.12327	.00001	50	.00001	50	.05969	3026	3.688	.4707	✓	13623
13632	205.76	280	126	.07529	.00001	50	.00001	50	.05803	1105	2.091	.5507	✓	13632
13633	462.99	356	290	.15501	.00001	50	.00001	50	.11345	2415	5.011	.7596	?	13633
13641	1027.38	414	179	.09611	.00001	50	.00001	50	.01536	4014	3.061	.6527	?	13641
13642	1603.53	345	114	.09652	.00001	50	.00001	50	.03047	6153	2.768	.4590	✓	13642
13643	2271.24	367	270	.12095	.00001	50	.01667	50	.02268	6765	3.725	.4109	?	13643
13651	1062.12	443	262	.10197	.00001	50	.00001	50	.03138	5456	3.955	.2511	?	13651
13652	1891.56	323	130	.08977	.00001	50	.00001	50	.02765	5718	3.084	.2272	?	13652
13653	2608.78	405	205	.13084	.00001	50	.00001	50	.03706	3324	3.973	.2450	?	13653
13661	1010.70	336	130	.05058	.00001	50	.00001	50	.04505	5524	1.565	.3492	?	13661
13662	503.29	283	127	.07508	.00001	50	.00001	50	.04762	1714	2.091	.5461	?	13662
13663	1763.30	331	200	.10594	.00001	50	.04003	50	.05506	3614	3.029	.5370	?	13663
13672	965.52	195	34	.10095	.00001	50	.00001	50	.04129	6152	3.282	.2272	?	13672
13673	1992.50	182	196	.08037	.00001	50	.00001	50	.02023	5068	2.542	.2506	✓	13673
13681	1061.10	268	120	.10566	.00001	50	.00001	50	.05547	6114	3.268	.2216	?	13681
13682	208.17	200	316	.19781	.00001	50	.00001	50	.20727	942	6.244	.8265	?	13682
13683	1406.15	254	114	.09115	.00001	50	.00001	50	.05736	6152	2.816	.5540	✓	13683
13691	1473.59	301	118	.11776	.00001	50	.00001	50	.05898	5435	3.576	.5604	✓	13691
13692	238.16	196	85	.09433	.00001	50	.00001	50	.04360	1536	3.051	.4072	✓	13692
13693	915.33	226	107	.08139	.00001	50	.00523	50	.02471	4325	2.522	.2206	?	13693
13702	969.57	176	110	.08738	.00001	50	.00001	50	.04876	2234	2.504	.5106	?	13702
13703	882.33	201	279	.09165	.00001	50	.00556	50	.02061	5666	2.865	.5490	✓	13703

13712	1049.[illegible]	185	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	F	13712
13715	[illegible]	[illegible]	180	[illegible]	.00001	50	[illegible]	50	[illegible]	1956	3.399	[illegible]	F	13715
13722	2359.22	252	85	.39282	.00001	50	.00001	50	.04059	7162	2.625	.4265	F	13722
13725	2060.56	240	170	.09354	.00001	50	.00001	50	.01352	7256	2.034	.2045	F	13725
13729	[illegible]	215	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	1.576	[illegible]	F	13729
13735	1.52	211	121	.06926	.00001	50	.00001	50	.03650	51	1.116	.0581	F	13735
13741	1225.13	356	102	.09052	.00001	50	.00001	50	.04762	6066	2.716	.3707	F	13741
13742	1217.43	315	329	.10767	.00001	50	.00001	50	.03646	6605	3.199	.3695	F	13742
13745	227.81	208	139	.06826	.00001	50	.00033	50	.02778	2061	2.204	.6118	F	13745
13751	1029.51	366	118	.10157	.00001	50	.00001	50	.06427	5115	2.899	.6003	F	13751
13752	65.05	364	45	.09455	.00001	50	.00885	50	.05751	920	3.394	.6603	F	13752
13755	62.34	275	157	.09326	.00001	50	.00844	50	.05339	1064	2.595	.8774	F	13755
13761	1130.44	494	207	.19010	.00001	50	.00001	50	.07221	5207	5.165	.3534	F	13761
13762	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	3.769	[illegible]	F	13762
13765	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	13765
13771	1001.10	229	217	.11010	.00001	50	.02422	50	.01113	9463	3.182	.1717	F	13771
13772	[illegible]	193	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	1.872	.3596	F	13772
13775	[illegible]	174	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	13775
13782	[illegible]	202	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	2.552	[illegible]	F	13782
13785	[illegible]	220	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	13785
13791	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	13791
13792	[illegible]	324	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	F	13792
13795	982.26	250	135	.07068	.00001	50	.00001	50	.06545	5525	1.954	.5644	F	13795
13802	41.31	188	164	.04776	.00001	50	.00001	50	.02111	509	.554	.3094	F	13802
13803	137.70	229	258	.08566	.00001	50	.01285	50	.04321	1609	2.970	.5532	F	13803
13811	1110.61	299	122	.08045	.00001	50	.00001	50	.06051	7056	2.370	.5232	F	13811
13812	64.82	201	14	.05161	.00001	50	.00001	50	.05153	960	1.690	.4725	F	13812
13813	61.03	207	153	.05531	.00001	50	.00001	50	.03461	1264	1.465	.8612	F	13813
13822	330.55	224	113	.06256	.00001	50	.00001	50	.02471	2241	1.773	.3493	F	13822

14041	[illegible]	362	472	.09506	.00001	50	[illegible]	50	[illegible]	740	2.987	[illegible]	P	14041
14042	101.76	250	151	[illegible]	.00001	50	[illegible]	50	.10009	857	2.057	.7256	P	14042
14043	205.76	256	346	.08606	.00001	50	.04044	50	.06274	1655	2.566	.6169	P	14043
14051	1014.95	371	331	.12275	.00001	50	.00001	50	.06520	5066	3.325	.2662	P	14051
14052	1654.58	286	139	.07099	.00001	50	[illegible]	50	[illegible]	3605	1.885	[illegible]	P	14052
14053	2013.20	346	273	.08502	.00001	50	.03485	50	.05546	7171	2.226	.7209	P	14053
14061	1009.25	363	200	.11152	.00001	50	.01523	50	.05827	6624	3.001	.7029	P	14061
14062	108.56	243	158	.03775	.00001	50	.00001	50	.01823	1647	.884	.5776	P	14062
14063	1100.30	320	296	.09257	.00001	50	.00001	50	.07651	4776	2.454	.7513	P	14063
14071	1001.15	404	549	.18126	.00001	50	.00001	50	.05169	6282	5.360	.1476	P	14071
14072	2033.10	330	299	.12638	.00001	50	.00001	50	.05166	6712	3.524	.7039	P	14072
14073	361.26	303	86	.17615	.00001	50	.05422	50	.15362	1242	5.076	.7551	P	14073
14081	1093.50	386	188	.16499	.00001	50	.00001	50	.06957	5101	6.683	.2025	P	14081
14082	[illegible]	280	132	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	4.119	[illegible]	P	14082
14083	[illegible]	274	490	[illegible]	.00001	50	[illegible]	50	[illegible]	6564	[illegible]	[illegible]	P	14083
14091	1056.80	254	226	.09676	.00001	50	.03756	50	.02474	5532	2.586	.4105	P	14091
14092	[illegible]	185	152	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	14092
14093	99.6[illegible]	186	497	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	.6406	P	14093
14101	[illegible]	370	184	[illegible]	.00001	50	[illegible]	50	.04845	6244	4.886	.2976	P	14101
14102	1603.18	[illegible]	195	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	.5408	P	14102
14103	[illegible]	351	311	[illegible]	.00001	50	.01440	50	[illegible]	[illegible]	[illegible]	[illegible]	P	14103
14112	[illegible]	136	107	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	.893	[illegible]	P	14112
14113	46.17	142	241	.06755	.00001	50	.01465	50	.05655	705	1.859	.4644	P	14113
14121	1070.91	215	139	.08656	.00001	50	.06111	50	.04921	6311	2.338	.4581	P	14121
14122	255.36	142	97	.02611	.00001	50	.00001	50	.01462	1351	.660	.5506	P	14122
14123	234.30	145	222	.02765	.00001	50	.00533	50	.01513	2025	.657	.5251	P	14123
14131	1014.95	325	147	.15675	.00001	50	.00001	50	.05672	5625	4.275	.2707	P	14131
14132	1351.06	212	92	.08634	.00001	50	.00001	50	.01201	3061	2.424	.4711	P	14132
14133	1693.71	216	220	.02501	.00001	50	.00001	50	.05656	4514	2.522	.2287	P	14133
14142	393.32	132	132	.04655	.00001	50	.02822	50	.02820	1502	1.253	.2682	P	14142
14143	[illegible]	135	490	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	14143
14152	89.10	127	17	.10469	.00001	50	.03269	50	.05201	522	3.551	.6607	P	14152
14153	180.61	135	185	.05138	.00001	50	.02625	50	.03102	1444	1.267	.7669	P	14153
14161	[illegible]	199	132	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	14161
14162	851.[illegible]	143	48	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	.888	[illegible]	P	14162
14163	821.17	146	200	.03779	.00001	50	.00556	50	[illegible]	2461	.613	.4629	P	14163
14172	506.39	125	112	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	14172
14173	652.86	[illegible]	435	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	14173
14181	1271.73	152	117	.02469	.00001	50	.00001	50	.01009	6153	.551	.2371	P	14181
14182	258.30	137	100	.02352	.00001	50	.00001	50	.01582	2722	.562	.4106	P	14182
14183	138.31	141	258	.03356	.00001	50	.00001	50	.02505	1050	.860	.7313	P	14183
14192	375.86	135	152	.05680	.00001	50	.00001	50	.01811	1351	1.496	.2550	P	14192
14193	366.05	146	314	.07225	.00001	50	.00001	50	.03125	1600	2.148	.8879	P	14193
14202	468.99	136	98	.05183	.00001	50	.00665	50	.03004	1227	1.310	.1587	P	14202
14203	552.62	146	262	.04757	.00001	50	.00444	50	.01803	3636	1.307	.3761	P	14203
14212	85.05	135	28	.03300	.00001	50	.00003	50	.02026	1264	.712	.7109	P	14212
14213	40.55	136	193	.02177	.00001	50	.01244	50	.01152	651	.628	.8573	P	14213
14221	1002.78	235	122	.06509	.00001	50	.00001	50	.04339	8229	1.867	.5607	P	14221
14222	1125.97	191	112	.05533	.00001	50	.03422	50	.02270	8521	1.611	.3596	P	14222
14231	192.87	152	170	.02433	.00001	50	.00001	50	.00438	2567	.593	[illegible]	P	14231
14232	[illegible]	142	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	2456	[illegible]	[illegible]	P	14232
14233	[illegible]	136	446	[illegible]	.00001	50	.00444	50	[illegible]	1247	[illegible]	[illegible]	P	14233
14241	[illegible]	166	[illegible]	[illegible]	.00001	50	[illegible]	50	.06240	[illegible]	[illegible]	[illegible]	P	14241
14242	[illegible]	154	45	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	.4689	P	14242
14243	[illegible]	161	105	.04608	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	14243
14252	1119.62	155	139	.03505	.00001	50	.00511	50	.01259	3634	1.021	.3125	P	14252
14253	562.[illegible]	152	491	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	14253
14262	197.86	158	50	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	14262
14263	110.97	150	234	.04500	.00001	50	.00001	50	.02754	1155	1.072	.6304	P	14263
14272	1208.52	160	15	.02563	.00001	50	.01376	50	.00775	5017	.628	.3162	P	14272
14273	561.35	164	192	.04266	.00001	50	.00001	50	.01662	2637	1.158	.4356	P	14273
14281	1108.05	197	49	.04759	.00001	50	.05667	50	.03031	7561	1.203	.4666	P	14281
14282	115.80	152	159	.02305	.00001	50	.00603	50	.01405	1021	.501	.4618	P	14282
14283	210.63	158	126	.02292	.00001	50	.01344	50	.01236	1675	.536	.4197	P	14283
14292	229.23	150	81	.02635	.00001	50	.00001	50	.00835	1177	.662	.4338	P	14292
14293	1213.30	165	256	.02785	.00001	50	.00001	50	.00627	6135	.551	.2652	P	14293
14302	286.2[illegible]	156	28	[illegible]	.00001	50	[illegible]	50	[illegible]	2805	.587	[illegible]	P	14302
14303	185.[illegible]	152	146	[illegible]	.00001	50	.01524	50	[illegible]	[illegible]	.555	[illegible]	P	14303
14312	[illegible]	226	45	[illegible]	.00001	50	[illegible]	50	.04651	[illegible]	2.573	.3406	P	14312
14313	[illegible]	175	198	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	.554	.4076	P	14313
14321	[illegible]	361	26	[illegible]	.00001	50	[illegible]	50	.06649	[illegible]	[illegible]	[illegible]	P	14321
14322	1012.50	267	324	.12459	.00001	50	.00001	50	.11655	2255	3.469	.6164	P	14322
14323	1375.58	241	100	.09555	.00001	50	.00001	50	.06642	4255	2.602	.7246	P	14323
14331	1256.[illegible]	241	129	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	P	14331
14332	76.14	172	140	.03022	.00001	50	.00667	50	.01755	1067	.655	.4756	P	14332
14333	141.75	182	364	.02532	.00001	50	.01222	50	.01570	1651	.574	.7255	P	14333
14342	1292.75	172	89	.02521	.00001	50	.00533	50	.00752	4551	.696	.2626	P	14342
14343	410.67	155	242	.02250	.00001	50	.00758	50	.00567	2318	.518	.4585	P	14343
14351	1162.32	247	112	.09253	.00001	50	.00001	50	.00850	4601	2.492	.5742	P	14351
14352	783.76	175	20	[illegible]	.00001	50	.00001	50	.01370	2634	.752	.2587	P	14352
14353	883.71	187	154	.03435	.00001	50	.01133	50	.01076	5525	.783	.4302	P	14353

14364	[illegible]	160	148	.01883	.00001	50	.00001	50	[illegible]	[illegible]	.420	[illegible]	?	14364
14365	[illegible]	151	410	.01536	.00001	50	.00867	50	.00606	[illegible]	[illegible]	.5148	?	14365
14372	625.78	157	75	.25005	.00001	50	.00001	50	.02543	2081	.700	.3756	?	14372
14373	342.82	157	251	.02676	.00001	50	.00444	50	.01055	1205	.554	.4250	✓	14373
14381	[illegible]	505	[illegible]	[illegible]	.00001	50	.00001	50	.06443	[illegible]	[illegible]	[illegible]	?	14381
14382	1256.32	253	50	.08121	.00001	50	.05378	50	.04844	5774	2.281	.5242	✓	14382
14383	1239.30	251	152	.10642	.00001	50	.00001	50	.09025	5695	2.550	.5375	✓	14383
14392	1871.10	230	136	.07423	.00001	50	.00001	50	.05673	6607	1.826	.5062	✓	14392
14393	2470.50	222	135	.06754	.00001	50	.00001	50	.04510	8035	1.756	.4565	✓	14393
14402	3350.59	381	105	.16853	.00001	50	.00001	50	.07305	7003	5.088	.6819	✓	14402
14403	1707.46	320	275	.17463	.00001	50	.00001	50	.13413	3018	5.230	.8233	✓	14403
14411	1022.22	559	336	.16867	.00001	50	.00001	50	.05131	5672	4.747	.5826	?	14411
14412	456.53	420	225	.16945	.00001	50	.05844	50	.18507	1280	4.739	.6356	?	14412
[illegible]	[illegible]	396	[illegible]	.18602	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	.9342	?	[illegible]
14422	[illegible]	504	[illegible]	.09684	.00001	50	.00001	50	.05590	6576	2.510	.6900	?	14422
14423	2820.83	325	212	.16150	.00001	50	.00001	50	.10527	5297	4.710	.8873	?	14423
[illegible]	45.36	255	104	.02656	.00001	50	.00678	50	[illegible]	[illegible]	[illegible]	.6793	?	[illegible]
[illegible]	49.36	297	293	[illegible]	.00001	50	.05467	50	[illegible]	904	5.042	.9819	?	[illegible]
14441	[illegible]	565	[illegible]	.11414	.00001	50	.00001	50	.05227	6706	5.188	.7414	?	14441
14442	448.4[illegible]	325	88	[illegible]	.00001	50	.01600	50	[illegible]	4566	.482	.6809	?	14442
[illegible]	[illegible]	266	[illegible]	.08058	.00001	50	.00689	50	.02015	1614	.820	.7036	?	[illegible]
14451	[illegible]	547	150	[illegible]	.00001	50	.00001	50	.04583	6950	1.659	.5605	?	14451
14452	824.50	320	125	.07462	.00001	50	.00001	50	.06125	6102	1.915	.6075	✓	14452
14453	1305.72	337	301	.12252	.00001	50	.00001	50	.05776	5430	3.405	.7903	✓	14453
14461	1160.73	500	245	.22156	.00001	50	.00001	50	.05570	5693	6.752	.2940	✓	14461
14462	1932.04	392	155	.15112	.00001	50	.00001	50	.06537	5610	4.280	.0046	✓	14462
14463	1359.07	385	325	.17335	.00001	50	.00001	50	.05580	5473	4.570	.8066	✓	14463
14471	1001.57	404	240	.22446	.00001	50	.00001	50	.03484	8071	7.032	.1755	✓	14471
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	168	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	188	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	1.457	[illegible]	?	[illegible]
14592	1645.34	175	157	.05342	.00001	50	.00001	50	.01352	2542	[illegible]	.5550	?	14592
14593	2077.12	191	315	.02030	.00001	50	.01422	50	.01021	10523	.711	.6121	✓	14593
[illegible]	[illegible]	198	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
14705	1060.54	195	206	.02327	.00001	50	.00356	50	.00884	7565	.555	.4757	✓	14705
14712	227.51	198	126	.04630	.00001	50	.00001	50	.03204	1041	1.166	.6552	✓	14712
14713	56.76	175	278	.02876	.00001	50	.00578	50	.01625	653	.645	.4732	✓	14713
14722	303.56	204	132	.03606	.00001	50	.00444	50	.01642	2735	.675	.5321	✓	14722
14723	783.63	190	286	.01577	.00001	50	.00422	50	.00564	4486	.370	.4576	✓	14723
14732	2850.56	208	151	.02274	.00001	50	.00001	50	.00435	3542	.517	.3165	✓	14732
14733	1325.16	207	313	.02216	.00001	50	.00667	50	.00682	5498	.513	.4156	?	14733
14742	30.25	215	223	.02030	.00001	50	.01044	50	.02176	615	.454	.7074	?	14742
[illegible]	[illegible]	215	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	229	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
14752	1355.53	240	331	.02802	.00001	50	.00867	50	.01061	6093	.658	.5625	?	14752
[illegible]	[illegible]	225	198	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	1.498	[illegible]	?	[illegible]
[illegible]	[illegible]	279	297	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	246	[illegible]	[illegible]	.00001	50	.00624	50	[illegible]	[illegible]	.576	[illegible]	?	[illegible]
[illegible]	[illegible]	244	86	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	250	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	245	68	[illegible]	.00001	50	.00680	50	.00540	[illegible]	.460	[illegible]	?	[illegible]
14762	2026.59	350	219	.11273	.00001	50	.00972	50	.05200	5297	3.053	.5647	✓	14762
14763	1610.26	328	348	.07806	.00001	50	.00001	50	.04391	6659	1.959	.6012	✓	14763
14792	1621.29	445	165	.13506	.00001	50	.00933	50	.05276	5088	3.763	.4565	✓	14792
14793	348.30	410	222	.10006	.00001	50	.01044	50	.14677	1380	5.536	.9225	✓	14793
14801	1935.21	573	251	.09753	.00001	50	.00800	50	.02600	6246	2.613	.2355	✓	14801
14802	1415.56	525	136	.12065	.00001	50	.01511	50	.03491	6463	3.347	.3065	✓	14802
14803	152.36	475	272	.16782	.00001	50	.01153	50	.11044	867	4.202	.8217	?	14803
14811	1337.58	584	185	.10721	.00001	50	.00001	50	.03770	3549	2.630	.2371	?	14811
[illegible]	161.44	[illegible]	[illegible]	[illegible]	.00001	50	.01200	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
14813	394.49	469	339	.12467	.00001	50	.00001	50	.10594	1901	5.128	.9211	?	14813
14823	12.56	297	[illegible]	.06555	.00001	50	.02778	50	.08434	215	1.156	.5543	?	14823
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
14832	1655.32	[illegible]	[illegible]	.11835	.00001	50	.00001	50	.04014	4517	[illegible]	.3175	?	14832
[illegible]	[illegible]	[illegible]	6	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
14842	552.35	583	335	.08452	.00001	50	.00001	50	.07280	2062	2.077	.6555	?	14842
14843	857.40	453	67	.11240	.00001	50	.00001	50	.03875	7370	3.122	.2022	✓	14843
14851	1040.65	365	302	.09764	.00001	50	.01667	50	.03593	6395	2.460	.5441	✓	14851
14852	1070.01	252	270	.03806	.00001	50	.00001	50	.02655	2111	.652	.4601	✓	14852
14853	2573.30	253	397	.03500	.00001	50	.00570	50	.00411	2407	.602	.2072	✓	14853
14861	1134.25	234	324	.03920	.00001	50	.01978	50	.00537	6202	.621	.1251	✓	14861
14862	1026.55	211	255	.02252	.00001	50	.00644	50	.00619	6502	.513	.3524	?	14862
14863	679.15	212	1	.03040	.00001	50	.02244	50	.01540	2546	.705	.4765	?	14863
14871	1180.72	217	292	.02465	.00001	50	.00756	50	.00656	10796	.546	.3605	✓	14871
14872	125.65	164	219	.01555	.00001	50	.03400	50	.01042	1267	.344	.4255	?	14872
14873	27.20	181	216	.01802	.00001	50	.00156	50	.01320	525	.401	.7067	?	14873
14881	1037.55	247	337	.01068	.00001	50	.00623	50	.00724	5846	.305	.5057	?	14881
[illegible]	440.64	199	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	219	269	[illegible]	.00001	50	[illegible]	50	[illegible]	2006	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	246	298	[illegible]	.00001	50	[illegible]	50	[illegible]	10238	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	176	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	944	.468	[illegible]	?	[illegible]
[illegible]	[illegible]	198	[illegible]	[illegible]	.00001	50	.00422	50	[illegible]	[illegible]	.466	[illegible]	?	[illegible]
14902	425.35	157	155	.04072	.00001	50	.00001	50	.00525	2145	.515	.4001	✓	14902
[illegible]	[illegible]	165	[illegible]	[illegible]	.00001	50	.00404	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	266	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
14912	1726.77	139	255	.02900	.00001	50	.00001	50	.00567	6307	.715	.3410	✓	14912
14913	1550.44	205	298	.02675	.00001	50	.01356	50	.00535	6672	.642	.5012	✓	14913
14921	1002.76	221	290	.02421	.00001	50	.00800	50	.00693	6407	.552	.4257	✓	14921
14922	112.35	175	253	.01227	.00001	50	.00756	50	.02214	432	.458	.5641	?	14922
14923	209.75	180	319	.02227	.00001	50	.00689	50	.00977	1901	.346	.6567	?	14923
14932	164.43	164	176	.03720	.00001	50	.00178	50	.01587	1916	.525	.6470	✓	14932
14933	63.43	163	5	.04996	.00001	50	.00001	50	.02359	941	1.326	.3651	?	14933
14942	132.30	164	106	.05126	.00001	50	.00378	50	.02251	1291	.578	.6024	?	14942
[illegible]	[illegible]	167	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	198	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	163	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	167	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	179	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
14952	45.55	157	260	.01702	.00001	50	.00667	50	.01647	560	.265	.6810	?	14952
14953	29.59	151	232	.01626	.00001	50	.00756	50	.01762	507	.414	.0765	✓	14953
[illegible]	[illegible]	173	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
14972	19.91	154	265	.01966	.00001	50	.00711	50	.02607	101	.418	.6950	?	14972
14973	16.20	157	53	.02771	.00001	50	.00978	50	.02265	305	.752	.6921	✓	14973
14981	1047.33	178	271	.01956	.00001	50	.00001	50	.00873	5198	.451	.3830	✓	14981
14982	355.26	153	188	.02831	.00001	50	.00001	50	.01362	2136	.645	.4477	✓	14982
14983	257.56	157	248	.03374	.00001	50	.01111	50	.02264	1174	.321	.5291	?	14983
14992	178.76	156	178	.04502	.00001	50	.00001	50	.01334	1087	1.092	.4113	?	14992
14993	151.47	157	350	.05626	.00001	50	.00444	50	.02692	1125	1.656	.6266	✓	14993

15001	[illegible]	169	[illegible]	.02140	.00001	50	[illegible]	50	[illegible]	[illegible]	.467	[illegible]	7	15001
15002	[illegible]	155	[illegible]	.02154	.00001	50	.00424	50	.00162	[illegible]	.569	.7336	7	15002
15003	126.36	150	283	.01764	.00001	50	.00511	50	.00765	2043	.447	.4535	7	15003
15011	1020.32	105	255	.02014	.00001	50	.00001	50	.00478	5342	.460	.6281	/	15011
15012	452.44	156	262	.02230	.00001	50	.00862	50	.00560	[illegible]	.466	.5450	7	15012
15013	629.20	153	252	.02833	.00001	50	.00001	50	.01037	2692	.550	.3080	/	15013
15022	4.66	116	171	.03465	.00001	50	.00001	50	.05012	142	.550	.9655	/	15022
15023	2.42	115	280	.02621	.00001	50	.01244	50	.03195	215	.549	.9854	/	15023
15031	1206.30	154	258	.02425	.00001	50	.00001	50	.00707	3217	.575	.2515	/	15031
15032	269.58	161	140	.03447	.00001	50	.00578	50	.02546	1556	.607	.6174	/	15032
15033	267.30	139	283	.02905	.00001	50	.00444	50	.01176	2351	.720	.4551	/	15033
15041	1576.15	167	276	.02562	.00001	50	.00001	50	.00617	5333	.569	.3840	7	15041
15042	86.29	133	318	.03411	.00001	50	.00001	50	.01673	560	.335	.6835	7	15042
[illegible]	[illegible]	170	[illegible]	.02830	.00001	50	.00556	50	.00745	[illegible]	.468	[illegible]	7	[illegible]
15051	[illegible]	156	[illegible]	.02855	.00001	50	.00001	50	.00551	[illegible]	[illegible]	[illegible]	7	15051
15052	346.34	133	326	.02431	.00001	50	.00001	50	.00545	2509	.587	.0344	7	15052
[illegible]	[illegible]	[illegible]	[illegible]	.02105	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15061	[illegible]	173	256	.02135	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	15061
15062	[illegible]	142	160	.02326	.00001	50	.00778	50	.00662	[illegible]	.486	.2206	7	15062
[illegible]	[illegible]	[illegible]	266	.02677	.00001	50	.00001	50	.00554	[illegible]	.600	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	.02182	.00001	50	.00480	50	.00785	[illegible]	.576	.2066	7	[illegible]
[illegible]	[illegible]	[illegible]	251	.05061	.00001	50	.00822	50	.00665	[illegible]	[illegible]	[illegible]	7	[illegible]
15081	1030.35	171	140	.02475	.00001	50	.01089	50	.00620	7472	.553	.2380	/	15081
15082	635.52	150	126	.02844	.00001	50	.00001	50	.01547	2605	.663	.4857	/	15082
15083	263.50	165	265	.02720	.00001	50	.00001	50	.00555	2095	.639	.5635	/	15083
15091	1007.54	167	256	.02365	.00001	50	.01044	50	.00565	3666	.570	.1775	/	15091
15092	852.12	149	172	.02552	.00001	50	.00001	50	.00404	8127	.564	.1751	/	15092
15093	160.54	159	324	.02835	.00001	50	.00333	50	.01403	1646	.700	.4877	/	15093
15102	2002.32	112	112	.04205	.00001	50	.01111	50	.00606	4849	1.026	.3155	7	15102
15103	[illegible]	163	278	[illegible]	.00001	50	.00001	50	.03100	[illegible]	[illegible]	[illegible]	7	15103
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15113	622.55	142	273	.06426	.00001	50	.01772	50	.01607	3251	1.555	.0983	7	15113
15123	1051.26	[illegible]	116	.02977	.00001	50	.00001	50	.00283	[illegible]	.652	[illegible]	7	15123
[illegible]	[illegible]	156	[illegible]	[illegible]	.00001	50	.01528	50	.00545	[illegible]	1.106	[illegible]	7	[illegible]
[illegible]	[illegible]	156	[illegible]	.02676	.00001	50	.00778	50	.00504	[illegible]	.541	[illegible]	7	[illegible]
15133	1150.70	154	253	.02243	.00001	50	.00001	50	.00554	[illegible]	.628	[illegible]	7	15133
15141	[illegible]	183	[illegible]	.02355	.00001	50	.00001	50	.00664	[illegible]	[illegible]	[illegible]	7	15141
[illegible]	[illegible]	172	[illegible]	.02464	.00001	50	.00620	50	.00484	[illegible]	.550	[illegible]	7	[illegible]
15143	156.05	151	277	.02921	.00001	50	.00911	50	.01142	740	.553	.6431	7	15143
15152	157.95	137	120	.02540	.00001	50	.00267	50	.01001	802	.521	.6021	/	15152
15153	559.42	153	253	.02824	.00001	50	.00001	50	.00745	3797	.556	.4075	/	15153
15162	318.32	155	124	.02800	.00001	50	.00001	50	.01446	2028	.624	.6665	/	15162
15163	141.75	160	263	.02542	.00001	50	.01022	50	.02404	653	.500	.7762	/	15163
15172	41.31	157	62	.02022	.00001	50	.00667	50	.01645	575	.452	.3524	/	15172
15173	151.47	175	211	.02856	.00001	50	.00669	50	.01135	2202	.721	.4603	7	15173
15181	1144.52	138	123	.02307	.00001	50	.00001	50	.00653	3029	.537	.4111	7	15181
15182	274.55	152	45	.02116	.00001	50	.00711	50	.01693	1897	.454	.4523	/	15182
15183	265.12	182	168	.02152	.00001	50	.01000	50	.00874	2714	.514	.3726	7	15183
15192	167.92	177	132	.02078	.00001	50	.00001	50	.01152	1736	.450	.5462	7	15192
15193	[illegible]	178	268	.02155	.00001	50	.00711	50	.00577	3021	.451	.6877	7	15193
15201	[illegible]	246	[illegible]	.02245	.00001	50	.01023	50	[illegible]	[illegible]	[illegible]	[illegible]	7	15201
[illegible]	[illegible]	201	[illegible]	.02361	.00001	50	.00001	50	.01136	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	198	[illegible]	.02278	.00001	50	.00001	50	.01046	[illegible]	.611	.5566	7	[illegible]
15211	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.01000	50	.00566	[illegible]	[illegible]	[illegible]	7	15211
[illegible]	[illegible]	205	[illegible]	.02090	.00001	50	.00001	50	[illegible]	[illegible]	.559	[illegible]	7	[illegible]
15213	750.55	201	273	.03027	.00001	50	.00001	50	.01557	2298	.750	.6527	/	15213
15221	[illegible]	[illegible]	[illegible]	.02452	.00001	50	.00001	50	.00682	[illegible]	[illegible]	.2166	7	15221
[illegible]	146.67	170	[illegible]	.02246	.00001	50	.00001	50	.01563	[illegible]	[illegible]	[illegible]	7	[illegible]
15223	259.20	174	307	.02735	.00001	50	.00467	50	.01043	1935	.521	.7260	/	15223
15232	552.11	164	128	.02833	.00001	50	.00001	50	.00695	3148	.667	.3354	/	15232
15233	1651.55	177	213	.02917	.00001	50	.00001	50	.00655	6333	.675	.3511	/	15233
15242	569.43	173	131	.02840	.00001	50	.00001	50	.00756	2695	.657	.4622	7	15242
15243	154.71	169	214	.03082	.00001	50	.00556	50	.01113	1512	.745	.5472	7	15243
15252	1057.83	182	145	.02960	.00001	50	.01311	50	.01192	3637	.671	.4556	/	15252
15253	620.95	184	203	.04116	.00001	50	.01511	50	.01785	2406	.968	.5917	7	15253
15262	1318.05	203	[illegible]	.03657	.00001	50	.00001	50	.01126	3321	.661	[illegible]	7	15262
[illegible]	[illegible]	205	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15271	[illegible]	[illegible]	[illegible]	.03471	.00001	50	.04553	50	.01566	[illegible]	[illegible]	[illegible]	7	15271
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	265	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15281	[illegible]	283	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	15281
15282	[illegible]	277	162	.06650	.00001	50	.00001	50	.05302	4710	1.508	.1912	7	15282
15283	2023.38	289	271	.08514	.00001	50	.00001	50	.04603	5150	2.158	.5250	/	15283
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	.01355	[illegible]	[illegible]	[illegible]	7	[illegible]
15293	[illegible]	197	225	[illegible]	.00001	50	.02289	50	.01604	4039	1.201	.5508	7	15293
15302	952.25	222	165	.06045	.00001	50	.01222	50	.01181	4060	1.425	.3961	/	15302
15303	548.37	218	306	.04364	.00001	50	.03956	50	.04505	3331	1.013	.6477	/	15303
15311	1006.62	373	212	.13355	.00001	50	.00001	50	.05364	5808	3.760	.5072	/	15311
15312	26.45	221	105	.06267	.00001	50	.04572	50	.09405	470	1.721	.7406	7	15312
15313	[illegible]	251	226	.09635	.00001	50	.00001	50	.13477	1533	[illegible]	.9157	7	15313
15321	1008.45	403	215	.08201	.00001	50	.00001	50	.03284	4856	1.668	.2866	/	15321

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	584	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15332	135.56	194	237	.02772	.00001	50	.00001	50	.04295	920	.526	.5354	7	15332
15333	125.35	237	15	.05457	.00001	50	.02867	50	.02782	1011	1.524	.5347	/	15333
[illegible]	[illegible]	210	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15343	100.54	213	232	.04504	.00001	50	.00644	50	.01241	1401	1.107	.4745	/	15343
15351	1030.35	435	240	[illegible]	.00001	50	.03422	50	.03027	5046	2.117	.1255	/	15351
15352	405.51	292	223	.09712	.00001	50	.01756	50	.06176	2189	[illegible]	.5712	/	15352
15353	210.50	323	331	.11985	.00001	50	.05933	50	.04553	1317	3.346	.8033	/	15353
15361	1054.34	456	359	.12280	.00001	50	.01333	50	.05538	3504	3.353	.1753	/	15361
15362	237.32	334	246	.09872	.00001	50	.02222	50	.04103	1137	2.659	.8137	/	15362
15363	165.45	262	329	.07777	.00001	50	.03911	50	.04575	1522	2.163	.6167	7	15363
15371	1309.30	[illegible]	339	.12136	.00001	50	.00001	50	.04557	2048	[illegible]	.7426	7	15371
[illegible]	[illegible]	204	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	210	67	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15382	620.55	190	215	.04436	.00001	50	.01800	50	.01621	2893	1.361	.0461	7	15382
[illegible]	[illegible]	182	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	178	188	[illegible]	.00001	50	.00001	50	.01646	3040	1.431	[illegible]	7	[illegible]
[illegible]	[illegible]	175	[illegible]	[illegible]	.00001	50	[illegible]	50	.02604	1665	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	286	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	6093	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	199	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	1.941	[illegible]	7	[illegible]
[illegible]	[illegible]	259	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15411	1005.55	475	225	.11800	.00001	50	.00001	50	.02537	9107	3.126	.1863	/	15411
15412	727.38	324	226	.10957	.00001	50	.02022	50	.06593	6097	2.984	.7257	/	15412
15413	1251.14	359	355	.09954	.00001	50	.01067	50	.04181	6178	1.700	.4545	/	15413
15421	1004.40	256	205	.07172	.00001	50	.02400	50	.04505	5203	1.746	.4655	/	15421
15422	212.22	135	231	.04566	.00001	50	.00001	50	.02655	1444	1.273	.3618	/	15422
15423	361.51	201	17	.04801	.00001	50	.00001	50	.01614	1546	1.250	.2359	/	15423
15431	1309.46	192	280	.03365	.00001	50	.01409	50	.00533	6720	.728	.2326	7	15431
15432	31.64	155	136	.03728	.00001	50	.00001	50	.04022	270	.760	.6312	7	15432
[illegible]	[illegible]	169	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15441	1082.47	189	226	.03301	.00001	50	.01400	50	.00634	7800	.704	.1777	7	15441
15442	748.44	164	[illegible]	[illegible]	.00001	50	.00001	50	.00555	[illegible]	.657	[illegible]	7	15442
[illegible]	[illegible]	164	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	172	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15453	[illegible]	173	[illegible]	[illegible]	.00001	50	[illegible]	50	.01731	2171	.571	[illegible]	7	15453
[illegible]	[illegible]	160	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	168	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15472	320.46	173	162	.05440	.00001	50	.00533	50	.01562	2001	.752	.6054	7	15472
15473	121.50	176	207	.00750	.00001	50	.00711	50	.05507	830	2.520	.0420	/	15473
15481	1118.61	353	303	.10962	.00001	50	.00001	50	.04426	5056	2.551	.4956	/	15481
15482	557.75	192	133	.03426	.00001	50	.00689	50	.01411	2606	.757	.4515	/	15482
15483	326.74	254	205	.10852	.00001	50	.00001	50	.06663	5160	3.011	.7253	/	15483
15491	1056.36	327	280	.13165	.00001	50	.01911	50	.07325	5228	3.543	.7152	/	15491
15492	42.53	180	246	.06417	.00001	50	.00001	50	.05373	795	1.451	.4055	7	15492
15493	56.75	193	18	.07061	.00001	50	.02022	50	.05195	1249	2.035	.5055	7	15493
15501	1124.51	306	288	.11766	.00001	50	.00001	50	.06275	6286	3.125	.6555	/	15501
15502	128.60	175	215	.04862	.00001	50	.01800	50	.03157	1593	1.124	.6054	7	15502
15503	145.60	170	1	.03062	.00001	50	.00001	50	.01536	1721	.568	.5356	7	15503
15511	1008.06	284	[illegible]	.10136	.00001	50	[illegible]	50	[illegible]	6006	[illegible]	[illegible]	7	15511
[illegible]	[illegible]	154	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	183	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	138	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	158	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	171	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	.840	[illegible]	7	[illegible]
15532	502.22	134	138	.03567	.00001	50	.00001	50	.02105	1301	.652	.7217	/	15532
[illegible]	[illegible]	139	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	150	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	.466	[illegible]	7	[illegible]
15543	76.14	127	212	.02025	.00001	50	.00800	50	.00685	1429	.442	.6961	/	15543
15551	1176.12	240	266	.12980	.00001	50	.00001	50	.04651	5525	3.588	.5256	/	15551
15552	554.45	173	228	.04745	.00001	50	.00001	50	.04175	4980	1.275	.4532	/	15552
15553	452.76	169	212	.03853	.00001	50	.00001	50	.01695	2546	.576	.5820	7	15553
15562	60.75	130	233	.03132	.00001	50	.01570	50	.03252	777	.710	.7730	7	15562
15563	162.61	150	65	.07025	.00001	50	.02267	50	.06004	2223	1.556	.7245	/	15563
15571	1152.60	258	259	.11255	.00001	50	.00001	50	.03761	3693	2.945	.4452	7	15571
15572	815.07	174	232	.05001	.00001	50	.01267	50	.04273	3009	1.161	.5035	7	15572
[illegible]	[illegible]	[illegible]	158	[illegible]	.00001	50	.04200	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
15593	161.44	173	81	.07570	.00001	50	.00001	50	.06715	1084	[illegible]	.7224	7	15593
15601	1300.35	253	251	.10767	.00001	50	.00400	50	.03503	5317	[illegible]	.2121	/	15601
[illegible]	[illegible]	172	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	2.549	[illegible]	7	[illegible]
15603	279.45	235	80	.10060	.00001	50	.00001	50	.08515	1823	2.529	.8918	7	15603
15611	1025.16	265	262	.08901	.00001	50	.00001	50	.04637	5500	2.222	.1345	/	15611
15612	1981.26	222	121	.11809	.00001	50	.00001	50	.09411	3387	3.266	.8035	/	15612
15613	1156.35	239	288	.12945	.00001	50	.03778	50	.06297	2894	3.648	.7952	/	15613
15621	1200.35	170	146	.06351	.00001	50	.00001	50	.05562	3224	1.736	.4462	7	15621
15622	687.09	137	57	.04282	.00001	50	.01200	50	.02290	3149	1.046	.5324	7	15622
15623	1131.57	137	188	.04115	.00001	50	.00001	50	.01242	4024	.555	.4605	/	15623

