

**SYSTEMS DEVELOPMENT FOR ENVIRONMENTAL IMPACT
ASSESSMENT OF CONCENTRATE DISPOSAL**

**CorVue and CorSpy Interactive Visualization
Tools for CORMIX Mixing Zone Analysis**

Agreement No. 10-FC-81-0785

**Desalination and Water Purification Research and Development
Program Final Report No. 98**

July 2003



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Technical Service Center
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14. ABSTRACT This report details development of CORMIX desktop computer information systems to address the hydrodynamic, ecological, and regulatory issues associated with the fate and transport of desalination facility concentrate discharged into surface waters. The information systems described here improve the ecological impact assessment, regulatory management, and scientific prediction of concentrate behavior within the mixing zone, a limited region where the initial mixing of a discharge occurs. The <i>CorSpy</i> and <i>CorVue</i> computer visualization techniques developed in this project are tools which enhance communication of environmental impacts associated within the hydrodynamic mixing zone to scientists, engineers, regulators, industry, and the public. This report describes state-of-the-art systems for hydrodynamic process simulation, environmental impact visualization, regulatory risk assessment, and infrastructure design. This 1-year project (with optional 2 nd and 3 rd years) began at the Oregon Graduate Institute (OGI) and was completed at Portland State University when the PI accepted a position at the later university. The objective of the project was to develop visualizations for hydrodynamic simulation models of the mixing zones specific to desalination facility concentrate discharges. A proposed future project year would develop computer-aided design (CAD) systems to suggest and visualize techniques for improvement of mixing behavior and make suggestions for outfall design optimization					
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**Robert L. Doneker, Ph.D., P.E.
Assistant Research Professor
Portland State University
Department of Civil and Environmental Engineering
PO Box 751
1719 S. W. 10th No. 128
Portland OR 97201**

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Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Executive Summary

This report details development of CORMIX desktop computer information systems to address the hydrodynamic, ecological, and regulatory issues associated with the fate and transport of desalination facility concentrate discharged into surface waters. The information systems described here improve the ecological impact assessment, regulatory management, and scientific prediction of concentrate behavior within the mixing zone, a limited region where the initial mixing of a discharge occurs. The *CorSpy* and *CorVue* computer visualization techniques developed in this project are tools which enhance communication of environmental impacts associated within the hydrodynamic mixing zone to scientists, engineers, regulators, industry, and the public. This report describes state-of-the-art systems for hydrodynamic process simulation, environmental impact visualization, regulatory risk assessment, and infrastructure design.

This 1-year project (with optional 2nd and 3rd years) began at the Oregon Graduate Institute (OGI) and was completed at Portland State University when the PI accepted a position at the later university. The objective of the project was to develop visualizations for hydrodynamic simulation models of the mixing zones specific to desalination facility concentrate discharges. A proposed future project year would develop computer-aided design (CAD) systems to suggest and visualize techniques for improvement of mixing behavior and make suggestions for outfall design optimization.

The standard Cormix model is free to Federal and State water quality regulators, but all others must pay for a yearly license fee. Non-regulatory Federal agencies can receive discounts. This following link has pricing information:

<<http://www.mixzon.com/sales/uspricing.php>>

An evaluation version of CORMIX is available for a 30 day period (or 15 executions, whatever comes first). The user must register with MIXON first to get to the download.

The evaluation version becomes the full CORMIX model after the user purchases a license with software unlock codes. Software downloads can be found at:

<<http://www.mixzon.com/downloads/index.html>>

1. Background

Problem Scenario and Our Vision: A persistent drought grips a coastal community. A water utility seeks a permit to construct a desalination facility. However, the local fishing industry strongly objects. Most vocal are the oystermen, who fear that the concentrate waste disposed from the facility will adversely affect centuries-old harvest beds. However, regulators, plant designers, and the public have access to validated computer models and advanced visualization techniques. Simulations show that the saline discharge plunges quickly into a derelict shipping channel, and then is rapidly dispersed by a strong ambient current. Visualizations of the advanced multiport diffuser system designed for the facility illustrate the behavior of the concentrate plume to the public with easily understood graphic animations. These visualizations show in detail the plume first rising and then sinking to the bottom where it is quickly diluted to background levels long before contact with sensitive oyster beds. After the fishermen withdraw their objections, opposition soon eases and the desalination facility is permitted. Expanded fresh water supplies attract new business and industries to the area, strengthening the local economy.