[illegible]	[illegible]	108	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	109	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
15542	515.19	121	88	.26076	.00001	50	.00001	50	.02622	2662	1.566	.4012	?	15542
15545	1037.54	133	253	.25066	.00001	50	.00001	50	.01656	3333	1.225	.3065	/	15545
15551	[illegible]	248	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	15551
15552	2752.66	156	94	.25756	.00001	50	.00001	50	.04747	3790	1.475	.4472	/	15552
15555	821.61	146	229	.24770	.00001	50	.00911	50	.01536	2351	1.210	.5052	/	15555
15562	133.56	113	139	.26975	.00001	50	.00311	50	.03590	1283	1.760	.6421	/	15562
15565	39.53	120	305	.27323	.00001	50	.01044	50	.04521	1190	2.174	.7456	/	15565
15572	759.54	140	105	.25342	.00001	50	.01333	50	.03605	2403	1.356	.4975	/	15572
15575	569.47	141	257	.25771	.00001	50	.00444	50	.02395	2981	1.556	.4926	/	15575
15652	53.86	142	59	.26349	.00001	50	.00001	50	.04503	1125	1.730	.7525	?	15682
15685	20.52	134	207	.27272	.00001	50	.01264	50	.07232	685	2.275	.6633	?	15685
15691	[illegible]	240	116	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	2.341	[illegible]	?	15691
15694	[illegible]	151	[illegible]	[illegible]	.00001	50	.01223	50	.02595	[illegible]	1.148	[illegible]	?	15694
15695	174.15	150	205	.25902	.00001	50	.00001	50	.03380	1291	1.326	.7111	?	15695
15704	[illegible]	154	[illegible]	.25624	.00001	50	.01074	50	[illegible]	[illegible]	[illegible]	[illegible]	?	15704
15705	[illegible]	160	[illegible]	[illegible]	.00001	50	.00600	50	[illegible]	[illegible]	[illegible]	[illegible]	?	15705
15712	2442.07	248	105	.10180	.00001	50	.01528	50	.05632	5795	2.766	.4776	?	15712
15715	[illegible]	161	250	.26675	.00001	50	.00824	50	.04347	[illegible]	[illegible]	.5402	?	15715
15721	[illegible]	374	116	.11309	.00001	50	.00001	50	.04307	4991	2.040	.3765	?	15721
15722	456.27	246	92	.08754	.00001	50	.00001	50	.02516	4062	2.294	.4807	?	15722
15725	510.14	226	160	.10182	.00001	50	.00001	50	.06336	1991	2.220	.5322	/	15725
15732	229.23	177	120	.26372	.00001	50	.00001	50	.06131	724	1.373	.4024	/	15732
15735	459.77	197	264	.27621	.00001	50	.01644	50	.03446	2028	1.559	.5321	/	15735
15741	1120.61	359	121	.11564	.00001	50	.01000	50	.05717	6060	2.550	.3125	/	15741
15742	372.67	285	162	.09762	.00001	50	.00001	50	.09563	1114	2.462	.7073	/	15742
15745	573.46	276	215	.11525	.00001	50	.01756	50	.05740	2186	3.050	.6262	/	15745
15752	1710.72	293	116	.09020	.00001	50	.00001	50	.06271	1276	2.275	.4235	?	15752
15755	2172.77	395	304	.12163	.00001	50	.02505	50	.05092	7236	1.226	.0746	?	15755
15761	[illegible]	[illegible]	166	.09556	.00001	50	.04074	50	[illegible]	[illegible]	2.351	[illegible]	?	15761
15762	329.40	396	112	.10304	.00001	50	.00001	50	.07244	1220	2.609	.6705	?	15762
15765	65.05	[illegible]	[illegible]	.07375	.00001	50	.00001	50	.05590	795	1.702	.5949	?	15765
15771	[illegible]	[illegible]	[illegible]	.08313	.00001	50	.01172	50	.02744	[illegible]	1.659	[illegible]	?	15771
15774	[illegible]	380	147	.09335	.00001	50	.00423	50	.04407	[illegible]	1.206	[illegible]	?	15774
15775	718.12	331	243	.07030	.00001	50	.00001	50	.03047	3912	1.720	.7597	?	15775
15781	[illegible]	[illegible]	146	[illegible]	.00001	50	.01173	50	.05058	[illegible]	[illegible]	[illegible]	?	15781
15784	[illegible]	193	145	.06305	.00001	50	.00001	50	[illegible]	3338	[illegible]	.6020	?	15784
15785	2176.37	350	267	.09520	.00001	50	.02200	50	.06475	5588	2.461	.6021	?	15785
15791	1023.84	242	253	.10026	.00001	50	.03022	50	.05203	5602	1.550	.5231	/	15791
15792	617.22	172	151	.04324	.00001	50	.00001	50	.02152	4132	.557	.5620	/	15792
15793	1569.22	177	278	.04935	.00001	50	.00001	50	.02267	5795	1.151	.4205	/	15793
15801	1151.01	176	255	.05667	.00001	50	.00001	50	.02505	5080	1.354	.3770	/	15801
15802	66.67	133	178	.05925	.00001	50	.00956	50	.04531	705	1.456	.6075	/	15802
15805	205.74	169	321	.05825	.00001	50	.00001	50	.02681	2186	1.601	.6011	?	15805
15811	1054.55	107	259	.06002	.00001	50	.00001	50	.02661	5175	1.005	.4157	?	15811
15812	52.34	121	165	.06060	.00001	50	.01044	50	.03620	920	1.369	.6264	/	15812
15815	315.09	159	255	.07813	.00001	50	.00001	50	.05415	4051	2.139	.6305	?	15815
15821	1002.76	115	154	.05762	.00001	50	.00001	50	.04561	3282	1.440	.2641	?	15821
15822	265.12	96	148	.07020	.00001	50	.00001	50	.05027	3673	1.455	.4470	?	15822
15825	[illegible]	79	278	.05442	.00001	50	.01175	50	.02564	994	.938	[illegible]	?	15825
15832	[illegible]	112	[illegible]	.04502	.00001	50	.00078	50	.04560	[illegible]	1.144	[illegible]	?	15832
15835	[illegible]	87	[illegible]	.03576	.00001	50	.00956	50	.00431	[illegible]	[illegible]	[illegible]	?	15835
15841	[illegible]	150	[illegible]	.05123	.00001	50	.00001	50	.02075	6060	1.107	.7241	?	15841
15842	[illegible]	145	[illegible]	.06831	.00001	50	.05400	50	.05464	6253	1.461	.6472	?	15842
15845	153.00	102	235	.02350	.00001	50	.00001	50	.01292	1702	.321	.6750	/	15845
15851	[illegible]	114	140	.02740	.00001	50	.04267	50	.01561	3561	.376	[illegible]	?	15851
15852	[illegible]	99	128	.02430	.00001	50	.00467	50	.01165	[illegible]	.471	[illegible]	?	15852
15855	423.63	93	209	.01646	.00001	50	.00422	50	.00463	2531	.379	.4702	/	15855
15862	6.91	54	245	.01950	.00001	50	.00756	50	.02536	125	.226	.4761	/	15862
15865	12.96	79	325	.07337	.00001	50	.00001	50	.07506	507	2.112	.9355	/	15865
15872	464.36	57	146	.05765	.00001	50	.00622	50	.01515	2478	.650	.5127	?	15872
15875	358.70	88	285	.05790	.00001	50	.00056	50	.02595	2245	.658	.7567	?	15875
15882	1880.11	93	101	.05682	.00001	50	.00756	50	.00395	7854	.527	.1121	/	15882
15885	925.12	193	265	.07356	.00001	50	.00001	50	.01992	6036	2.322	.3231	?	15885
15892	379.04	88	127	.05060	.00001	50	.00356	50	.02160	1814	1.218	.5820	?	15892
15895	[illegible]	108	[illegible]	.06355	.00001	50	.00001	50	[illegible]	[illegible]	1.441	[illegible]	?	15895
15901	[illegible]	84	98	.02076	.00001	50	.00001	50	.00447	[illegible]	.460	[illegible]	?	15901
15902	420.36	81	456	.03503	.00001	50	.01824	50	.01205	[illegible]	.459	[illegible]	?	15902
15905	[illegible]	84	149	.02855	.00001	50	.00003	50	.00494	[illegible]	.438	[illegible]	?	15905
15914	[illegible]	81	[illegible]	.02306	.00001	50	.00869	50	.00555	[illegible]	.440	[illegible]	?	15914
15915	145.79	190	205	.11776	.00001	50	.00001	50	.01452	1522	5.425	.6603	?	15915
15922	1220.42	94	71	.02518	.00001	50	.00001	50	.00660	5070	.525	.3327	/	15922
15925	[illegible]	101	168	.02148	.00001	50	.00953	50	.01165	[illegible]	[illegible]	[illegible]	?	15925
15931	1045.71	153	110	.05661	.00001	50	.01556	50	.02464	5150	1.449	.4146	?	15931
15932	147.42	122	338	.05057	.00001	50	.00001	50	.01547	1060	.562	.7562	/	15932
15935	59.13	116	142	.01830	.00001	50	.00378	50	.01572	705	.351	.8020	/	15935
15941	1164.22	178	135	.06754	.00001	50	.00001	50	.03505	5627	1.759	.3627	/	15941
15942	377.53	145	98	.05172	.00001	50	.00001	50	.03332	4783	1.212	.4505	?	15942
15945	[illegible]	115	316	.02493	.00001	50	.00711	50	.01336	[illegible]	.728	.7547	?	15945
15952	151.97	82	167	.02355	.00001	50	.00609	50	.01217	1500	.534	.6451	/	15952

[illegible]	[illegible]	83	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	82	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	4032	[illegible]	[illegible]	?	[illegible]
15955	857.94	120	231	.26252	.00001	50	.00001	50	.03012	6030	1.555	.5013	?	15955
15972	310.14	90	55	.21620	.00001	50	.00444	50	.00446	5410	.350	.4513	?	15972
[illegible]	[illegible]	82	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
15983	357.36	62	53	.21255	.00001	50	.00001	50	.30521	2708	.312	.3556	/	15983
15985	566.38	91	232	.23104	.00001	50	.00001	50	.32607	2509	.312	.5082	/	15985
15992	1152.25	97	38	.22160	.00001	50	.01267	50	.31201	6599	.464	.2962	/	15992
15995	535.41	93	150	.21061	.00001	50	.00356	50	.30702	1646	.414	.5600	/	15995
16001	1307.58	250	133	.29201	.00001	50	.00001	50	.31663	6301	2.451	.3542	/	16001
16002	160.20	120	62	.22592	.00001	50	.00723	50	.32195	1550	.637	.6477	/	16002
16005	119.37	139	141	.21826	.00001	50	.00001	50	.31601	1084	.627	.7244	?	16005
16011	1322.85	156	131	.25037	.00001	50	.02622	50	.30751	6675	1.230	.4707	?	16011
[illegible]	[illegible]	151	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	134	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16022	1129.21	96	118	.21985	.00001	50	.00001	50	.30512	6131	.458	.2196	?	16022
[illegible]	[illegible]	82	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	85	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	84	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	96	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	99	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	97	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16051	347.35	78	135	.22072	.00001	50	.00001	50	.31247	3351	.557	.4981	/	16051
16051	1316.35	259	137	.28826	.00001	50	.00001	50	.35561	7958	2.844	.6183	/	16051
16052	410.67	112	34	.22961	.00001	50	.00001	50	.31355	2458	.615	.3955	/	16052
16055	321.57	136	135	.23500	.00001	50	.00600	50	.32033	2006	.737	.7428	/	16055
16061	1301.12	431	137	.31148	.00001	50	.01202	50	.30516	5567	3.741	.6013	/	16061
16062	552.50	157	66	.25555	.00001	50	.01600	50	.31665	2771	1.421	.6013	?	16062
16072	1125.62	135	131	.20355	.00001	50	.00001	50	.30675	3654	2.421	.6050	?	16072
16082	130.02	89	131	.21976	.00001	50	.00001	50	.31217	1950	.407	.5225	?	16082
[illegible]	[illegible]	47	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16092	50.65	89	71	.21931	.00001	50	.02572	50	.30695	2226	.460	.5213	?	16092
[illegible]	[illegible]	84	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	118	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	84	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	84	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	94	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	91	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16121	1306.62	479	156	.29165	.00001	50	.00001	50	.35592	5072	2.251	.5020	/	16121
16122	2375.30	249	52	.29472	.00001	50	.00001	50	.37012	6712	2.529	.5122	/	16122
16125	2555.17	251	149	.27660	.00001	50	.01464	50	.35697	6789	2.226	.5661	/	16125
16132	767.62	114	119	.24054	.00001	50	.01064	50	.31766	2870	1.350	.5025	/	16132
16135	1625.57	117	233	.22351	.00001	50	.03064	50	.31023	5021	.511	.4081	/	16135
16142	543.70	115	2	.23655	.00001	50	.00001	50	.30613	2691	.670	.5125	/	16142
16145	295.74	131	193	.22214	.00001	50	.03572	50	.31095	1666	.537	.7152	/	16145
16151	1216.16	162	32	.26240	.00001	50	.02311	50	.32206	6579	1.320	.4052	?	16151
16152	35.54	135	26	.26020	.00001	50	.00001	50	.34544	345	.545	.5551	?	16152
16155	51.30	137	135	.21282	.00001	50	.01629	50	.31285	1447	.656	.7052	/	16155
16162	20.70	130	35	.21257	.00001	50	.03713	50	.31002	920	.276	.5214	?	16162
16165	358.57	118	71	.21262	.00001	50	.00001	50	.30446	7413	.448	.5567	?	16165
[illegible]	[illegible]	228	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	258	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	134	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	144	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	201	83	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16205	2410.20	226	165	.20076	.00001	50	.00001	50	.36552	6160	2.372	.6545	?	16205
[illegible]	[illegible]	112	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	103	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16222	320.53	110	34	.22327	.00001	50	.02260	50	.31440	1717	.751	.4057	?	16222
16225	320.32	111	253	.22957	.00001	50	.03533	50	.31561	2660	.655	.5927	?	16225
16212	1697.51	126	72	.22660	.00001	50	.00001	50	.30576	5371	.617	.6165	/	16212
16215	1659.40	127	231	.31101	.00001	50	.00001	50	.30795	6725	.474	.6061	/	16215
16221	1360.17	225	32	.29794	.00001	50	.03667	50	.35282	6200	2.298	.3157	?	16221
16222	1350.25	164	47	.23876	.00001	50	.00001	50	.37790	3549	3.527	.6216	?	16222
16225	2302.32	157	155	.24126	.00001	50	.01666	50	.35075	6669	3.569	.6244	?	16225
16231	1306.62	170	136	.23961	.00001	50	.01032	50	.33038	2200	2.155	.2320	?	16231
[illegible]	[illegible]	205	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	248	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	214	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	141	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	140	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16252	522.70	111	173	.21562	.00001	50	.00001	50	.31635	2534	.647	.6727	?	16252
16255	1750.30	112	215	.22318	.00001	50	.00600	50	.31042	5224	.773	.6152	?	16255
[illegible]	[illegible]	112	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16262	352.56	110	225	.22075	.00001	50	.00001	50	.31824	1750	.525	.5452	?	16262
16271	1354.21	154	135	.23245	.00001	50	.00001	50	.34174	6128	.730	.3741	/	16271
16272	32.55	120	28	.27281	.00001	50	.00001	50	.36194	342	2.291	.7736	?	16272
16275	59.26	124	212	.25066	.00001	50	.00001	50	.31616	1681	.615	.1661	/	16275
16282	551.01	113	132	.22207	.00001	50	.00001	50	.31266	1845	.475	.6452	?	16282
[illegible]	[illegible]	126	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16292	834.30	135	78	.22714	.00001	50	.00001	50	.30651	3797	.613	.5316	/	16292

[illegible]	[illegible]	140	[illegible]	[illegible]	.00001	50	.01111	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	117	[illegible]	[illegible]	[illegible]	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16203	12.15	118	199	.05260	.00001	50	.01800	50	.04122	125	.155	.9315	✓	16203
16212	2155.12	210	52	.12066	.00001	50	.00001	50	.05029	5451	3.113	.5211	✓	16212
[illegible]	555.65	150	[illegible]	.08044	.00001	50	.00422	50	.01484	2491	.542	.6724	?	[illegible]
16221	1239.30	189	131	.10702	.00001	50	.00001	50	.03513	5055	2.977	.2109	✓	16221
16222	1265.22	125	261	.13446	.00001	50	.00044	50	.06481	2106	4.280	.6801	✓	16222
16223	1224.12	119	146	.12855	.00001	50	.00001	50	.03626	6237	1.582	.4500	✓	16223
16232	49.41	151	83	.05674	.00001	50	.00001	50	.07207	505	1.150	.7065	?	16232
16331	15.32	172	255	.13086	.00001	50	.00001	50	.09475	615	1.459	.9123	?	16331
16341	1031.55	364	35	.14701	.00001	50	.00001	50	.04175	6041	4.239	.2152	✓	16341
16342	960.55	281	23	.17131	.00001	50	.00001	50	.06095	3040	4.520	.5627	?	16342
16343	[illegible]	286	176	.17180	.00001	50	.00001	50	.11316	1515	4.669	.8366	?	16343
[illegible]	[illegible]	248	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	288	43	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16355	1450.71	304	161	.12100	.00001	50	.00001	50	.05742	4055	3.265	.3008	?	16355
[illegible]	[illegible]	121	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	169	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16282	1331.64	257	75	.07456	.00001	50	.00001	50	.04580	5116	1.355	.3951	✓	16282
16283	501.02	266	158	.08541	.00001	50	.00001	50	.10745	2388	2.331	.7124	✓	16283
16291	1065.96	223	156	.06437	.00001	50	.00001	50	.04402	5616	1.557	.2425	✓	16291
16292	707.12	267	103	.07153	.00001	50	.00001	50	.04413	5588	1.645	.5773	✓	16292
16393	378.27	198	212	.04794	.00001	50	.00001	50	.01788	2115	1.062	.6160	✓	16393
16402	860.22	124	148	.02325	.00001	50	.00911	50	.00681	3760	.464	.4665	✓	16402
16403	321.01	127	306	.02626	.00001	50	.00444	50	.01269	1945	.560	.6250	?	16403
16412	50.72	118	145	.02722	.00001	50	.00001	50	.01762	1279	.602	.7535	?	16412
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16421	1261.42	137	137	.02344	.00001	50	.00572	50	.00760	3126	.221	.1910	?	16421
16422	338.95	136	[illegible]	.02506	.00001	50	.00001	50	.01366	1836	.345	.5766	?	16422
[illegible]	[illegible]	149	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	142	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16433	256.55	117	303	.02977	.00001	50	.00823	50	.01313	1941	.715	.5901	?	16433
[illegible]	[illegible]	147	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	155	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16452	2257.42	155	[illegible]	.03545	.00001	50	.00001	50	.01245	5494	.759	.5600	?	16452
16453	1562.40	167	221	.03171	.00001	50	.00111	50	.00660	4111	.710	.3428	✓	16453
16462	2618.66	175	62	.03971	.00001	50	.00001	50	.02231	6895	.501	.3552	✓	16462
16463	1160.17	161	229	.02675	.00001	50	.02178	50	.00533	4871	.561	.3323	✓	16463
16472	570.04	201	45	.05706	.00001	50	.00001	50	.01062	5011	1.351	.6175	✓	16472
16473	343.44	177	295	.02872	.00001	50	.00956	50	.00615	2406	.545	.3155	✓	16473
16481	1336.02	433	123	.11560	.00001	50	.01511	50	.04612	5206	3.029	.4645	?	16481
16482	1025.40	238	23	.07551	.00001	50	.00001	50	.04293	3204	1.572	.4435	?	16482
16483	2735.62	262	119	.08355	.00001	50	.00001	50	.04163	3184	2.214	.5236	✓	16483
16491	1125.09	219	128	.04152	.00001	50	.00001	50	.02152	5071	.558	.4237	?	16491
16492	65.80	128	[illegible]	.01592	.00001	50	.00001	50	.01848	979	.235	.6593	?	16492
16493	68.04	128	[illegible]	.01470	.00001	50	.00572	50	.01011	900	.345	.7213	?	16493
[illegible]	679.55	127	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	184	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5861	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16521	1554.52	210	152	.06767	.00001	50	.00001	50	.03295	3359	1.550	.5930	✓	16521
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16531	1073.78	188	153	.02552	.00001	50	.00000	50	.00715	5476	.552	.2928	✓	16531
16532	655.25	163	119	.02467	.00001	50	.00001	50	.01187	2642	.529	.5035	✓	16532
16533	1618.31	166	266	.02757	.00001	50	.00001	50	.00712	5597	.630	.4245	✓	16533
16542	1035.55	136	101	.02562	.00001	50	.00001	50	.01407	3760	.569	.4370	?	16542
16543	1302.05	129	205	.03255	.00001	50	.03822	50	.00794	8287	.216	.4557	?	16543
16551	1031.16	152	145	.03964	.00001	50	.03822	50	.00627	6208	.501	.2545	✓	16551
16552	50.22	129	66	.01876	.00001	50	.00600	50	.01283	1031	.258	.5222	?	16552
16553	240.02	143	170	.02930	.00001	50	.00667	50	.02220	3800	.032	.4466	?	16553
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16563	1850.54	153	259	.05250	.00001	50	.03400	50	.00705	5107	.720	.3952	?	16563
16571	1347.02	174	142	.03372	.00001	50	.00001	50	.00850	7125	.745	.2147	✓	16571
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16573	85.06	158	102	.02260	.00001	50	.00001	50	.01284	1106	.527	.7022	?	16573
16581	1053.00	174	326	.02313	.00001	50	.00600	50	.00644	5333	.505	.3115	✓	16581
16582	1361.86	165	153	.02154	.00001	50	.00001	50	.00532	6271	.487	.1920	✓	16582
16583	272.16	162	225	.02352	.00001	50	.00001	50	.01596	1792	.512	.6877	✓	16583
16612	57.20	141	163	.05304	.00001	50	.00001	50	.02322	941	.057	.7165	?	16612
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00511	[illegible]	[illegible]	[illegible]	[illegible]	.8055	[illegible]	[illegible]
16621	1058.67	170	151	.02548	.00001	50	.01756	50	.00584	5808	.567	.2615	✓	16621

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	142	288	.02204	.00001	[illegible]	.00553	50	.02465	[illegible]	[illegible]	.0545	?	[illegible]
16531	1929.22	176	176	.02220	.00001	50	.00553	50	.00641	5137	.535	.2507	?	16531
16532	546.56	158	158	.02383	.00001	50	.00511	50	.01005	1575	.520	.6015	✓	16532
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	4741	[illegible]	[illegible]	?	[illegible]
16541	1076.45	178	272	.01927	.00001	50	.01044	50	.00651	3007	.423	.3915	✓	16541
16542	635.22	156	205	.02342	.00001	50	.00044	50	.01252	2627	.423	.5705	✓	16542
16543	665.22	153	240	.02234	.00001	50	.00267	50	.00647	2946	.510	.5755	✓	16543
16551	1225.18	161	283	.01934	.00001	50	.07409	50	.00405	5644	.416	.2033	✓	16551
16552	3530.57	157	161	.02066	.00001	50	.00867	50	.00581	7277	.447	.4536	✓	16552
16553	3139.61	152	213	.02242	.00001	50	.00001	50	.00543	4921	.507	.4757	✓	16553
16562	2069.24	156	171	.02460	.00001	50	.00711	50	.00745	4942	.529	.4965	?	16562
16563	4907.72	150	221	.02825	.00001	50	.00001	50	.01062	6875	.621	.4217	?	16563
[illegible]	1240.54	188	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	175	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	870	[illegible]	[illegible]	?	[illegible]
16573	39.54	186	216	.04625	.00001	50	.02222	50	.00292	740	1.000	.8671	?	16573
[illegible]	[illegible]	218	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	190	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.01426	4104	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	141	[illegible]	[illegible]	[illegible]	[illegible]	.00424	50	.01486	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	145	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	140	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16705	2579.40	166	257	.03326	.00001	50	.01511	50	.01507	4725	.776	.4031	✓	16705
16713	12.15	133	231	.02521	.00001	50	.00001	50	.02641	435	.440	.9447	✓	16713
16722	1552.77	159	161	.03105	.00001	50	.00001	50	.01260	4576	.579	.5337	✓	16722
16723	509.02	152	221	.02850	.00001	50	.00001	50	.01267	2462	.511	.7072	✓	16723
16731	1054.62	236	249	.07046	.00001	50	.02200	50	.01731	5374	1.633	.2373	✓	16731
16732	1452.02	132	170	.05206	.00001	50	.02429	50	.02650	3077	1.237	.5063	✓	16732
16733	346.75	130	327	.07064	.00001	50	.00822	50	.03283	1811	1.502	.7110	?	16733
16742	1720.46	133	133	.05776	.00001	50	.00889	50	.01650	4640	1.427	.3959	?	16742
[illegible]	[illegible]	195	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16751	1200.07	256	209	.08516	.00001	50	.00001	50	.02115	6562	2.251	.1424	?	16751
16752	305.37	222	[illegible]	.08150	.00001	50	.00001	50	.05284	[illegible]	2.021	.6165	?	16752
[illegible]	[illegible]	214	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	196	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16762	75.71	201	13	.12145	.00001	50	.01911	50	.03251	650	[illegible]	.6856	?	16762
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16781	1205.56	255	109	.06352	.00001	50	.00001	50	.02082	5759	1.531	.2205	?	16781
16782	81.00	207	179	.05516	.00001	50	.01200	50	.03565	615	.554	.7255	✓	16782
16783	149.65	229	225	.08425	.00001	50	.00001	50	.05316	1264	2.256	.7225	✓	16783
16791	1035.16	258	277	.08935	.00001	50	.00001	50	.01565	5212	2.351	.1452	✓	16791
16792	100.44	226	135	.08101	.00001	50	.00001	50	.06277	507	2.210	.4750	✓	16792
16793	720.05	237	247	.08115	.00001	50	.00001	50	.01205	2971	2.155	.2600	✓	16793
16801	1001.16	227	329	.05251	.00001	50	.01511	50	.01132	4649	1.254	.0513	?	16801
16802	162.00	213	251	.07715	.00001	50	.01067	50	.04575	1140	2.027	.5440	?	16802
16803	236.55	221	55	.07645	.00001	50	.00533	50	.03215	1624	2.258	.5354	✓	16803
16811	1015.74	229	285	.06035	.00001	50	.01200	50	.01734	4812	1.657	.0555	?	16811
16812	1308.16	182	203	.05540	.00001	50	.00001	50	.01257	3452	1.287	.4903	?	16812
16813	1800.17	192	[illegible]	.05421	.00001	50	.01000	50	.01441	6114	1.368	.1427	?	16813
[illegible]	[illegible]	207	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	.01214	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	2456.45	189	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	.01554	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	172	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.01176	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	148	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.01441	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	164	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16842	1070.11	144	106	.03041	.00001	50	.00311	50	.00275	8557	.526	.4357	✓	16842
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	1.060	[illegible]	?	[illegible]
16853	1612.02	150	12	.04551	.00001	50	.00001	50	.01172	5647	1.055	.3030	✓	16853
16852	847.25	157	[illegible]	.04681	.00001	50	.01133	50	.01491	4924	1.124	.4367	✓	16852
16863	356.40	159	224	.05760	.00001	50	.01333	50	.02451	1931	1.442	.4133	✓	16863
16871	1566.47	225	216	.06516	.00001	50	.00001	50	.01623	4703	1.569	.0501	?	16871
16872	1352.81	193	213	.05806	.00001	50	.00267	50	.01075	6414	1.426	.2971	?	16872
16873	326.56	136	352	.07297	.00001	50	.02356	50	.05265	1177	1.551	.5717	✓	16873
16881	1276.12	199	223	.05875	.00001	50	.00001	50	.01673	3579	1.415	.3414	?	16881
16882	210.05	160	229	.05840	.00001	50	.00001	50	.03467	1195	.612	.5817	?	16883
[illegible]	[illegible]	168	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	170	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	126	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	612	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	192	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	167	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16905	58.85	151	42	.05927	.00001	50	.00001	50	.05682	687	1.255	.6252	?	16905
16911	1124.61	224	227	.06402	.00001	50	.00001	50	.01247	5414	1.559	.0277	✓	16911
[illegible]	[illegible]	188	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
16915	1755.22	106	48	.06476	.00001	50	.00001	50	.01025	3108	1.525	.2522	?	16915
16921	1026.74	171	242	.04830	.00001	50	.00001	50	.01775	4607	1.156	.1545	✓	16921
16922	1461.24	153	271	.04767	.00001	50	.00001	50	.01527	5476	1.176	.1849	✓	16922
16923	1544.50	152	66	.04655	.00001	50	.00001	50	.01082	6221	1.117	.3852	✓	16923
16931	1242.45	171	23	.04195	.00001	50	.00311	50	.01247	2992	1.012	.1024	?	16931
16933	608.37	154	283	.05914	.00001	50	.01489	50	.01551	2081	1.471	.6335	?	16933
16935	567.95	156	74	.04841	.00001	50	.00001	50	.02283	2276	1.165	.6725	✓	16935

16541	[illegible]	114	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	6854	.548	[illegible]	?	16541
16542	[illegible]	93	[illegible]	[illegible]	.00001	50	.00800	50	[illegible]	2012	[illegible]	[illegible]	?	16542
16545	847.26	95	205	.01772	.00001	50	.00001	50	.00645	2965	.427	.4072	?	16545
16552	554.54	93	165	.02250	.00001	50	.00356	50	.01132	2500	.454	.5076	/	16552
16555	[illegible]	116	400	.02105	.00001	50	.01554	50	.01493	[illegible]	[illegible]	.4677	?	16555
16562	72.05	96	121	.03244	.00001	50	.00001	50	.01635	960	.479	.5056	/	16562
16565	83.52	103	202	.03400	.00001	50	.00001	50	.02006	1503	.752	.7614	/	16565
16571	1031.57	168	267	.04452	.00001	50	.00001	50	.00657	5168	1.109	.1305	/	16571
16572	1857.05	130	155	.05080	.00001	50	.01333	50	.01237	5194	.552	.5102	/	16572
16575	2204.01	156	206	.05900	.00001	50	.01467	50	.01075	5066	1.526	.3076	/	16575
16581	1349.76	170	254	.06555	.00001	50	.01133	50	.01322	5941	1.751	.1356	/	16581
16582	622.95	135	221	.06551	.00001	50	.00001	50	.02012	4402	1.551	.2975	?	16582
16585	156.02	140	216	.05540	.00001	50	.00001	50	.02637	3549	1.375	.5466	?	16585
16591	[illegible]	140	288	[illegible]	.00001	50	.00888	50	[illegible]	5138	[illegible]	[illegible]	?	16591
16594	[illegible]	112	222	.05468	.00001	50	.00001	50	[illegible]	[illegible]	1.100	[illegible]	?	16594
16595	211.41	128	228	.05316	.00001	50	.01804	50	.02524	2605	1.421	.5330	?	16595
17001	[illegible]	129	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	6075	[illegible]	[illegible]	?	17001
17004	68.04	88	206	.01906	.00001	50	.00001	50	.01993	[illegible]	.351	.6851	?	17004
17005	49.40	87	155	.01045	.00001	50	.00689	50	.00762	488	.411	.7014	?	17005
17014	[illegible]	173	189	.06962	.00001	50	.00001	50	[illegible]	[illegible]	1.640	[illegible]	?	17014
17015	[illegible]	156	[illegible]	.07456	.00001	50	.04000	50	.02384	7590	2.077	.5644	?	17015
17022	[illegible]	151	[illegible]	.06060	.00001	50	.01353	50	.01500	6506	[illegible]	[illegible]	?	17022
17025	532.20	156	205	.06664	.00001	50	.01770	50	.02405	2546	1.744	.4954	/	17025
17031	1150.26	162	152	.04515	.00001	50	.01464	50	.00523	5172	1.113	.2665	/	17031
17032	227.61	163	125	.05496	.00001	50	.01067	50	.03187	2276	1.338	.5734	/	17032
17035	176.15	163	265	.07716	.00001	50	.00001	50	.03651	1082	2.062	.4523	/	17035
17042	26.35	122	202	.05666	.00001	50	.00756	50	.03235	792	1.363	.7316	/	17042
17045	51.02	163	39	.05735	.00001	50	.00001	50	.04607	1481	1.561	.5055	/	17045
17051	1370.83	160	154	.04112	.00001	50	.00822	50	.00605	5911	.508	.1277	?	17051
17052	510.26	159	147	.04746	.00001	50	.01499	50	.02274	1557	1.052	.4055	?	17052
17055	449.48	[illegible]	[illegible]	[illegible]	.00001	50	.00489	50	[illegible]	4133	[illegible]	[illegible]	?	17055
17062	160.03	153	165	.04831	.00001	50	.01044	50	.02745	1065	1.115	.4035	?	17062
17065	508.62	154	[illegible]	.05506	.00001	50	.00001	50	.02427	3637	[illegible]	.4155	?	17065
17072	[illegible]	150	[illegible]	.05668	.00001	50	.00001	50	[illegible]	4695	1.416	.2466	?	17072
17075	180.36	175	225	.06896	.00001	50	.01578	50	.03443	1137	[illegible]	.2350	?	17075
17081	[illegible]	212	226	.06597	.00001	50	.00889	50	.01500	6575	1.377	.1537	?	17081
17084	[illegible]	163	[illegible]	.07044	.00001	50	.00001	50	[illegible]	6873	.937	.2436	?	17084
17085	796.09	174	[illegible]	.06147	.00001	50	.01467	50	.00834	4071	1.662	.5744	?	17085
17091	1344.02	252	271	.05752	.00001	50	.01422	50	.01205	5667	1.405	.2063	?	17091
17092	852.12	230	217	.06341	.00001	50	.01222	50	.02048	3902	1.861	.4570	/	17092
17095	877.23	183	154	.07691	.00001	50	.00001	50	.03745	2478	2.111	.4653	/	17095
17102	1305.21	174	245	.05815	.00001	50	.02556	50	.01526	7338	1.466	.3061	/	17102
17105	326.60	150	25	.05446	.00001	50	.01711	50	.02610	2515	1.305	.5770	/	17105
17111	1136.00	212	247	.06163	.00001	50	.00001	50	.01543	5464	1.545	.1317	/	17111
17112	606.62	181	202	.06776	.00001	50	.00001	50	.02695	2012	1.615	.5556	?	17112
17115	916.11	182	247	.06322	.00001	50	.00001	50	.01632	4029	1.611	.3960	?	17115
17121	1105.65	213	342	.05350	.00001	50	.00533	50	.01625	4359	1.328	.2075	/	17121
17122	336.96	176	240	.06476	.00001	50	.00001	50	.03258	1267	1.725	.5025	?	17122
17125	362.35	182	17	.06120	.00001	50	.00001	50	.02065	1655	1.750	.4616	?	17125
17132	57.36	138	262	.06366	.00001	50	.01200	50	.03033	1497	1.642	.4154	?	17132
17135	42.95	125	64	.07061	.00001	50	.04623	50	.04951	908	[illegible]	.7584	?	17135
17141	1001.16	194	[illegible]	.05787	.00001	50	.00001	50	.01354	8074	1.452	.1056	?	17141
17144	[illegible]	157	[illegible]	.05266	.00001	50	.00604	50	.03443	[illegible]	1.148	.2414	?	17144
17145	322.80	156	350	.06304	.00001	50	.00001	50	.01284	2846	[illegible]	.2250	?	17145
17151	1014.93	150	441	.04405	.00001	50	.00001	50	.01267	6036	1.061	.1444	?	17151
17152	26.73	110	239	.05310	.00001	50	.01667	50	.05644	342	1.236	.5422	/	17152
17155	68.85	116	59	.05973	.00001	50	.01800	50	.03561	595	1.317	.5016	?	17155
17161	1005.21	145	407	.05874	.00001	50	.00001	50	.01344	5507	1.445	.1455	?	17161
17162	98.05	103	275	.05127	.00001	50	.00644	50	.01005	904	.724	.4144	/	17162
17165	58.32	113	29	.05711	.00001	50	.00001	50	.03411	724	1.400	.6851	/	17165
17172	2556.36	139	152	.05964	.00001	50	.00001	50	.01555	3664	1.537	.3471	/	17172
17175	4059.72	135	339	.05020	.00001	50	.00356	50	.01225	5988	1.271	.2870	?	17175
17181	1317.30	223	226	.06217	.00001	50	.00303	50	.01597	3022	1.762	.1975	?	17181
17182	746.01	174	202	.05785	.00001	50	.00001	50	.02672	2006	1.450	.4753	/	17182
17185	816.86	178	325	.05868	.00001	50	.01733	50	.02165	3052	1.527	.5073	?	17185
17191	1367.83	203	277	.05641	.00001	50	.02103	50	.01901	5659	1.436	.2076	?	17191
17194	[illegible]	156	242	.05888	.00001	50	[illegible]	50	.02447	[illegible]	1.495	.5262	?	17194
17195	555.38	124	[illegible]	.05876	.00001	50	.01913	50	.02687	1919	1.520	.5060	?	17195
17202	[illegible]	120	[illegible]	.05014	.00001	50	.00001	50	.00055	6234	1.255	.5164	?	17202
17205	[illegible]	153	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	?	17205
17214	700.55	147	[illegible]	.05456	.00001	50	.00804	50	.02016	4546	1.402	.2332	?	17214
17215	702.16	150	211	.05430	.00001	50	.00953	50	.02055	3707	1.261	.4711	?	17215
17221	1302.78	211	241	.05062	.00001	50	.01222	50	.00695	3926	.546	.2411	/	17221
17224	[illegible]	154	[illegible]	.06750	.00001	50	.00803	50	.01401	4149	1.361	.2466	?	17224
17225	846.82	150	325	.05065	.00001	50	.00001	50	.02852	1755	1.200	.4765	?	17225
17231	1253.07	211	271	.05904	.00001	50	.00978	50	.01733	5520	1.538	.2513	/	17231
17232	1813.55	154	206	.05364	.00001	50	.00356	50	.01403	5538	1.216	.3435	/	17232
17233	2069.55	173	246	.05666	.00001	50	.01444	50	.01640	6321	1.449	.4142	/	17233
17242	238.94	116	209	.05750	.00001	50	.01422	50	.04544	1245	1.259	.4631	?	17242
17245	[illegible]	138	68	.07753	.00001	50	.00001	50	.05676	5048	2.365	.2737	?	17245
17251	1022.22	210	273	.05522	.00001	50	.00001	50	.01475	5628	1.406	.2166	/	17251