This project expands the functionality of CORMIX, a USEPA-approved simulation and decision support



Figure 1. Example of a wastewater outfall and shoreline plume boundary interaction. The wastewater plume contacts the shoreline and exhibits upstream density current buoyant spreading. Due to the shallow water discharge location, near-field instabilities with significant benthic and shoreline impacts are likely (Photo: I. Wood).

system for environmental impact assessment of mixing zones resulting from continuous point source discharges.

The CORMIX system emphasizes the role of boundary interaction to predict mixing behavior and plume geometry. The methodology contains systems to model submerged single-port and multiport diffuser discharges as well as surface discharge sources.

Effluents considered may be conservative, non-conservative, heated, or contain suspended sediments. This project develops the advanced CORMIX information systems specific to desalination concentrate disposal water quality modeling, regulatory decision support, environmental impact visualization, and techniques for outfall specification and design optimization.

1.1 Project Objective

The project objective was to develop *interactive computer visualization tools* for 3-Dimensional (3D) display of mixing zone processes for concentrate disposal plumes.

The *CorVue* and *CorSpy* visualization tools described below deliver project objectives to the public.

The CorVue computer visualization tool displays mixing zone processes and the behavior of concentrate plumes on benthic regions and shoreline boundaries. Visualization tools address concentrate plume boundary interaction, near-field dynamic attachments, instabilities, density currents, upstream buoyant spreading, and formation of density-stratified terminal layers. Interactive graphic tools display the effect of flow stability and boundary interaction on mixing behavior. New techniques address regulatory mixing zones which may be specified as lengths, areas, or volumes around the discharge point.

Tools display concentration profiles for near-field and far-field mixing processes. Visualizations include the negatively buoyant flow classifications for single port discharges (CORMIX1), multiport diffuser discharges (CORMIX2), and surface discharge sources (CORMIX3).

The CorSpy tool is an interactive 3-D outfall design and specification tool for single port (CORMIX1) and multiport (CORMIX2) and surface (CORMIX3) discharges. CorSpy provides a 3-D view location of the outfall in relation to ambient boundaries, and provides interactive specification of discharge diffuser orientation parameters. It visualizes unidirectional, alternating, and staged diffuser types, and illustrates optimized designs with fanned multiport diffusers with or without “duckbill” check-valves.

2. Technical Approach

The technical approach to concentrate disposal management focused on the development of desktop computer information systems for environmental impact assessment, regulatory compliance, and decision support for outfall design optimization. The CORMIX system uses the artificial intelligence technology of rule-based expert systems to provide a rigorous and comprehensive assessment of the initial mixing process to users who may possess only a limited background in physical science.

2.1 Characterization of Concentrate Mixture

The concentrate or reject will be treated as a single-phase liquid for mixing zone simulation. Desalination reject may typically be twice the original seawater solution of dissolved metals. The reject may also contain dissolved chemicals used in the pretreatment of the feed water, including low concentrations of anti-scalants, surfactants,

and acid. Constituents of the concentrate can be specified as conventional, non-conventional, or toxic under NPDES permit regulations. Characterization of three types of pollutant constituents within the concentrate is considered for simulation systems development:

- (a) Conservative Pollutant: The pollutant does not undergo any decay/growth processes within the mixing zone.
- (b) Non-conservative Pollutant: The pollutant undergoes a first order decay or growth process within the mixing zone. One needs to specify the coefficient of decay k (positive number) or growth (negative number) in units of day^{-1} (per day) and elapsed time t since discharge as:

$$\text{(Eq. 1)} \quad c=c_0e^{-kt}$$

- (c) Heated Discharge: The discharge experiences heat loss to the atmosphere in cases where the plume contacts the water surface. It is necessary to specify the discharge condition in terms of excess temperature ("delta T") above ambient in units $^{\circ}\text{C}$, and the surface heat exchange coefficient in units $\text{W}/\text{m}^2, ^{\circ}\text{C}$. Values of the heat exchange coefficient depend on ambient water temperature and wind speed and will be supplied to the user at data entry time.