17244	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	17244
17245	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	17245
17251	1247.40	110	253	.05025	.00001	50	.01212	50	[illegible]	5436	1.465	.1775	?	17251
17252	26.70	110	256	.05432	.00001	50	.02156	50	.05564	215	1.191	.5607	/	17252
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17271	1261.42	156	215	.07048	.00001	50	.00001	50	.04423	5047	2.023	.2075	/	17271
17272	56.71	97	250	.06445	.00001	50	.00001	50	.07510	432	.511	.5695	/	17272
17275	56.76	59	26	.05252	.00001	50	.00001	50	.03202	885	1.406	.7554	/	17275
17281	1325.64	151	205	.04602	.00001	50	.02570	50	.01045	5623	1.104	.1473	/	17281
17283	2206.37	157	[illegible]	.04856	.00001	50	.00001	50	.04232	7209	1.187	.3085	?	17283
17285	2720.75	110	321	.04625	.00001	50	.00001	50	.01575	5352	1.162	.3655	/	17285
17291	1348.14	116	257	.03470	.00001	50	.03467	50	.01152	4511	.550	.2315	/	17291
17293	2034.48	155	[illegible]	.02744	.00001	50	.00011	50	.00752	2932	.606	.2331	?	17293
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17302	360.57	76	113	.02766	.00001	50	.00001	50	.00852	4921	.568	.7622	?	17302
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17321	1011.85	151	231	.05288	.00001	50	.00001	50	.00452	7032	.774	.1032	/	17321
17322	2211.30	102	65	.02461	.00001	50	.00001	50	.00546	6674	.336	.1501	/	17322
17325	2610.70	119	237	.05346	.00001	50	.01267	50	.00514	8614	.771	.1835	/	17325
17332	959.87	88	112	.05047	.00001	50	.00001	50	.01806	1766	.947	.6092	/	17332
17345	526.53	93	278	.06446	.00001	50	.00001	50	.02233	2459	1.006	.6584	/	17345
17352	266.74	93	91	.05256	.00001	50	.00001	50	.03255	2460	.706	.6545	/	17352
17355	550.56	156	256	.05356	.00001	50	.00550	50	.01402	4538	.767	.4542	?	17355
17361	1301.02	156	132	.05955	.00001	50	.00001	50	.01254	6830	1.160	.2040	/	17361
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17365	275.40	139	252	.05954	.00001	50	.01400	50	.03175	2227	.721	.5905	?	17365
17373	1316.60	113	166	.03900	.00001	50	.00001	50	.01537	4253	.850	.2356	?	17373
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17383	[illegible]	151	113	.04220	.00001	50	.00001	50	.01296	3703	1.211	.5035	?	17383
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17392	1627.75	157	155	.04060	.00001	50	.00001	50	.01444	5227	1.239	.4125	?	17392
17395	1656.23	156	275	.05546	.00001	50	.00001	50	.00572	5190	.840	.3456	?	17395
17402	2357.75	121	163	.04076	.00001	50	.02956	50	.01307	5500	.559	.4005	?	17402
17405	2450.57	131	[illegible]	.03855	.00001	50	.00467	50	.00596	5737	.561	.2825	?	17405
17412	275.34	123	122	.04156	.00001	50	.00001	50	.01596	1938	1.010	.4135	?	17412
17415	12.50	119	238	.06247	.00001	50	.00001	50	.02565	994	1.568	.7312	?	17415
17422	356.77	144	155	.05142	.00001	50	.00001	50	.01557	4917	1.227	.4152	?	17422
17425	515.46	127	285	.05965	.00001	50	.00353	50	.01142	5533	1.200	.5919	?	17425
17432	151.45	139	38	.04335	.00001	50	.02044	50	.03476	1520	1.017	.6726	?	17432
17435	71.24	153	263	.04950	.00001	50	.00001	50	.03253	960	1.259	.6571	?	17435
17441	1156.30	176	155	.05061	.00001	50	.00001	50	.01752	5144	1.130	.2465	?	17441
17442	40.50	154	58	.07003	.00001	50	.00001	50	.07141	534	1.543	.6363	?	17442
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17452	350.02	137	151	.04040	.00001	50	.00022	50	.01054	626	.214	.5021	/	17452
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17472	352.44	126	132	.03476	.00001	50	.00001	50	.02063	1523	.614	.5440	/	17472
17475	556.21	126	3	.03895	.00001	50	.01222	50	.01658	630	.355	.6651	/	17475
17481	1370.62	143	291	.03350	.00001	50	.00001	50	.00513	6609	.776	.2225	/	17481
17482	113.40	116	[illegible]	.03961	.00001	50	.00001	50	.05276	904	.557	.6075	/	17482
17485	545.55	161	[illegible]	.03255	.00001	50	.03379	50	.01003	2130	.701	.5355	?	17485
17491	1354.51	161	[illegible]	.03245	.00001	50	.01111	50	.00576	6292	.745	.2675	/	17491
17492	2634.12	113	148	.03825	.00001	50	.00001	50	.01307	2977	.331	.4275	?	17492
17493	2301.21	113	239	.03355	.00001	50	.03878	50	.01054	3041	.616	.1533	?	17493
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17521	1155.16	136	188	.05067	.00001	50	.01956	50	.01045	5740	1.120	.2251	?	17521
17522	2250.12	114	195	.03710	.00001	50	.00001	50	.00612	6168	.679	.1536	?	17522
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17525	1209.26	130	171	.05061	.00001	50	.00001	50	.00662	5007	.864	.1816	/	17525
17532	251.91	32	134	.05054	.00001	50	.00001	50	.01604	2351	.333	.5057	/	17532
17535	53.46	34	321	.05511	.00001	50	.00001	50	.03043	758	.856	.5573	/	17535
17542	53.15	47	77	.05012	.00001	50	.00001	50	.04645	522	1.662	.4775	?	17542
17545	247.50	73	228	.05480	.00001	50	.01000	50	.02235	2515	1.650	.6232	?	17545
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	?	[illegible]
17555	1210.55	28	252	.03766	.00001	50	.00001	50	.00565	6712	.572	.2977	/	17555

17541	[illegible]	140	[illegible]	[illegible]	.00001	50	.00667	50	[illegible]	[illegible]	[illegible]	[illegible]	F	17541
17542	[illegible]	70	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	.2267	F	17542
17543	61.61	130	250	.04324	.00001	50	.01153	50	.02034	867	1.217	.4792	F	17543
17571	1040.24	112	235	.02014	.00001	50	.00001	50	.01015	4010	.720	.2214	/	17571
17572	[illegible]	94	58	.04460	.00001	50	.00001	50	.03160	4790	1.076	[illegible]	F	17572
17573	110.07	97	220	.03324	.00001	50	.01044	50	.01251	1702	.850	.3474	/	17573
17561	1070.11	99	256	.03032	.00001	50	.00622	50	.01062	5088	.777	.1717	/	17561
17562	148.22	70	153	.04052	.00001	50	.00001	50	.01710	1609	1.025	.5621	/	17562
17563	120.50	73	235	.05401	.00001	50	.00001	50	.03667	1452	1.437	.6721	/	17563
17591	1157.46	99	238	.03524	.00001	50	.00689	50	.00681	5538	.860	.2061	/	17591
17592	365.56	76	163	.06456	.00001	50	.00629	50	.02095	2332	1.120	.5205	/	17592
17593	657.65	89	281	.04244	.00001	50	.00001	50	.01615	4557	1.061	.5054	F	17593
17602	740.35	57	117	.05324	.00001	50	.00772	50	.03205	2931	1.290	.5201	F	17602
17601	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	F	17601
17612	[illegible]	95	[illegible]	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	F	17612
17613	2360.36	99	226	.05995	.00001	50	.01867	50	.00591	3024	1.340	.3006	F	17613
17622	[illegible]	115	78	[illegible]	.00001	50	.00001	50	[illegible]	[illegible]	[illegible]	[illegible]	F	17622
17621	[illegible]	113	[illegible]	[illegible]	.00001	50	.04711	50	[illegible]	[illegible]	[illegible]	[illegible]	F	17621
17531	[illegible]	[illegible]	[illegible]	.05265	.00001	50	.00511	50	[illegible]	5606	.760	.275	F	17531
17532	[illegible]	[illegible]	[illegible]	[illegible]	.00001	50	.00956	50	[illegible]	[illegible]	[illegible]	[illegible]	F	17532
17533	[illegible]	148	264	[illegible]	.00001	50	.00628	50	[illegible]	[illegible]	[illegible]	[illegible]	F	17533
17541	[illegible]	[illegible]	[illegible]	.09444	.00001	50	.00001	50	.00746	[illegible]	.856	.1646	F	17541
17542	557.28	123	125	.03612	.00001	50	.00001	50	.01152	1901	.867	.3735	/	17542
17643	1346.22	135	277	.03462	.00001	50	.01244	50	.01675	4411	.827	.4015	/	17643
17551	1069.20	116	200	.03251	.00001	50	.00001	50	.01230	5700	.721	.2523	/	17551
17552	46.17	31	142	.02120	.00001	50	.01311	50	.03775	525	.258	.6704	/	17552
17653	52.34	102	266	.03365	.00001	50	.00356	50	.02126	1609	.761	.7635	/	17653
17661	1000.35	75	165	.03256	.00001	50	.00001	50	.00825	5206	.722	.1823	/	17661
17662	33.21	36	158	.06406	.00001	50	.00001	50	.04003	320	1.356	.6135	F	17662
17663	149.85	60	222	.02947	.00001	50	.01089	50	.01230	1879	.745	.3415	F	17663
WS Ave.: [illegible]		184		[illegible]							[illegible]			

Each raster's flow vector slope was used to calculate the raster's LS factor prior to determining its respective cell's average LS-factor.

Each raster along its respective cell's [illegible] most distant path used the raster's flow vector slope to calculate the cell's TC [illegible] segment slope [illegible].

Each raster's terrain slope was used to calculate its respective cell's average land slope.

Orphan raster code: F=means that no orphan channel raster(s) are involved for this cell ID;

/=means that orphan channel raster(s) make up this cell. The entire subarea for this cell ID is made up of reassigned channel raster(s) to a righthand cell whose subarea did not previously have any rasters that were assigned to any related source, right, or leftside cells.

E.2. DISCRETIZATION RESULTS: ANNAGNPS_REACH.DAT (8.3KM^2)

221	220	31560	233.92	[illegible]	.00148	none	2212	2213	221
222	221	2801.79	[illegible]	[illegible]	.01588	2201	2222	2223	222
223	222	154953	233.85	[illegible]	.00152	none	2232	2233	223
224	223	2753.13	253.37	2555	.01495	2241	2242	2243	224
225	224	479920	349.79	5201	.01224	none	2252	2253	225
226	225	398969	259.20	4845	.00545	none	2262	2263	226
227	226	1270.89	279.93	1092	.00303	2271	2272	2273	227
228	227	395901	260.14	[illegible]	.00095	none	2282	2283	228
229	228	380030	270.09	[illegible]	.00395	none	2292	2293	229
230	229	[illegible]	282.53	2394	.00091	none	2302	2303	230
231	230	1270.56	321.93	[illegible]	.02150	2311	2312	2313	231
232	231	[illegible]	305.85	3405	.03019	none	2322	2323	232
233	232	6570.59	354.67	4523	.01035	none	2332	2333	233
234	233	2499.82	451.17	6322	.02444	2341	2342	2343	234
235	233	3268.29	451.56	6421	.03045	2351	2352	2353	235
236	232	3193.92	769.51	6909	.01669	2361	2362	2363	236
237	229	370102	252.30	4554	.00331	none	2372	2373	237
238	237	368901	232.10	2390	.00033	none	2382	2383	238
239	238	2148.71	320.89	5321	.01004	2391	2392	2393	239
240	239	365600	242.70	598	.00001	none	2402	2403	240
241	240	363536	233.19	1354	.00107	none	2412	2413	241
242	241	1598.75	313.95	5347	.00919	2421	2422	2423	242
243	241	358243	256.33	2424	.00243	none	2432	2433	243
244	243	5250.42	325.25	5578	.01178	none	2442	2443	244
245	244	[illegible]	373.58	[illegible]	.01169	2451	2452	2453	245
246	244	2285.59	370.32	4597	.01164	2461	2462	2463	246
247	243	352899	291.59	6351	.00054	none	2472	2473	247
248	247	1631.31	337.51	2695	.01121	2481	2482	2483	248
249	247	348901	299.52	4739	.00033	none	2492	2493	249
250	249	1353.54	398.83	2998	.00255	2501	2502	2503	250
251	249	346240	371.43	1574	.00134	none	2512	2513	251
252	251	1152.60	219.79	2539	.02571	2521	2522	2523	252
253	251	341640	331.90	599	.00001	none	2532	2533	253
254	253	341601	395.20	689	.00053	none	2542	2543	254
255	254	3995.07	356.59	10534	.01658	2551	2552	2553	255
256	254	[illegible]	394.40	[illegible]	.03255	none	2562	2563	256
257	256	320096	[illegible]	[illegible]	.00195	none	2572	2573	257
258	257	1334.71	328.81	2135	.01334	2581	2582	2583	258
259	257	325989	322.89	5027	.00025	none	2592	2593	259
260	259	2541.11	389.11	9442	.01471	2601	2602	2603	260
261	259	318005	316.19	195	.00009	none	2612	2613	261
262	261	2491.19	327.96	2484	.00074	none	2622	2623	262
263	262	1202.74	330.66	2561	.00663	2631	2632	2633	263
264	262	[illegible]	336.65	[illegible]	.00255	none	2642	2643	264
265	261	2279.34	494.25	2703	.01536	2651	2652	2653	265
266	264	[illegible]	356.40	3739	.00251	none	2662	2663	266
267	266	2771.41	412.29	2710	.01129	2671	2672	2673	267
268	266	[illegible]	364.83	[illegible]	.00155	none	2682	2683	268
269	268	1350.29	364.84	2549	.01254	2691	2692	2693	269
270	268	[illegible]	370.43	2997	.00123	none	2702	2703	270
271	270	[illegible]	374.27	4293	.00035	none	2712	2713	271
272	271	3165.46	127.73	2065	.01595	2721	2722	2723	272
273	271	[illegible]	357.79	4131	.00265	none	2732	2733	273
274	273	1654.52	392.21	2281	[illegible]	2741	2742	2743	274
275	273	43985.4	358.71	1629	.00145	none	2752	2753	275
276	275	1654.72	396.61	2277	.00507	2761	2762	2763	276
277	275	43024.3	395.61	6654	.00751	none	2772	2773	277

278	277	[illegible]	[illegible]	5423	.03395	none	2782	2783	278
279	278	1329.29	423.18	1391	.01139	2791	2792	2793	279
280	279	9426.16	434.37	5456	.00495	none	2802	2803	280
281	280	1798.78	[illegible]	2957	.01111	2811	2812	2813	281
282	280	5219.04	495.12	6932	.00306	none	2822	2823	282
283	282	1411.32	533.72	2749	.01122	2831	2832	2833	283
284	282	1534.21	559.72	3830	.01797	2841	2842	2843	284
285	277	28877.3	411.34	[illegible]	.00143	none	2852	2853	285
286	285	1751.19	434.16	1906	.01637	2861	2862	2863	286
287	285	1526.12	[illegible]	1338	.00385	none	2872	2873	287
288	287	2445.11	443.55	4530	.01518	2881	2882	2883	288
289	287	[illegible]	427.33	[illegible]	[illegible]	none	2892	2893	289
290	289	1568.56	454.61	2083	.00531	none	2902	2903	290
291	290	[illegible]	[illegible]	1943	.01393	2911	2912	2913	291
292	290	2421.90	455.21	4351	.00192	2921	2922	2923	292
293	289	5081.13	497.66	2503	.00413	none	2932	2933	293
294	293	1111.45	435.47	3309	.01119	2941	2942	2943	294
295	293	3713.94	440.72	6444	.00701	2951	2952	2953	295
296	[illegible]	1756.85	370.52	4535	.01341	2961	2962	2963	296
297	[illegible]	244464	421.14	[illegible]	.01141	none	2972	2973	297
298	297	241365	335.74	1388	.00111	none	2982	2983	298
299	297	230498	325.31	5253	.00274	none	2992	2993	299
300	299	[illegible]	323.69	3909	.00391	none	3002	3003	300
301	300	[illegible]	[illegible]	1888	.00167	none	3012	3013	301
302	301	1225.88	312.12	2662	.00234	3021	3022	3023	302
303	301	199660	346.57	12491	.00064	none	3032	3033	303
304	303	[illegible]	335.33	4336	[illegible]	none	3042	3043	304
305	304	13224.6	318.53	127	.00081	none	[illegible]	3053	305
306	305	6962.20	387.34	11349	.00255	3061	3062	3063	306
307	305	2521.54	[illegible]	11209	.00153	none	3072	3073	307
308	[illegible]	[illegible]	[illegible]	[illegible]	.00232	none	3082	3083	308
309	308	3342.52	354.19	4895	[illegible]	3091	3092	3093	309
310	[illegible]	19886.5	392.65	[illegible]	.00245	none	3102	3103	310
311	310	[illegible]	299.13	[illegible]	.00239	3111	3112	3113	311
312	310	14395.3	359.41	1764	.00511	none	3122	3123	312
313	312	2539.14	413.41	[illegible]	[illegible]	none	3132	3133	313
314	313	4449.52	451.79	[illegible]	[illegible]	3141	3142	3143	314
315	313	1236.07	[illegible]	1334	[illegible]	3151	3152	3153	315
316	312	5971.00	412.29	6520	.00551	none	3162	3163	316
317	316	1563.39	455.53	1040	[illegible]	3171	3172	3173	317
318	316	3355.40	476.61	5195	.00411	none	3182	3183	318
319	318	1127.99	479.79	1211	[illegible]	3191	3192	3193	319
320	319	1278.33	473.84	2952	.00340	3201	3202	3203	320
321	319	3236.62	[illegible]	[illegible]	.00751	3211	3212	3213	321
322	304	[illegible]	271.19	[illegible]	.00092	none	3222	3223	322
323	322	9857.25	379.44	5537	.01249	none	3232	3233	323
324	323	6132.77	392.89	5424	.00561	none	3242	3243	324
325	324	2593.11	433.11	3586	.00371	3251	3252	3253	325
326	324	[illegible]	414.59	1351	.01757	3261	3262	3263	326
327	323	1421.83	354.41	3536	.00695	3271	3272	3273	327
328	323	[illegible]	[illegible]	[illegible]	.00245	none	3282	3283	328
329	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3291	3292	3293	329
330	325	[illegible]	492.71	14745	.00155	none	3302	3303	330
331	[illegible]	[illegible]	471.45	3636	.00111	none	3312	3313	331
332	331	3293.61	432.27	5520	.00795	3321	3322	3323	332
333	331	[illegible]	415.45	3943	.00324	none	3332	3333	333
334	333	[illegible]	[illegible]	4700	.03241	none	3342	3343	334

335	334	19394.5	493.75	3694	.03615	none	3352	3353	335
336	335	3695.28	482.35	13229	.03639	3361	3362	3363	336
337	335	14751.5	485.72	5554	.03255	none	3372	3373	337
338	337	4473.65	[illegible]	1129	.03189	3381	3382	3383	338
339	337	8632.42	593.85	14926	.03153	3391	3392	3393	339
340	334	[illegible]	442.14	2305	.03493	none	3402	3403	340
341	340	3323.74	509.20	9587	.03496	3411	3412	3413	341
342	340	[illegible]	[illegible]	12119	.03123	3421	3422	3423	342
343	335	15940.5	[illegible]	2152	.03561	none	3432	3433	343
344	343	1641.54	435.93	1452	.03622	3441	3442	3443	344
345	343	[illegible]	435.61	1113	.03561	none	3452	3453	345
346	345	2259.73	473.20	3905	.03629	3461	3462	3463	346
347	345	3558.63	399.66	12642	.03578	3471	3472	3473	347
348	339	5542.19	479.52	1596	.03421	none	3482	3483	348
349	348	2635.74	454.51	6409	[illegible]	3491	3492	3493	349
350	348	4391.62	392.84	14752	.03588	3501	3502	3503	350
351	333	1142.91	345.30	1688	.03672	3511	3512	3513	351
352	330	2428.19	330.35	3426	.03518	3521	3522	3523	352
353	299	122243	331.14	6158	.03782	none	3532	3533	353
354	353	[illegible]	335.01	2346	.03144	none	3542	3543	354
355	354	3061.25	335.41	2153	.03154	none	3552	3553	355
356	355	1658.69	344.85	3542	.03593	3561	3562	3563	356
357	356	5233.92	344.73	3547	.03292	none	3572	3573	357
358	357	2542.53	385.13	2951	.03943	3581	3582	3583	358
359	357	4973.53	368.42	3821	.03503	3591	3592	3593	359
360	354	[illegible]	348.16	2942	[illegible]	none	3602	3603	360
361	360	[illegible]	349.11	5693	.03655	none	3612	3613	361
362	361	21916.5	351.19	121	.03201	none	3622	[illegible]	362
363	362	1112.37	352.47	1323	.03033	3631	3632	3633	363
364	362	[illegible]	352.47	4618	.03938	none	3642	3643	364
365	364	[illegible]	364.02	5134	[illegible]	none	3652	3653	365
366	365	[illegible]	395.31	5371	.03452	3661	3662	3663	366
367	365	1298.32	387.51	2791	.03145	3671	3672	3673	367
368	374	[illegible]	358.51	2247	[illegible]	none	3682	3683	368
369	368	[illegible]	385.93	[illegible]	[illegible]	none	3692	3693	369
370	369	4631.32	340.21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	370
371	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	371
372	371	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	372
373	372	[illegible]	430.42	[illegible]	.03362	none	[illegible]	[illegible]	373
374	373	[illegible]	[illegible]	[illegible]	.03966	[illegible]	[illegible]	[illegible]	374
375	373	[illegible]	452.43	[illegible]	[illegible]	none	[illegible]	[illegible]	375
376	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	376
377	376	1450.49	553.43	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	377
378	[illegible]	2213.32	561.31	5409	[illegible]	[illegible]	[illegible]	[illegible]	378
379	378	[illegible]	[illegible]	4651	.03624	none	[illegible]	[illegible]	379
380	[illegible]	1474.44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	380
381	380	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	381
382	[illegible]	4605.44	[illegible]	[illegible]	[illegible]	[illegible]	3822	[illegible]	382
383	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	383
384	383	15903.5	447.45	11203	.03127	none	3842	3843	384
385	384	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	385
386	[illegible]	1493.41	[illegible]	1523	[illegible]	[illegible]	[illegible]	[illegible]	386
387	385	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	387
388	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	388
389	[illegible]	3244.17	445.31	[illegible]	.03572	[illegible]	3892	3893	389
390	385	37482.1	572.36	1469	[illegible]	none	3902	3903	390
391	390	[illegible]	[illegible]	[illegible]	[illegible]	none	3912	3913	391

392	391	[illegible]	306.59	4591	[illegible]	3921	3922	3923	392
393	391	24431.2	475.64	[illegible]	.03519	none	3932	3933	393
394	393	3572.14	526.59	2467	.02252	none	3942	3943	394
395	394	2151.13	628.42	5751	.02465	3951	3952	3953	395
396	394	[illegible]	557.22	2274	.03356	3961	3962	3963	396
397	393	[illegible]	536.43	1064	.03149	none	3972	3973	397
398	397	12410.8	538.29	4475	.03973	none	3982	3983	398
399	398	15270.5	[illegible]	3246	[illegible]	none	3992	3993	399
400	399	[illegible]	[illegible]	1391	.03352	4001	4002	4003	400
401	[illegible]	[illegible]	[illegible]	3074	[illegible]	none	4012	4013	401
402	401	5320.44	461.23	[illegible]	.03144	none	4022	4023	402
403	402	[illegible]	755.25	1102	.03394	4031	4032	4033	403
404	402	[illegible]	[illegible]	2291	[illegible]	4041	4042	4043	404
405	401	6512.35	462.35	4749	.03622	none	4052	4053	405
406	405	[illegible]	[illegible]	2475	[illegible]	4061	4062	4063	406
407	405	[illegible]	216.55	3751	.03113	4071	4072	4073	407
408	[illegible]	[illegible]	[illegible]	1021	[illegible]	4081	4082	4083	408
409	[illegible]	1488.53	[illegible]	1593	.03702	4091	4092	4093	409
410	[illegible]	[illegible]	[illegible]	1383	.03359	none	4102	4103	410
411	[illegible]	[illegible]	412.55	1793	[illegible]	4111	4112	4113	411
412	[illegible]	[illegible]	[illegible]	3454	.03105	none	4122	4123	412
413	412	1230.12	[illegible]	1596	[illegible]	4131	4132	4133	413
414	411	5174.39	425.30	2254	.03601	4141	4142	4143	414
415	[illegible]	[illegible]	552.06	4176	.03904	none	4152	4153	415
416	415	[illegible]	559.21	6559	[illegible]	none	4162	4163	416
417	416	[illegible]	[illegible]	[illegible]	.03344	4171	4172	4173	417
418	[illegible]	[illegible]	[illegible]	[illegible]	.03426	4181	4182	4183	418
419	415	[illegible]	307.55	[illegible]	.03297	none	4192	4193	419
420	419	[illegible]	[illegible]	[illegible]	.03452	4201	4202	4203	420
421	419	[illegible]	352.28	2254	.03319	4211	4212	4213	421
422	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4221	4222	4223	422
423	[illegible]	[illegible]	510.58	2112	.03022	4231	4232	4233	423
424	[illegible]	3261.22	328.32	[illegible]	[illegible]	4241	4242	4243	424
425	[illegible]	1472.64	310.47	[illegible]	.03658	4251	4252	4253	425
426	[illegible]	[illegible]	[illegible]	[illegible]	.03643	4261	4262	4263	426
427	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4271	4272	4273	427
428	[illegible]	[illegible]	334.29	[illegible]	.03542	4281	4282	4283	428
429	[illegible]	1233.24	[illegible]	[illegible]	[illegible]	none	4292	4293	429
430	[illegible]	[illegible]	[illegible]	[illegible]	.03335	4301	4302	4303	430
431	[illegible]	2192.25	[illegible]	[illegible]	[illegible]	4311	4312	4313	431
432	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4321	4322	4323	432
433	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4331	4332	4333	433
434	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4341	4342	4343	434
435	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4351	4352	4353	435
436	434	[illegible]	[illegible]	[illegible]	.03491	4361	4362	4363	436
437	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	437
438	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	438
439	[illegible]	[illegible]	[illegible]	[illegible]	.03494	none	[illegible]	[illegible]	439
440	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	440
441	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	441
442	441	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	442
443	442	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	443
444	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	444
445	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	445
446	445	[illegible]	[illegible]	6025	.03270	[illegible]	[illegible]	[illegible]	446
447	445	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	447
448	[illegible]	[illegible]	[illegible]	[illegible]	.03342	none	[illegible]	[illegible]	448

449	445	24.972	155.49	5899	.00288	none	4492	4493	449
450	449	237163	158.30	1604	.00091	none	4502	4503	450
451	450	233464	188.48	15501	.00136	none	4512	4513	451
452	451	224730	156.87	15133	.00103	none	4522	4523	452
453	452	211635	273.80	5489	.00101	none	4532	4533	453
454	453	213919	[illegible]	22224	.00189	none	4542	4543	454
455	454	230153	253.98	3456	.00519	none	4552	4553	455
456	455	160324	250.27	18514	.00042	none	4562	4563	456
457	456	214152	258.75	2110	[illegible]	none	4572	4573	457
458	457	52665.9	262.58	4134	.00254	none	4582	4583	458
459	458	2120.58	328.62	4641	.03242	4591	4592	4593	459
460	458	20093.5	256.80	23594	.00142	none	4602	4603	460
461	460	4499.55	327.52	6576	.00534	4611	4612	4613	461
462	[illegible]	[illegible]	[illegible]	5451	[illegible]	none	4622	4623	462
463	462	[illegible]	345.75	6952	[illegible]	none	4632	4633	463
464	463	2350.45	[illegible]	5955	.01251	4641	4642	4643	464
465	463	[illegible]	356.35	[illegible]	.01068	4651	4652	4653	465
466	463	[illegible]	[illegible]	9995	.00412	none	4662	4663	466
467	466	2233.34	392.56	4960	.00688	4671	4672	4673	467
468	466	2455.75	[illegible]	[illegible]	[illegible]	4681	4682	4683	468
469	467	[illegible]	[illegible]	[illegible]	[illegible]	none	4692	4693	469
470	468	133516	278.63	[illegible]	[illegible]	none	4702	4703	470
471	470	1283.34	259.23	3154	.03320	4711	4712	4713	471
472	[illegible]	[illegible]	253.54	7335	[illegible]	none	4722	4723	472
473	[illegible]	4916.79	321.37	15552	.00293	4731	4732	4733	473
474	472	21964.4	[illegible]	2623	.00310	none	4742	4743	474
475	474	[illegible]	304.91	1949	.00268	none	4752	4753	475
476	475	[illegible]	306.45	[illegible]	[illegible]	none	4762	4763	476
477	476	14255.2	[illegible]	2046	.00220	none	4772	4773	477
478	[illegible]	[illegible]	322.78	2936	.00545	4781	4782	4783	478
479	[illegible]	12555.3	371.69	2949	.00220	none	4792	4793	479
480	479	[illegible]	350.51	2955	.00446	none	4802	4803	480
481	480	2503.41	365.54	4751	[illegible]	4811	4812	4813	481
482	[illegible]	2310.73	374.79	4951	.00076	4821	4822	4823	482
483	479	[illegible]	352.69	6054	.02215	4831	4832	4833	483
484	476	12973.2	327.24	5223	.00148	none	4842	4843	484
485	484	[illegible]	[illegible]	[illegible]	.01580	4851	4852	4853	485
486	484	66972.1	326.33	311	[illegible]	none	4862	4863	486
487	486	[illegible]	333.81	2931	[illegible]	none	4872	4873	487
488	487	[illegible]	338.45	1159	.00436	none	4882	4883	488
489	488	9125.10	365.13	3215	.00675	none	4892	4893	489
490	[illegible]	4565.97	[illegible]	1944	.00862	none	4902	4903	490
491	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4911	4912	4913	491
492	[illegible]	1235.24	425.47	2294	.02823	4921	4922	4923	492
493	492	3207.55	458.52	9511	.03563	4931	4932	4933	493
494	455	2548.36	335.43	[illegible]	[illegible]	4941	4942	4943	494
495	[illegible]	[illegible]	344.80	1577	.01293	none	4952	4953	495
496	495	[illegible]	[illegible]	5541	.03616	none	4962	4963	496
497	496	2993.52	497.46	5649	.01348	4971	4972	4973	497
498	496	4556.76	592.99	5163	.01978	4981	4982	4983	498
499	[illegible]	53472.4	399.33	5802	[illegible]	none	4992	4993	499
500	499	2416.20	[illegible]	5111	[illegible]	5001	5002	5003	500
501	498	[illegible]	[illegible]	1211	[illegible]	none	5012	5013	501
502	501	[illegible]	[illegible]	[illegible]	[illegible]	5021	5022	5023	502
503	501	27530.8	394.65	5156	.01427	none	5032	5033	503
504	503	22130.5	[illegible]	532	.01062	none	5042	5043	504
505	504	[illegible]	434.22	[illegible]	[illegible]	5051	5052	5053	505

506	504	19791.5	421.65	3656	.00124	none	5062	5063	506
507	506	9766.17	[illegible]	12950	[illegible]	none	5072	5073	507
508	507	4501.49	[illegible]	1546	.02086	5081	5082	5083	508
509	507	1455.95	[illegible]	2319	.02425	5091	5092	5093	509
510	[illegible]	[illegible]	412.03	1229	.00537	none	5102	5103	510
511	510	2852.17	449.22	2061	.01192	none	5112	5113	511
512	511	1587.46	451.38	5545	.01604	5121	5122	5123	512
513	511	1565.90	[illegible]	2456	.01431	5131	5132	5133	513
514	513	6547.40	[illegible]	1615	.00259	none	5142	5143	514
515	514	2674.62	[illegible]	6155	.01656	5151	5152	5153	515
516	514	2794.15	[illegible]	4075	.03880	5161	5162	5163	516
517	[illegible]	4537.52	[illegible]	5683	.01155	5171	5172	5173	517
518	458	1589.05	556.69	5066	.03380	none	5182	5183	518
519	[illegible]	4505.61	[illegible]	2825	.01359	5191	5192	5193	519
520	[illegible]	[illegible]	[illegible]	5658	[illegible]	5201	5202	5203	520
521	[illegible]	1654.52	[illegible]	1531	.01160	5211	5212	5213	521
522	474	[illegible]	[illegible]	5582	.01695	5221	5222	5223	522
523	469	5558.55	321.74	15752	.00932	5231	5232	5233	523
524	456	[illegible]	[illegible]	5972	.00072	none	5242	5243	524
525	524	9554.76	704.34	7623	.00306	none	5252	5253	525
526	525	1475.59	[illegible]	4442	.02799	5261	5262	5263	526
527	526	1858.03	[illegible]	6562	.00525	none	5272	5273	527
528	527	5499.23	353.53	5440	.03349	5281	5282	5283	528
529	[illegible]	2274.54	352.15	5552	.01334	5291	5292	5293	529
530	524	2327.96	[illegible]	4256	[illegible]	5301	5302	5303	530
531	455	25222.9	246.28	[illegible]	.00273	none	5312	5313	531
532	531	[illegible]	[illegible]	13336	.00560	5321	5322	5323	532
533	532	[illegible]	259.57	2916	.00229	none	5332	5333	533
534	533	1946.93	257.12	9135	.03585	5341	5342	5343	534
535	532	[illegible]	261.19	549	.00051	none	5352	5353	535
536	535	[illegible]	272.97	5920	.00860	5361	5362	5363	536
537	535	[illegible]	239.99	11513	.00459	none	5372	5373	537
538	537	14577.3	222.12	5463	.00591	none	5382	5383	538
539	[illegible]	2561.47	[illegible]	4417	.00684	5391	5392	5393	539
540	535	[illegible]	334.30	[illegible]	.00051	none	5402	5403	540
541	540	11326.8	340.59	1519	.00262	none	5412	5413	541
542	541	[illegible]	[illegible]	6066	.00550	none	5422	5423	542
543	542	5269.25	395.34	5593	[illegible]	5431	5432	5433	543
544	542	[illegible]	[illegible]	5557	.01256	5441	5442	5443	544
545	541	1641.59	[illegible]	[illegible]	.01546	5451	5452	5453	545
546	540	[illegible]	[illegible]	6701	.02295	5461	5462	5463	546
547	537	[illegible]	[illegible]	1443	.03329	5471	5472	5473	547
548	454	[illegible]	[illegible]	3553	.00202	none	5482	5483	548
549	[illegible]	1595.49	328.36	4581	.01550	5491	5492	5493	549
550	549	[illegible]	299.52	1344	.00263	5501	5502	5503	550
551	[illegible]	2695.47	234.82	[illegible]	[illegible]	5511	5512	5513	551
552	451	[illegible]	232.12	4883	.01261	5521	5522	5523	552
553	[illegible]	[illegible]	[illegible]	[illegible]	.00502	none	5532	5533	553
554	553	[illegible]	[illegible]	5587	.01309	5541	5542	5543	554
555	553	3361.50	231.66	9510	.03465	5551	5552	5553	555
556	[illegible]	[illegible]	[illegible]	2416	[illegible]	none	5562	5563	556
557	556	[illegible]	[illegible]	2675	[illegible]	5571	5572	5573	557
558	556	[illegible]	223.18	[illegible]	.01157	5581	5582	5583	558
559	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5591	5592	5593	559
560	448	[illegible]	[illegible]	[illegible]	.00293	none	5602	5603	560
561	[illegible]	[illegible]	[illegible]	4457	[illegible]	none	5612	5613	561
562	[illegible]	[illegible]	[illegible]	4495	[illegible]	none	5622	5623	562

563	562	2209.61	209.0?	4124	.00638	5631	5632	5633	563
564	562	45277.5	[illegible]	3165	[illegible]	none	5642	5643	564
565	564	2238.40	213.95	5358	.00736	5651	5652	5653	565
566	564	31415.5	242.5?	2137	.0009?	none	5662	5673	566
567	566	32126.2	208.05	2269	.0022?	none	5672	5673	567
568	567	23401.2	213.55	4586	.0021?	none	5682	5683	568
569	568	21337.?	223.28	4352	.00033	none	5692	5693	569
570	569	15592.5	232.28	6391	.00373	none	5702	5703	570
571	570	15515.5	200.53	5226	.00144	none	5712	5713	571
572	571	5553.63	336.61	16586	.0016?	5721	5722	5723	572
573	57?	3574.25	339.05	11135	.01961	5731	5732	5733	573
574	573	1658.04	200.96	1?91	.01555	5741	5742	5743	574
575	569	2930.61	259.61	6400	.01781	5751	5752	5753	575
576	575	5449.37	[illegible]	1251	.00159	none	5762	5763	576
577	576	2121.3?	240.5?	3846	.01005	5771	5772	5773	577
578	576	3333.59	236.64	6491	.00654	5781	5782	5783	578
579	564	2551.58	215.14	1225	.0010?	5791	5792	5793	579
580	566	2290.16	221.72	5531	.00513	5801	5802	5803	580
581	561	2654.34	211.07	5085	.00615	5811	5812	5813	581
582	569	2314.92	196.66	1141	.00027	5821	5822	5823	582
583	433	1542.13	185.36	2045	.00153	5831	5832	5833	583
584	176	15598.5	151.35	5491	.00190	none	5842	5843	584
585	584	6253.53	155.22	3136	.00135	none	5852	5853	585
586	585	4705.10	176.24	6705	.0005?	5861	5862	5863	586
587	585	1550.34	173.64	4383	.00685	5871	5872	5873	587
588	584	8411.04	156.??	5352	.0012?	none	5882	5883	588
589	588	2655.66	194.35	[illegible]	.00413	5891	5892	5893	589
590	588	3522.65	179.13	4097	.00513	5901	5902	5903	590
591	175	2337.06	155.14	2024	.01065	5911	5912	5913	591
592	165	3250.59	184.15	7522	.00511	5921	5922	5923	592
593	165	1098.67	144.53	2340	.01775	5931	5932	5933	593
594	162	6216.14	116.02	6925	.00196	none	5942	5943	594
595	594	2090.15	198.21	4575	.00511	5951	5952	5953	595
596	594	2325.51	161.65	3327	.00159	5961	5962	5963	596
597	157	2354.04	151.17	5120	.00650	5971	5972	5973	597
598	156	1496.28	134.81	1440	.01189	5981	5982	5983	598
599	155	1735.11	134.65	4361	.00724	5991	5992	5993	599
600	154	2433.29	142.50	5325	.00424	6001	6002	6003	600
601	151	2308.26	126.23	3327	.00524	6011	6012	6013	601
602	150	2337.04	152.92	1704	.00391	6021	6022	6023	602
603	149	6595.34	122.34	5050	.00349	none	6032	6033	603
604	603	2916.30	155.26	13869	.0010	6041	6042	6043	604
605	603	2425.52	131.35	3567	.00554	6051	6052	6053	605
606	148	6952.25	128.66	6490	.00355	none	6062	6063	606
607	606	3353.40	152.96	611	.00456	6071	6072	6073	607
608	606	2754.16	145.94	5447	.00594	6081	6082	6083	608
609	145	6235.09	155.77	12179	.00326	none	6092	6093	609
610	609	1524.65	157.21	2308	.00263	6101	6102	6103	610
611	609	1335.31	155.98	2148	.00152	6111	6112	6113	611
612	144	1527.66	133.44	5942	.00746	6121	6122	6123	612
613	143	2658.58	121.35	3145	.00442	6131	6132	6133	613
614	142	1331449	20.52	5555	.00152	none	6142	6143	614
615	614	5922.44	104.55	2204	.01194	none	6152	6153	615
616	615	2311.41	120.62	4306	.00524	6161	6162	6163	616
617	615	2713.72	133.26	4120	.00514	6171	6172	6173	617
618	614	2977.53	86.96	12903	.00028	none	6182	6183	618
619	618	1680057	8.50	472	.00001	none	6192	6193	619

620	619	3271.52	114.87	4789	.00538	6201	6202	6203	620
621	618	1268353	95.68	21208	.00053	none	6212	6213	621
622	621	1552411	195.11	1148	.00033	none	6222	6223	622
623	622	3416.68	111.64	3134	.00585	none	6232	6233	623
624	623	2767.46	131.11	8245	.00533	6241	6242	6243	624
625	623	2189.52	151.69	2675	.00253	6251	6252	6253	625
626	622	1545.94	151.56	1344	.00015	none	6262	6263	626
627	626	154.594	151.37	7533	.00034	none	6272	6273	627
628	627	105535	131.30	883	.00021	none	6282	6283	628
629	628	1357.17	117.16	2214	.00154	6291	6292	6293	629
630	628	103408	101.10	2954	.00001	none	6302	6303	630
631	630	107721	107.36	8305	.00055	none	6312	6313	631
632	631	1475.47	127.48	5401	.00506	6321	6322	6323	632
633	631	85759.2	111.23	2755	.00003	none	6332	6333	633
634	633	5244.15	111.44	5019	.00040	none	6342	6343	634
635	634	7180.13	113.54	3513	.00058	none	6352	6353	635
636	635	1634.11	124.50	3613	.00081	6361	6362	6363	636
637	635	53958.0	116.81	4107	.00109	none	6372	6373	637
638	637	[illegible]	126.1?	5740	.00170	none	6382	6383	638
639	637	6549.34	132.02	5222	.00497	none	6392	6393	639
640	639	1256.87	115.73	1971	.00569	6401	6402	6403	640
641	639	1525.51	116.11	5578	.00162	6411	6412	6413	641
642	636	[illegible]	124.15	4371	.00577	none	6422	6423	642
643	642	[illegible]	127.52	3848	.00071	none	6432	6433	643
644	643	[illegible]	134.15	497	.00091	none	6442	6443	644
645	644	4502.79	140.50	659	.00099	none	6452	6453	645
646	645	2903.58	143.11	425	.00271	none	6462	6463	646
647	646	1440.27	155.95	1122	.00362	6471	6472	6473	647
648	646	1252.31	143.55	1597	.00527	6481	6482	6483	648
649	645	1921.32	143.37	1145	.00554	6491	6492	6493	649
650	644	45289.5	132.29	4461	.00067	none	6502	6503	650
651	650	15546.0	153.15	1577	.00075	none	6512	6513	651
652	651	42535.5	143.34	487	.00495	none	6522	6523	652
653	652	4563.11	143.00	530	.00225	none	6532	6533	653
654	657	1157.24	153.19	1503	.00529	6541	6542	6543	654
655	652	2917.00	158.33	4851	.00457	6551	6552	6553	655
656	652	35424.7	143.66	2084	.00035	none	6562	6563	656
657	656	3711.37	145.28	5138	.00147	none	6572	6573	657
658	657	34175.8	151.90	3379	.00255	none	6582	6583	658
659	656	3441.59	174.37	4548	.00319	6591	6592	6593	659
660	658	[illegible]	155.30	645	.00071	none	6602	6603	660
661	660	21594.4	151.30	582	.00062	none	6612	6613	661
662	661	15651.6	160.79	5621	.00135	none	6622	6623	662
663	662	15946.0	189.42	5492	.00255	none	6632	6633	663
664	663	[illegible]	177.02	5613	.00143	none	6642	6643	664
665	664	1662.00	141.55	5563	.00427	6651	6652	6653	665
666	664	5594.45	130.11	8514	.00285	none	6662	6663	666
667	666	5121.31	223.25	1513	.00528	6671	6672	6673	667
668	666	1125.90	205.66	2215	.00740	6681	6682	6683	668
669	663	1152.50	151.13	2561	.00491	6691	6692	6693	669
670	662	1212.77	112.24	1459	.00605	6701	6702	6703	670
671	661	6023.45	135.3?	15555	.00421	none	6712	6713	671
672	671	2524.09	226.52	5576	.00654	6721	6722	6723	672
673	671	3216.25	205.30	1840	.00462	6731	6732	6733	673
674	670	2319.17	183.54	5979	.00554	6741	6742	6743	674
675	[illegible]	3447.29	182.38	1643	.00555	6751	6752	6753	675
676	660	1936.92	150.17	4553	.00537	6761	6762	6763	676

677	651	1141.50	169.92	6077	.00683	6771	6772	6773	677
678	657	1965.14	169.41	6977	.00717	6781	6782	6783	678
679	645	1113.5	144.54	4594	.00544	none	6792	6793	679
680	678	1110.40	182.74	10965	.00560	6801	6802	6803	680
681	679	7392.47	152.34	1928	.00500	none	6812	6813	681
682	680	5992.89	161.32	1438	.01051	none	6822	6823	682
683	682	1157.49	185.85	1102	.00427	6831	6832	6833	683
684	682	4064.79	191.30	12798	.00395	6841	6842	6843	684
685	661	1136.47	157.59	1135	.00616	6851	6852	6853	685
686	642	1612.89	161.15	14421	.00458	6861	6862	6863	686
687	637	1435.73	136.52	4258	.00591	6871	6872	6873	687
688	634	1316.32	134.99	7038	.00659	6881	6882	6883	688
689	633	3933.84	119.12	2515	.00528	none	6892	6893	689
690	659	2943.54	145.29	9442	.00498	6901	6902	6903	690
691	689	6521.24	131.58	2145	.00530	none	6912	6913	691
692	691	5615.05	162.29	19335	.00426	6921	6922	6923	692
693	691	1982.37	145.56	4504	.00416	6931	6932	6933	693
694	683	3718.25	118.57	6491	.00356	6941	6942	6943	694
695	621	1731604	104.25	9545	.00018	none	6952	6953	695
696	691	1687.23	116.15	2961	.00500	6961	6962	6963	696
697	695	1726645	105.57	6049	.00015	none	6972	6973	697
698	697	1725071	104.88	2918	.00035	none	6982	6983	698
699	698	1540935	109.13	12598	.00077	none	6992	6993	699
700	699	1531158	112.10	9787	.00095	none	7002	7003	700
701	700	5151.60	118.86	2599	.00218	none	7012	7013	701
702	701	2525.92	134.15	4723	.00598	7021	7022	7023	702
703	701	1491.21	136.49	3585	.00636	7031	7032	7033	703
704	703	1522797	116.61	7217	.00056	none	7042	7043	704
705	704	56563.4	125.23	2593	.00215	none	7052	7053	705
706	705	15842.1	137.75	31565	.00076	none	7062	7063	706
707	706	65910.7	143.40	2651	.00091	none	7072	7073	707
708	707	62790.4	157.01	17634	.00135	none	7082	7083	708
709	708	5691.73	176.57	2030	.00252	none	7092	7093	709
710	709	2772.46	233.11	9419	.00879	7101	7102	7103	710
711	709	6236.25	235.69	10661	.00454	none	7112	7113	711
712	711	1638.52	238.19	2952	.00512	7121	7122	7123	712
713	711	2422.27	240.99	9739	.00587	7131	7132	7133	713
714	705	45080.6	132.80	2576	.00001	none	7142	7143	714
715	714	37330.5	173.74	4425	.00085	none	7152	7153	715
716	715	13275.1	193.14	14258	.00108	none	7162	7163	716
717	716	3063.47	223.75	4359	.00923	7171	7172	7173	717
718	716	5261.97	233.04	3614	.00682	7181	7182	7183	718
719	715	22987.1	170.59	2085	.00056	none	7192	7193	719
720	719	12578.5	193.13	15284	.00253	none	7202	7203	720
721	720	6529.17	237.34	6593	.00698	none	7212	7213	721
722	721	3148.47	272.29	2634	.00692	none	7222	7223	722
723	722	1214.15	335.93	1556	.02561	7231	7232	7233	723
724	722	1690.38	307.44	2719	.01607	7241	7242	7243	724
725	721	1274.13	230.17	1454	.01103	7251	7252	7253	725
726	720	1585.19	236.13	2106	.01504	7261	7262	7263	726
727	719	10914.8	188.53	5066	.00456	none	7272	7273	727
728	727	5324.13	241.39	15949	.00647	7281	7282	7283	728
729	727	3583.19	231.43	9514	.00787	7291	7292	7293	729
730	714	1241.10	187.80	1426	.00548	none	7302	7303	730
731	730	3906.52	213.80	4361	.00627	none	7312	7313	731
732	731	1073.25	241.88	1509	.01507	7321	7322	7323	732
733	731	1524.42	250.90	2952	.01306	7331	7332	7333	733

734	729	2115.72	218.62	5073	.01161	7341	7342	7343	734
735	727	1514.20	157.89	1184	.00609	7351	7352	7353	735
736	726	4238.39	161.27	2566	.00403	7361	7362	7363	736
737	701	6533.16	155.57	6077	.00290	none	7372	7373	737
738	737	2712.06	167.73	5649	.00712	7381	7382	7383	738
739	737	1444.57	158.35	3126	.00520	7391	7392	7393	739
740	734	1433808	120.37	2455	.00037	none	7402	7403	740
741	740	5023.40	138.91	7755	.00530	7411	7412	7413	741
742	740	1429463	121.33	2456	.00160	none	7422	7423	742
743	742	1246.59	125.98	1562	.00326	7431	7432	7433	743
744	742	1426358	125.13	896	.00001	none	7442	7443	744
745	744	1358659	128.27	5438	.00041	none	7452	7453	745
746	745	46756.9	134.55	5452	.00196	none	7462	7463	746
747	746	42516.1	150.46	2857	.00366	none	7472	7473	747
748	747	6264.79	273.36	25402	.00313	7481	7482	7483	748
749	747	30920.7	161.41	12572	.00111	none	7492	7493	749
750	749	2578.74	211.65	4211	.01108	7501	7502	7503	750
751	749	28473.5	165.27	13522	.00125	none	7512	7513	751
752	751	24500.5	195.91	2119	.00162	none	7522	7523	752
753	752	13842.2	205.11	1424	.00138	none	7532	7533	753
754	753	3572.15	212.19	7502	.00739	7541	7542	7543	754
755	753	6968.13	228.16	12124	.00145	none	7552	7553	755
756	755	1219.14	200.67	1783	.00152	7561	7562	7563	756
757	755	2272.58	261.58	5507	.00165	7571	7572	7573	757
758	752	15411.7	236.85	5748	.00212	none	7582	7583	758
759	758	9194.57	213.17	4219	.00173	none	7592	7593	759
760	759	7212.24	217.99	3151	.00511	none	7602	7603	760
761	760	2280.36	215.43	6523	.01415	7611	7612	7613	761
762	760	1098.35	230.44	2622	.02931	7621	7622	7623	762
763	759	1953.50	247.38	3574	.01454	7631	7632	7633	763
764	758	1961.32	226.81	2443	.00922	7641	7642	7643	764
765	751	1244.93	232.95	1468	.01465	7651	7652	7653	765
766	748	1649.97	155.12	2306	.00935	7661	7662	7663	766
767	746	1311950	127.30	5696	.00001	none	7672	7673	767
768	767	1307165	127.30	2654	.00001	none	7682	7683	768
769	768	4919.13	127.30	2002	.00001	none	7692	7693	769
770	769	1268.41	147.98	3645	.01126	7701	7702	7703	770
771	769	5473.04	175.01	12446	.00077	7711	7712	7713	771
772	768	1301563	127.30	255	.00001	none	7722	none	772
773	772	1265435	127.30	2679	.00001	none	7732	7733	773
774	773	1262559	115.66	13452	.00033	none	7742	7743	774
775	774	2569.52	197.81	9396	.01090	7751	7752	7753	775
776	774	1252253	131.27	7706	.00056	none	7762	7763	776
777	776	1214536	154.33	29398	.00151	none	7772	7773	777
778	777	1201259	173.64	12619	.00289	none	7782	7783	778
779	778	1194413	196.30	14601	.00395	none	7792	7793	779
780	779	1033357	209.15	1492	.00001	none	7802	7803	780
781	780	4321.41	224.76	2120	.01495	none	7812	7813	781
782	781	1438.37	241.21	1723	.02231	7821	7822	7823	782
783	781	2059.23	254.29	5050	.01416	7831	7832	7833	783
784	783	125027	219.74	10771	.00344	none	7842	7843	784
785	784	122431	217.90	1136	.00001	none	7852	7853	785
786	785	120091	250.58	5969	.00167	none	7862	7863	786
787	786	113616	255.10	42	.00001	none	7872	7873	787
788	787	4073.16	253.41	9617	.00463	7881	7882	7883	788
789	787	109406	255.10	3258	.00001	none	7892	7893	789
790	789	108410	255.10	2190	.00001	none	7902	7903	790

905	893	2328.72	261.74	3356	.03505	9051	9052	9053	905
906	828	2236.56	232.50	2173	.01636	9061	9062	9063	906
907	887	424215	182.40	4426	.00032	none	9072	9073	907
908	907	921969	165.60	1465	.00001	none	9082	9083	908
909	908	831469	165.13	5233	.00001	none	9092	9093	909
910	909	464936	169.24	25585	.03054	none	9102	9103	910
911	910	455395	180.73	15996	.03065	none	9112	9113	911
912	911	445655	190.72	3476	.00211	none	9122	9123	912
913	912	1361.92	221.95	5321	.01410	9131	9132	9133	913
914	912	442392	199.30	2456	.00001	none	9142	9143	914
915	914	1341.69	217.32	2625	.01466	9151	9152	9153	915
916	914	440352	199.30	4237	.00001	none	9162	9163	916
917	916	426635	199.62	2309	.00033	none	9172	9173	917
918	917	1126.71	262.25	2105	.00575	9181	9182	9183	918
919	917	422315	232.26	1103	.00157	none	9192	9193	919
920	919	2534.25	334.61	5516	.02109	9201	9202	9203	920
921	920	415616	235.37	1415	.03111	none	9212	9213	921
922	921	1371.91	237.03	5132	.01973	9221	9222	9223	922
923	921	414765	215.32	1667	.00064	none	9232	9233	923
924	923	1306.55	235.90	2219	.01099	9241	9242	9243	924
925	925	411991	214.01	2306	.00125	none	9252	9253	925
926	925	4091.19	232.48	412	.00005	none	9262	9263	926
927	926	1393.59	281.09	9438	.02671	9271	9272	9273	927
928	926	3169.55	287.05	3303	.01650	9281	9282	9283	928
929	925	402095	233.12	11754	.00156	none	9292	9293	929
930	929	5563.99	327.37	11649	.02141	9301	9302	9303	930
931	929	395137	245.20	1355	.00001	none	9312	9313	931
932	931	394297	245.20	1365	.00001	none	9322	9323	932
933	932	1445.34	245.23	2511	.00001	9331	9332	9333	933
934	932	382155	245.23	2260	.00001	none	9342	9343	934
935	934	379377	243.23	2155	.00001	none	9352	9353	935
936	935	4226.55	260.55	5351	.00483	none	9362	9363	936
937	936	1604.61	346.57	3523	.02800	9371	9372	9373	937
938	936	1673.46	334.95	2691	.02236	9381	9382	9383	938
939	935	175.07	245.25	537	.00001	none	none	9393	939
940	939	92141.3	245.20	120	.00001	none	9402	9403	940
941	940	1224.49	252.85	4800	.00064	9411	9412	9413	941
942	940	90128.7	251.16	12491	.00146	none	9422	9423	942
943	942	2018.26	328.31	4565	.02284	9431	9432	9433	943
944	942	84244.9	279.27	12016	.01260	none	9442	9443	944
945	944	2343.39	351.66	4236	.02206	9451	9452	9453	945
946	944	78046.7	351.29	4451	.00236	none	9462	9463	946
947	946	1473.39	355.66	3259	.02298	9471	9472	9473	947
948	946	74565.3	312.18	2772	.00336	none	9482	9483	948
949	948	1790.58	385.60	1172	.03191	9491	9492	9493	949
950	948	72065.1	327.40	255	.00335	none	9502	9503	950
951	950	70594.1	330.15	5374	.01512	none	9512	9513	951
952	951	2037.52	404.95	5203	.02865	9521	9522	9523	952
953	951	64632.3	350.52	3961	.00251	none	9532	9533	953
954	953	6612.70	374.43	515	.01670	none	9542	9543	954
955	954	1401.74	439.43	4196	.02945	9551	9552	9553	955
956	954	5137.42	404.39	5311	.01171	none	9562	9563	956
957	956	1942.51	472.58	2697	.02236	9571	9572	9573	957
958	956	2346.58	462.35	2898	.02546	9581	9582	9583	958
959	953	54654.7	417.19	15427	.07454	none	9592	9593	959
960	959	4006.26	464.87	4244	.01300	none	9602	9603	960
961	960	1153.14	551.23	1304	.00921	9611	9612	9613	961

962	960	1171.47	540.14	6026	.03331	9621	9622	9623	962
963	959	45152.5	142.50	6450	.00229	none	9632	9633	963
964	963	1179.75	415.25	1364	.02404	9641	9642	9643	964
965	963	36703.2	404.64	5312	.00299	none	9652	9653	965
966	965	2163.76	528.74	6633	.01751	9661	9662	9663	966
967	965	32294.1	451.17	2996	.00235	none	9672	9673	967
968	967	1721.25	518.00	4701	.01577	9681	9682	9683	968
969	967	29352.7	449.54	2663	.00384	none	9692	9693	969
970	969	1860.50	549.14	6626	.01741	9701	9702	9703	970
971	969	27359.4	431.31	1916	.00319	none	9712	9713	971
972	971	1164.24	511.33	1986	.01651	9721	9722	9723	972
973	971	25445.7	511.23	1341	.00709	none	9732	9733	973
974	973	1559.84	634.31	13346	.01916	9741	9742	9743	974
975	973	22252.5	546.75	9875	.00535	none	9752	9753	975
976	975	2242.50	633.91	3619	.01220	9761	9762	9763	976
977	975	22012.7	554.23	3181	.00265	none	9772	9773	977
978	977	5546.35	734.38	5213	.01149	9781	9782	9783	978
979	977	5484.51	627.53	13462	.00774	9791	9792	9793	979
980	959	1137.41	436.56	2024	.03651	9801	9802	9803	980
981	959	192557	245.21	1206	.01031	none	9812	9813	981
982	981	176555	245.25	121	.00001	none	none	9823	982
983	982	1265.22	211.88	2194	.00311	9831	9832	9833	983
984	982	172355	245.23	1356	.00001	none	9842	9843	984
985	984	171567	256.88	10591	.00124	none	9852	9853	985
986	985	1518.69	273.21	1391	.01456	9861	9862	9863	986
987	985	161495	269.30	352	.01003	none	9872	9873	987
988	987	1253.37	234.95	2462	.01779	9881	9882	9883	988
989	987	203396	213.59	111	.00075	none	9892	9893	989
990	983	1457.19	275.59	2550	.01552	9901	9902	9903	990
991	989	165534	211.62	5516	.00519	none	9912	9913	991
992	990	158343	199.43	517	.00001	none	9922	9923	992
993	992	120313	239.40	3713	.00001	none	9932	9933	993
994	992	14741.2	239.40	918	.00091	none	9942	9943	994
995	994	1899.52	333.56	3215	.01195	9951	9952	9953	995
996	994	12434.3	319.55	12560	.03567	none	9962	9963	996
997	996	2502.24	459.71	4482	.00651	9971	9972	9973	997
998	996	424.53	391.55	8429	.01902	9981	9982	9983	998
999	998	134915	521.35	23785	.00405	none	9992	9993	999
1000	999	2297.26	413.92	4961	.01206	10001	10002	10003	1000
1001	999	91523.9	414.64	2264	.00895	none	10012	10013	1001
1002	1001	55255.9	475.15	515	.00031	none	10022	10023	1002
1003	1002	2271.48	551.51	13599	.01926	10031	10032	10033	1003
1004	1002	53521.3	454.64	1576	.00185	none	10042	10043	1004
1005	1004	2291.49	552.35	9001	.02811	10051	10052	10053	1005
1006	1004	15847.9	439.81	10278	.00266	none	10062	10063	1006
1007	1006	10954.5	411.52	2614	.00464	none	10072	10073	1007
1008	1007	07992.2	432.69	6639	.00635	none	10082	10083	1008
1009	1008	3441.82	534.25	2719	.01312	none	10092	10093	1009
1010	1009	1132.62	600.95	3064	.02481	10101	10102	10103	1010
1011	1009	3256.37	659.14	5156	.02552	10111	10112	10113	1011
1013	1008	57147.1	524.07	4675	.00262	none	10132	10133	1013
1014	1013	1236.89	544.79	1322	.03145	10141	10142	10143	1014
1015	1013	44355.9	534.15	1353	.00001	none	10152	10153	1015
1016	1015	41869.2	534.12	1386	.00351	none	10162	10163	1016
1017	1016	15975.9	553.56	1764	.02304	none	10172	10173	1017
1018	1017	1604.02	815.42	3468	.02749	10181	10182	10183	1018
1019	1017	14262.9	621.31	13345	.00651	none	10192	10193	1019

1020	1019	5130.64	483.68	1576	.10351	none	10202	10203	1020
1021	1020	1221.88	491.48	1214	.10376	10211	10212	10213	1021
1022	1020	7561.92	206.76	5930	.10510	10221	10222	10223	1022
1023	1019	6259.68	678.23	1583	.10091	none	10232	10233	1023
1024	1023	3564.73	135.17	9115	.10246	10241	10242	10243	1024
1025	1024	1418.51	133.09	3068	.10212	10251	10252	10253	1025
1026	1016	31705.3	588.07	10133	.10592	none	10262	10263	1026
1027	1026	23516.5	192.33	2155	.10129	none	10272	10273	1027
1028	1023	24825.2	64.53	1155	.10523	none	10282	10283	1028
1029	1028	21321.2	635.45	6525	.10051	none	10292	10293	1029
1030	1024	5551.68	120.51	2353	.10135	none	10302	10303	1030
1031	1030	1355.13	16.93	1571	.04244	10311	10312	10313	1031
1032	1030	5665.16	159.42	3259	.01926	none	10322	10323	1032
1033	1032	2415.31	535.53	1569	.02659	10331	10332	10333	1033
1034	1032	2314.39	520.24	5124	.03565	10341	10342	10343	1034
1035	1029	9437.51	134.45	3.28	.09966	none	10352	10353	1035
1036	1035	6724.93	167.55	[illegible]	.02031	none	10362	10363	1036
1037	1036	4075.68	809.85	9561	.05859	10371	10372	10373	1037
1038	1036	1942.51	724.37	2728	.01122	10381	10382	10383	1038
1039	1035	1106.43	220.60	2014	.01820	10391	10392	10393	1039
1040	1020	1759.15	223.39	5215	.03699	10401	10402	10403	1040
1041	1021	1492.87	156.21	4801	.05200	10411	10412	10413	1041
1042	1026	1491.39	615.15	1720	.03105	10421	10422	10423	1042
1043	1015	6441.37	655.53	11439	.02281	10431	10432	10433	1043
1044	1008	3390.65	513.11	19133	.01214	10441	10442	10443	1044
1045	1072	1529.25	809.32	5575	.07520	10451	10452	10453	1045
1046	1000	1991.07	487.93	2551	[illegible]	10461	10462	10463	1046
1047	1031	6295.35	571.53	17959	.01614	10471	10472	10473	1047
1048	992	118154	239.42	6845	.10330	none	10482	10483	1048
1049	1048	113564	295.53	4955	.10543	none	10492	10493	1049
1050	1049	13264.3	334.14	51985	.10712	10501	10502	10503	1050
1051	1049	40405.5	123.23	3615	.10215	none	10512	10513	1051
1052	1051	60252.4	411.59	21254	.10514	none	10522	10523	1052
1053	1052	5346.16	416.62	3955	.10360	none	10532	10533	1053
1054	1053	1507.05	515.56	1454	.03546	10541	10542	10543	1054
1055	1053	5755.6	474.22	3921	.10458	none	10552	10553	1055
1056	1055	2145.74	542.44	2645	.01276	10561	10562	10563	1056
1057	1055	4875.61	122.51	6624	.10805	none	10572	10573	1057
1058	1057	2586.36	577.73	1244	.03332	10581	10582	10583	1058
1059	1057	41298.9	571.15	5445	.10590	none	10592	10593	1059
1060	1059	33119.3	711.51	10564	.10019	none	10602	10603	1060
1061	1060	1314.53	475.25	1574	.03054	10611	10612	10613	1061
1062	1060	23511.5	654.09	2157	.01535	none	10622	10623	1062
1063	1062	12744.9	[illegible]	2052	.10769	none	10632	10633	1063
1064	1063	29039.52	748.47	4758	[illegible]	10641	10642	10643	1064
1065	1063	16252.9	721.31	5641	.10392	none	10652	10653	1065
1066	1065	3359.69	556.52	10203	.01409	10661	10662	10663	1066
1067	1065	17522.2	791.40	2474	.01961	none	10672	10673	1067
1068	1067	5553.60	986.75	27207	.01434	10681	10682	10683	1068
1069	1067	2616.35	575.26	2353	.03541	10691	10692	10693	1069
1070	1067	9032.29	711.11	6572	.01611	none	10702	10703	1070
1071	1030	6229.09	355.60	105	.04116	none	10712	10713	1071
1072	1071	2414.49	531.99	1522	.03921	10721	10722	10723	1072
1073	1071	4571.57	323.44	2561	.10352	none	10732	10733	1073
1074	1073	1239.24	947.32	3236	.03540	10741	10742	10743	1074
1075	1073	2522.55	995.95	9565	.01282	10751	10752	10753	1075
1076	1073	1537.60	411.65	1468	.03548	10761	10762	10763	1076

1077	1076	1262.12	611.70	5253	.04327	10771	10772	10773	1077
1078	1062	21435.8	191.67	5299	.04016	none	10782	10783	1078
1079	1078	3406.05	604.62	9552	.04062	10791	10792	10793	1079
1080	1078	12126.4	533.24	1358	.01032	none	10802	10803	1080
1081	1080	1216.15	[illegible]	4401	.01161	none	10812	10813	1081
1082	1081	5925.39	152.64	4197	.01454	none	10822	10823	1082
1083	1082	5312.70	553.75	10333	.02445	10831	10832	10833	1083
1084	1082	1933.95	747.52	3751	.05839	10841	10842	10843	1084
1085	1081	2323.94	[illegible]	3329	.01262	10851	10852	10853	1085
1086	1085	4359.61	879.57	6651	.01190	10861	10862	10863	1086
1087	1081	4337.84	381.22	1901	.03141	none	10872	10873	1087
1088	1087	1125.95	425.14	1159	.04121	10881	10882	10883	1088
1089	1087	4101.24	428.65	3452	.01760	none	10892	10893	1089
1090	1080	1835.30	510.30	1781	.04369	10901	10902	10903	1090
1091	1090	2261.33	433.54	5253	.01585	10911	10912	10913	1091
1092	1048	2412.26	245.66	3312	.05256	10921	10922	10923	1092
1093	1092	27349.4	253.43	5645	.03713	none	10932	10933	1093
1094	1093	2619.95	323.65	1355	.02575	10941	10942	10943	1094
1095	1093	23345.	152.42	1214	.01589	none	10952	10953	1095
1096	1095	1856.52	[illegible]	4520	.01020	10961	10962	10963	1096
1097	1095	21415.0	55.33	3560	.00331	none	10972	10973	1097
1098	1097	16899.5	512.10	2211	.03515	none	10982	10983	1098
1099	1095	1135.39	427.44	15595	.03149	10991	10992	10993	1099
1100	1098	9952.64	395.67	15237	.01229	none	11002	11003	1100
1101	1100	3221.64	525.50	[illegible]	.02444	11011	11012	11013	1101
1102	1100	1813.50	[illegible]	1407	.01410	11021	11022	11023	1102
1103	1094	3061.14	325.35	3550	.00763	11031	11032	11033	1103
1104	991	1351.95	208.52	1392	.05590	11041	11042	11043	1104
1105	952	3327.30	152.34	5557	.02584	11051	11052	11053	1105
1106	954	1437.75	241.67	2443	.01125	11061	11062	11063	1106
1107	931	12685.3	241.77	1341	.00701	none	11072	11073	1107
1108	1107	1612.50	254.63	1211	.03738	none	11082	11083	1108
1109	1108	1413.22	325.50	7618	.01316	11091	11092	11093	1109
1110	1108	2752.93	370.18	1031	.01699	11101	11102	11103	1110
1111	1107	1706.53	249.54	1951	.03659	none	11112	11113	1111
1112	1111	2434.61	219.	3141	.01122	11121	11122	11123	1112
1113	1111	4473.65	[illegible]	5033	.01105	11131	11132	11133	1113
1114	946	15229.4	721.34	1061	.00718	none	11142	11143	1114
1115	1114	11712.3	236.60	10639	.00393	none	11152	11153	1115
1116	1115	1105.48	245.86	1151	.01135	11161	11162	11163	1116
1117	1115	6255.15	285.62	7362	.01167	11171	11172	11173	1117
1118	1114	1464.13	132.39	1148	.00501	11181	11182	11183	1118
1119	942	2199.21	215.14	5135	.01335	11191	11192	11193	1119
1120	919	2513.09	240.26	2573	.02463	11201	11202	11203	1120
1121	900	196259	181.30	2515	.00058	none	11212	11213	1121
1122	1121	149552	181.28	2966	.00307	none	11222	11223	1122
1123	1121	3621.58	180.92	3582	.05485	11231	11232	11233	1123
1124	1122	58113.1	147.99	8904	.01202	none	11242	11243	1124
1125	1124	25162.52	174.51	1822	.00605	11251	11252	11253	1125
1126	1121	159623	171.11	1276	.00001	none	11262	11263	1126
1127	1126	259386	115.14	5457	.00061	none	11272	11273	1127
1128	1127	56592.4	[illegible]	5174	.00021	none	11282	11283	1128
1129	1128	51456.1	156.29	3114	.01161	none	11292	11293	1129
1130	1129	63449.3	119.16	941	.00001	none	11302	none	1130
1131	1130	24111.34	114.40	615	.00001	none	11312	11313	1131
1132	1131	1212.45	190.16	1591	.01127	11321	11322	11323	1132
1133	1131	1591.17	182.36	1124	.00552	11331	11332	11333	1133

1134	1133	[illegible]	179.47	1351	.03071	none	1.1312	1.1343	1134
1135	1134	[illegible]	[illegible]	1368	.03095	[illegible]	1.1352	1.1353	1135
1136	1134	39449.9	179.43	5534	.03091	none	[illegible]	1.1363	1136
1137	1136	3439.2	180.59	14319	.03095	none	1.1372	1.1373	1137
1138	1137	85985.[illegible]	191.41	2443	.03012	none	1.1382	1.1383	1138
1139	1138	5848.[illegible]	203.53	8274	.03178	none	1.1392	1.1393	1139
1140	1139	6594.29	215.54	4556	.03095	[illegible]	1.1402	1.1403	1140
1141	1140	55409.7	205.65	2943	.03071	none	1.1412	1.1413	1141
1142	1141	5.333.5	219.33	7751	.03215	none	1.1422	1.1423	1142
1143	1142	4422.9	227.15	15108	.03259	none	1.1432	1.1433	1143
1144	1143	[illegible]	252.06	12741	.03228	none	1.1442	1.1443	1144
1145	1144	24.53.2	170.72	481	.03381	none	1.1452	1.1453	1145
1146	1145	2.428.6	259.38	3129	.03230	none	1.1462	1.1463	1146
1147	1146	133.5.3	315.24	1741	.03451	none	1.1472	1.1473	1147
1148	1147	6444.36	371.65	[illegible]	.03351	1.1481	1.1482	1.1483	1148
1149	1147	2883.35	345.38	8121	.03248	1.1491	1.1492	1.1493	1149
1150	1149	445.25	[illegible]	16494	.03181	none	1.1502	1.1503	1150
1151	1150	2532.29	491.53	1803	.03383	1.1511	1.1512	1.1513	1151
1152	1151	5.62.24	502.3	7228	.03215	1.1521	1.1522	1.1523	1152
1153	1145	[illegible]	332.46	5644	.03265	1.1531	1.1532	1.1533	1153
1154	1144	3.355.6	324.71	6937	.03494	1.1541	1.1542	1.1543	1154
1155	1145	[illegible]	241.67	5982	.03044	none	1.1552	1.1553	1155
1156	1155	3561.57	312.61	6399	.03145	1.1561	1.1562	1.1563	1156
1157	1156	1530.[illegible]	330.50	2159	.03029	1.1571	1.1572	1.1573	1157
1158	1142	[illegible]	457.31	14955	.03724	1.1581	1.1582	1.1583	1158
1159	1141	[illegible]	325.41	[illegible]	[illegible]	1.1591	1.1592	1.1593	1159
1160	1159	[illegible]	203.58	1572	[illegible]	1.1601	1.1602	1.1603	1160
1161	1157	12.9.32	205.53	4583	.03495	none	1.1612	1.1613	1161
1162	[illegible]	4594.24	235.45	12163	.03598	1.1621	1.1622	1.1623	1162
1163	1161	1414.26	219.53	1467	.03245	1.1631	1.1632	1.1633	1163
1164	[illegible]	[illegible]	199.65	[illegible]	.03468	1.1641	1.1642	1.1643	1164
1165	1129	4170.11	179.53	5267	.03711	1.1651	1.1652	1.1653	1165
1166	1125	[illegible]	195.50	4862	.03422	1.1661	1.1662	1.1663	1166
1167	1127	249562	[illegible]	127	.03051	none	1.1672	none	1167
1168	[illegible]	[illegible]	[illegible]	13411	.03346	none	1.1682	1.1683	1168
1169	1166	.32823	194.42	1283	.03066	none	1.1692	1.1693	1169
1170	1169	.96369	191.56	10591	.03025	none	1.1702	1.1703	1170
1171	1170	.14.512	201.72	16112	.03554	none	1.1712	1.1713	1171
1172	1171	.32453	219.25	15762	.03457	none	1.1722	1.1723	1172
1173	1172	.75948	234.71	6558	.03231	none	1.1732	1.1733	1173
1174	1173	1595.35	261.24	1351	.03296	1.1741	1.1742	1.1743	1174
1175	1175	.14389	240.79	5444	.03391	none	1.1752	1.1753	1175
1176	1175	17.38.9	341.21	20565	.03462	1.1761	1.1762	1.1763	1176
1177	1176	.56879	252.21	7567	.03209	none	1.1772	1.1773	1177
1178	1177	.55325	269.16	4509	.03351	none	1.1782	1.1783	1178
1179	1178	.25581	256.13	5364	.03556	none	1.1792	1.1793	1179
1180	1179	6.019.7	302.37	2104	.03645	none	1.1802	1.1803	1180
1181	1180	[illegible]	302.82	3133	.03356	1.1811	1.1812	1.1813	1181
1182	1180	59253.9	315.53	3129	.03410	none	1.1822	1.1823	1182
1183	1182	59945.0	330.13	5191	.03153	none	1.1832	1.1833	1183
1184	1183	84752.5	390.36	4126	.03243	none	1.1842	1.1843	1184
1185	1184	5.405.5	419.50	1266	.03071	none	1.1852	1.1853	1185
1186	1185	21.9.65	[illegible]	4497	.03495	1.1861	1.1862	1.1863	1186
1187	1186	7950.3	447.80	[illegible]	[illegible]	none	1.1872	1.1873	1187
1188	1187	2006.17	493.34	5356	.02528	1.1881	1.1882	1.1883	1188
1189	1187	26365.2	441.73	4997	.03141	none	1.1892	1.1893	1189
1190	1189	12367.3	435.41	8591	.03041	none	1.1902	1.1903	1190

1191	1190	6.511.0	235.25	2154	.03536	none	1.1912	1.1913	1191
1192	1191	[illegible]	[illegible]	5112	.03531	none	1.1922	1.1923	1192
1193	1192	2.23.80	135.50	3207	.03711	1.1931	1.1932	1.1933	1193
1194	1192	[illegible]	642.41	9231	[illegible]	none	1.1942	1.1943	1194
1195	1194	6821.1	[illegible]	15919	.03361	1.1951	1.1952	1.1953	1195
1196	1194	1458.00	[illegible]	1384	.03283	1.1961	1.1962	1.1963	1196
1197	1191	9.625.6	145.35	5426	.03379	none	1.1972	1.1973	1197
1198	1197	[illegible]	135.25	3377	.03394	none	1.1982	1.1983	1198
1199	1198	[illegible]	[illegible]	[illegible]	.03331	none	1.1992	1.1993	1199
1200	1199	.581.15	129.83	1156	.03292	none	1.2002	1.2003	1200
1201	1200	[illegible]	[illegible]	[illegible]	.03165	1.2011	1.2012	1.2013	1201
1202	1201	.3477.5	535.13	[illegible]	.03215	none	1.2022	1.2023	1202
1203	1202	[illegible]	135.02	1431	.03031	1.2031	1.2032	1.2033	1203
1204	1202	4144.14	132.59	12504	.03351	1.2041	1.2042	1.2043	1204
1205	1204	2.153.5	[illegible]	4541	.03934	none	1.2052	1.2053	1205
1206	1205	[illegible]	15.46	[illegible]	.03425	1.2061	1.2062	1.2063	1206
1207	1206	[illegible]	[illegible]	[illegible]	.03413	none	1.2072	1.2073	1207
1208	1207	.3338.5	14.05	[illegible]	.03249	none	1.2082	1.2083	1208
1209	1208	1.415.5	[illegible]	4192	.03396	none	1.2092	1.2093	1209
1210	1209	[illegible]	25.56	[illegible]	[illegible]	none	1.2102	1.2103	1210
1211	1210	[illegible]	135.47	[illegible]	.03337	1.2111	1.2112	1.2113	1211
1212	1211	[illegible]	[illegible]	[illegible]	.03421	1.2121	1.2122	1.2123	1212
1213	1210	.3452.5	23.58	[illegible]	.03623	none	1.2132	1.2133	1213
1214	1213	[illegible]	[illegible]	1244	.03126	none	1.2142	1.2143	1214
1215	1214	4251.25	173.34	[illegible]	.03834	none	1.2152	1.2153	1215
1216	1215	[illegible]	[illegible]	4356	[illegible]	none	1.2162	1.2163	1216
1217	1216	[illegible]	[illegible]	556	[illegible]	1.2171	1.2172	1.2173	1217
1218	1216	2103.53	[illegible]	5281	.03361	1.2181	1.2182	1.2183	1218
1219	1218	[illegible]	30.05	1564	.03025	1.2191	1.2192	1.2193	1219
1220	1214	.394.10	95.32	1124	.03164	1.2201	1.2202	1.2203	1220
1221	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.2211	1.2212	1.2213	1221
1222	1203	.859.05	123.65	2917	.03935	1.2221	1.2222	1.2223	1222
1223	1222	[illegible]	33.76	[illegible]	.03597	1.2231	1.2232	1.2233	1223
1224	[illegible]	[illegible]	[illegible]	5270	[illegible]	1.2241	1.2242	1.2243	1224
1225	1197	[illegible]	675.31	2656	.03468	none	1.2252	1.2253	1225
1226	1225	1292.55	33.56	2724	.03225	1.2261	1.2262	1.2263	1226
1227	1225	[illegible]	153.89	[illegible]	.03116	1.2271	1.2272	1.2273	1227
1228	1193	.298.94	[illegible]	[illegible]	.03195	1.2281	1.2282	1.2283	1228
1229	1184	[illegible]	515.35	3009	.03512	1.2291	1.2292	1.2293	1229
1230	1184	.483.41	449.35	2218	.03704	1.2301	1.2302	1.2303	1230
1231	[illegible]	.559.15	141.91	4512	.02406	1.2311	1.2312	1.2313	1231
1232	1182	.463.94	935.03	1316	.06001	1.2321	1.2322	1.2323	1232
1233	[illegible]	56459.5	538.12	2244	.03557	none	1.2332	1.2333	1233
1234	1233	31864.5	362.14	5316	.03125	none	1.2342	1.2343	1234
1235	1234	3131.94	175.31	1679	.03026	none	1.2352	1.2353	1235
1236	1235	3453.46	834.23	3224	.03242	1.2361	1.2362	1.2363	1236
1237	[illegible]	5165.16	536.56	7548	.03232	1.2371	1.2372	1.2373	1237
1238	1234	[illegible]	430.53	5962	.03218	none	1.2382	1.2383	1238
1239	1235	4140.22	465.42	1304	.03146	none	1.2392	1.2393	1239
1240	1239	1652.43	525.13	3615	.02531	1.2401	1.2402	1.2403	1240
1241	1237	2460.51	[illegible]	4345	.03212	1.2411	1.2412	1.2413	1241
1242	1238	7516.4	451.63	5827	.03995	none	1.2422	1.2423	1242
1243	1242	2542.55	622.55	5992	.02245	1.2431	1.2432	1.2433	1243
1244	1242	[illegible]	541.21	5336	.03185	none	1.2442	1.2443	1244
1245	1244	2297.55	615.19	4791	.02296	1.2451	1.2452	1.2453	1245
1246	1244	2307.46	598.22	2226	.01863	none	1.2462	1.2463	1246
1247	1246	5125.55	655.19	5415	.01958	none	1.2472	1.2473	1247

1248	1247	1735.33	705.51	1391	.13152	.12481	.12452	.12485	1248
1249	[illegible]	1462.19	225.00	651	.13053	.12481	.12192	.12495	1249
1250	1248	[illegible]	635.65	1521	.13490	[illegible]	.12502	.12505	1250
[illegible]	1253	1361.58	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1252	1117	[illegible]	[illegible]	8197	[illegible]	none	.12522	.12532	1252
1253	1251	2254.31	497.88	535	.13556	[illegible]	.12532	.12533	1253
1254	1252	10487.5	365.43	2318	.13250	none	.12542	.12545	1254
1255	1254	[illegible]	591.38	[illegible]	.13193	none	.12552	.12555	1255
1256	1255	[illegible]	461.23	3164	.13560	.12561	.12562	.12565	1256
[illegible]	1255	14100.3	338.14	4293	.13290	none	[illegible]	[illegible]	[illegible]
1258	[illegible]	[illegible]	500.51	1506	.13452	[illegible]	.12582	[illegible]	1258
1259	1257	[illegible]	491.40	9155	.13135	none	.12592	[illegible]	1259
1260	1259	5548.15	521.93	1985	.13765	none	.12602	.12603	1260
[illegible]	[illegible]	[illegible]	541.79	[illegible]	[illegible]	[illegible]	.12612	.12613	[illegible]
[illegible]	1260	[illegible]	549.31	6543	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1263	[illegible]	[illegible]	515.14	2562	.13218	[illegible]	.12632	.12635	1263
1264	1254	[illegible]	412.92	[illegible]	.13295	[illegible]	[illegible]	.12643	1264
[illegible]	[illegible]	1524.45	325.53	2152	[illegible]	[illegible]	.12652	[illegible]	[illegible]
[illegible]	[illegible]	1966.58	242.3	[illegible]	[illegible]	[illegible]	.12662	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	231.44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	5604	[illegible]	[illegible]	.12672	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13356	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	3536	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	3564	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
1282	[illegible]	1602.33	[illegible]	4103	[illegible]	.12821	.12822	.12823	1282
1283	[illegible]	2552.24	[illegible]	2295	[illegible]	[illegible]	.12832	[illegible]	[illegible]
1284	[illegible]	[illegible]	[illegible]	[illegible]	.13452	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
1286	[illegible]	[illegible]	391.23	[illegible]	[illegible]	[illegible]	.12862	.12862	[illegible]
[illegible]	[illegible]	9275.82	[illegible]	[illegible]	[illegible]	none	.12872	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1294	14202.5	[illegible]	[illegible]	.13565	none	[illegible]	[illegible]	[illegible]
[illegible]	1290	[illegible]	[illegible]	[illegible]	.13599	[illegible]	.12912	.12915	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	.12922	.12925	[illegible]
[illegible]	1292	1698.42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1292	5596.84	542.13	[illegible]	.13506	none	.12942	.12943	1294
[illegible]	1294	3459.51	[illegible]	10388	[illegible]	.12951	.12952	.12953	[illegible]
1296	1294	[illegible]	420.13	[illegible]	[illegible]	[illegible]	.12962	.12963	1296
[illegible]	1262	1321.11	206.43	2247	.13350	[illegible]	.12972	.12973	[illegible]
1298	[illegible]	[illegible]	[illegible]	[illegible]	.13308	none	.12982	[illegible]	[illegible]
1299	1296	[illegible]	[illegible]	4183	.13450	none	.12992	.12993	1299
1300	1299	1561.22	231.90	3319	.13322	.13001	.13002	.13003	1300
1301	1299	22499.1	218.21	2946	.13323	none	.13012	.13013	1301
1302	1301	15453.2	251.56	6714	.13024	none	.13022	.13025	1302
1303	1302	1597.02	505.49	2556	.13565	.13031	.13032	.13033	1303
1304	1302	14415.5	532.85	3957	.13490	none	.13042	.13043	1304