The hydrodynamic simulation models and graphics provide a prediction of the physical dilution S defined as

$$\text{(Eq. 2)} \quad s = \frac{c_0}{c}$$

where c_0 is the initial constituent concentration and c is the concentration within the plume at a given point downstream.

2.2 Software Design

The interactive and fully integrated software delivered employs object-oriented code for visual display, structured procedural code for hydrodynamic simulation, and rule-based logic code for model selection, simulation interpretation, regulatory assessment, and design optimization [33-35].

The visualization tools developed are object-oriented 3-dimensional graphic display libraries. The graphic libraries and visualization techniques developed will define the ambient environment, discharge conditions, regulatory constraints, and plume pollutant properties. The visualization techniques developed are constructed in C++ code for transportability.

The code developed in this project was developed with 32-bit Windows NT running on Pentium-IV engineering graphic workstations. Careful selection of graphic development tool libraries were undertaken to assure portability to Pentium based PC's as the intended runtime platform.

2.3 Significant Deliverables

A complete set of visualization tools for 3-D display of concentrate disposal outfall systems and resulting mixing zone behavior are delivered by the CorVue and CorSpy tools. Graphic tools produced specifically address 3-D mixing zone visualization for existing negatively buoyant plume CORMIX1 (NV and NH flow classes), CORMIX2 (NMU and NMH flow classes). Visualizations routines include functions for interactive

display of plume concentration profiles, physical properties, scaling, axis, current vectors, labels, benthic impacts, and regulatory mixing zone boundaries. Graphic routines developed display spatial extent and concentration profiles for environmental impact assessment including attached Coanda and wake flows within the near-field. Ambient environment visualizations include representation local and far-field depths and local and far-field bottom slope. Plume visualization routines have also been developed to display possible discharge outfall configurations for concentrate disposal including: single port, alternating multiport, staged multiport, unidirectional multiport, surface protruding, surface flush, surface co-flowing discharges for the CORMIX (near-bottom discharge) systems. Single port and multiport diffusers graphic display include “duckbill” check-valves and fanned diffusers for optimization of near-field mixing. These routines have been integrated into the existing rule base and simulation system for comprehensive interactive graphic visualization and display of outfall design and resulting mixing zone behavior. The development of these graphic tools provides the design visualization foundation in the optional Phase 2 FY2003 development of Computer-Aided-Design systems for concentrate disposal. In addition, these graphics will assist in the development and validation of new hydrodynamic simulation models as called for in optional Phase 3 FY2004 of the Project.

3. Conclusions

The result of this project is improved environmental management achieved by technology transfer through interactive simulation and decision support software. Systems developed can be used by scientists to improve prediction techniques, by regulators to assess and manage risk, and finally by consultants, engineers, and the public to analyze impacts and

optimize outfall design. The systems developed can have immediate and widespread application to several thousand desalination concentrate discharges worldwide.

Techniques developed improve scientific prediction of mixing zones by supporting researchers in calibration and validation of hydrodynamic models. Regulators can obtain enhanced scientific methods to analyze water quality impacts of mixing zones. The public benefits from the design and management advice the system displays to correct avoidable and undesirable mixing behavior. Since the same integrated software analysis tools will be used by all of these groups, communication among them about mixing phenomena, risk assessment, regulatory requirements, and design optimization will be improved.

4. Environmental Impact

This project produced improved decision support to over 3000 CORMIX mixing zone model users worldwide. The techniques developed provide regulators and the public with the tools to understand mixing processes and to mitigate impacts of concentrate disposal.

In summary, this project:

- Enables scientists to improve hydrodynamic mixing zone prediction of concentrate waste disposal.
- Supports regulators in management of concentrate discharges within the NPDES permit system.
- Produces visualization tools to show the public the environmental impacts of concentrate disposal.

5. Acknowledgements

This project was supported by a grant from the Bureau of Reclamation, contract Agreement No. 01-FC-81-0785. USEPA also provides support for CORMIX distribution and support through Agreement Number No. CX824847-01-1, Ms. Lauren McWilliams, project officer.