1305	1304	3049.61	121.02	5934	.13345	.13051	.13052	.13053	1305
[illegible]	1304	[illegible]	128.61	[illegible]	.13042	none	.13062	.13063	[illegible]
[illegible]	1302	6404.54	[illegible]	9435	.13030	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	342.12	[illegible]	.13144	[illegible]	.13082	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	331.88	[illegible]	.13161	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	4451	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2436.48	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	211.69	3335	.13144	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13548	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	none	[illegible]	[illegible]
[illegible]	[illegible]	5454.05	[illegible]	[illegible]	.13125	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2452.05	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	2445	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13223	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	4624	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13358	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	6413	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13362	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13402	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13432	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	.13452	[illegible]	[illegible]
1344	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	.13442	.13443	1344
[illegible]	1344	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13452	[illegible]	[illegible]
[illegible]	1344	[illegible]	[illegible]	[illegible]	.13483	none	[illegible]	.13465	[illegible]
[illegible]	1346	[illegible]	233.81	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	223.6	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	211.68	[illegible]	.13994	[illegible]	[illegible]	[illegible]	[illegible]
1350	1349	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	1350
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1352	1350	[illegible]	[illegible]	[illegible]	.13324	none	.13522	[illegible]	1352
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13532	[illegible]	[illegible]
1354	1352	[illegible]	269.26	4556	[illegible]	.13541	.13512	.13543	1354
[illegible]	[illegible]	1468.34	[illegible]	[illegible]	[illegible]	[illegible]	.13552	[illegible]	1355
1356	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	.13562	.13563	1356
[illegible]	1356	[illegible]	[illegible]	1466	[illegible]	none	.13572	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13288	.13581	.13582	[illegible]	[illegible]
[illegible]	[illegible]	24293.5	[illegible]	5924	[illegible]	none	.13592	[illegible]	[illegible]
1360	1359	[illegible]	[illegible]	5996	.13046	.13601	.13602	.13603	1360
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.13435	none	.13612	[illegible]	[illegible]

1590	1589	1232.27	71.93	1789	.00110	15901	15902	15903	1590
1591	1589	[illegible]	73.69	3813	.00091	none	15912	15913	1591
1592	1591	8532.57	93.53	5528	.00141	none	15922	15923	1592
1593	1592	1252.27	112.43	2934	.00401	15931	15932	15933	1593
1594	1592	1910.47	105.50	2196	.00231	15941	15942	15943	1594
1595	1591	[illegible]	74.41	2939	.00335	none	15952	15953	1595
1596	1595	289132	75.42	5075	.00233	none	15962	15963	1596
1597	1596	[illegible]	73.53	753	.00052	none	15972	15973	1597
1598	1597	150295	79.79	3432	.00131	none	15982	15983	1598
1599	1598	5330.61	84.06	7328	.0017	none	15992	15993	1599
1600	1599	[illegible]	105.06	3889	.00438	16001	16002	16003	1600
1601	[illegible]	2106.94	95.04	2443	.00231	16011	16012	16013	1601
1602	1599	226.524	53.95	4976	.00079	none	16022	16023	1602
1603	1601	12.054	52.05	540	.00001	none	16032	16033	1603
1604	1603	[illegible]	52.60	5948	.00001	none	16042	16043	1604
1605	1604	5505.15	84.19	3165	.00015	none	16052	16053	1605
1606	1605	1245.19	130.37	5166	.00130	16061	16062	16063	1606
1607	1605	3010.63	130.94	12535	.00398	16071	16072	16073	1607
1608	1604	[illegible]	83.02	1550	.00025	none	16082	16083	1608
1609	1608	202.992	83.20	685	.00001	none	16092	16093	1609
1610	1609	1395.65	83.29	1066	.00001	16101	16102	16103	1610
1611	1609	2102.3	83.44	3614	.00038	none	16112	16113	1611
1612	1611	[illegible]	144.14	16615	.01481	16121	16122	16123	1612
1613	1611	[illegible]	85.21	7951	.00081	none	16132	16133	1613
1614	1613	1139.12	73.61	9415	.00125	none	16142	16143	1614
1615	1614	1230.62	93.51	1374	.00183	16151	16152	16153	1615
1616	1614	1111.50	93.11	1611	.00025	none	16162	16163	1616
1617	1616	[illegible]	105.23	11345	[illegible]	16171	16172	16173	1617
1618	1616	[illegible]	141.39	11332	.01225	16181	16182	16183	1618
1619	1615	[illegible]	93.91	5381	.00031	none	16192	16193	1619
1620	1619	2594.15	93.14	[illegible]	.00214	none	16202	16203	1620
1621	1620	9937.75	103.55	9456	.00227	none	16212	16213	1621
1622	1621	4122.58	229.63	13945	.03146	16221	16222	16223	1622
1623	1622	2132.98	164.56	[illegible]	.01455	16231	16232	16233	1623
1624	1623	2155.95	[illegible]	[illegible]	[illegible]	16241	16242	16243	1624
1625	1624	[illegible]	91.80	2414	.00041	none	16252	16253	1625
1626	1625	[illegible]	[illegible]	[illegible]	.00048	none	16262	16263	1626
1627	1626	[illegible]	[illegible]	3519	.00071	[illegible]	16272	16273	1627
1628	1626	[illegible]	162.19	4170	.00111	none	16282	16283	1628
1629	1628	[illegible]	[illegible]	4514	.00014	none	16292	16293	1629
1630	1629	[illegible]	[illegible]	452	.00001	none	16302	16303	1630
1631	1630	[illegible]	134.41	9412	.00280	none	16312	16313	1631
1632	1631	4325.60	[illegible]	11390	.01342	16321	16322	16323	1632
1633	1632	[illegible]	[illegible]	1304	.00558	none	16332	16333	1633
1634	1633	2098.73	152.57	8327	.01158	16341	16342	16343	1634
1635	1633	4551.20	103.65	14684	.01139	16351	16352	16353	1635
1636	1635	3073.38	[illegible]	9225	.00441	16361	16362	16363	1636
1637	1628	6013.70	145.93	16525	.01174	none	16372	16373	1637
1638	1637	3109.23	206.92	10231	.01514	16381	16382	16383	1638
1639	1637	2232.56	161.15	1427	.00034	16391	16392	16393	1639
1640	1625	[illegible]	196.92	4835	.00017	none	16402	16403	1640
1641	1640	[illegible]	123.35	1526	.00051	none	16412	16413	1641
1642	1641	1903.44	123.43	3156	.00157	16421	16422	16423	1642
1643	1642	55306.0	[illegible]	6510	.00125	none	16432	16433	1643
1644	1643	40325.4	123.61	4520	.00078	none	16442	16443	1644
1645	1634	25851.6	125.38	13670	.00158	none	16452	16453	1645
1646	1645	[illegible]	[illegible]	9685	.00121	none	16462	16463	1646

1647	1646	[illegible]	[illegible]	1338	.00412	none	16472	16473	1647
1648	1647	[illegible]	212.19	10252	[illegible]	16481	16482	16483	1648
1649	1647	1278.99	[illegible]	1148	.00215	16491	16492	16493	1649
1650	1649	1958.92	182.17	[illegible]	.00332	none	16502	16503	1650
1651	1650	[illegible]	215.63	14029	.03994	16511	16512	16513	1651
1652	1650	[illegible]	[illegible]	2908	.00238	16521	16522	16523	1652
1653	[illegible]	5070.35	135.11	9501	.00284	16531	16532	16533	1653
1654	[illegible]	[illegible]	121.60	1164	[illegible]	none	16542	16543	1654
1655	1654	1290.50	123.34	1220	[illegible]	16551	16552	16553	1655
1656	1654	16368.5	126.35	4060	.00121	none	16562	16563	1656
1657	1656	12506.4	[illegible]	[illegible]	.00031	none	16572	16573	1657
1658	1652	5237.05	143.48	11250	[illegible]	none	16582	16583	1658
1659	1655	1532.52	112.55	1428	.00220	16591	16592	16593	1659
1660	1658	[illegible]	152.54	3259	.00154	16601	16602	16603	1660
1661	1660	4245.45	150.15	2095	.00144	none	16612	16613	1661
1662	1661	1291.05	112.53	1849	.00094	16621	16622	16623	1662
1663	1661	[illegible]	146.37	6404	.00284	16631	16632	16633	1663
1664	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16641	16642	16643	1664
1665	1663	7640.67	135.39	19111	.00241	16651	16652	16653	1665
1666	[illegible]	1742.34	[illegible]	25236	.00229	none	16662	16663	1666
1667	1666	1152.05	[illegible]	1661	.00145	[illegible]	16672	16673	1667
1668	1666	[illegible]	[illegible]	5347	.00625	16681	16682	16683	1668
1669	[illegible]	[illegible]	[illegible]	1605	.00121	none	16692	16693	1669
1670	[illegible]	[illegible]	[illegible]	12093	[illegible]	none	16702	16703	1670
1671	1670	[illegible]	127.40	[illegible]	.00301	none	none	[illegible]	1671
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	9424	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	none	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1704	1702	15416.4	115.20	345	.00001	none	17042	17043	1704
1705	1704	2130.59	124.17	1796	.00424	17051	17052	17053	1705
1706	1704	15239.5	120.15	5137	.00539	none	17062	17063	1706
1707	1706	6624.60	129.90	5854	.00183	none	17072	17073	1707
1708	1703	5953.40	143.50	5606	.00509	17081	17082	17083	1708
1709	1707	2133.44	152.21	4035	.00311	17091	17092	17093	1709
1710	1706	6321.54	123.81	3764	.00192	none	17102	17103	1710
1711	1710	2457.13	155.83	6982	.00674	17111	17112	17113	1711
1712	1710	2525.35	152.82	6159	.00733	17121	17122	17123	1712
1713	1701	4060.44	135.82	1594	.00515	none	17132	17133	1713
1714	1713	5739.53	119.80	7914	.00284	17141	17142	17143	1714
1715	1713	1110.51	110.34	1566	.00584	17151	17152	17153	1715
1716	1696	1152.55	85.67	1966	.01525	17161	17162	17163	1716
1717	1595	19536.2	131.44	17394	.00326	none	17172	17173	1717
1718	1717	2524.25	149.61	5911	.00460	17181	17182	17183	1718
1719	1717	1632.67	143.58	5613	.00854	17191	17192	17193	1719
1720	1466	20429.8	83.24	8591	.00234	none	17202	17203	1720
1721	1720	9445.91	96.12	5851	.00232	none	17212	17213	1721
1722	1721	2766.96	105.19	13134	.00565	17221	17222	17223	1722
1723	1721	5136.11	103.12	11934	.00459	17231	17232	17233	1723
1724	1720	3795.44	95.26	3691	.00556	none	17242	17243	1724
1725	1721	5376.46	111.63	11891	.00557	17251	17252	17253	1725
1726	1724	1296.53	111.49	1137	.00347	17261	17262	17263	1726
1727	1557	1584.85	82.42	1356	.01647	17271	17272	17273	1727
1728	1566	5191.33	72.44	13349	.00435	17281	17282	17283	1728
1729	[illegible]	4453.14	76.66	20499	.00112	17291	17292	17293	1729
1730	53	2349.53	82.45	3799	.00122	17301	17302	17303	1730
1731	35	1934.85	61.53	179	.00001	17311	17312	17313	1731
1732	32	40934.5	61.51	5308	.00224	none	17322	17323	1732
1733	1732	6037.69	53.49	15540	.00402	17331	17332	17333	1733
1734	1732	33307.1	67.14	[illegible]	.00043	none	17342	17343	1734
1735	1734	12655.4	70.52	2026	.00012	none	17352	17353	1735
1736	1735	2934.65	75.15	5878	.00018	17361	17362	17363	1736
1737	1735	9176.15	85.16	9067	.00034	none	17372	17373	1737
1738	1737	2345.39	134.54	11569	.00494	17381	17382	17383	1738
1739	1737	4226.14	134.21	9705	.00212	17391	17392	17393	1739
1740	[illegible]	19467.9	75.15	5499	.00135	none	17402	17403	1740
1741	1740	11335.9	115.53	1536	.00001	none	17412	17413	1741
1742	1741	2655.20	115.27	1301	.00067	none	17422	17423	1742
1743	1742	10585.6	[illegible]	1985	.00180	none	17432	17433	1743
1744	1743	[illegible]	132.25	1729	.00026	17441	17442	17443	1744
1745	1743	4249.45	135.56	4463	.00018	17451	17452	17453	1745
1746	1743	5504.36	116.93	3164	.00121	17461	17462	17463	1746
1747	1741	1439.59	111.42	5265	.00332	17471	17472	17473	1747
1748	1743	1527.60	135.12	2121	.00079	17481	17482	17483	1748
1749	33	5953.26	35.52	14173	.00441	17491	17492	17493	1749
1750	24	3975.71	64.51	508	.00546	none	17502	17503	1750
1751	[illegible]	[illegible]	75.75	1484	.00126	17511	17512	17513	1751
1752	1751	5293.92	36.51	12559	.00533	17521	17522	17523	1752
1753	3	1521.35	67.41	2915	.02038	17531	17532	17533	1753
1754	6	3992.27	35.78	2457	.00219	none	17542	17543	1754
1755	1751	6325.20	67.27	5204	.00161	none	17552	17553	1755
1756	1755	4231.23	59.50	2126	.00598	17561	17562	17563	1756
1757	1756	1193.44	[illegible]	1479	.00665	17571	17572	17573	1757
1758	1754	1355.94	43.50	2465	.00707	17581	17582	17583	1758
1759	5	2235.14	52.10	4541	.00106	17591	17592	17593	1759
1760	2	27560.9	[illegible]	6537	.00435	none	17602	17603	1760
1761	1760	21345.1	65.39	2284	.00268	none	17612	17613	1761
1762	1761	11216.9	68.76	1192	.00122	none	17622	17623	1762
1763	1762	5119.39	115.63	6511	.00778	17631	17632	17633	1763
1764	1762	3571.29	109.28	6301	.00334	17641	17642	17643	1764
1765	1761	1291.71	71.20	1214	.00031	17651	17652	17653	1765
1766	1760	1383.41	44.96	1439	.01499	17661	17662	17663	1766

Number of cells (outlet, left, right, & total): 383 1750 1765 4390

The channel vector's flow vector fields within each reach were used to calculate the respective reach slope.

APPENDIX F: QUAL-IT SOURCES

F.1. QUALIT.F

```
File: C:\qualIT\qualIT_working.f
      Program qualIT

                    This program is qualIT.exe
                         (main executable)

              part of the qualIT software package
                         (version 1.0)

      The latest version of this program, along with manuals
      and other supporting documentation can always
      be found at http://www.thinknew.ca/software/

      Developed by R.T. Parker for GIUT analysis of water
      quality models. Free to use - if you do use it in the course
      of producing any report, project, paper or software, you are
      requested and required to cite it by name and also to
      cite one of the reference papers (as listed on the website above)

      Any derivative work MUST keep this comment section intact.

      If you want to use this source, we probably want you to as
      well, and we'd like to help. Send us an email at contact@thinknew.ca

                            (C) 2008

      Program dependencies: fixrit.et;
                            qual2e and/or mikell

      Implicit None
      Real v1,v2,v3,v4,v5,v6,v7,v8,v9,v10
      Real v11,v12,v13,v14,v15,v16,v17,v18,v19,v20
      Real v21,v22,v23,v24,v25,v26,v27,v28,v29,v30
      Real v31,v32,v33,v34,v35,v36,v37,v38,v39,v40
      Real v41,v42,v43,v44,v45,v46,v47,v48,v49,v50
      Real v51,v52,v53,v54,v55,v56,v57,v58,v59,v60
      Real v61,v62,v63,v64,v65,v66,v67,v68,v69,v70
      Real v71,v72,v73,v74,v75,v76,v77,v78,v79,v80
      Real v81,v82,v83,v84,v85,v86,v87,v88,v89,v90
      Real v91,v92,v93,v94,v95,v96,v97,v98,v99,v100
      Real v101,v102,v103,v104,v105,v106,v107,v108,v109,v110
      Real v111,v112,v113,v114,v115,v116,v117,v118,v119,v120
      Real v121,v122,v123,v124,v125,v126,v127,v128,v129,v130
      Real v131,v132,v133,v134,v135,v136,v137,v138,v139,v140
      Real v141,v142,v143,v144,v145,v146,v147,v148,v149,v150
      Real v151,v152,v153,v154,v155,v156,v157,v158,v159,v160
      Real v161,v162,v163,v164,v165,v166,v167,v168,v169,v170
      Real v171,v172,v173,v174,v175,v176
      Integer v177,v178,v179,v180,v181,v182,v183
      Real v184,v185
      [illegible]
      open (unit = 50, file = Char(82) // Char(117) // Char(113) // Char(43) // Char(101)
     + // Char(126) // Char(116) // Char(105) // Char(110) // Char(105) // Char(125)
     + // Char(46) // Char(116) // Char(120) // Char(116))
      read (50,*) v181;read (50,*) v182;read (50,*) v183
      close(50)
      IF (v182.gt.1) THEN
      do 3 [illegible]
      do 2 [illegible]
      [illegible]
    2 continue
    3 continue
      ENDIF
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      IF (v184(v181)>0.8) THEN
      v94=4*(v33-v32)/5;v95=5*(v33-v32)/5
      ELSE IF (v184(v181)>0.6) THEN
      v94=4*(v33-v32)/5;v95=4*(v33-v32)/5
      ELSE IF (v184(v181)>0.4) THEN
      v94=2*(v33-v32)/5;v95=3*(v33-v32)/5
      ELSE IF (v184(v181)>0.2) THEN
      v94=1*(v33-v32)/5;v95=2*(v33-v32)/5
      ELSE
      v94=0*(v33-v32)/5;v95=1*(v33-v32)/5
      END IF
      v1=(v95-v94)*v184(v181)+v94
      IF (v184(v181)>0.8) THEN
      v96=4*(v35-v34)/5;v100=5*(v35-v34)/5
      ELSE IF (v184(v181)>0.6) THEN
      v96=3*(v35-v34)/5;v100=4*(v35-v34)/5

Page: 1

File: C:\qualIT\qualIT_working.f
      ELSE IF (v184(v181)>0.4) THEN
      v96=2*(v35-v34)/5;v100=3*(v35-v34)/5
      ELSE IF (v184(v181)>0.2) THEN
      v96=1*(v35-v34)/5;v100=2*(v35-v34)/5
      ELSE
      v96=0*(v35-v34)/5;v100=1*(v35-v34)/5
      END IF
      v2=(v100-v96)*v184(v181)+v96
      IF (v184(v181)>0.8) THEN
      v97=4*(v39-v35)/5;v101=5*(v39-v35)/5
      ELSE IF (v184(v181)>0.6) THEN
      v97=3*(v39-v35)/5;v101=4*(v39-v35)/5
      ELSE IF (v184(v181)>0.4) THEN
      v97=2*(v39-v35)/5;v101=3*(v39-v35)/5
      ELSE IF (v184(v181)>0.2) THEN
      v97=1*(v39-v35)/5;v101=2*(v39-v35)/5
      ELSE
      v97=0*(v39-v35)/5;v101=1*(v39-v35)/5
      END IF
      v3=(v101-v97)*v184(v181)+v97
      IF (v184(v181)>0.8) THEN
      v98=4*(v40-v36)/5;v102=5*(v40-v36)/5
      ELSE IF (v184(v181)>0.6) THEN
      v98=3*(v40-v36)/5;v102=4*(v40-v36)/5
      ELSE IF (v184(v181)>0.4) THEN
      v98=2*(v40-v36)/5;v102=3*(v40-v36)/5
      ELSE IF (v184(v181)>0.2) THEN
      v98=1*(v40-v36)/5;v102=2*(v40-v36)/5
      ELSE
      v98=0*(v40-v36)/5;v102=1*(v40-v36)/5
      END IF
      v4=(v102-v98)*v184(v181)+v98
      IF (v184(v181)>0.8) THEN
      v99=4*(v41-v37)/5;v103=5*(v41-v37)/5
      ELSE IF (v184(v181)>0.6) THEN
      v99=3*(v41-v37)/5;v103=4*(v41-v37)/5
      ELSE IF (v184(v181)>0.4) THEN
      v99=2*(v41-v37)/5;v103=3*(v41-v37)/5
      ELSE IF (v184(v181)>0.2) THEN
      v99=1*(v41-v37)/5;v103=2*(v41-v37)/5
      ELSE
      v99=0*(v41-v37)/5;v103=1*(v41-v37)/5
      END IF
      v5=(v103-v99)*v184(v181)+v99
      IF (v184(v181)>0.8) THEN
      v104=4*(v43-v42)/5;v105=5*(v43-v42)/5
      ELSE IF (v184(v181)>0.6) THEN
      v104=3*(v43-v42)/5;v105=4*(v43-v42)/5
      ELSE IF (v184(v181)>0.4) THEN
      v104=2*(v43-v42)/5;v105=3*(v43-v42)/5
      ELSE IF (v184(v181)>0.2) THEN
      v104=1*(v43-v42)/5;v105=2*(v43-v42)/5
      ELSE
      v104=0*(v43-v42)/5;v105=1*(v43-v42)/5
      END IF
      v6=(v105-v104)*v184(v181)+v104
      IF (v184(v181)>0.8) THEN
      [illegible]
      ELSE IF (v184(v181)>0.6) THEN
      [illegible]
      ELSE IF (v184(v181)>0.4) THEN
      [illegible]
      ELSE IF (v184(v181)>0.2) THEN
      [illegible]
      ELSE
      [illegible]
      END IF
      [illegible]
      IF (v184(v181)>0.8) THEN
      [illegible]
      ELSE IF (v184(v181)>0.6) THEN
      [illegible]
      ELSE IF (v184(v181)>0.4) THEN
      [illegible]
      ELSE IF (v184(v181)>0.2) THEN
      [illegible]
      ELSE
      [illegible]
      END IF
      [illegible]
      IF (v184(v181)>0.8) THEN
      [illegible]
      ELSE IF (v184(v181)>0.6) THEN
      [illegible]
      ELSE IF (v184(v181)>0.4) THEN
      [illegible]
      ELSE IF (v184(v181)>0.2) THEN
      [illegible]
      ELSE
      [illegible]

Page: 2
```

File: C:\qualIT\qualIT.working.f

```
[illegible]
```


File: C:\qualIT\qualIT.working.f

```
[illegible]
```

File: C:\qualIT\qualIT.working.f

```
[illegible]
```


File: C:\qualIT\qualIT.working.f

```
[illegible]
```

File: C:\qualIT\qualIT.working.f

```
      open (unit = 1001, file = Char(67) // Char(58) // Char(92) // Char(113)
     . // Char(117) // Char(97) // Char(108) // Char(73) // Char(84) // Char(82)
     . // Char(117) // Char(110) // Char(115) // Char(92) // Char(116) // Char(109)
     . // Char(112) // Char(92) // Char(82) // Char(117) // Char(110) // Char(68)
     . // Char(97) // Char(116) // Char(97) // Char(46) // Char(116) // Char(120)
     . // Char(116))
      write (1001, *) v156;write (1001, *) v177;write (1001, *) v222
      write (1001, *) v159;write (1001, *) v191;write (1001, *) v192
      write (1001, *) v193;write (1001, *) v193;write (1001, *) v194
      write (1001, *) v195;write (1001, *) v196;write (1001, *) v197
      write (1001, *) v198;write (1001, *) v199;write (1001, *) v200
      write (1001, *) v201;write (1001, *) v203;write (1001, *) v202
      write (1001, *) v204;write (1001, *) v205;write (1001, *) v206
      write (1001, *) v207;write (1001, *) v208;write (1001, *) v209
      write (1001, *) v210;write (1001, *) v211;write (1001, *) v212
      write (1001, *) v1;write (1001, *) v2;write (1001, *) v3
      write (1001, *) v4;write (1001, *) v5;write (1001, *) v6
      write (1001, *) v7;write (1001, *) v8;write (1001, *) v9
      write (1001, *) v10;write (1001, *) v11;write (1001, *) v12
      write (1001, *) v13;write (1001, *) v17;write (1001, *) v18
      write (1001, *) v19;write (1001, *) v20;write (1001, *) v21
      write (1001, *) v158;write (1001, *) v157;write (1001, *) v160
      write (1001, *) v159;write (1001, *) v161;write (1001, *) v161
      write (1001, *) v162;write (1001, *) v163;write (1001, *) v164
      write (1001, *) v165;write (1001, *) v166;write (1001, *) v167
      write (1001, *) v168;write (1001, *) v169;write (1001, *) v170
      write (1001, *) v171;write (1001, *) v172;write (1001, *) v173
      write (1001, *) v174;write (1001, *) v175;write (1001, *) v176
      close(1001)
      call system("C:\qualITRuns\tmp\FLAT2FLAT RunData.txt qualIT_sub.xfl sub2_in.xtl run.inp")
      call system("C:\qualITRuns\sub2Call.bat")
      call system("C:\qualITRuns\tmp\FLAT2FLAT run.out sub2_out.xfl qualIT_in.xtl WQResults.txt")
      call system("DEL C:\qualITRuns\tmp\RunData.txt")
      call system("DEL C:\qualITRuns\tmp\run.inp")
      call system("DEL C:\qualITRuns\tmp\run.out")
      open (unit = 1011, file = "C:\qualITRuns\tmp\WQResults.txt")
      read (1011,*) v203;read (1011,*) v202;read (1011,*) v204
      read (1011,*) v205;read (1011,*) v206;read (1011,*) v207
      read (1011,*) v208;read (1011,*) v209;read (1011,*) v210
      read (1011,*) v211;read (1011,*) v212
      call system("DEL C:\qualITRuns\tmp\WQResults.txt")
      END
      real function v124(v500)
      integer v500,v501,v502,v503,v504,v505,v506,v507,v508,v509,v510,v511
      double precision v512, v513, v514
      parameter (v501=2147483563,v502=2147483399,v512=1./v501,v503=v501-1,
     . v504=40014,v505=40692,v506=53668,v507=52774,v508=12211,
     . v509=3791,v510=32,v511=1+v503/v510,v513=1.2e-7,v514=1.-v513)
      integer v500,v178,v366,iv(v510),iy
      save iv,iy,v500
      data v500/123456789/, iv/v510*0/, iy/0/
      if(v500.le.0) then
      v500=max(v500,1)
      v500=v500
      do 100 v178=v510+8,1,-1
      v366=v500/v506
      v500=v504*(v500-v366*v506)-v366*v508
      if(v500.lt.0) then
      v500=v500+v501
      endif
      if(v178.le.v510) then
      iv(v178)=v500
      endif
100   continue
      iy=iv(1)
      endif
      v366=v500/v506
      v500=v504*(v500-v366*v506)-v366*v508
      if(v500.lt.0) then
      v500=v500+v501
      endif
      v366=v500/v506
      v500=v505*(v500-v366*v507)-v366*v509
      if(v500.lt.0) then
      v500=v500+v502
      endif
```

Page: 7

File: C:\qualIT\qualIT.working.f

```
      v178=1+iy/v511
      iy=iv(v178)-v500
      iv(v178)=v500
      if(iy.lt.1) then
      iy=iy+v503
      endif
      v124=min(v512*iy,v514)
      return
      END
      SUBROUTINE sub2(v384,v375,v381,v168,v179,v193,v392,
     . v375,v376,v377,v389,
     . v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12,v13,v14,v15,v16,
     . v17,v18,v19,v20,v21,v22,v23,v26,v27,v28,v29,v23,v24,v30,v31,
     . v156,v157,v158,v159,v160,
     . v161,v162,v163,v164,v165,
     . v166,v167,v168,v169,v170,
     . v171,v172,v173,v174,v175,
     . v176,v177)
      Implicit None
      Real v1,v2,v3,v4,v5,v6,v7,v8,v9,v10
      Real v11,v12,v13,v14,v15,v16,v17,v18,v19,v20
      Real v21,v22,v23,v24,v25,v26,v27,v28,v29,v30
      Real v31
      Real v156,v157,v158,v159,v160
      Real v161,v162,v163,v164,v165,v166,v167,v168,v169,v170
      Real v171,v172,v173,v174,v175,v176,v177,v178,v179
      Real v193,v179(1000),v191(1000),v193(1000)
      Real v388,v389,v391,v392,v393,v394,v391(1000)
      Real v379(1000,20),v391(1000,20),v392(1000,20)
      Integer v375(1000),v376(1000),v377(1000,20),v378(1000),v379(1000)
      Integer v380(1000),v383(1000),v384,v385,v386,v387,v388
      do 35 v177 = 1, v384
      IF (v378(v177).eq.0) THEN
      IF (v383(v177).ne.1) THEN
      v158(v177)=2;v179(v177)=0.0;v193(v177)=0.0;v383(v177)=1
      END IF
      END IF
      v379(v177)=0
35    continue
      do 45 v177 = 1, v384
      IF (v378(v177).eq.0) THEN
      Call sub2(v375(v177),v376(v177),v384(v177),v158(v177),v193(v177),
     . v389(v177,1),v389(v177,2),v389(v177,3),v389(v177,4),v389(v177,5),
     . [illegible]
     . [illegible]
     . [illegible]
     . v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12,v13,v14,v15,v16,v17,v18,v19,v20,v21,
     . v156,v157,v158,v159,v160,v161,
     . v162,v163,v164,v165,v166,v167,
     . v168,v169,v170,v171,v172,
     . v173,v174,v175,v176)
      v379(v177)=1
      Call sub2(v375(v177),v376(v177),v384(v177),v158(v177),v193(v177),
     . [illegible]
     . [illegible]
     . [illegible]
     . [illegible]
     . v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12,v13,v14,v15,v16,v17,v18,v19,v20,v21,
     . v156,v157,v158,v159,v160,v161,
     . v162,v163,v164,v165,v166,v167,
     . v168,v169,v170,v171,v172,
     . v173,v174,v175,v176)
      END IF
45    continue
      v178=1
75    IF (v178.le.v384) THEN
      IF (v379(v178).eq.0) THEN
      v379(v178)=1
      do 97 v385=1, v376(v178)
      do 95 v177=1,v384
      IF (v375(v177).eq.v377(v178,v385)) THEN
      IF (v379(v177).eq.0) THEN
      v387(v178)=0
      END IF
      END IF
95    continue
97    continue
      IF (v380(v178).eq.1) THEN
      do 120 v386=1, v376(v178)
      do 110 v177=1,v384
      IF (v382(v178).eq.1) THEN
      IF (v375(v177).eq.v377(v178,v386)) THEN
      do 100 v386=2,11
      v389(v178,v386)=(v389(v178,1)*v389(v178,v386)+v391(v177,1)*v391(v177,v386))/(v389(v178,1)+v391(v177,1))
100   continue
      IF (v383(v178).ne.1) THEN
      v158(v178)=(v389(v178,1)*v158(v178)+v391(v177,1)*v158(v177))/(v389(v178,1)+v391(v177,1))
      v193(v178)=(v389(v178,1)*v193(v178)+v391(v177,1)*v193(v177))/(v389(v178,1)+v391(v177,1))
      v193(v178)=(v389(v178,1)*v193(v178)+v391(v177,1)*v193(v177))/(v389(v178,1)+v391(v177,1))
      ENDIF
```

Page: 8

File: C:\qualIT\qualIT.working.f

```
[illegible]
END IF
ELSE IF [illegible] THEN
[illegible]
continue
[illegible]
END IF
END IF
continue
continue
[illegible]
END IF
[illegible]
SUBROUTINE [illegible]
[illegible]
```


File: C:\qualIT\qualIT.working.f

```
read [illegible]
close[illegible]
open (unit = [illegible]
[illegible]
continue
continue
[illegible]
```

```
File: C:\qua.II\qua.II\working.f
      open (unit=5, file='Char(67) // Char(58) // Char(92) // Char(100)
     + // Char(101) // Char(116) // Char(111) // Char(83) // Char(...) // Char(116)
     + // Char(...) // Char(46) // Char(100) // Char(...) // Char(116))
      read (5,*) v487;read (5,*) v481
      do 49 v113 = 1, v484
      read (5,*) v475;read (5,*) v476
      IF (v476.eq.1) THEN
      read (5,*) v486,v4..,v488,v4..,v4..,v491,v4..,v493,v494,v4..,v496
      ELSE IF (v476.eq.2) THEN
      read (5,*) v468
      v487 v2..*v468(1,2);v488 v2..*v468(1,3);v489 v2..*v468(1,4)
      v490 v2..*v468(1,5);v491 v2..*v468(1,7);v492 v2..*v468(1,8)
      v493 v2..*v468(1,9);v494 v2..*v468(1,...);v496 v2..*v468(1,11)
      v4.. v2..*v468(1,1..)
      END IF
      v... ...
 47   continue
      v1.. v...
      IF (...(v1..).or.v4...) goto 47
      [illegible]
      [illegible]
      [illegible]
      [illegible]
 49   continue
      close(5)
      call ...(v...4, v..., v..., v..., v..., v..., v...,
      v..., v..., v..., v...,
     + v1,v2,v3,v4,v..,v..,v..,v..,v9,v..,v..,v..,v13,v14,v15,v..,
     + v..,v..,v..,v..,v..,v..,v..,v26,v2.,v..,v..,v..,v..,v..,v..,
     + v1..,v1..,v1..,v1..,v1..,
     + v1..,v1..,v1..,v1..,v1..,
     + v1..,v1..,v1..,v1..,v1..,
     + v1..,v1..,v1..,v1..,v1..,
     + v1..,v1..)
      END
```

F.2. QUALIT_RETEST.F

```
File: C:\qualIT\qualIT_ReTest.working.f
      Program qualIT_ReTest

              This program is qualIT_ReTest.exe
                 (run retesting executable)

              part of the qual-IT software package
                         (version 1.2)

      The latest version of this program, along with manuals
      and other supporting documentation can always
      be found at http://www.thinkner.ca/software/

      Developed by G.T. Parker for CCME analysis of water
      quality models. Free to use -- if you do use it in the course
      of producing any report, project, paper or software, you are
      requested and required to cite it by name and also to
      cite one of the reference papers (as listed on the website there)

      Any derivative work MUST keep this comment section intact.

      If you want to use this source, we probably want you to as
      well, and we'd like to help. Send us an email at contact@thinkner.ca

                              (C) 2008

      Program dependencies: Starttab;
                            qual2e and/or mike11

      Implicit None
      Real v1,v2,v3,v4,v5,v6,v7,v8,v9,v10
      Real v11,v12,v13,v14,v15,v16,v17,v18,v19,v20
      Real v21,v22,v23,v24,v25,v26,v27,v28,v29,v30
      Real v31,v32,v33,v34,v35,v36,v37,v38,v39,v40
      Real v41,v42,v43,v44,v45,v46,v47,v48,v49,v50
      Real v51,v52,v53,v54,v55,v56,v57,v58,v59,v60
      Real v61,v62,v63,v64,v65,v66,v67,v68,v69,v70
      [illegible]

Page: 1

File: C:\qualIT\qualIT_ReTest.working.f
      [illegible]

Page: 2
```

File: C:\qualIT\qualIT_ReTest.working.f

[illegible]

File: C:\qualIT\qualIT_ReTest.working.f

[illegible]

File: C:\qualIT\qualIT_ReTest.working.f

```
END IF
[illegible]
IF [illegible] THEN
[illegible]
ELSE IF [illegible] THEN
[illegible]
ELSE IF [illegible] THEN
[illegible]
ELSE IF [illegible] THEN
[illegible]
ELSE
[illegible]
END IF
[illegible]
```


File: C:\qualIT\qualIT_ReTest.working.f

```
      Call sub4[illegible]
      goto 1
      ENDIF
      goto 4
400   close[illegible]
[illegible]
      End
      SUBROUTINE [illegible]
[illegible]
      Implicit None
[illegible]
      End
      SUBROUTINE [illegible]
[illegible]
```

File: C:\qualIT\qualIT_ReTest.working.f

```
     + v166,v167,v168,v169,v170,
     + v171,v172,v173,v174,v175,
     + v176)
       Implicit None
       Real v1,v2,v3,v4,v5,v6,v7,v8,v9,v10
       Real v11,v12,v13,v14,v15,v16,v17,v18,v19,v20
       Real v21
       Real v156,v157,v158,v159,v160
       Real v161,v162,v163,v164,v165,v166,v167,v168,v169,v170
       Real v171,v172,v173,v174,v175,v176
       Real v189,v190
       Real v191,v192,v193,v194,v195,v196,v197,v198,v199,v200
       Real v201,v202,v203,v204,v205,v206,v207,v208,v209,v210
       Real v211,v212,v213,v214,v215
       open (unit = 1001, file = Char(67) // Char(58) // Char(92) // Char(113)
     + // Char(117) // Char(97) // Char(108) // Char(73) // Char(84) // Char(82)
     + // Char(117) // Char(110) // Char(115) // Char(92) // Char(116) // Char(109)
     + // Char(112) // Char(92) // Char(82) // Char(117) // Char(110) // Char(68)
     + // Char(97) // Char(116) // Char(97) // Char(46) // Char(116) // Char(120)
     + // Char(116))
       write (1001, *) v189;write (1001, *) v190;write (1001, *) v191
       write (1001, *) v192;write (1001, *) v193;write (1001, *) v195
       write (1001, *) v194;write (1001, *) v196;write (1001, *) v197
       write (1001, *) v198;write (1001, *) v199;write (1001, *) v200
       write (1001, *) v201;write (1001, *) v202;write (1001, *) v203
       write (1001, *) v204;write (1001, *) v205;write (1001, *) v206
       write (1001, *) v207;write (1001, *) v208;write (1001, *) v209
       write (1001, *) v210;write (1001, *) v211;write (1001, *) v212
       write (1001, *) v213;write (1001, *) v214;write (1001, *) v215
       write (1001, *) v1;write (1001, *) v2;write (1001, *) v3
       write (1001, *) v4;write (1001, *) v5;write (1001, *) v6
       write (1001, *) v7;write (1001, *) v8;write (1001, *) v9
       write (1001, *) v10;write (1001, *) v11;write (1001, *) v12
       write (1001, *) v13;write (1001, *) v14;write (1001, *) v15
       write (1001, *) v16;write (1001, *) v20;write (1001, *) v21
       write (1001, *) v156;write (1001, *) v157;write (1001, *) v158
       write (1001, *) v159;write (1001, *) v160;write (1001, *) v161
       write (1001, *) v162;write (1001, *) v163;write (1001, *) v164
       write (1001, *) v165;write (1001, *) v166;write (1001, *) v167
       write (1001, *) v168;write (1001, *) v169;write (1001, *) v170
       write (1001, *) v171;write (1001, *) v172;write (1001, *) v173
       write (1001, *) v174;write (1001, *) v175;write (1001, *) v176
       close(1001)
       call system("C:\qualITRuns\tmp\FLATxFLAT RunData.txt qualIT_out.xfl qualIT_in.xfl run.tmp")
       call system("C:\qualITRuns\sub2Call.bat")
       call system("C:\qualITRuns\tmp\FLATxFLAT run.out run_out.xfl qualIT_in.xfl MCResults.txt")
       call system("DEL C:\qualITRuns\tmp\RunData.txt")
       call system("DEL C:\qualITRuns\tmp\run.tmp")
       call system("DEL C:\qualITRuns\tmp\run.out")
       open (unit = 1011, file = "C:\qualITRuns\tmp\MCResults.txt")
       read (1011,*) v[illegible];read (1011,*) v21[illegible];read (1011,*) v2[illegible]
       read (1011,*) v208;read (1011,*) v209;read (1011,*) v211
       read (1011,*) v211;read (1011,*) v212;read (1011,*) v213
       read (1011,*) v214;read (1011,*) v215
       call system("DEL C:\qualITRuns\tmp\MCResults.txt")
       END
       real function v153(v500)
       integer v500,v501,v502,v503,v504,v505,v506,v507,v508,v509,v510,v511
       double precision v512, v513, v514
       parameter (v501=2147483563,v502=2147483399,v512=1./v501,v513=v501-1,
     + v504=40014,v505=40692,v506=53668,v507=52774,v508=12211,
     + v509=3791,v510=32,v511=1+v513/v510,v514=1.2e-7,v514=1.-v514)
       integer v503,v178,v371,iv(v510),iy
       SAVE iv,iy,v503
       DATA v503/123456789/, iv/v510*0/, iy/0/
       if(v500.le.0) then
       v500=max(-v500,1)
       v503=v500
       do 100 v178=v510+8,1,-1
       v371=v500/v506
       v500=v504*(v500-v371*v506)-v371*v507
       if(v500.lt.0) then
       v500=v500+v501
       endif
       if(v178.le.v510) then
       iv(v178)=v500
       endif
 100   continue
       iy=iv(1)
       endif
       v371=v500/v506
       v500=v504*(v500-v371*v506)-v371*v507
       if(v500.lt.0) then
       v500=v500+v501
       endif
       v371=v503/v508
       v503=v505*(v503-v371*v508)-v371*v509
       if(v503.lt.0) then
       v503=v503+v502
       endif
```


File: C:\qualIT\qualIT_ReTest.working.f

```
       v178=1+iy/v511
       iy=iv(v178)-v503
       iv(v178)=v500
       if(iy.lt.1) then
       iy=iy+v513
       endif
       v153=min(v512*iy,v514)
       return
      END
       SUBROUTINE sub3(v377,v378,v384,v191,v192,v193,v385,
     + v386,v379,v380,v381,
     + v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12,v13,v14,v15,v16,
     + v17,v18,v19,v20,v21,v22,v23,v26,v27,v28,v29,v13,v24,v25,v31,
     + v156,v157,v158,v159,v160,
     + v161,v162,v163,v164,v165,
     + v166,v167,v168,v169,v170,
     + v171,v172,v173,v174,v175,
     + v176,v178)
       Implicit None
       Real v1,v2,v3,v4,v5,v6,v7,v8,v9,v10
       Real v11,v12,v13,v14,v15,v16,v17,v18,v19,v20
       Real v21,v22,v23,v26,v27,v28,v29,v23,v24,v25
       Real v31
       Real v156,v157,v158,v159,v160
       Real v161,v162,v163,v164,v165,v166,v167,v168,v169,v170
       Real v171,v172,v173,v174,v175,v176
       Real v184,v185,v186,v187,v188
       Real v191(1000),v192(1000),v193(1000),v384(1000),v392(1000,20)
       Real v394(1000,20),v401(1000,20)
       Integer v177,v178,v179,v380,v372
       Integer v377(1000),v379(1000),v385(1000,10),v382(1000),v383(1000)
       Integer v385(1000),v386(1000),v387,v382,v378,v381,v391
       do 31 v177 = 1, v381
       IF (v379(v177).eq.1) THEN
       IF (v386(v177).ne.1) THEN
       v191(v177) = [illegible]
       v[illegible](v177) = [illegible]
       END IF
       END IF
       v[illegible](v[illegible]) = [illegible]
 31    continue
       do 4[illegible] v177 = 1, v38[illegible]
       IF (v3[illegible](v177).eq.1) THEN
       CALL sub1(v392(v177,1),v394(v177,1),v191(v177),v192(v177),v193(v177),
     + [illegible]
     + [illegible]
     + [illegible]
     + [illegible]
     + v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12,v13,v14,v15,v16,v17,v18,v19,v20,v21,
     + v156,v157,v158,v159,v160,v161,
     + v162,v163,v164,v165,v166,v167,
     + v168,v169,v170,v171,v172,
     + v173,v174,v175,v176)
       CALL sub2(v392(v177),v394(v177),v191(v177),v192(v177),v193(v177),
     + [illegible]
     + [illegible]
     + [illegible]
     + [illegible]
     + v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12,v13,v14,v15,v16,v17,v18,v19,v20,v21,
     + v156,v157,v158,v159,v160,v161,
     + v162,v163,v164,v165,v166,v167,
     + v168,v169,v170,v171,v172,
     + v173,v174,v175,v176)
       v382(v177) = 1
       END IF
 4[illegible]  continue
       v178 = 1
 [illegible] IF (v178.le.v380) THEN
       IF (v382(v178).eq.0) THEN
       v383(v178)=1
       do [illegible] v3[illegible]=1, v3[illegible](v178)
       do [illegible] v177 = 1,v38[illegible]
       IF (v3[illegible](v177).eq.v3[illegible](v178,v3[illegible])) THEN
       IF (v3[illegible](v177).eq.0) THEN
       v383(v178)=0
       END IF
       END IF
 [illegible] continue
 [illegible] continue
       IF (v383(v178).eq.1) THEN
       do 120 v3[illegible]=1, v3[illegible](v178)
       do 110 v177=1,v38[illegible]
       IF (v385(v178).eq.1) THEN
       IF (v3[illegible](v177).eq.v3[illegible](v178,v3[illegible])) THEN
       do 100 v372=1,20
       v392(v178,v372)=(v392(v178,1)*v392(v178,v372)+v394(v177,1)*v394(v177,v372))/(v392(v178,1)+v394(v177,1))
 100   continue
       IF (v385(v178).ne.1) THEN
       v191(v178)=(v392(v178,1)*v191(v178)+v394(v177,1)*v191(v177))/(v392(v178,1)+v394(v177,1))
       v192(v178)=(v392(v178,1)*v192(v178)+v394(v177,1)*v192(v177))/(v392(v178,1)+v394(v177,1))
```

File: C:\qualIT\qualIT_ReTest.working.f

[illegible]

File: C:\qualIT\qualIT_ReTest.working.f

[illegible]

F.2. QUALIT_OUTPUTALL.F

File: C:\qualIT\qualIT_OutputAll.working.f

```
      Program qualIT_OutputAll

            This program is qualIT_OutputA...exe
              (detailed output execution)

            part of the qualIT software package
                    (version 1.0)

      The latest version of this program, along with random.d
      and other supporting documentation can always
      be found at http://www.thinknow.ca/software/

      Developed by G.T. Parker for CIUE analysis of water
      quality models. Free to use.  If you do use it in the course
      of producing any report, project, paper or software, you are
      requested and required to cite it by name and also to
      cite one of the reference papers (as listed on the website above)

      Any derivative work MUST keep this comment section intact.

      If you want to use this source, we probably want you to as
      well, and we'd like to help. Send us an email at contact@thinknow.ca

                              (C) 2002

      Program dependencies: fixrit.at;
                            qual2e and/or mike11

      Implicit None
      Real v1,v2,v3,v4,v5,v6,v7,v8,v9,v10
      Real v11,v12,v13,v14,v15,v16,v17,v18,v19,v20
      Real v21,v22,v23,v24,v25,v26,v27,v28,v29,v30
      Real v31,v32,v33,v34,v35,v36,v37,v38,v39,v40
      Real v41,v42,v43,v44,v45,v46,v47,v48,v49,v50
      Real v51,v52,v53,v54,v55,v56,v57,v58,v59,v60
      Real v61,v62,v63,v64,v65,v66,v67,v68,v69,v70
      Real v71,v72,v73,v74,v75,v76,v77,v78,v79,v80
      Real v81,v82,v83,v84,v85,v86,v87,v88,v89,v90
      Real v91,v92,v93,v94,v95,v96,v97,v98,v99,v100
      Real v101,v102,v103,v104,v105,v106,v107,v108,v109,v110
      Real v111,v112,v113,v114,v115,v116,v117,v118,v119,v120
      Real v121,v122,v123,v124,v125,v126,v127,v128,v129,v130
      Real v131,v132,v133,v134,v135,v136,v137,v138,v139,v140
      Real v141,v142,v143,v144,v145,v146,v147,v148,v149,v150
      Real v151,v152,v153,v154,v155,v156,v157,v158,v159,v160
      Real v161,v162,v163,v164,v165,v166,v167,v168,v169,v170
      Real v171,v172,v173,v174,v175,v176
      Real v183,v184,v185,v186,v187,v188
      Integer v177,v178,v179,v180,v181,v182
      [illegible]
      Open (unit=150, file=Char(82) // Char(101) // Char(114) // Char(114)
     * // Char(95) // Char(82) // Char(117) // Char(110) // Char(83) // Char(117)
     * // Char(109) // Char(109) // Char(97) // Char(114) // Char(121) // Char(46)
     * // Char(116) // Char(120) // Char(116))
    1 read (150,end=400,fmt=*) v182, v181, v128, v18[illegible]
    4 v179=v179+1
      IF (v182.ge.v179) THEN
      do 2 v181=1,31
      v184=v183(v181)
    2 continue
      ELSE
      v53=10.0822;v37=6;v64=v66=0.35;v54=0.35;v52=1.1;v50=1.1
      v4=[illegible]
      [illegible]
      IF (v183(v181)>0.8) THEN
      v94=4*(v33-v32)/5;v95=5*(v33-v32)/5
      ELSE IF (v183(v181)>0.6) THEN
      v94=3*(v33-v32)/5;v95=4*(v33-v32)/5
      ELSE IF (v183(v181)>0.4) THEN
      v94=2*(v33-v32)/5;v95=3*(v33-v32)/5
      ELSE IF (v183(v181)>0.2) THEN
      v94=1*(v33-v32)/5;v95=2*(v33-v32)/5
      ELSE
      v94=0*(v33-v32)/5;v95=1*(v33-v32)/5
      END IF
      v2=(v95-v94)*v183(v181)+v94
      IF (v183(v181)>0.8) THEN
      v96=4*(v35-v34)/5;v100=5*(v35-v34)/5
      ELSE IF (v183(v181)>0.6) THEN
      v96=3*(v35-v34)/5;v100=4*(v35-v34)/5
      ELSE IF (v183(v181)>0.4) THEN
      v96=2*(v35-v34)/5;v100=3*(v35-v34)/5
```


File: C:\qualIT\qualIT_OutputAll.working.f

```
      ELSE IF (v183(v181)>0.2) THEN
      v96=1*(v35-v34)/5;v100=2*(v35-v34)/5
      ELSE
      v96=0*(v35-v34)/5;v100=1*(v35-v34)/5
      END IF
      v3=(v100-v96)*v183(v181)+v96
      IF (v183(v181)>0.8) THEN
      v97=4*(v39-v35)/5;v101=5*(v39-v35)/5
      ELSE IF (v183(v181)>0.6) THEN
      v97=3*(v39-v35)/5;v101=4*(v39-v35)/5
      ELSE IF (v183(v181)>0.4) THEN
      v97=2*(v39-v35)/5;v101=3*(v39-v35)/5
      ELSE IF (v183(v181)>0.2) THEN
      v97=1*(v39-v35)/5;v101=2*(v39-v35)/5
      ELSE
      v97=0*(v39-v35)/5;v101=1*(v39-v35)/5
      END IF
      v3=(v101-v97)*v183(v181)+v97
      IF (v183(v181)>0.8) THEN
      v98=4*(v40-v38)/5;v102=5*(v40-v38)/5
      ELSE IF (v183(v181)>0.6) THEN
      v98=3*(v40-v38)/5;v102=4*(v40-v38)/5
      ELSE IF (v183(v181)>0.4) THEN
      v98=2*(v40-v38)/5;v102=3*(v40-v38)/5
      ELSE IF (v183(v181)>0.2) THEN
      v98=1*(v40-v38)/5;v102=2*(v40-v38)/5
      ELSE
      v98=0*(v40-v38)/5;v102=1*(v40-v38)/5
      END IF
      v4=(v102-v98)*v183(v181)+v98
      IF (v183(v181)>0.8) THEN
      v99=4*(v41-v37)/5;v103=5*(v41-v37)/5
      ELSE IF (v183(v181)>0.6) THEN
      v99=3*(v41-v37)/5;v103=4*(v41-v37)/5
      ELSE IF (v183(v181)>0.4) THEN
      v99=2*(v41-v37)/5;v103=3*(v41-v37)/5
      ELSE IF (v183(v181)>0.2) THEN
      v99=1*(v41-v37)/5;v103=2*(v41-v37)/5
      ELSE
      v99=0*(v41-v37)/5;v103=1*(v41-v37)/5
      END IF
      v5=(v103-v99)*v183(v181)+v99
      IF (v183(v181)>0.8) THEN
      v104=4*(v43-v42)/5;v105=5*(v43-v42)/5
      ELSE IF (v183(v181)>0.6) THEN
      v104=3*(v43-v42)/5;v105=4*(v43-v42)/5
      ELSE IF (v183(v181)>0.4) THEN
      v104=2*(v43-v42)/5;v105=3*(v43-v42)/5
      ELSE IF (v183(v181)>0.2) THEN
      v104=1*(v43-v42)/5;v105=2*(v43-v42)/5
      ELSE
      v104=0*(v43-v42)/5;v105=1*(v43-v42)/5
      END IF
      [illegible]
```

File: C:\qualIT\qualIT_OutputAll.working.f

```
[illegible]
```


File: C:\qualIT\qualIT_OutputAll.working.f

```
[illegible]
```

File: C:\qualIT\qualIT_OutputAll.working.f

```
      END IF
      v26=(v144-v145)*v153(v121)+v145
      IF (v153(v121)>0.8) THEN
      v147=4*(v84-v85)/5;v146=5*(v84-v85)/5
      ELSE IF (v153(v121)>0.6) THEN
      v147=3*(v84-v85)/5;v146=4*(v84-v85)/5
      ELSE IF (v153(v121)>0.4) THEN
      v147=2*(v84-v85)/5;v146=3*(v84-v85)/5
      ELSE IF (v153(v121)>0.2) THEN
      v147=1*(v84-v85)/5;v146=2*(v84-v85)/5
      ELSE
      v147=0*(v84-v85)/5;v146=1*(v84-v85)/5
      END IF
      v27=(v146-v147)*v153(v121)+v147
      IF (v153(v121)>0.8) THEN
      v149=4*(v86-v87)/5;v148=5*(v86-v87)/5
      ELSE IF (v153(v121)>0.6) THEN
      v149=3*(v86-v87)/5;v148=4*(v86-v87)/5
      ELSE IF (v153(v121)>0.4) THEN
      v149=2*(v86-v87)/5;v148=3*(v86-v87)/5
      ELSE IF (v153(v121)>0.2) THEN
      v149=1*(v86-v87)/5;v148=2*(v86-v87)/5
      ELSE
      v149=0*(v86-v87)/5;v148=1*(v86-v87)/5
      END IF
      v28=(v148-v149)*v153(v121)+v149
      IF (v153(v121)>0.8) THEN
      v151=4*(v88-v89)/5;v150=5*(v88-v89)/5
      ELSE IF (v153(v121)>0.6) THEN
      v151=3*(v88-v89)/5;v150=4*(v88-v89)/5
      ELSE IF (v153(v121)>0.4) THEN
      v151=2*(v88-v89)/5;v150=3*(v88-v89)/5
      ELSE IF (v153(v121)>0.2) THEN
      v151=1*(v88-v89)/5;v150=2*(v88-v89)/5
      ELSE
      v151=0*(v88-v89)/5;v150=1*(v88-v89)/5
      END IF
      v29=(v150-v151)*v153(v121)+v151
      IF (v153(v121)>0.8) THEN
      v139=4*(v76-v77)/5;v138=5*(v76-v77)/5
      ELSE IF (v153(v121)>0.6) THEN
      v139=3*(v76-v77)/5;v138=4*(v76-v77)/5
      ELSE IF (v153(v121)>0.4) THEN
      v139=2*(v76-v77)/5;v138=3*(v76-v77)/5
      ELSE IF (v153(v121)>0.2) THEN
      v139=1*(v76-v77)/5;v138=2*(v76-v77)/5
      ELSE
      v139=0*(v76-v77)/5;v138=1*(v76-v77)/5
      END IF
      v23=(v138-v139)*v153(v121)+v139
      IF (v153(v121)>0.8) THEN
      v141=4*(v78-v79)/5;v140=5*(v78-v79)/5
      ELSE IF (v153(v121)>0.6) THEN
      v141=3*(v78-v79)/5;v140=4*(v78-v79)/5
      ELSE IF (v153(v121)>0.4) THEN
      v141=2*(v78-v79)/5;v140=3*(v78-v79)/5
      ELSE IF (v153(v121)>0.2) THEN
      v141=1*(v78-v79)/5;v140=2*(v78-v79)/5
      ELSE
      v141=0*(v78-v79)/5;v140=1*(v78-v79)/5
      END IF
      v24=(v140-v141)*v153(v121)+v141
      IF (v153(v121)>0.8) THEN
      v153=4*(v90-v91)/5;v152=5*(v90-v91)/5
      ELSE IF (v153(v121)>0.6) THEN
      v153=3*(v90-v91)/5;v152=4*(v90-v91)/5
      ELSE IF (v153(v121)>0.4) THEN
      v153=2*(v90-v91)/5;v152=3*(v90-v91)/5
      ELSE IF (v153(v121)>0.2) THEN
      v153=1*(v90-v91)/5;v152=2*(v90-v91)/5
      ELSE
      v153=0*(v90-v91)/5;v152=1*(v90-v91)/5
      END IF
      v30=(v152-v153)*v153(v121)+v153
      IF (v153(v121)>0.8) THEN
      v155=4*(v92-v93)/5;v154=5*(v92-v93)/5
      ELSE IF (v153(v121)>0.6) THEN
      v155=3*(v92-v93)/5;v154=4*(v92-v93)/5
      ELSE IF (v153(v121)>0.4) THEN
      v155=2*(v92-v93)/5;v154=3*(v92-v93)/5
      ELSE IF (v153(v121)>0.2) THEN
      v155=1*(v92-v93)/5;v154=2*(v92-v93)/5
      ELSE
      v155=0*(v92-v93)/5;v154=1*(v92-v93)/5
      END IF
      v31=(v154-v155)*v153(v121)+v155
      v156=1.324;v157=1.047;v158=1.0159;v159=1;v160=1.36;v161=1.047
      v162=2;v163=1;v164=1;v165=1.047;v166=1;v167=1.047;v168=1.047
      v169=1;v170=1;v171=1.047;v172=1.047;v173=1.047;v174=1.047
      v175=1;v176=1
```


File: C:\qualIT\qualIT_OutputAll.working.f

```
      call sub4(v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12,v13,v14,v15,
     .   v16,v17,v18,v19,v20,v21,
     .   v22,v25,v26,v27,v28,v29,v23,v24,v30,v31,
         v156,v157,v158,v159,v160,v161,
         v162,v163,v164,v165,v166,v167,
     .   v168,v169,v170,v171,v172,
     .   v173,v174,v175,v176,
     .   v179)
         goto 1
         ENDIF
         goto 4
 400     close(111)
         do 291 v1=1,21
 291  continue
         do 292 v1=1,4
 292  continue
 300  format (3000(I3))
 301  format (1000(E15.7))
         close(53)
         End
         SUBROUTINE sub1(v189,v190,v191,v192,v193,
         v195,v194,v196,v197,v198,v199,v200,v201,v202,v203,v204,
     .   v205,v206,v207,v208,v209,v210,v211,v212,v213,v214,v215,
         v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12,v13,v14,v15,v16,
     .   v17,v18,v19,v20,v21,
     .   v156,v157,v158,v159,v160,
         v161,v162,v163,v164,v165,
     .   v166,v167,v168,v169,v170,
         v171,v172,v173,v174,v175,
     .   v176)
         Implicit None
         Real v1,v2,v3,v4,v5,v6,v7,v8,v9,v10
         Real v11,v12,v13,v14,v15,v16,v17,v18,v19,v20
         Real v21
         Real v156,v157,v158,v159,v160
         Real v161,v162,v163,v164,v165,v166,v167,v168,v169,v170
         Real v171,v172,v173,v174,v175,v176
         Real v189,v190
         Real v191,v192,v193,v194,v195,v196,v197,v198,v199,v200
         Real v201,v202,v203,v204,v205,v206,v207,v208,v209,v210
         Real v211,v212,v213,v214,v215
         open (unit = 1001, file = Char(67) // Char(58) // Char(92) // Char(113)
     .   // Char(117) // Char(97) // Char(108) // Char(73) // Char(84) // Char(82)
     .   // Char(117) // Char(110) // Char(115) // Char(92) // Char(116) // Char(109)
     .   // Char(112) // Char(92) // Char(82) // Char(117) // Char(110) // Char(68)
     .   // Char(97) // Char(116) // Char(97) // Char(46) // Char(116) // Char(120)
     .   // Char(116))
         write (1001, *) v189;write (1001, *) v190;write (1001, *) v191
         write (1001, *) v192;write (1001, *) v193;write (1001, *) v195
         write (1001, *) v194;write (1001, *) v196;write (1001, *) v197
         write (1001, *) v198;write (1001, *) v199;write (1001, *) v200
         write (1001, *) v201;write (1001, *) v202;write (1001, *) v203
         write (1001, *) v204;write (1001, *) v205;write (1001, *) v206
         write (1001, *) v207;write (1001, *) v208;write (1001, *) v209
         write (1001, *) v210;write (1001, *) v211;write (1001, *) v212
         write (1001, *) v213;write (1001, *) v214;write (1001, *) v215
         write (1001, *) v1;write (1001, *) v2;write (1001, *) v3
         write (1001, *) v4;write (1001, *) v5;write (1001, *) v6
         write (1001, *) v7;write (1001, *) v8;write (1001, *) v9
         write (1001, *) v10;write (1001, *) v11;write (1001, *) v12
         write (1001, *) v13;write (1001, *) v14;write (1001, *) v15
         write (1001, *) v19;write (1001, *) v20;write (1001, *) v21
         write (1001, *) v156;write (1001, *) v157;write (1001, *) v158
         write (1001, *) v159;write (1001, *) v160;write (1001, *) v161
         write (1001, *) v162;write (1001, *) v163;write (1001, *) v164
         write (1001, *) v165;write (1001, *) v166;write (1001, *) v167
         write (1001, *) v168;write (1001, *) v169;write (1001, *) v170
         write (1001, *) v171;write (1001, *) v172;write (1001, *) v173
         write (1001, *) v174;write (1001, *) v175;write (1001, *) v176
         close(1001)
         call system("C:\qualITRuns\tmp\FLAT2FLAT RunData.txt qualIT_out.xtl sub1_in.xtl run.cv6111");
         call system("C:\qualITRuns\MakeZeroCell.bat")
         call system("C:\qualITRuns\tmp\FLAT2FLAT run.res11 sub1_out.xtl qualIT_in.xtl NGResults.txt");
         call system("DEL C:\qualITRuns\tmp\RunData.txt")
         call system("DEL C:\qualITRuns\tmp\run.cv6111")
         call system("DEL C:\qualITRuns\tmp\run.res11")
         open (unit = 1011, file = 'C:\qualITRuns\tmp\NGResults.txt')
         read (1011,*) v206;read (1011,*) v207;read (1011,*) v207
         read (1011,*) v208;read (1011,*) v209;read (1011,*) v210
         read (1011,*) v211;read (1011,*) v212;read (1011,*) v213
         read (1011,*) v214;read (1011,*) v215
         call system("DEL C:\qualITRuns\tmp\NGResults.txt")
         END
         SUBROUTINE sub2(v189,v190,v191,v192,v193,
     .   v195,v194,v196,v197,v198,v199,v200,v201,v202,v203,v204,
     .   v205,v206,v207,v208,v209,v210,v211,v212,v213,v214,v215,
         v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12,v13,v14,v15,v16,
     .   v17,v18,v19,v20,v21,
     .   v156,v157,v158,v159,v160,
         v161,v162,v163,v164,v165,
```

File: C:\qualIT\qualIT_OutputAll.working.f

```
     .  v166,v167,v168,v169,v170,
     .  v171,v172,v173,v174,v175,
     .  v176)
        Implicit None
        Real v1,v2,v3,v4,v5,v6,v7,v8,v9,v10
        Real v11,v12,v13,v14,v15,v16,v17,v18,v19,v20
        Real v21
        Real v156,v157,v158,v159,v160
        Real v161,v162,v163,v164,v165,v166,v167,v168,v169,v170
        Real v171,v172,v173,v174,v175,v176
        Real v189,v190
        Real v191,v192,v193,v194,v195,v196,v197,v198,v199,v200
        Real v201,v202,v203,v204,v205,v206,v207,v208,v209,v210
        Real v211,v212,v213,v214,v215
        open (unit = 1001, file = Char(67) // Char(58) // Char(92) // Char(113)
     .  // Char(117) // Char(97) // Char(108) // Char(73) // Char(84) // Char(82)
     .  // Char(117) // Char(110) // Char(115) // Char(92) // Char(116) // Char(109)
     .  // Char(112) // Char(92) // Char(82) // Char(117) // Char(110) // Char(68)
     .  // Char(97) // Char(116) // Char(97) // Char(46) // Char(116) // Char(120)
     .  // Char(116))
        write (1001, *) v189;write (1001, *) v190;write (1001, *) v191
        write (1001, *) v192;write (1001, *) v193;write (1001, *) v195
        [illegible]
        write (1001, *) v1;write (1001, *) v2;write (1001, *) v3
        write (1001, *) v4;write (1001, *) v5;write (1001, *) v6
        write (1001, *) v7;write (1001, *) v8;write (1001, *) v9
        write (1001, *) v10;write (1001, *) v11;write (1001, *) v12
        write (1001, *) v13;write (1001, *) v17;write (1001, *) v18
        write (1001, *) v19;write (1001, *) v20;write (1001, *) v21
        [illegible]
        close(1001)
        call system("C:\qualITRuns\tmp\FLATZFLAT RunData.txt qualIT_cur.xfl sub2_in.xfl run.inp")
        call system("C:\qualITRuns\sub2Cell.bat")
        call system("C:\qualITRuns\tmp\FLATZFLAT run.out sub2_out.xfl qualIT_in.xfl MQResults.txt")
        call system("DEL C:\qualITRuns\tmp\RunData.txt")
        call system("DEL C:\qualITRuns\tmp\run.inp")
        call system("DEL C:\qualITRuns\tmp\run.out")
        open (unit = 1011, file = 'C:\qualITRuns\tmp\MQResults.txt')
        read (1011,*) v205;read (1011,*) v206;read (1011,*) v207
        read (1011,*) v208;read (1011,*) v209;read (1011,*) v210
        read (1011,*) v211;read (1011,*) v212;read (1011,*) v213
        read (1011,*) v214;read (1011,*) v215
        call system("DEL C:\qualITRuns\tmp\MQResults.txt")
        END
        real function v152(v530)
        [illegible]
        double precision v532, v533, v534
        parameter [illegible]
        [illegible]
        integer v565,v176,v371,iv(v510),iy
        SAVE iv,iy,v553
        DATA v550/12345678/, iv/v510*0/, iy/0/
        if(v530.le.0) then
        v550=max(v530,1)
        v550 v550
        do 100 v176 v510+8,1,-1
        v371 v550/v536
        v550=v534*(v550 v371*v536) v371*v505
        if(v550.lt.0) then
        v550=v550+v531
        endif
        if(v176.le.v510) then
        iv(v176)=v550
        endif
  100   continue
        iy iv(1)
        endif
        v371 v550/v536
        v550=v534*(v550 v371*v536) v371*v505
        if(v550.lt.0) then
        v550 v550+v531
        endif
        v371 v553/v536
        v553=v535*(v553 v371*v537) v371*v509
        if(v553.lt.0) then
        v553 v553+v532
        endif
```


File: C:\qualIT\qualIT_OutputAll.working.f

```
        v176 1+iy/v511
        iy=iv(v176)-v553
        iv(v176)=v550
        if(iy.lt.1) then
        iy=iy+v531
        endif
        v152=min(v512*iy,v514)
        return
      END
        SUBROUTINE sum2(v389,v376,v384,v191,v192,v193,v355,
     .  v378,v379,v380,v382,
        v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12,v13,v14,v15,v16,
     .  v17,v18,v19,v20,v21,v22,v23,v24,v27,v28,v29,v23,v24,v30,v31,
        v156,v157,v158,v159,v160,
        v161,v162,v163,v164,v165,
     .  v166,v167,v168,v169,v170,
        v171,v172,v173,v174,v175,
     .  v176, v179)
        Implicit None
        Real v1,v2,v3,v4,v5,v6,v7,v8,v9,v10
        Real v11,v12,v13,v14,v15,v16,v17,v18,v19,v20
        Real v21,v22,v23,v24,v25,v26,v27,v28,v29,v30
        Real v31
        Real v156,v157,v158,v159,v160
        Real v161,v162,v163,v164,v165,v166,v167,v168,v169,v170
        Real v171,v172,v173,v174,v175,v176
        Real v184,v185,v186,v187,v188
        Real v191(1000),v192(1000),v193(1000),v384(1000),v392(1000,20)
        Real v394(1000,20),v371(1000,20)
        Integer v177,v178,v179,v371,v372
        Integer v376(1000),v378(1000),v383(1000,20),v382(1000),v383(1000)
        Integer v385(1000),v386(1000),v387,v388,v389,v390,v391
        do 35 v177 1, v357
        IF (v378(v177).eq.0) THEN
        IF (v376(v177).ne.1) THEN
        [illegible]
        v386(v177) 1
        END IF
        END IF
        v382(v177) 0
   35   continue
        do 65 v177 1, v357
        IF (v376(v177).eq.0) THEN
        Call sum2(v378(v177),v384(v177),v191(v177),v192(v177),v193(v177),
        [illegible]
        v392(v177) 1
        END IF
   65   continue
        v178=1
   95   IF (v178.gt.v357) THEN
        IF (v382(v178).eq.0) THEN
        v383(v178) 1
        do 85 v372 1, v379(v178)
        do 87 v177 1,v357
        IF (v378(v177).eq.v383(v178,v372)) THEN
        IF (v382(v177).eq.0) THEN
        v383(v178) 0
        END IF
        END IF
   87   continue
   85   continue
        IF (v383(v178).eq.1) THEN
        do 120 v371=1, v379(v178)
        do 110 v177=1,v357
        IF (v385(v178).eq.1) THEN
        IF (v378(v177).eq.v380(v178,v371)) THEN
        do 100 v372=1,11
        v392(v178,v372)=(v392(v178,1)*v392(v178,v372)+v394(v177,1)*v394(v177,v372))/(v392(v178,1)+v394(v177,1))
  100   continue
        IF (v386(v178).ne.1) THEN
        v191(v178)=(v392(v178,1)*v191(v178)+v394(v177,1)*v191(v177))/(v392(v178,1)+v394(v177,1))
        v192(v178)=(v392(v178,1)*v192(v178)+v394(v177,1)*v192(v177))/(v392(v178,1)+v394(v177,1))
```

File: C:\qualIT\qualIT_OutputAll.working.f

```
      [illegible]
      ENDIF
      [illegible]
      END IF
      ELSE IF [illegible] THEN
      IF [illegible] THEN
      [illegible]
 [illegible] continue
      IF [illegible] THEN
      [illegible]
      END IF
      [illegible]
      END IF
      END IF
 [illegible] continue
 [illegible] continue
      Call sub1 [illegible]
      [illegible]
      END IF
      END IF
      [illegible]
      END IF
      open (unit = 60, file = Char[illegible] // Char[illegible] ...
      [illegible]
      read (60,*) [illegible]
      [illegible]
      continue
      write [illegible]
      format [illegible]
      END
      SUBROUTINE sub1(v1,v2,v3,v4,v5,v6,v7,v8,v9,v10, [illegible]
      [illegible]
      Implicit None
      Real v1,v2,v3,v4,v5,v6,v7,v8,v9,v10
      [illegible]
      Integer [illegible]
```


File: C:\qualIT\qualIT_OutputAll.working.f

```
      Integer [illegible]
      open (unit = 60, file = Char[illegible] // Char[illegible] ...
      [illegible]
      read (60,*) [illegible]
      close(60)
      open (unit = 11, file = Char[illegible] ...
      open (unit = 12, file = Char[illegible] ...
      open (unit = 13, file = Char[illegible] ...
      open (unit = 14, file = Char[illegible] ...
      open (unit = 15, file = Char[illegible] ...
      open (unit = 16, file = Char[illegible] ...
      open (unit = 17, file = Char[illegible] ...
      open (unit = 18, file = Char[illegible] ...
      open (unit = 19, file = Char[illegible] ...
      open (unit = 20, file = Char[illegible] ...
      open (unit = 21, file = Char[illegible] ...
      open (unit = 52, file = Char[illegible] ...
      open (unit = 53, file = Char[illegible] ...
      open (unit = [illegible], file = Char[illegible] ...
      read [illegible]
      do [illegible]
      read [illegible]
      IF [illegible] THEN
      [illegible]
      END IF
      IF [illegible] THEN
      END IF
      [illegible]
 [illegible] continue
 [illegible] continue
      [illegible]
 40   continue
      [illegible]
 [illegible] continue
```

```
[illegible] qme.[illegible]_output[illegible]working.[illegible]
        [illegible]
        [illegible]
        v1,v2,v3,v4,v5,v6,[illegible]
        [illegible]
        [illegible]
        [illegible]
        [illegible]
        [illegible]
        [illegible]
      END
```

Page: [illegible]

APPENDIX G: CONCEPTUAL PROCESSES IN RIVERINE WATER QUALITY KINETICS MODEL

This Appendix contains Chapter 5 of the following reference

Chapra, S.C., Pelletier, G.J. and Tao, H. 2007. QUAL2K: A Modeling Framework for Simulating River and Stream Water Quality, Version 2.07: Documentation and Users Manual. Civil and Environmental Engineering Dept., Tufts University, Medford, MA., Steven.Chapra@tufts.edu

and is presented as an illustrative example of conceptual elements in a modern water quality model.

5 CONSTITUENT MODEL

5.1 Constituents and General Mass Balance

The model constituents are listed in Table 5.

Table 5 Model state variables

Variable	Symbol	Units*
Conductivity	s	μmhos
Inorganic suspended solids	m_i	mgD/L
Dissolved oxygen	o	mgO$_2$/L
Slowly reacting CBOD	c_s	mgO$_2$/L
Fast reacting CBOD	c_f	mgO$_2$/L
Organic nitrogen	n_o	μgN/L
Ammonia nitrogen	n_a	μgN/L
Nitrate nitrogen	n_n	μgN/L
Organic phosphorus	p_o	μgP/L
Inorganic phosphorus	p_i	μgP/L
Phytoplankton	a_p	μgA/L
Detritus	m_o	mgD/L
Pathogen	X	cfu/100 mL
Alkalinity	Alk	mgCaCO$_3$/L
Total inorganic carbon	c_T	mole/L
Bottom algae biomass	a_b	mgA/m^2
Bottom algae nitrogen	IN_b	mgN/m^2
Bottom algae phosphorus	IP_b	mgP/m^2

* mg/L = g/m^3; In addition, the terms D, C, N, P, and A refer to dry weight, carbon, nitrogen, phosphorus, and chlorophyll a, respectively. The term cfu stands for colony forming unit which is a measure of viable bacterial numbers.

For all but the bottom algae variables, a general mass balance for a constituent in an element is written as (Figure 17)

$$\frac{dc_i}{dt} = \frac{Q_{i-1}}{V_i} c_{i-1} - \frac{Q_i}{V_i} c_i - \frac{Q_{ab,i}}{V_i} c_i + \frac{E'_{i-1}}{V_i}(c_{i-1} - c_i) + \frac{E'_i}{V_i}(c_{i+1} - c_i) + \frac{W_i}{V_i} + S_i \qquad (53)$$

where W_i = the external loading of the constituent to element i [g/d or mg/d], and S_i = sources and sinks of the constituent due to reactions and mass transfer mechanisms [g/m^3/d or mg/m^3/d].

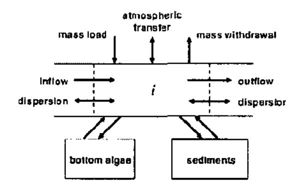


Figure 17 Mass balance.

The external load is computed as (recall Eq. 2),

$$W_i = \sum_{j=1}^{psi} Q_{ps,i,j} c_{psi,j} + \sum_{j=1}^{npsi} Q_{nps,i,j} c_{npsi,j} \qquad (54)$$

where $c_{psi,j}$ is the jth point source concentration for element i [mg/L or μg/L], and $c_{npsi,j}$ is the jth non-point source concentration for element i [mg/L or μg/L].

For bottom algae, the transport and loading terms are omitted.

$$\frac{da_{b,i}}{dt} = S_{b,i} \qquad (55)$$

$$\frac{dIN_{b,i}}{dt} = S_{bN,i} \qquad (56)$$

$$\frac{dIP_{b,i}}{dt} = S_{bP,i} \qquad (57)$$

where $S_{b,i}$ = sources and sinks of bottom algae biomass due to reactions [mgA/m^2/d], $S_{bN,i}$ = sources and sinks of bottom algae nitrogen due to reactions [mgN/m^2/d], and $S_{bP,i}$ = sources and sinks of bottom algae phosphorus due to reactions [mgP/m^2/d].

The sources and sinks for the state variables are depicted in Figure 18 (note that the internal levels of nitrogen and phosphorus in the bottom algae are not depicted). The mathematical representations of these processes are presented in the following sections.

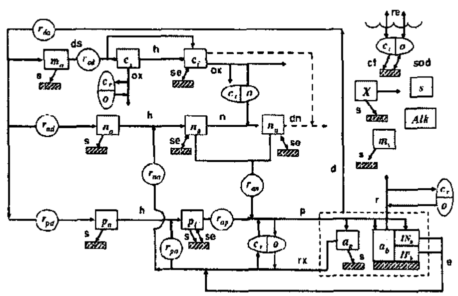


Figure 18 Model kinetics and mass transfer processes. The state variables are defined in Table 5. Kinetic processes are dissolution (ds), hydrolysis (h), oxidation (ox), nitrification (n), denitrification (dn), photosynthesis (p), respiration (r), excretion (e), death (d), respiration/excretion (rx). Mass transfer processes are reaeration (re), settling (s), sediment oxygen demand (SOD), sediment exchange (se), and sediment inorganic carbon flux (cf).

5.2 Reaction Fundamentals

5.2.1 Biochemical Reactions

The following chemical equations are used to represent the major biochemical reactions that take place in the model (Stumm and Morgan 1996):

Plant Photosynthesis and Respiration:

<u>Ammonium as substrate:</u>

$$106CO_2 + 16NH_4^+ + HPO_4^{2-} + 106H_2O \underset{R}{\overset{P}{\rightleftarrows}} C_{106}H_{263}O_{110}N_{16}P_1 + 106O_2 + 14H^+ \quad (58)$$

<u>Nitrate as substrate:</u>

$$106CO_2 + 16NO_3^- + HPO_4^{2-} + 122H_2O + 18H^+ \underset{R}{\overset{P}{\rightleftarrows}} C_{106}H_{263}O_{110}N_{16}P_1 + 138O_2 \quad (59)$$

Nitrification:

$$NH_4^+ + 2O_2 \rightarrow NO_3^- + H_2O + 2H^+ \quad (60)$$

Denitrification:

$$5CH_2O + 4NO_3^- + 4H^+ \rightarrow 5CO_2 + 2N_2 + 7H_2O \quad (61)$$

Note that a number of additional reactions are used in the model such as those involved with simulating pH and unionized ammonia. These will be outlined when these topics are discussed later in this document.

5.2.2 Stoichiometry of Organic Matter

The model requires that the stoichiometry of organic matter (i.e., phytoplankton and detritus) be specified by the user. The following representation is suggested as a first approximation (Redfield et al. 1963, Chapra 1997).

$$100\,gD : 40\,gC : 7200\,mgN : 1000\,mgP : 1000\,mgA \quad (62)$$

where gX = mass of element X [g] and mgY = mass of element Y [mg]. The terms D, C, N, P, and A refer to dry weight, carbon, nitrogen, phosphorus, and chlorophyll *a*, respectively. It should be noted that chlorophyll *a* is the most variable of these quantities with a range of approximately 500-2000 mgA (Laws and Chalup 1990, Chapra 1997).

These values are then combined to determine stoichiometric ratios as in

$$r_{xy} = \frac{gX}{gY} \quad (63)$$

For example, the amount of detritus (in grams dry weight or gD) that is released due to the death of a unit amount of phytoplankton (in milligrams of chlorophyll *a* or mgA) can be computed as

$$r_{da} = \frac{100\,gD}{1000\,mgA} = 0.1\frac{gD}{mgA}$$

5.2.2.1 Oxygen Generation and Consumption

The model requires that the rates of oxygen generation and consumption be prescribed. If ammonia is the substrate, the following ratio (based on Eq. 58) can be used to determine the grams of oxygen generated for each gram of plant matter that is produced through photosynthesis.

$$r_{oa} = \frac{106\,moleO_2(32\,gO_2/moleO_2)}{106\,moleC(12\,gC/moleC)} = 2.67\frac{gO_2}{gC} \quad (64)$$

If nitrate is the substrate, the following ratio (based on Eq. 59) applies

$$r_{on} = \frac{138\,moleO_2(32\,gO_2/moleO_2)}{106\,moleC(12\,gC/moleC)} = 3.47\frac{gO_2}{gC} \quad (65)$$

Note that Eq. (58) is also used for the stoichiometry of the amount of oxygen consumed for plant respiration.

For nitrification, the following ratio is based on Eq. (60)

$$r_{on} = \frac{2\ \text{moleO}_2(32\ \text{gO}_2/\text{moleO}_2)}{1\ \text{moleN}(14\ \text{gN/moleN})} = 4.57\frac{\text{gO}_2}{\text{gN}} \tag{66}$$

5.2.2.2 CBOD Utilization Due to Denitrification

As represented by Eq. (61), CBOD is utilized during denitrification,

$$r_{ondn} = 2.67\frac{\text{gO}_2}{\text{gC}}\frac{5\ \text{moleC}\times 12\ \text{gC/moleC}}{4\ \text{moleN}\times 14\ \text{gN/moleN}}\times\frac{1\ \text{gN}}{1000\ \text{mgN}} = 0.00286\frac{\text{gO}_2}{\text{mgN}} \tag{67}$$

5.2.3 Temperature Effects on Reactions

The temperature effect for all first-order reactions used in the model is represented by

$$k(T) = k(20)\theta^{T-20} \tag{68}$$

where $k(T)$ = the reaction rate [/d] at temperature T [°C] and θ = the temperature coefficient for the reaction.

5.3 Composite Variables

In addition to the model's state variables, Q2K also displays several composite variables that are computed as follows.

Total Organic Carbon (mgC/L):

$$TOC = \frac{c_s + c_f}{r_{oc}} + r_{ca}a_p + r_{cd}m_o \tag{69}$$

Total Nitrogen (μgN/L):

$$TN = n_o + n_a + n_n + r_{na}a_p \tag{70}$$

Total Phosphorus (μgP/L):

$$TP = p_o + p_i + r_{pa}a_p \tag{71}$$

Total Kjeldahl Nitrogen (μgN/L):

$$TKN = n_o + n_a + r_{na}a_p \tag{72}$$

Total Suspended Solids (mgD/L):

$$TSS = r_{da}a_p + m_o + m_i \tag{73}$$

Ultimate Carbonaceous BOD (mgO$_2$/L):

$$CBOD_u = c_s + c_f + r_{oc}r_{ca}a_p + r_{oc}r_{cd}m_o \tag{74}$$

5.4 Relationship of Model Variables and Data

For all but slow and fast CBOD (c_f and c_s), there exists a relatively straightforward relationship between the model state variables and standard water-quality measurements. These are outlined next. Then we discuss issues related to the more difficult problem of measuring CBOD.

5.4.1 Non-CBOD Variables and Data

The following are measurements that are needed for comparison of non-BOD variables with model output

TEMP = temperature (°C)
TKN = total kjeldahl nitrogen (μgN/L) or TN = total nitrogen (μgN/L)
NH4 = ammonium nitrogen (μgN/L)
NO2 = nitrite nitrogen (μgN/L)
NO3 = nitrate nitrogen (μgN/L)
CHLA = chlorophyll *a* (μgA/L)
TP = total phosphorus (μgP/L)
SRP = soluble reactive phosphorus (μgP/L)
TSS = total suspended solids (mgD/L)
VSS = volatile suspended solids (mgD/L)
TOC = total organic carbon (mgC/L)
DOC = dissolved organic carbon (mgC/L)
DO = dissolved oxygen (mgO$_2$/L)
PH = pH
ALK = alkalinity (mgCaCO$_3$/L)
COND = specific conductance (umhos)

The model state variables can then be related to these measurements as follows:

s = COND

m_i = TSS – VSS or TSS – r_{dc} (TOC – DOC)

o = DO

n_o = TKN – NH4 – r_{na} CHLA   or n_o = TN – NO2 – NO3 – NH4 – r_{na} CHLA

n_a = NH4

n_n = NO2 + NO3

p_o = TP − SRP − r_{pa} CHLA

p_i = SRP

a_p = CHLA

m_o = VSS − r_{da} CHLA or r_{dc} (TOC − DOC) − r_{da} CHLA

pH = PH

Alk = ALK

5.4.2 Carbonaceous BOD

The interpretation of BOD measurements in natural waters is complicated by three primary factors:

- Filtered versus unfiltered. If the sample is unfiltered, the BOD will reflect oxidation of both dissolved and particulate organic carbon. Since Q2K distinguishes between dissolved (c_s and c_f) and particulate (m_o and a_p) organics, an unfiltered measurement alone does not provide an adequate basis for distinguishing these individual forms. In addition, one component of the particulate BOD, phytoplankton (a_p) can further complicate the test through photosynthetic oxygen generation.
- Nitrogenous BOD. Along with the oxidation of organic carbon (CBOD), nitrification also contributes to oxygen depletion (NBOD). Thus, if the sample (a) contains reduced nitrogen and (b) nitrification is not inhibited, the measurement includes both types of BOD.
- Incubation time. Short-term, usually 5-day, BODs are typically performed. Because Q2K uses ultimate CBOD, 5-day BODs must be converted to ultimate BODs in a sensible fashion.

We suggest the following as practical ways to measure CBOD in a manner that accounts for the above factors and results in measurements that are compatible with Q2K.

Filtration. The sample should be filtered prior to incubation in order to separate dissolved from particulate organic carbon.

Nitrification inhibition. Nitrification can be suppressed by adding a chemical inhibiting agent such as TCMP (2-chloro-6-(trichloro methyl) pyridine. The measurement then truly reflects CBOD. In the event that inhibition is not possible, the measured value can be corrected for nitrogen by subtracting the oxygen equivalents of the reduced nitrogen (= r_{on} × TKN) in the sample. However, as with all such difference-based adjustments, this correction may exhibit substantial error.

Incubation time. The model is based on ultimate CBOD, so two approaches are possible. (1) use a sufficiently long period so that the ultimate value is measured, or (2) use a 5-day measurement and extrapolate the result to the ultimate. The latter method is often computed with the formula

$$\text{CBODFNU} = \frac{\text{CBODFN5}}{1 - e^{-k_1 t}} \qquad (75)$$

where CBODFNU[2] = the ultimate dissolved carbonaceous BOD [mgO$_2$/L], CBODFN5 = the 5-day dissolved carbonaceous BOD [mgO$_2$/L], and k_1 = the CBOD decomposition rate in the bottle [/d].

It should be noted that, besides practical considerations of time and expense, there may be other benefits from using the 5-day measurement with extrapolation, rather that performing the longer-term CBOD. Although extrapolation does introduce some error, the 5-day value has the advantage that it would tend to minimize possible nitrification effects which, even when inhibited, can begin to be exerted on longer time frames.

If all the above provisions are implemented, the result should correspond to the model variables by

$c_f + c_s$ = CBODFNU

Slow versus Fast CBOD. The final question relates to discrimination between fast and slow CBODU. Although we believe that there is currently no single, simple, economically-feasible answer to this problem, we think that the following 2 strategies represent the best current alternatives.

Option 1: Represent all the dissolved, oxidizable organic carbon with a single pool (fast CBOD). The model includes parameters to bypass slow CBOD. If no slow CBOD inputs are entered, this effectively drops it from the model. For this case,

c_f = CBODFNU

c_s = 0

Option 2: Use an ultimate CBOD measurement for the fast fraction and compute slow CBOD by difference with a DOC measurement. For this case,

c_f = CBODFNU

c_s = r_{oc} DOC − CBODFNU

Option 2 works very nicely for systems where two distinct types of CBOD are present. For example, sewage effluent and autochthonous carbon from the aquatic food chain might be considered as fast CBOD. In contrast, industrial wastewaters such as pulp and paper mill effluent or allochthonous DOC from the watershed might be considered more recalcitrant and hence could be lumped into the slow CBOD fraction. In such case, the hydrolysis rate converting the slow into the fast fraction could be set to zero to make the two forms independent.

For both options, the CBODFNU can either be (a) measured directly using a long incubation time or (b) computed by extrapolation with Eq. 75. In both situations, a time frame of several

[2] The nomenclature FNU stands for Filtration, Nitrification inhibition and Ultimate

weeks to a month (i.e., a 20- to 30-day CBOD) is probably a valid period in order to oxidize most of the readily degradable organic carbon. We base this assumption on the fact that bottle rates for sewage-derived organic carbon are on the order of 0.05 to 0.3/d (Chapra 1997). As in Figure 19, such rates suggest that much of the readily oxidizable CBOD will be exerted in about 20 to 30 days.

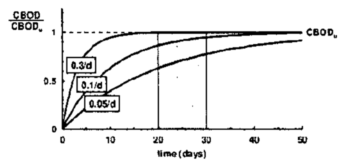


Figure 19 Progression of CBOD test for various levels of the bottle decomposition rate.

In addition, we believe that practitioners should consider conducting long-term CBOD tests at 30°C rather than at the commonly employed temperature of 20°C. The choice of 20°C originated from the fact that the average daily temperature of most receiving waters and wastewater treatment plants in the temperate zone in summer is approximately 20°C.

If the CBOD measurement is intended to be used for regulation or to assess treatment plant performance, it makes sense to standardize the test at a particular temperature. And for such purposes, 20°C is as reasonable a choice as any. However, if the intent is to measure an ultimate CBOD, anything that speeds up the process while not jeopardizing the measurement's integrity would seem beneficial.

The saprophytic bacteria that break down nonliving organic carbon in natural waters and sewage thrive best at temperatures from 20°C to 40°C. Thus, a temperature of 30°C is not high enough that the bacterial assemblage would shift to thermophilic organisms that are atypical of natural waters and sewage. The benefit should be higher oxidation rates which would result in shorter analysis times for CBOD measurements. Assuming that a $Q_{10} \cong 2$ is a valid approximation for bacterial decomposition, a 20-day BOD at 30°C should be equivalent to a 30-day BOD at 20°C.

5.5 Constituent Reactions

The mathematical relationships that describe the individual reactions and concentrations of the model state variables (Table 5) are presented in the following paragraphs.

5.5.1 Conservative Substance (s)

By definition, conservative substances are not subject to reactions:

$$S_s = 0 \qquad (76)$$

5.5.2 Phytoplankton (a_p)

Phytoplankton increase due to photosynthesis. They are lost via respiration, death, and settling

$$S_{ap} = \text{PhytoPhoto} - \text{PhytoResp} - \text{PhytoDeath} - \text{PhytoSettl} \qquad (77)$$

5.5.2.1 Photosynthesis

Phytoplankton photosynthesis is computed as

$$\text{PhytoPhoto} = \mu_p a_p \qquad (78)$$

where μ_p = phytoplankton photosynthesis rate [/d] is a function of temperature, nutrients, and light.

$$\mu_p = k_{gp}(T)\phi_{Np}\phi_{Lp} \qquad (79)$$

where $k_{gp}(T)$ = the maximum photosynthesis rate at temperature T [/d], ϕ_{Np} = phytoplankton nutrient attenuation factor [dimensionless number between 0 and 1], and ϕ_{Lp} = the phytoplankton light attenuation coefficient [dimensionless number between 0 and 1].

Nutrient Limitation. Michaelis-Menten equations are used to represent growth limitation for inorganic nitrogen, phosphorus and inorganic carbon. The minimum value is then used to compute the nutrient attenuation factor.

$$\phi_{Np} = \min\left(\frac{n_a + n_n}{k_{sNp} + n_a + n_n}, \frac{p_i}{k_{sPp} + p_i}, \frac{[H_2CO_3^*] + [HCO_3^-]}{k_{sCp} + [H_2CO_3^*] + [HCO_3^-]}\right) \qquad (80)$$

where k_{sNp} = nitrogen half-saturation constant [μgN/L] k_{sPp} = phosphorus half-saturation constant [μgP/L], k_{sCp} = inorganic carbon half-saturation constant [mole/L], $[H_2CO_3^*]$ = dissolved carbon dioxide concentration [mole/L], and $[HCO_3^-]$ = bicarbonate concentration [mole/L].

Light Limitation. It is assumed that light attenuation through the water follows the Beer-Lambert law,

$$PAR(z) = PAR(0)e^{-k_e z} \qquad (81)$$

where $PAR(z)$ = photosynthetically available radiation (PAR) at depth z below the water surface [ly/d][3], and k_e = the light extinction coefficient [m^{-1}]. The PAR at the water surface is assumed to be a fixed fraction of the solar radiation (Szeicz 1984, Baker and Frouin 1987):

$$PAR(0) = 0.47\ I(0)$$

The extinction coefficient is related to model variables by

[3] ly/d = langley per day. A langley is equal to a calorie per square centimeter. Note that a ly/d is related to the μE/m²/d by the following approximation 1 μE/m²/s ≅ 0.45 Langley/day (LI-CR, Lincoln, NE).

$$k_e = k_{eb} + \alpha_i m_i + \alpha_o m_o + \alpha_p a_p + \alpha_{pn} a_p^{2/3} \tag{82}$$

where k_{eb} = the background coefficient accounting for extinction due to water and color [/m], α_i, α_o, α_p, and α_{pn} are constants accounting for the impacts of inorganic suspended solids [L/mgD/m], particulate organic matter [L/mgD/m], and chlorophyll [L/μgA/m and (L/μgA)$^{2/3}$/m], respectively. Suggested values for these coefficients are listed in Table 6.

Table 6 Suggested values for light extinction coefficients

Symbol	Value	Reference
α_i	0.052	Di Toro (1978)
α_o	0.174	Di Toro (1978)
α_p	0.0088	Riley (1956)
α_{pn}	0.054	Riley (1956)

Three models are used to characterize the impact of light on phytoplankton photosynthesis (Figure 20):

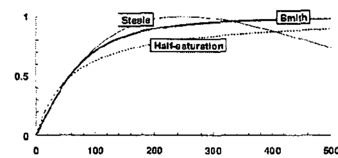


Figure 20 The three models used for phytoplankton and bottom algae photosynthetic light dependence. The plot shows growth attenuation versus PAR intensity (ly/d).

Half-Saturation (Michaelis-Menten) Light Model (Baly 1935):

$$F_{Lp} = \frac{I(z)}{K_{Lp} + I(z)} \tag{83}$$

where F_{Lp} = phytoplankton growth attenuation due to light and K_{Lp} = the phytoplankton light parameter. In the case of the half saturation model, the light parameter is a half saturation coefficient [ly/d]. This function can be combined with the Beer-Lambert law and integrated over water depth, H [m], to yield the phytoplankton light attenuation coefficient

$$\phi_{Lp} = \frac{1}{k_e H} \ln\left(\frac{K_{Lp} + I(0)}{K_{Lp} + I(0)e^{-k_e H}} \right) \tag{84}$$

Smith's Function (Smith 1936):

$$F_{Lp} = \frac{I(z)}{\sqrt{K_{Lp}^2 + I(z)^2}} \tag{85}$$

where K_{Lp} = the Smith parameter for phytoplankton [ly/d]; that is, the PAR at which growth is 70.7% of the maximum. This function can be combined with the Beer-Lambert law and integrated over water depth to yield

$$\phi_{Lp} = \frac{1}{k_e H} \ln\left(\frac{I(0)/K_{Lp} + \sqrt{1 + (I(0)/K_{Lp})^2}}{(I(0)/K_{Lp})e^{-k_e H} + \sqrt{1 + ((I(0)/K_{Lp})e^{-k_e H})^2}} \right) \tag{86}$$

Steele's Equation (Steele 1962):

$$F_{Lp} = \frac{I(z)}{K_{Lp}} e^{1 - \frac{I(z)}{K_{Lp}}} \tag{87}$$

where K_{Lp} = the PAR at which phytoplankton growth is optimal [ly/d]. This function can be combined with the Beer-Lambert law and integrated over water depth to yield

$$\phi_{Lp} = \frac{2.718282}{k_e H} \left(e^{-\frac{I(0)}{K_{Lp}} e^{-k_e H}} - e^{-\frac{I(0)}{K_{Lp}}} \right) \tag{88}$$

5.5.2.2 Losses

Respiration. Phytoplankton respiration is represented as a first-order rate that is attenuated at low oxygen concentration.

$$\text{PhytoResp} = F_{oxp} k_{rp}(T)\, a_p \tag{89}$$

where $k_{rp}(T)$ = temperature-dependent phytoplankton respiration/excretion rate [/d] and F_{oxp} = attenuation due to low oxygen [dimensionless]. Oxygen attenuation is modeled by Eqs. (119) to (121) with the oxygen dependency represented by the parameter K_{sop}.

Death. Phytoplankton death is represented as a first-order rate,

$$\text{PhytoDeath} = k_{dp}(T)\, a_p \tag{90}$$

where $k_{dp}(T)$ = temperature-dependent phytoplankton death rate [/d].

Settling. Phytoplankton settling is represented as

$$\text{PhytoSettl} = \frac{v_a}{H} a_p \tag{91}$$

where v_a = phytoplankton settling velocity [m/d].

5.5.3 Bottom algae (a_b)

Bottom algae increase due to photosynthesis. They are lost via respiration and death.

$$S_b = \text{BotAlgPhoto} - \text{BotAlgResp} - \text{BotAlgDeath} \quad (92)$$

5.5.3.1 Photosynthesis

Two representations can be used to model bottom algae photosynthesis. The first is based on a temperature-corrected zero-order rate attenuated by nutrient and light limitation (McIntyre 1973, Rutherford et al. 1999).

$$\text{BotAlgPhoto} = C_{gb}(T)\phi_{Nb}\phi_{Lb} \quad (93)$$

where $C_{gb}(T)$ = the zero-order temperature-dependent maximum photosynthesis rate [mgA/(m² d)], ϕ_{Nb} = bottom algae nutrient attenuation factor [dimensionless number between 0 and 1], and ϕ_{Lb} = the bottom algae light attenuation coefficient [dimensionless number between 0 and 1].

The second uses a first-order model.

$$\text{BotAlgPhoto} = C_{gb}(T)\phi_{Nb}\phi_{Lb}\phi_{Sb}a_b \quad (94)$$

where, for this case, $C_{gb}(T)$ = the first-order temperature-dependent maximum photosynthesis rate [d^{-1}], and ϕ_{Sb} = bottom algae space limitation attenuation factor.

Temperature Effect. As for the first-order rates, an Arrhenius model is employed to quantify the effect of temperature on bottom algae photosynthesis.

$$C_{gb}(T) = C_{gb}(20)\theta^{T-20} \quad (95)$$

Nutrient Limitation. The effect of nutrient limitation on bottom plant photosynthesis is modeled in a different way than for the phytoplankton. Rather than being dependent on external nutrient concentration, the photosynthesis rate is dependent on intracellular nutrients using a formulation originally developed by Droop (1974).

$$\phi_{Nb} = \min\left[1 - \frac{q_{0N}}{q_N}, 1 - \frac{q_{0P}}{q_P}, \frac{[H_2CO_3^*] + [HCO_3^-]}{k_{sCb} + [H_2CO_3^*] + [HCO_3^-]}\right] \quad (96)$$

where q_N and q_P = the cell quotas of nitrogen [mgN mgA^{-1}] and phosphorus [mgP mgA^{-1}], respectively, q_{0N} and q_{0P} = the minimum cell quotas of nitrogen [mgN mgA^{-1}] and phosphorus [mgP mgA^{-1}], respectively, and , k_{sCb} = inorganic carbon half-saturation constant for the bottom algae [mole/L]. The minimum cell quotas are the levels of intracellular nutrient at which growth ceases.

The cell quotas represent the ratios of the intracellular nutrient to the bottom plant's biomas.

$$q_N = \frac{IN_b}{a_b} \quad (97)$$

$$q_P = \frac{IP_b}{a_b} \quad (98)$$

where IN_b = intracellular nitrogen concentration [mgN/m²] and IP_b = intracellular phosphorus concentration [mgP/m²].

Light Limitation. In contrast to the phytoplankton, light limitation at any time is determined by the amount of PAR reaching the bottom of the water column. This quantity is computed with the Beer Lambert law (recall Eq. 81) evaluated at the bottom of the river,

$$I(H) = I(0)e^{-k_e H} \quad (99)$$

As with the phytoplankton, three models (Eqs. 83, 85 and 87) are used to characterize the impact of light on bottom algae photosynthesis. Substituting Eq. (99) into these models yields the following formulas for the bottom algae light attenuation coefficient.

Half-Saturation Light Mode (Baly 1935):

$$\phi_{Lb} = \frac{I(0)e^{-k_e H}}{K_{Lb} + I(0)e^{-k_e H}} \quad (100)$$

Smith's Function: (Smith 1936)

$$\phi_{Lb} = \frac{I(0)e^{-k_e H}}{\sqrt{K_{Lb}^2 + \left(I(0)e^{-k_e H}\right)^2}} \quad (101)$$

Steele's Equation (Steele 1962):

$$\phi_{Lb} = \frac{I(0)e^{-k_e H}}{K_{Lb}} e^{1 - \frac{I(0)e^{-k_e H}}{K_{Lb}}} \quad (102)$$

where K_{Lb} = the appropriate bottom algae light parameter for each light model.

Space Limitation. If a first-order growth model is used, a term must be included to impose a space limitation on the bottom algae. A logistic model is used for this purpose as in

$$\phi_{Sb} = 1 - \frac{a_b}{a_{b,max}}$$

where $a_{b,max}$ = the carrying capacity [mgA/m²].

5.5.3.2 Losses

Respiration. Bottom algae respiration is represented as a first-order rate that is attenuated at low oxygen concentration,

$$\text{BotAlgResp} = F_{oxb} k_{rb}(T) a_b \tag{103}$$

where $k_{rb}(T)$ = temperature-dependent bottom algae respiration rate [/d] and F_{oxb} = attenuation due to low oxygen [dimensionless]. Oxygen attenuation is modeled by Eqs. (119) to (121) with the oxygen dependency represented by the parameter K_{sob}.

Death. Bottom algae death is represented as a first-order rate.

$$\text{BotAlgDeath} = k_{db}(T) a_b \tag{104}$$

where $k_{db}(T)$ = the temperature-dependent bottom algae death rate [/d].

5.5.4 Bottom Algae Internal Nitrogen (IN_b)

The change in intracellular nitrogen in bottom algal cells is calculated from

$$S_{INb} = \text{BotAlgUpN} - q_N \text{ BotAlgDeath} - \text{BotAlgExN} \tag{105}$$

where BotAlgUpN = the uptake rate of nitrogen by bottom algae (mgN/m²/d), BotAlgDeath = bottom algae death (mgA/m²/d), and BotAlgExN = the bottom algae excretion of nitrogen (mgN/m²/d), which is computed as

$$\text{BotAlgExN} = q_N k_{eb}(T) a_b \tag{106}$$

where $k_{eb}(T)$ = the temperature-dependent bottom algae excretion rate [/d].

The N uptake rate depends on both external and intracellular nutrients as in (Rhee 1973),

$$\text{BotAlgUpN} = \rho_{mN} \frac{n_a + n_n}{k_{sNb} + n_a + n_n} \frac{K_{qN}}{K_{qN} + (q_N - q_{0N})} a_b \tag{107}$$

where ρ_{mN} = the maximum uptake rate for nitrogen [mgN/mgA/d], k_{sNb} = half-saturation constant for external nitrogen [μgN/L] and K_{qN} = half-saturation constant for intracellular nitrogen [mgN mgA^{-1}].

5.5.5 Bottom Algae Internal Phosphorus (IP_b)

The change in intracellular phosphorus in bottom algal cells is calculated from

$$S_{IPb} = \text{BotAlgUpP} - q_P \text{ BotAlgDeath} - \text{BotAlgExP} \tag{108}$$

where BotAlgUpP = the uptake rate of phosphorus by bottom algae (mgP/m²/d), BotAlgDeath = bottom algae death (mgA/m²/d), and BotAlgExP = the bottom algae excretion of phosphorus (mgP/m²/d), which is computed as

$$\text{BotAlgExP} = q_P k_{eb}(T) a_b \tag{109}$$

where $k_{eb}(T)$ = the temperature-dependent bottom algae excretion rate [/d].

The P uptake rate depends on both external and intracellular nutrients as in (Rhee 1973),

$$\text{BotAlgUpP} = \rho_{mP} \frac{p_i}{k_{sPb} + p_i} \frac{K_{qP}}{K_{qP} + (q_P - q_{0P})} a_b \tag{110}$$

where ρ_{mP} = the maximum uptake rate for phosphorus [mgP/mgA/d], k_{sPb} = half-saturation constant for external phosphorus [μgP/L] and K_{qP} = half saturation constant for intracellular phosphorus [mgP mgA^{-1}]

5.5.6 Detritus (m_o)

Detritus or particulate organic matter (POM) increases due to plant death. It is lost via dissolution and settling

$$S_{mo} = r_{da} \text{ PhytoDeath} + r_{da} \text{ BotAlgDeath} - \text{DetrDiss} - \text{DetrSettl} \tag{111}$$

where

$$\text{DetrDiss} = k_{dt}(T) m_o \tag{112}$$

where $k_{dt}(T)$ = the temperature-dependent detritus dissolution rate [/d] and

$$\text{DetrSettl} = \frac{v_{dt}}{H} m_o \tag{113}$$

where v_{dt} = detritus settling velocity [m/d].

5.5.7 Slowly Reacting CBOD (c_s)

Slowly reacting CBOD increases due to detritus dissolution. It is lost via hydrolysis and oxidation,

$$S_{cs} = (1 - F_f) r_{od} \text{ DetrDiss} - \text{SlowCHydr} - \text{SlowCOxid} \tag{114}$$

where F_f = the fraction of detrital dissolution that goes to fast reacting CBOD [dimensionless], and

$$\text{SlowCHydr} = k_{hc}(T) c_s \tag{115}$$

where $k_{hc}(T)$ = the temperature-dependent slow CBOD hydrolysis rate [/d], and

$$\text{SlowCOxid} = F_{oxc}\, k_{dcs}(T) c_s \tag{116}$$

where $k_{dcs}(T)$ = the temperature-dependent slow CBOD oxidation rate [/d] and F_{oxc} = attenuation due to low oxygen [dimensionless].

5.5.8 Fast Reacting CBOD (c_f)

Fast reacting CBOD is gained via the dissolution of detritus and the hydrolysis of slowly-reacting CBOD. It is lost via oxidation and denitrification.

$$S_{cf} = F_f r_{od}\,\text{DetrDiss} + \text{SlowCHydr} - \text{FastCOxid} - r_{ondn}\,\text{Denitr} \tag{117}$$

where

$$\text{FastCOxid} = F_{oxc}\, k_{dc}(T) c_f \tag{118}$$

where $k_{dc}(T)$ = the temperature-dependent fast CBOD oxidation rate [/d] and F_{oxc} = attenuation due to low oxygen [dimensionless]. The parameter r_{ondn} is the ratio of oxygen equivalents lost per nitrate nitrogen that is denitrified (Eq. 67). The term Denitr is the rate of denitrification [μgN/L/d]. It will be defined in Sec. 5.5.12 below.

Three formulations are used to represent the oxygen attenuation:

Half-Saturation:

$$F_{oxm} = \frac{o}{K_{socf} + o} \tag{119}$$

where K_{socf} = half saturation constant for the effect of oxygen on fast CBOD oxidation [mgO$_2$/L].

Exponential:

$$F_{oxm} = (1 - e^{-K_{socf}\, o}) \tag{120}$$

where K_{socf} = exponential coefficient for the effect of oxygen on fast CBOD oxidation [L/mgO$_2$].

Second-Order Half Saturation:

$$F_{oxm} = \frac{o^2}{K_{socf} + o^2} \tag{121}$$

where K_{socf} = half-saturation constant for second-order effect of oxygen on fast CBOD oxidation [mgO$_2^2$/L^2].

5.5.9 Organic Nitrogen (n_o)

Organic nitrogen increases due to plant death. It is lost via hydrolysis and settling.

$$S_{no} = r_{na}\,\text{PhytoDeath} + q_{ND}\,\text{BotAlgDeath} - \text{ONHydr} - \text{ONSettl} \tag{122}$$

The rate of organic nitrogen hydrolysis is computed as

$$\text{ONHydr} = k_{hn}(T) n_o \tag{123}$$

where $k_{hn}(T)$ = the temperature-dependent organic nitrogen hydrolysis rate [/d].

$$\text{ONSettl} = \frac{v_{on}}{H} n_o \tag{124}$$

where v_{on} = organic nitrogen settling velocity [m/d].

5.5.10 Ammonia Nitrogen (n_a)

Ammonia nitrogen increases due to organic nitrogen hydrolysis, phytoplankton respiration/excretion and bottom plant excretion. It is lost via nitrification and plant photosynthesis:

$$S_{na} = \text{ONHydr} + r_{na}\,\text{PhytoResp} - \text{Nitrif} + \text{BotAlgExN} - r_{na} P_{ap}\,\text{PhytoPhoto} - P_{ab}\,\text{BotAlgUpN} \tag{125}$$

The ammonia nitrification rate is computed as

$$\text{Nitrif} = F_{oxna} k_n(T) n_a \tag{126}$$

where $k_n(T)$ = the temperature-dependent nitrification rate for ammonia nitrogen [/d] and F_{oxna} = attenuation due to low oxygen [dimensionless]. Oxygen attenuation is modeled by Eqs. (119) to (121) with the oxygen dependency represented by the parameter K_{sona}.

The coefficients P_{ap} and P_{ab} are the preferences for ammonium as a nitrogen source for phytoplankton and bottom algae, respectively.

$$P_{ap} = \frac{n_a n_n}{(k_{hnxp} + n_a)(k_{hnxp} + n_n)} + \frac{n_a k_{hnxp}}{(n_a + n_n)(k_{hnxp} + n_n)} \tag{127}$$

$$P_{ab} = \frac{n_a n_n}{(k_{hnxb} + n_a)(k_{hnxb} + n_n)} + \frac{n_a k_{hnxb}}{(n_a + n_n)(k_{hnxb} + n_n)} \tag{128}$$

where k_{hnxp} = preference coefficient of phytoplankton for ammonium [mgN/m^3] and k_{hnxb} = preference coefficient of bottom algae for ammonium [mgN/m^3].

5.5.11 Unionized Ammonia

The model simulates total ammonia. In water, the total ammonia consists of two forms: ammonium ion, NH_4^+, and unionized ammonia, NH_3. At normal pH (6 to 8), most of the total ammonia will be in the ionic form. However at high pH, unionized ammonia predominates. The amount of unionized ammonia can be computed as

$$n_{au} = F_u n_a \tag{129}$$

where n_{au} = the concentration of unionized ammonia [ugN/L], and F_u = the fraction of the total ammonia that is in unionized form,

$$F_u = \frac{K_a}{10^{-pH} + K_a} \tag{130}$$

where K_a = the equilibrium coefficient for the ammonia dissociation reaction, which is related to temperature by

$$pK_a = 0.09018 + \frac{2729.92}{T_a} \tag{131}$$

where T_a is absolute temperature [K] and $pK_a = -\log_{10}(K_a)$. Note that the fraction of the total ammonia that is in ionized form, F_i, can be computed as $1 - F_u$ or

$$F_i = \frac{10^{-pH}}{10^{-pH} + K_a} \tag{132}$$

5.5.12 Nitrate Nitrogen (n_n)

Nitrate nitrogen increases due to nitrification of ammonia. It is lost via denitrification and plant photosynthesis:

$$S_{ni} = \text{Nitrif} - \text{Denitr} - r_{na}(1 - P_{ap})\text{PhytoPhoto} - (1 - P_{ab})\ \text{BotAlgUptakeN} \tag{133}$$

The denitrification rate is computed as

$$\text{Denitr} = (1 - F_{oxdn})k_{dn}(T)n_n \tag{134}$$

where $k_{dn}(T)$ = the temperature-dependent denitrification rate of nitrate nitrogen [/d] and F_{oxdn} = effect of low oxygen on denitrification [dimensionless] as modeled by Eqs. (119) to (121) with the oxygen dependency represented by the parameter K_{sodn}.

5.5.13 Organic Phosphorus (p_o)

Organic phosphorus increases due to plant death. It is lost via hydrolysis and settling.

$$S_{po} = r_{pa}\text{PhytoDeath} + q_{ap}\ \text{BotAlgDeath} - \text{OPHydr} - \text{OPSettl} \tag{135}$$

where the rate of organic phosphorus hydrolysis is computed as

$$\text{OPHydr} = k_{hp}(T)\,p_o \tag{136}$$

where $k_{hp}(T)$ = the temperature-dependent organic phosphorus hydrolysis rate [/d]. Organic phosphorus settling is determined as

$$\text{OPSettl} = \frac{v_{op}}{H}\,p_o \tag{137}$$

where v_{op} = organic phosphorus settling velocity [m/d].

5.5.14 Inorganic Phosphorus (p_i)

Inorganic phosphorus increases due to organic phosphorus hydrolysis, phytoplankton respiration/excretion and bottom plant excretion. It is lost via plant photosynthesis. In addition, a settling loss is included for cases in which inorganic phosphorus is lost due to sorption onto settleable particulate matter such as iron oxyhydroxides:

$$S_{pi} = \text{DOPHydr} + r_{pa}\text{PhytoResp} + \text{BotAlgExP} - r_{pa}\text{PhytoPhoto} - \text{BotAlgUpP} - \text{IPSettl} \tag{138}$$

where

$$\text{IPSettl} = \frac{v_{ip}}{H}\,p_i \tag{139}$$

where v_{ip} = inorganic phosphorus settling velocity [m/d].

5.5.15 Inorganic Suspended Solids (m_i)

Inorganic suspended solids are lost via settling.

$$S_{mi} = -\,\text{InorgSettl}$$

where

$$\text{InorgSettl} = \frac{v_i}{H}\,m_i \tag{140}$$

where v_i = inorganic suspended solids settling velocity [m/d].

5.5.16 Dissolved Oxygen (o)

Dissolved oxygen increases due to plant photosynthesis. It is lost via fast CBOD oxidation, nitrification and plant respiration. Depending on whether the water is undersaturated or oversaturated it is gained or lost via reaeration.

$$S_o = r_{oa}\,\text{PhytoPhoto} + r_{oa}\,\text{BotAlgPhoto} - r_{oc}\,\text{FastCOxid} - r_{on}\,\text{NH4Nitr} - r_{oa}\,\text{PhytoResp} - r_{oa}\,\text{BotAlgResp} + \text{OxReaer} \quad (141)$$

where

$$\text{OxReaer} = k_a(T)\left(o_s(T, elev) - o\right) \quad (142)$$

where $k_a(T)$ = the temperature dependent oxygen reaeration coefficient [/d], $o_s(T, elev)$ = the saturation concentration of oxygen [mgO$_2$/L] at temperature, T, and elevation above sea level, $elev$.

5.5.16.1 Oxygen Saturation

The following equation is used to represent the dependence of oxygen saturation on temperature (APHA 1995)

$$\ln o_s(T, 0) = -139.34411 + \frac{1.575701\times10^5}{T_a} - \frac{6.642308\times10^7}{T_a^2} + \frac{1.243800\times10^{10}}{T_a^3} - \frac{8.621949\times10^{11}}{T_a^4} \quad (143)$$

where $o_s(T, 0)$ = the saturation concentration of dissolved oxygen in freshwater at 1 atm [mgO$_2$/L] and T_a = absolute temperature [K] where $T_a = T + 273.15$.

The effect of elevation is accounted for by

$$o_s(T, elev) = e^{\ln o_s(T,0)}(1 - 0.0001148\,elev) \quad (144)$$

5.5.16.2 Reaeration Formulas

The reaeration coefficient (at 20 °C) can be prescribed on the **Reach Worksheet**. If reaeration is not prescribed (that is, it is blank or zero for a particular reach), it is computed as a function of the river's hydraulics and (optionally) wind velocity.

$$k_a(20) = k_{ah}(20) + \frac{K_{Lw}(20)}{H} \quad (145)$$

where $k_{ah}(20)$ = the reaeration rate at 20 °C computed based on the river's hydraulic characteristics [d^{-1}], $K_L(20)$ = the reaeration mass-transfer coefficient based on wind velocity [m/d], and H = mean depth [m].

Hydraulic-based Formulas:

O'Connor-Dobbins (O'Connor and Dobbins 1958):

$$k_{ah}(20) = 3.93\frac{U^{0.5}}{H^{1.5}} \quad (146)$$

where U = mean water velocity [m/s] and H = mean water depth [m].

Churchill (Churchill et al. 1962):

$$k_{ah}(20) = 5.026\frac{U}{H^{1.67}} \quad (147)$$

Owens-Gibbs (Owens et al. 1964)

$$k_{ah}(20) = 5.32\frac{U^{0.67}}{H^{1.85}} \quad (148)$$

Tsivoglou-Neal (Tsivoglou and Neal 1976):

Low flow, Q = 0.0283 to 0.4247 cms (1 to 15 cfs):

$$k_{ah}(20) = 31{,}183\,US \quad (149)$$

High flow, Q = 0.4247 to 84.938 cms (15 to 3000 cfs):

$$k_{ah}(20) = 15{,}308\,US \quad (150)$$

where S = channel slope [m/m].

Thackston-Dawson (Thackston and Dawson 2001):

$$k_{ah}(20) = 2.16(1 + 9F^{0.25})\frac{U_*}{H} \quad (151)$$

where U_* = shear velocity [m/s], and F = the Froude number [dimensionless]. The shear velocity and the Froude number are defined as

$$U_* = \sqrt{gR_hS} \quad (152)$$

and

$$F = \frac{U}{\sqrt{gH_d}} \quad (153)$$

where g = gravitational acceleration (= 9.81 m/s^2), R_h = hydraulic radius [m], S = channel slope [m/m], and H_d = the hydraulic depth [m]. The hydraulic depth is defined as

$$H_d = \frac{A_c}{B_t} \quad (154)$$

$$S_o = r_{oa}\text{PhytoPhoto} + r_{oa}\text{BotAlgPhoto} - r_{oc}\text{FastCOxid} - r_{on}\text{NH4Nitr} - r_{oa}\text{PhytoResp} - r_{oa}\text{BotAlgResp} + \text{OxReaer} \tag{141}$$

where

$$\text{OxReaer} = k_a(T)\left(o_s(T, elev) - o\right) \tag{142}$$

where $k_a(T)$ = the temperature dependent oxygen reaeration coefficient [/d], $o_s(T, elev)$ = the saturation concentration of oxygen [mgO$_2$/L] at temperature, T, and elevation above sea level, *elev*.

5.5.16.1 Oxygen Saturation

The following equation is used to represent the dependence of oxygen saturation on temperature (APHA 1995)

$$\ln o_s(T, 0) = -139.34411 + \frac{1.575701\times10^5}{T_a} - \frac{6.642308\times10^7}{T_a^2} + \frac{1.243800\times10^{10}}{T_a^3} - \frac{8.621949\times10^{11}}{T_a^4} \tag{143}$$

where $o_s(T, 0)$ = the saturation concentration of dissolved oxygen in freshwater at 1 atm [mgO$_2$/L] and T_a = absolute temperature [K] where $T_a = T + 273.15$.

The effect of elevation is accounted for by

$$o_s(T, elev) = e^{\ln o_s(T, 0)}(1 - 0.0001148\, elev) \tag{144}$$

5.5.16.2 Reaeration Formulas

The reaeration coefficient (at 20 °C) can be prescribed on the **Reach Worksheet**. If reaeration is not prescribed (that is, it is blank or zero for a particular reach), it is computed as a function of the river's hydraulics and (optionally) wind velocity

$$k_a(20) = k_{ah}(20) + \frac{K_{Lw}(20)}{H} \tag{145}$$

where $k_{ah}(20)$ = the reaeration rate at 20 °C computed based on the river's hydraulic characteristics [d^{-1}], $K_l(20)$ = the reaeration mass-transfer coefficient based on wind velocity [m/d], and H = mean depth [m].

Hydraulic-based Formulas:

<u>O'Connor-Dobbins (O'Connor and Dobbins 1958):</u>

$$k_{ah}(20) = 3.93\frac{U^{0.5}}{H^{1.5}} \tag{146}$$

where U = mean water velocity [m/s] and H = mean water depth [m].

<u>Churchill (Churchill et al. 1962):</u>

$$k_{ah}(20) = 5.026\frac{U}{H^{1.67}} \tag{147}$$

Owens-Gibbs (Owens et al. 1964)

$$k_{ah}(20) = 5.32\frac{U^{0.67}}{H^{1.85}} \tag{148}$$

<u>Tsivoglou-Neal (Tsivoglou and Neal 1976):</u>

Low flow, Q = 0.0283 to 0.4247 cms (1 to 15 cfs):

$$k_{ah}(20) = 31{,}183\,US \tag{149}$$

High flow, Q = 0.4247 to 84.938 cms (15 to 3000 cfs):

$$k_{ah}(20) = 15{,}308\,US \tag{150}$$

where S = channel slope [m/m].

<u>Thackston-Dawson (Thackston and Dawson 2001):</u>

$$k_{ah}(20) = 2.16(1 + 9F^{0.25})\frac{U_*}{H} \tag{151}$$

where U_* = shear velocity [m/s], and F = the Froude number [dimensionless]. The shear velocity and the Froude number are defined as

$$U_* = \sqrt{gR_hS} \tag{152}$$

and

$$F = \frac{U}{\sqrt{gH_d}} \tag{153}$$

where g = gravitational acceleration (= 9.81 m/s^2), R_h = hydraulic radius [m], S = channel slope [m/m], and H_d = the hydraulic depth [m]. The hydraulic depth is defined as

$$H_d = \frac{A_c}{B_t} \tag{154}$$

values are specified, Q2K uses the following default values for these coefficients a_d = 1.25 and b_d = 0.9.

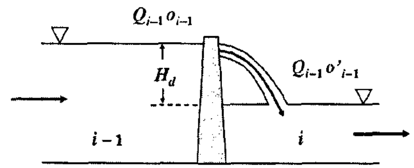


Figure 22 Water flowing over a river control structure.

Table 7 Coefficient values used to predict the effect of dams on stream reaeration.

(a) Water-quality coefficient	
Polluted state	a_d
Gross	0.65
Moderate	1.0
Slight	1.6
Clean	1.8
(b) Dam-type coefficient	
Dam type	b_d
Flat broad-crested regular step	0.70
Flat broad-crested irregular step	0.80
Flat broad-crested vertical face	0.60
Flat broad crested straight slope face	0.75
Flat broad-crested curved face	0.45
Round broad-crested curved face	0.75
Sharp-crested straight-slope face	1.00
Sharp-crested vertical face	0.80
Sluice gates	0.05

The oxygen mass balance for the element below the structure is written as

$$\frac{do_i}{dt}=\frac{Q_{i-1}}{V_i}o'_{i-1}-\frac{Q_i}{V_i}o_i-\frac{Q_{ab,i}}{V_i}o_i+\frac{E'_i}{V_i}(o_{i+1}-o_i)+\frac{W_{o,i}}{V_i}+S_{o,i} \quad (162)$$

where o'_{i-1} = the oxygen concentration entering the element [mgO$_2$/L], where

$$o'_{i-1}=o_{s,i-1}-\frac{o_{s,i-1}-o_{i-1}}{r_d} \quad (163)$$

5.5.17 Pathogen (*X*)

Pathogens are subject to death and settling.

$$S_X=-\text{PathDeath}-\text{PathSettl} \quad (164)$$

5.5.17.1 Death

Pathogen death is due to natural die-off and light (Chapra 1997). The death of pathogens in the absence of light is modeled as a first-order temperature-dependent decay and the death rate due to light is based on the Beer-Lambert law.

$$\text{PathDeath}=k_{dX}(T)X+\alpha_{path}\frac{I(0)/24}{k_eH}\left(1-e^{-k_eH}\right)X \quad (165)$$

where $k_{dX}(T)$ = temperature-dependent pathogen die-off rate [/d] and α_{path} = a light efficiency factor (dimensionless).

5.5.17.2 Settling

Pathogen settling is represented as

$$\text{PathSettl}=\frac{v_X}{H}X \quad (166)$$

where v_X = pathogen settling velocity [m/d].

5.5.18 pH

The following equilibrium, mass balance and electroneutrality equations define a freshwater dominated by inorganic carbon (Stumm and Morgan 1996).

$$K_1=\frac{[HCO_3^-][H^+]}{[H_2CO_3^*]} \quad (167)$$

$$K_2=\frac{[CO_3^{2-}][H^+]}{[HCO_3^-]} \quad (168)$$

$$K_w=[H^+][OH^-] \quad (169)$$

$$c_T=[H_2CO_3^*]+[HCO_3^-]+[CO_3^{2-}] \quad (170)$$

$$Alk=[HCO_3^-]+2[CO_3^{2-}]+[OH^-]-[H^+] \quad (171)$$

where K_1, K_2 and K_w are acidity constants, Alk = alkalinity [eq L^{-1}], $H_2CO_3^*$ = the sum of dissolved carbon dioxide and carbonic acid, HCO_3^- = bicarbonate ion, CO_3^{2-} = carbonate ion, H^+

= hydronium ion, OH^- = hydroxyl ion, and c_T = total inorganic carbon concentration [mole L^{-1}]. The brackets [ ] designate molar concentrations.

Note that the alkalinity is expressed in units of eq/L for the internal calculations. For input and output, it is expressed as $mgCaCO_3/L$. The two units are related by

$$Alk(mgCaCO_3/L) = 50{,}000 \times Alk(eq/L) \qquad (172)$$

The equilibrium constants are corrected for temperature by

Harned and Hamer (1933):

$$pK_w = \frac{4787.3}{T_a} + 7.1321\log_{10}(T_a) + 0.010365T_a - 22.80 \qquad (173)$$

Plummer and Busenberg (1982):

$$\log K_1 = -356.3094 - 0.06091964T_a + 21834.37/T_a + 126.8339\log T_a - 1{,}684{,}915/T_a^2 \qquad (174)$$

Plummer and Busenberg (1982):

$$\log K_2 = -107.8871 - 0.03252849T_a + 5151.79/T_a + 38.92561\log T_a - 563{,}713.9/T_a^2 \qquad (175)$$

The nonlinear system of five simultaneous equations (166 through 170) can be solved numerically for the five unknowns: $[H_2CO_3^*]$, $[HCO_3^-]$, $[CO_3^{2-}]$, $[OH^-]$, and $\{H^+\}$. An efficient solution method can be derived by combining Eqs. (167), (168) and (170) to define the quantities (Stumm and Morgan 1996)

$$\alpha_0 = \frac{[H^+]^2}{[H^+]^2 + K_1[H^+] + K_1K_2} \qquad (176)$$

$$\alpha_1 = \frac{K_1[H^+]}{[H^+]^2 + K_1[H^+] + K_1K_2} \qquad (177)$$

$$\alpha_2 = \frac{K_1K_2}{[H^+]^2 + K_1[H^+] + K_1K_2} \qquad (178)$$

where α_0, α_1, and α_2 = the fraction of total inorganic carbon in carbon dioxide, bicarbonate, and carbonate, respectively. Equations (169), (171), (177) and (178) can then be combined to yield,

$$Alk = (\alpha_1 + 2\alpha_2)c_T + \frac{K_w}{[H^+]} - [H^+] \qquad (179)$$

Thus, solving for pH reduces to determining the root, $\{H^+\}$, of

$$f([H^+]) = (\alpha_1 + 2\alpha_2)c_T + \frac{K_w}{[H^+]} - [H^+] - Alk \qquad (180)$$

where pH is then calculated with

$$pH = -\log_{10}[H^+] \qquad (181)$$

The root of Eq. (180) is determined with a numerical method. The user can choose either the Newton-Raphson or the bisection method (Chapra and Canale 2006) as specified on the QUAL2K sheet. The Newton-Raphson is faster and is the default method. However, it can sometimes diverge. In such cases, because it is more stable, the bisection method would be preferable.

5.5.19 Total Inorganic Carbon (c_T)

Total inorganic carbon concentration increases due to fast carbon oxidation and plant respiration. It is lost via plant photosynthesis. Depending on whether the water is undersaturated or oversaturated with CO_2, it is gained or lost via reaeration.

$$S_{cT} = r_{cco}\text{FastCOxid} + r_{cca}\text{PhytoResp} + r_{cca}\text{BotAlgResp} - r_{cca}\text{PhytoPhoto} - r_{cca}\text{BotAlgPhoto} + \text{CO2Reaer} \qquad (182)$$

where

$$\text{CO2Reaer} = k_{ac}(T)([CO_2]_s - \alpha_0 c_T) \qquad (183)$$

where $k_{ac}(T)$ = the temperature-dependent carbon dioxide reaeration coefficient [/d], and $[CO2]_s$ = the saturation concentration of carbon dioxide [mole/L].

The stoichiometric coefficients are computed as[4]

$$r_{cca} = r_{ca}\left(\frac{gC}{mgA}\right) \times \frac{moleC}{12\,gC} \times \frac{m^3}{1000\,L} \qquad (184)$$

$$r_{cco} = \frac{1}{r_{oc}}\left(\frac{gC}{gO_2}\right)\frac{moleC}{12\,gC} \times \frac{m^3}{1000\,L} \qquad (185)$$

5.5.19.1 Carbon Dioxide Saturation

The CO_2 saturation is computed with Henry's law,

$$[CO_2]_s = K_H p_{CO_2} \qquad (186)$$

---

[4] The conversion, $m^3 = 1000\,L$ is included because all mass balances express volume in m^3, whereas total inorganic carbon is expressed as mole/L.

where K_H = Henry's constant [mole (L atm)$^{-1}$] and p_{CO_2} = the partial pressure of carbon dioxide in the atmosphere [atm]. Note that the partial pressure is input on the **Rates Worksheet** in units of ppm. The program internally converts ppm to atm using the conversion: 10^{-6} atm/ppm.

The value of K_H can be computed as a function of temperature by (Edmond and Gieskes 1970)

$$pK_H = -\frac{2385.73}{T_a} - 0.0152642T_a + 14.0184 \quad (187)$$

The partial pressure of CO_2 in the atmosphere has been increasing, largely due to the combustion of fossil fuels (Figure 23). Values in 2007 are approximately $10^{-3.416}$ atm (≅ 383.7 ppm).

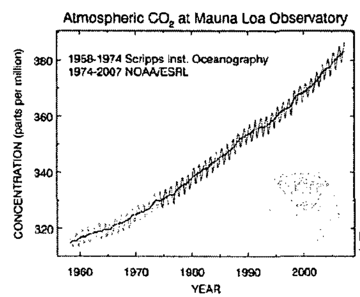


Figure 23 Concentration of carbon dioxide in the atmosphere as recorded at Mauna Loa Observatory, Hawaii.[5]

5.5.19.2 CO_2 Gas Transfer

The CO_2 reaeration coefficient can be computed from the oxygen reaeration rate by

$$k_{ac}(20) = \left(\frac{32}{44}\right)^{0.25} k_a(20) = 0.923\,k_a(20) \quad (188)$$

[5] Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends

5.5.19.3 Effect of Control Structures: CO_2

As was the case for dissolved oxygen, carbon dioxide gas transfer in streams can be influenced by the presence of control structures. Q2K assumes that carbon dioxide behaves similarly to dissolved oxygen (recall Sec. 5.5.16.3). Thus, the inorganic carbon mass balance for the element immediately downstream of the structure is written as

$$\frac{dc_{T,i}}{dt} = \frac{Q_{i-1}}{V_i}c'_{T,i-1} - \frac{Q_i}{V_i}c_{T,i} - \frac{Q_{ab,i}}{V_i}c_{T,i} + \frac{E'_i}{V_i}(c_{T,i-1} - c_{T,i}) + \frac{W_{cT,i}}{V_i} + S_{cT,i} \quad (189)$$

where $c'_{T,i-1}$ = the concentration of inorganic carbon entering the element [mgO$_2$/L], where

$$c'_{T,i-1} = (\alpha_1 + \alpha_2)c_{T,i-1} + CO_{2,i-1} - \frac{CO_{2s,i-1} - \alpha_2 c_{T,i-1}}{r_d} \quad (190)$$

where r_d is calculated with Eq. (161).

5.5.20 Alkalinity (Alk)

As summarized in the present model accounts for changes in alkalinity due to several mechanisms:

Table 8 Processes that effect alkalinity.

Process	Utilize	Create	Alkalinity change
Nitrif	NH4	NO3	Decrease
Denitr	NO3		Increase
OPHydr		SRP	Decrease
ONHydr		NH4	Increase
PhytoPhoto	NH4		Decrease
	NO3		Increase
	SRP		Increase
PhytoResp		NH4	Increase
		SRP	Decrease
BotAlgUpN	NH4		Decrease
	NO3		Increase
BotAlgUpP	SRP		Increase
BotAlgExcrN		NH4	Increase
BotAlgExcrP		SRP	Decrease

5.5.20.1 Nitrification

According to Eq. (60), nitrification utilizes ammonium and creates nitrate. Hence, because a positive ion is taken up and a negative ion is created, the alkalinity is decreased by two equivalents. The change in alkalinity can be related to the nitrification rate by

$$S_{a,nitr} = -\frac{2\text{ eq}}{\text{moleN}}\frac{\text{moleN}}{14.007\text{ gN}}\frac{\text{gN}}{10^6\,\mu\text{gN}}\frac{50{,}000\text{ mgCaCO}_3}{1\text{eq}}\text{Nitrif}\left(\frac{\mu\text{gN}}{\text{L d}}\right) \tag{191}$$

5.5.20.2 Denitrification

According to Eq. (61), denitrification utilizes nitrate and creates nitrogen gas. Hence, because a negative ion is taken up and a neutral compound is created, the alkalinity is increased by one equivalent. The change in alkalinity can be related to the denitrification rate by

$$S_{a,denitr} = \frac{1\text{eq}}{\text{moleN}}\frac{\text{moleN}}{14.007\text{ gN}}\frac{\text{gN}}{10^6\,\mu\text{gN}}\frac{50{,}000\text{ mgCaCO}_3}{1\text{eq}}\text{Denitr}\left(\frac{\mu\text{gN}}{\text{L d}}\right) \tag{192}$$

where the r's are ratios that translate the processes into the corresponding amount of alkalinity. The stoichiometric coefficients are derived from Eqs. (58) through (61) as in

5.5.20.3 Organic P Hydrolysis

Hydrolysis of organic P results in the creation of inorganic phosphate. Depending on the pH, the phosphate will either have 1 (pH ≅ 2 to 7) or 2 (pH ≅ 7 to 12) negative charges. Hence, because negative ions are being created, the alkalinity is decreased by one or two equivalents, respectively. The change in alkalinity can be related to the P hydrolysis rate by[6],

$$S_{a,OPh} =$$

$$-(\alpha_{H2PO4} + 2\alpha_{HPO4} + 3\alpha_{PO4})\frac{\text{eq}}{\text{moleP}}\frac{\text{moleP}}{30.974\text{ gP}}\frac{\text{gP}}{10^6\,\mu\text{gP}}\frac{50{,}000\text{ mgCaCO}_3}{1\text{eq}}\text{OPHydr}\left(\frac{\mu\text{gP}}{\text{L d}}\right) \tag{193}$$

where

$$\alpha_{H2PO4} = \frac{K_{p1}[\text{H}^+]^2}{[\text{H}^+]^3 + K_{p1}[\text{H}^+]^2 + K_{p1}K_{p2}[\text{H}^+] + K_{p1}K_{p2}K_{p3}} \tag{194}$$

$$\alpha_{HPO4} = \frac{K_{p1}K_{p2}[\text{H}^+]}{[\text{H}^+]^3 + K_{p1}[\text{H}^+]^2 + K_{p1}K_{p2}[\text{H}^+] + K_{p1}K_{p2}K_{p3}} \tag{195}$$

$$\alpha_{PO4} = \frac{K_{p1}K_{p2}K_{p3}}{[\text{H}^+]^3 + K_{p1}[\text{H}^+]^2 + K_{p1}K_{p2}[\text{H}^+] + K_{p1}K_{p2}K_{p3}} \tag{196}$$

where $K_{p1} = 10^{-2.15}$, $K_{p2} = 10^{-7.2}$, and $K_{p3} = 10^{-12.35}$.

5.5.20.4 Organic N Hydrolysis

Hydrolysis of organic N results in the creation of ammonia. Depending on the pH, the ammonia will either be in the form of ammonium ion with a single positive charge (pH < 9) or neutral

[6] Note that although it will almost always be negligible, Eq. (193) PO_4^{3-} for completeness.

ammonia gas (pH > 9). Hence, when the positive ions are created, the alkalinity is increased by one equivalent. The change in alkalinity can be related to the N hydrolysis rate by

$$S_{a,ONh} = F_i\frac{1\text{eq}}{\text{moleN}}\frac{\text{moleN}}{14.007\text{ gN}}\frac{\text{gN}}{10^6\,\mu\text{gN}}\frac{50{,}000\text{ mgCaCO}_3}{1\text{eq}}\text{ONHydr}\left(\frac{\mu\text{gN}}{\text{L d}}\right) \tag{197}$$

5.5.20.5 Phytoplankton Photosynthesis

Phytoplankton photosynthesis takes up nitrogen as either ammonia or nitrate and phosphorus as inorganic phosphate. If ammonia is the primary nitrogen source, this leads to a decrease in alkalinity because the uptake of the positively charged ammonium ions is much greater than the uptake of the negatively charged phosphate ions (recall the stoichiometry as described on p. 34). If nitrate is the primary nitrogen source, this leads to an increase in alkalinity because both nitrate and phosphate are negatively charged.

The following representation relates the change in alkalinity to phytoplankton photosynthesis depending on the nutrient sources as well as their speciation as governed by the pH.

$$\begin{aligned} S_{a,PhotoP} = \frac{50{,}000\text{ mgCaCO}_3}{1\text{eq}} & \left(-r_{na}P_{ap}F_i\frac{1\text{eq}}{\text{moleN}}\frac{\text{moleN}}{14.007\text{ gN}}\frac{\text{gN}}{10^6\,\mu\text{gN}}\right. \\ & + r_{na}(1-P_{ap})\frac{1\text{eq}}{\text{moleN}}\frac{\text{moleN}}{14.007\text{ gN}}\frac{\text{gN}}{10^6\,\mu\text{gN}} \\ & \left. + r_{pa}(\alpha_{H2PO4} + 2\alpha_{HPO4} + 3\alpha_{PO4})\frac{1\text{eq}}{\text{moleP}}\frac{\text{moleP}}{30.974\text{ gP}}\frac{\text{gP}}{10^6\,\mu\text{gP}}\right) \\ & \times \text{PhytoPhoto}\left(\frac{\mu\text{gA}}{\text{L d}}\right) \end{aligned} \tag{198}$$

5.5.20.6 Phytoplankton Respiration

Phytoplankton respiration releases ammonia and inorganic phosphate. Because the release of the positively charged ammonium ions is much greater than the uptake of the negatively charged phosphate ions (recall p. 34), this leads to an increase in alkalinity. The following representation relates the change in alkalinity to phytoplankton respiration including the effect of pH on the nutrient's speciation,

$$S_{c,PhytR} = \frac{50{,}000\ \text{mgCaCO}_3}{1\ \text{eq}} \left(r_{na} P_{ap} F_i \frac{1\ \text{eq}}{\text{moleN}} \frac{\text{moleN}}{14.007\ \text{gN}} \frac{\text{gN}}{10^6\ \mu\text{gN}} - r_{pa}(\alpha_{H2PO4} + 2\alpha_{HPO4} + 3\alpha_{PO4}) \frac{1\ \text{eq}}{\text{moleP}} \frac{\text{moleP}}{30.974\ \text{gP}} \frac{\text{gP}}{10^6\ \mu\text{gP}} \right) \times \text{PhytoResp}\left(\frac{\mu\text{gA}}{\text{L d}}\right) \tag{199}$$

5.5.20.7 Bottom Algae Nutrient Uptake

Bottom algae take up nitrogen as either ammonia or nitrate and phosphorus as inorganic phosphate. The following representation relates the change in alkalinity to bottom algae uptake rates depending on the nutrient sources as well as their speciation as governed by the pH.

$$S_{c,BAUp} = \frac{50{,}000\ \text{mgCaCO}_3}{1\ \text{eq}} \left((-P_{ab} F_i + (1 - P_{ab})) \frac{1\ \text{eq}}{\text{moleN}} \frac{\text{moleN}}{14.007\ \text{gN}} \frac{\text{gN}}{10^6\ \mu\text{gN}} \times \frac{\text{BotAlgUpN(mgN/m}^2\text{/d)}}{H(\text{m})} + (\alpha_{H2PO4} + 2\alpha_{HPO4} + 3\alpha_{PO4}) \frac{1\ \text{eq}}{\text{moleP}} \frac{\text{moleP}}{30.974\ \text{gP}} \frac{\text{gP}}{10^6\ \mu\text{gP}} \times \frac{\text{BotAlgUpP(mgP/m}^2\text{/d)}}{H(\text{m})} \right) \tag{200}$$

5.5.20.8 Bottom Algae Nutrient Excretion

Bottom algae excrete ammonia and inorganic phosphate. The following representation relates the change in alkalinity to bottom algae excretion rates including the effect of pH on the nutrient's speciation.

$$S_{c,BAEx} = \frac{50{,}000\ \text{mgCaCO}_3}{1\ \text{eq}} \left(F_i \frac{1\ \text{eq}}{\text{moleN}} \frac{\text{moleN}}{14.007\ \text{gN}} \frac{\text{gN}}{10^6\ \mu\text{gN}} \times \frac{\text{BotAlgExN(mgN/m}^2\text{/d)}}{H(\text{m})} - (\alpha_{H2PO4} + 2\alpha_{HPO4} + 3\alpha_{PO4}) \frac{1\ \text{eq}}{\text{moleP}} \frac{\text{moleP}}{30.974\ \text{gP}} \frac{\text{gP}}{10^6\ \mu\text{gP}} \times \frac{\text{BotAlgExP(mgP/m}^2\text{/d)}}{H(\text{m})} \right) \tag{201}$$

5.6 SOD/Nutrient Flux Model

Sediment nutrient fluxes and sediment oxygen demand (SOD) are based on a model developed by Di Toro (Di Toro et al. 1991, Di Toro and Fitzpatrick, 1993, Di Toro 2001). The present version also benefited from James Martin's (Mississippi State University, personal communication) efforts to incorporate the Di Toro approach into EPA's WASP modeling framework.

A schematic of the model is depicted in Figure 24. As can be seen, the approach allows oxygen and nutrient sediment-water fluxes to be computed based on the downward flux of particulate organic matter from the overlying water. The sediments are divided into 2 layers: a thin (≅ 1 mm) surface aerobic layer underlain by a thicker (10 cm) lower anaerobic layer. Organic carbon, nitrogen and phosphorus are delivered to the anaerobic sediments via the settling of particulate organic matter (i.e., phytoplankton and detritus). There they are transformed by mineralization reactions into dissolved methane, ammonium and inorganic phosphorus. These constituents are then transported to the aerobic layer where some of the methane and ammonium are oxidized. The flux of oxygen from the water required for these oxidations is the sediment oxygen demand. The following sections provide details on how the model computes this SOD along with the sediment-water fluxes of carbon, nitrogen and phosphorus that are also generated in the process.

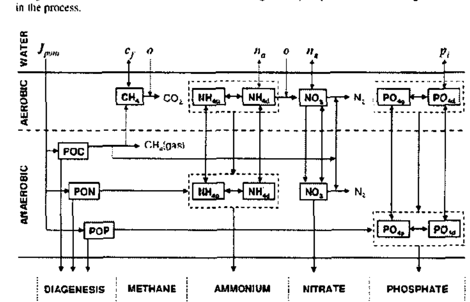


Figure 24 Schematic of SOD-nutrient flux model of the sediments.

5.6.1 Diagenesis

As summarized in Figure 25, the first step in the computation involves determining how much of the downward flux of particulate organic matter (POM) is converted into soluble reactive forms in the anaerobic sediments. This process is referred to as diagenesis. First the total downward flux is computed as the sum of the fluxes of phytoplankton and detritus settling from the water column

$$J_{POM} = r_{da} v_a a_p + v_{dt} m_o \tag{203}$$

where J_{POM} = the downward flux of POM [gD m^{-2} d^{-1}], r_{da} = the ratio of dry weight to chlorophyll a [gD/mgA], v_a = phytoplankton settling velocity [m/d], a_p = phytoplankton concentration [mgA/m^3], v_{dt} = detritus settling velocity [m/d], and m_o = detritus concentration [gD/m^3].

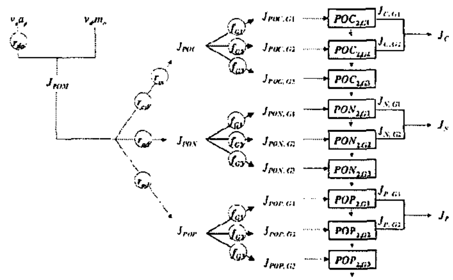


Figure 25 Representation of how settling particulate organic particles (phytoplankton and detritus) are transformed into fluxes of dissolved carbon (J_C), nitrogen (J_N) and phosphorus (J_P) in the anaerobic sediments.

Stoichiometric ratios are then used to divide the POM flux into carbon, nitrogen and phosphorus. Note that for convenience, we will express the particulate organic carbon (POC) as oxygen equivalents using the stoichiometric coefficient r_{oc}. Each of the nutrient fluxes is further broken down into three reactive fractions: labile (G1), slowly reacting (G2) and non-reacting (G3).

These fluxes are then entered into mass balances to compute the concentration of each fraction in the anaerobic layer. For example, for labile POC, a mass balance is written as

$$H_2 \frac{dPOC_{2,G1}}{dt} = J_{POC,G1} - k_{POC,G1} \theta_{POC,G1}^{T-20} H_2 POC_{2,G1} - w_2 POC_{2,G1} \quad (203)$$

where H_2 = the thickness of the anaerobic layer [m], $POC_{2,G1}$ = the concentration of the labile fraction of POC in the anaerobic layer [gO$_2$/m^3], $J_{POC,G1}$ = the flux of labile POC delivered to the anaerobic layer [gO$_2$/m^2/d], $k_{POC,G1}$ = the mineralization rate of labile POC [d^{-1}], $\theta_{POC,G1}$ = temperature correction factor for labile POC mineralization [dimensionless], and w_2 = the burial velocity [m/d]. At steady state, Eq. 197 can be solved for

$$POC_{2,G1} = \frac{J_{POC,G1}}{k_{POC,G1} \theta_{POC,G1}^{T-20} H_2 + w_2} \quad (204)$$

The flux of labile dissolved carbon, $J_{C,G1}$ [gO$_2$/m^2/d], can then be computed as

$$J_{C,G1} = k_{POC,G1} \theta_{POC,G1}^{T-20} H_2 POC_{2,G1} \quad (205)$$

In a similar fashion, a mass balance can be written and solved for the slowly reacting dissolved organic carbon. This result is then added to Eq. 199 to arrive at the total flux of dissolved carbon generated in the anaerobic sediments.

$$J_C = J_{C,G1} + J_{C,G2} \quad (206)$$

Similar equations are developed to compute the diagenesis fluxes of nitrogen, J_N [gN/m^2/d], and phosphorus J_P [gP/m^2/d].

5.6.2 Ammonium

Based on the mechanisms depicted in Figure 24, mass balances can be written for total ammonium in the aerobic layer and the anaerobic layers,

$$\begin{aligned} H_1 \frac{dNH_{4,1}}{dt} &= \omega_{12}(f_{pa2} NH_{4,2} - f_{pa1} NH_{4,1}) + K_{L12}(f_{da2} NH_{4,2} - f_{da1} NH_{4,1}) - w_2 NH_{4,1} \\ &+ s\left(\frac{n_a}{1000} - f_{da1} NH_{4,1}\right) - \frac{\kappa_{NH4,1}^2}{s} \theta_{NH4}^{T-20} \frac{K_{NH4}}{K_{NH4} + NH_{4,1}} \frac{o}{2K_{NH4,O2} + o} f_{da1} NH_{4,1} \end{aligned} \quad (207)$$

$$\begin{aligned} H_2 \frac{dNH_{4,2}}{dt} &= J_N + \omega_{12}(f_{pa1} NH_{4,1} - f_{pa2} NH_{4,2}) + K_{L12}(f_{da1} NH_{4,1} - f_{da2} NH_{4,2}) \\ &+ w_2 (NH_{4,1} - NH_{4,2}) \end{aligned} \quad (208)$$

where H_1 = the thickness of the aerobic layer [m], $NH_{4,1}$ and $NH_{4,2}$ = the concentration of total ammonium in the aerobic layer and the anaerobic layers, respectively [gN/m^3], n_a = the ammonium concentration in the overlying water [mgN/m^3], $\kappa_{NH4,1}$ = the reaction velocity for nitrification in the aerobic sediments [m/d], θ_{NH4} = temperature correction factor for nitrification [dimensionless], K_{NH4} = ammonium half saturation constant [gN/m^3], o = the dissolved oxygen concentration in the overlying water [gO$_2$/m^3], and $K_{NH4,O2}$ = oxygen half-saturation constant [mgO$_2$/L], and J_N = the diagenesis flux of ammonium [gN/m^2/d].

The fraction of ammonium in dissolved (f_{dai}) and particulate (f_{pai}) form are computed as

$$f_{dai} = \frac{1}{1 + m_i \pi_{ai}} \quad (209)$$

$$f_{pai} = 1 - f_{dai} \quad (210)$$

where m_i = the solids concentration in layer i [gD/m^3], and π_{ai} = the partition coefficient for ammonium in layer i [m^3/gD].

The mass transfer coefficient for particle mixing due to bioturbation between the layers, ω_{12} [m/d], is computed as

$$\omega_b = \frac{D_p \theta_{Dp}^{T-20}}{H_2} \frac{POC_{2,G1}/r_{oc}}{POC_R} \frac{o}{K_{M,Dp} + o} \tag{211}$$

where D_p = diffusion coefficient for bioturbation [m²/d], θ_{Dp} = temperature coefficient [dimensionless], POC_R = reference G1 concentration for bioturbation [gC/m³] and $K_{M,Dp}$ = oxygen half-saturation constant for bioturbation [gO$_2$/m³].

The mass transfer coefficient for pore water diffusion between the layers, K_{L12} [m/d], is computed as,

$$K_{L12} = \frac{D_d \theta_{Dd}^{T-20}}{H_2/2} \tag{212}$$

where D_d = pore water diffusion coefficient [m²/d], and θ_{Dd} = temperature coefficient [dimensionless].

The mass transfer coefficient between the water and the aerobic sediments, s [m/d], is computed as

$$s = \frac{SOD}{o} \tag{213}$$

where SOD = the sediment oxygen demand [gO$_2$/m²/d].

At steady state, Eqs. 201 and 202 are two simultaneous nonlinear algebraic equations. The equations can be linearized by assuming that the $NH_{4,1}$ term in the Monod term for nitrification is constant. The simultaneous linear equations can then be solved for $NH_{4,1}$ and $NH_{4,2}$. The flux of ammonium to the overlying water can then be computed as

$$J_{NH4} = s\left(f_{da1} NH_{4,1} - \frac{n_a}{1000}\right) \tag{214}$$

5.6.3 Nitrate

Mass balances for nitrate can be written for the aerobic and anaerobic layers as

$$H_1 \frac{dNO_{3,1}}{dt} = K_{L12}(NO_{3,2} - NO_{3,1}) - w_2 NO_{3,1} + s\left(\frac{n_a}{1000} - NO_{3,1}\right) + \frac{\kappa_{NH4,1}^2}{s} \theta_{NH4}^{T-20} \frac{K_{NH4}}{K_{NH4} + NH_{4,1}} \frac{o}{2K_{NH4,O2} + o} f_{da1} NH_{4,1} - \frac{\kappa_{NO3,1}^2}{s} \theta_{NO3}^{T-20} NO_{3,1} \tag{215}$$

$$H_2 \frac{dNO_{3,2}}{dt} = J_N + K_{L12}(NO_{3,1} - NO_{3,2}) + w_2(NO_{3,1} - NO_{3,2}) - \kappa_{NO3,2} \theta_{NO3}^{T-20} NO_{3,2} \tag{216}$$

where $NO_{3,1}$ and $NO_{3,2}$ = the concentration of nitrate in the aerobic layer and the anaerobic layers, respectively [gN/m³], n_a = the nitrate concentration in the overlying water [mgN/m³], $\kappa_{NO3,1}$ and $\kappa_{NO3,2}$ = the reaction velocities for denitrification in the aerobic and anaerobic sediments, respectively [m/d], and θ_{NO3} = temperature correction factor for denitrification [dimensionless].

In the same fashion as for Eqs. 201 and 202, Eqs. 209 and 210 can be linearized and solved for $NO_{3,1}$ and $NO_{3,2}$. The flux of nitrate to the overlying water can then be computed as

$$J_{NO3} = s\left(NO_{3,1} - \frac{n_a}{1000}\right) \tag{217}$$

Denitrification requires a carbon source as represented by the following chemical equation.

$$5CH_2O + 4NO_3^- + 4H^+ \rightarrow 5CO_2 + 2N_2 + 7H_2O \tag{218}$$

The carbon requirement (expressed in oxygen equivalents per nitrogen) can therefore be computed as

$$r_{ondn} = 2.67 \frac{gO_2}{gC} \frac{5\,moleC \times 12\,gC/moleC}{4\,moleN \times 14\,gN/moleN} \times \frac{1\,gN}{1000\,mgN} = 0.00286 \frac{gO_2}{mgN} \tag{219}$$

Therefore, the oxygen equivalents consumed during denitrification, $J_{O2,dn}$ [gO$_2$/m²/d], can be computed as

$$J_{O2,dn} = 1000 \frac{mgN}{gN} \times r_{ondn} \left(\frac{\kappa_{NO3,1}^2}{s} \theta_{NO3}^{T-20} NO_{3,1} - \kappa_{NO3,2} \theta_{NO3}^{T-20} NO_{3,2}\right) \tag{220}$$

5.6.4 Methane

The dissolved carbon generated by diagenesis is converted to methane in the anaerobic sediments. Because methane is relatively insoluble, its saturation can be exceeded and methane gas produced. As a consequence, rather than write a mass balance for methane in the anaerobic layer, an analytical model developed by Di Toro et al. (1990) is used to determine the steady-state flux of dissolved methane corrected for gas loss delivered to the aerobic sediments.

First, the carbon diagenesis flux is corrected for the oxygen equivalents consumed during denitrification,

$$J_{CH4,T} = J_C - J_{O2,dn} \tag{221}$$

where $J_{CH4,T}$ = the carbon diagenesis flux corrected for denitrification [gO$_2$/m²/d]. In other words, this is the total anaerobic methane production flux expressed in oxygen equivalents.

If $J_{CH4,T}$ is sufficiently large ($\geq 2K_{L12}C_s$), methane gas will form. In such cases, the flux can be corrected for the gas loss,

$$J_{CH4,d} = \sqrt{2K_{L12} C_s J_{CH4,T}} \tag{222}$$

where $J_{CH4,d}$ = the flux of dissolved methane (expressed in oxygen equivalents) that is generated in the anaerobic sediments and delivered to the aerobic sediments [gO$_2$/m^2/d], C_s = the saturation concentration of methane expressed in oxygen equivalents [mgO$_2$/L]. If $J_{CH4,T} < 2K_{L12}C_s$, then no gas forms and

$$J_{CH4,d} = J_{CH4,T} \quad (223)$$

The methane saturation concentration is computed as

$$C_s = 100\left(1 + \frac{H}{10}\right)1.024^{20-T} \quad (224)$$

where H = water depth [m] and T = water temperature [°C].

A methane mass balance can then be written for the aerobic layer as

$$H_1\frac{dCH_{4,1}}{dt} = J_{CH4,d} + s(c_f - CH_{4,1}) - \frac{\kappa_{CH4,1}^2}{s}\theta_{CH4}^{T-20}CH_{4,1} \quad (225)$$

where $CH_{4,1}$ = methane concentration in the aerobic layer [gO$_2$/m^3], c_f = fast CBOD in the overlying water [gO$_2$/m^3], $\kappa_{CH4,1}$ = the reaction velocity for methane oxidation in the aerobic sediments [m/d], and θ_{CH4} = temperature correction factor [dimensionless]. At steady, state, this balance can be solved for

$$CH_{4,1} = \frac{J_{CH4,d} + sc_f}{s + \frac{\kappa_{CH4,1}^2}{s}\theta_{CH4}^{T-20}} \quad (226)$$

The flux of methane to the overlying water, J_{CH4} [gO$_2$/m^2/d], can then be computed as

$$J_{CH4} = s(CH_{4,1} - c_f) \quad (227)$$

5.6.5 SOD

The SOD [gO$_2$/m^2/d] is equal to the sum of the oxygen consumed in methane oxidation and nitrification.

$$SOD = CSOD + NSOD \quad (228)$$

where $CSOD$ = the amount of oxygen demand generated by methane oxidation [gO$_2$/m^2/d] and $NSOD$ = the amount of oxygen demand generated by nitrification [gO$_2$/m^2/d]. These are computed as

$$CSOD = \frac{\kappa_{CH4,1}^2}{s}\theta_{CH4}^{T-20}CH_{4,1} \quad (229)$$

$$NSOD = r_{on}\frac{\kappa_{NH4,1}^2}{s}\theta_{NH4}^{T-20}\frac{K_{NH4}}{K_{NH4} + NH_{4,1}}\frac{o}{2K_{NH4,O2} + o}f_{da1}NH_{4,1} \quad (230)$$

where r_{on} = the ratio of oxygen to nitrogen consumed during nitrification [= 4.57 gO$_2$/gN].

5.6.6 Inorganic Phosphorus

Mass balances can be written total inorganic phosphorus in the aerobic layer and the anaerobic layers as

$$H_1\frac{dPO_{4,1}}{dt} = \omega_{12}(f_{pp2}PO_{4,2} - f_{pp1}PO_{4,1}) + K_{L12}(f_{dp2}PO_{4,2} - f_{dp1}PO_{4,1}) - \kappa_2 PO_{4,1} + s\left(\frac{p_i}{1000} - f_{dp1}PO_{4,1}\right) \quad (231)$$

$$H_2\frac{dPO_{4,2}}{dt} = J_P + \omega_{12}(f_{pp1}PO_{4,1} - f_{pp2}PO_{4,2}) + K_{L12}(f_{dp1}PO_{4,1} - f_{dp2}PO_{4,2}) + \kappa_2(PO_{4,1} - PO_{4,2}) \quad (232)$$

where $PO_{4,1}$ and $PO_{4,2}$ = the concentration of total inorganic phosphorus in the aerobic layer and the anaerobic layers, respectively [gP/m^3], p_i = the inorganic phosphorus in the overlying water [mgP/m^3], and J_P = the diagenesis flux of phosphorus [gP/m^2/d].

The fraction of phosphorus in dissolved (f_{dpi}) and particulate (f_{ppi}) form are computed as

$$f_{dpi} = \frac{1}{1 + m_i\pi_{pi}} \quad (233)$$

$$f_{ppi} = 1 - f_{dpi} \quad (234)$$

where π_{pi} = the partition coefficient for inorganic phosphorus in layer i [m^3/gD].

The partition coefficient in the anaerobic layer is set to an input value. For the aerobic layer, if the oxygen concentration in the overlying water column exceeds a critical concentration, o_{crit} [gO$_2$/m^3], then the partition coefficient is increased to represent the sorption of phosphorus onto iron oxyhydroxides as in

$$\pi_{p1} = \pi_{p2}(\Delta\pi_{PO4,1}) \quad (235)$$

where $\Delta\pi_{PO4,1}$ is a factor that increases the aerobic layer partition coefficient relative to the anaerobic coefficient.

If the oxygen concentration falls below o_{crit}, then the partition coefficient is decreased smoothly until it reaches the anaerobic value at zero oxygen.

$$\pi_{p1} = \pi_{p2} (\Delta \pi_{PO4,1})^{\ldots} \quad (236)$$

Equations 225 and 226 can be solved for $PO_{4,1}$ and $PO_{4,2}$. The flux of phosphorus to the overlying water can then be computed as

$$J_{PO4} = s\left(PO_{4,1} - \frac{p_i}{1000} \right) \quad (237)$$

5.6.7 Solution Scheme

Although the foregoing sequence of equations can be solved, a single computation will not yield a correct result because of the interdependence of the equations. For example, the surface mass transfer coefficient s depends on SOD. The SOD in turn depends on the ammonium and methane concentrations which themselves are computed via mass balances that depend on s. Hence, an iterative technique must be used. The procedure used in QUAL2K is

1. Determine the diagenesis fluxes: J_C, J_N and J_P.
2. Start with an initial estimate of SOD,

   $$SOD_{init} = J_C + r_{on}' J_N \quad (238)$$

   where r_{on}' = the ratio of oxygen to nitrogen consumed for total conversion of ammonium to nitrogen gas via nitrification/denitrification [= 1.714 gO_2/gN]. This ratio accounts for the carbon utilized for denitrification.
3. Compute s using

   $$s = \frac{SOD_{init}}{o} \quad (239)$$

4. Solve for ammonium, nitrate and methane, and compute the $CSOD$ and $NSOD$.
5. Make a revised estimate of SOD using the following weighted average

   $$SOD = \frac{SOD_{init} + CSOD + NSOD}{2} \quad (240)$$

6. Check convergence by calculating an approximate relative error

   $$\varepsilon_a = \left| \frac{SOD - SOD_{init}}{SOD} \right| \times 100\% \quad (241)$$

7. If ε_a is greater than a prespecified stopping criterion ε_s then set $SOD_{init} = SOD$ and return to step 2.
8. If convergence is adequate ($\varepsilon_a \le \varepsilon_s$), then compute the inorganic phosphorus concentrations.

9. Compute the ammonium, nitrate, methane and phosphate fluxes.

5.6.8 Supplementary Fluxes

Because of the presence of organic matter deposited prior to the summer steady-state period (e.g., during spring runoff), it is possible that the downward flux of particulate organic matter is insufficient to generate the observed SOD. In such cases, a supplementary SOD can be prescribed.

$$SOD_t = SOD + SOD_s \quad (242)$$

where SOD_t = the total sediment oxygen demand [$gO_2/m^2/d$], and SOD_s = the supplementary SOD [$gO_2/m^2/d$]. In addition, prescribed ammonia and methane fluxes can be used to supplement the computed fluxes.