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7. Appendix A: CorVue User Help

CorVue v 3.0: User Help Manual

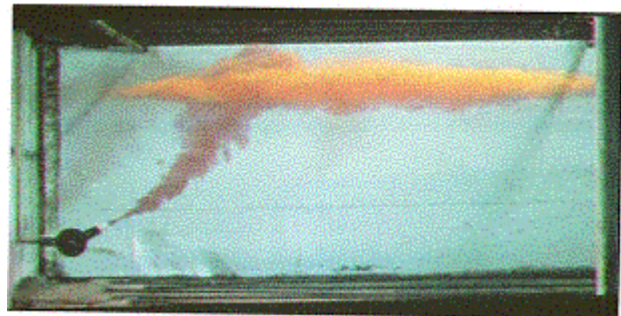
7.1 Introduction

CorVue v 3.0 *Interactive 3-D Mixing Zone Graphics*

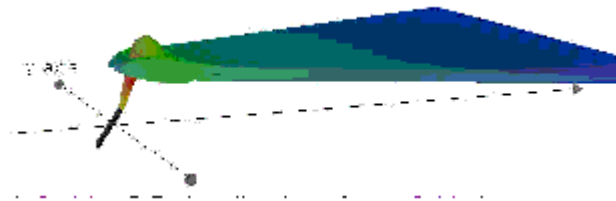
Do you want to see the 3-dimensional characteristics of your regulatory mixing zone? Would your clients needs be satisfied by visualization of mixing zone near-field and far-field properties? If so, then the advanced capabilities of CorVue may be your best solution.

This advanced tool allows the analyst to easily assess plume regulatory mixing zone behavior for [CORMIX1](#), [CORMIX2](#), and [CORMIX3](#) simulations. Quickly visualize boundary interactions and density current upstream intrusions for efficient documentation of regulatory compliance.

For More Information go to <http://www.cormix.info>



(Photo: Hofler, ETH).



A CorVue 3-D visualization of near-field plume trapping boundary interaction and upstream density current formation in a stratified crossflow (enhanced image)

The CorVue computer visualization tool described here displays mixing zone processes and the behavior of concentrate plumes on benthic regions and shoreline boundaries.

Visualization tools address concentrate plume boundary interaction, near-field dynamic attachments, instabilities, density currents, upstream buoyant spreading, and formation of

density-stratified terminal layers. Interactive graphic tools display the effect of flow stability and boundary interaction on mixing behavior. New techniques address regulatory mixing zones which may be specified as lengths, areas, or volumes around the discharge point. Tools display concentration profiles for near-field and far-field mixing processes. Visualizations include positively and negatively buoyant flow classifications for single port discharges (CORMIX1), multiport diffuser discharges (CORMIX2), and surface discharge sources (CORMIX3).

7.2 Hints for use:

Try the following lists of GUI toolbar functions, generally in order, to help optimize your visualization.

- Change the *region of visualization* to approximately 3-10 times near-field region
- Use the *scale factor* to change x-y and x-y distortion and set from approximately 1:1 to 10:1
- Change axis labels, ticks, and offsets
- Right click on screen to change font size)
- Use bottom, water surface, bank toggles
- Toggle controls for Modules, TDZ, RMZ
- Change the position of the water surface and current direction
- Use the rotate image tool
- Change camera position

7.3 Description of Functions and Controls





Figure 1.—CorVue Toolbar


While the Toolbar is given as one large bar above. Each toolbar can be moved individually.


7.3.1 Standard Toolbar



 **Open:** Opens and renders a file of a plume based on a CORMIX prediction file (*.prd).

 **New:** Creates a new copy of the prediction file already loaded in the application window. This allows the user to have several windows of the plume open simultaneously.

 **Save as postscript file:** Saves the current plume as a postscript file (*.ps), which can later be viewed and edited using an application like Adobe Photoshop®. Note that the CorVue v 4.0 application must be terminated or exited before the image in a postscript can be viewed.

 **Animate:** Allows users to view a series of CORMIX prediction files in a frame-by-frame animation. The user must select a text file, which contains a list of paths of CORMIX prediction files to be animated. The user can control the speed by specifying the time interval between each frame.

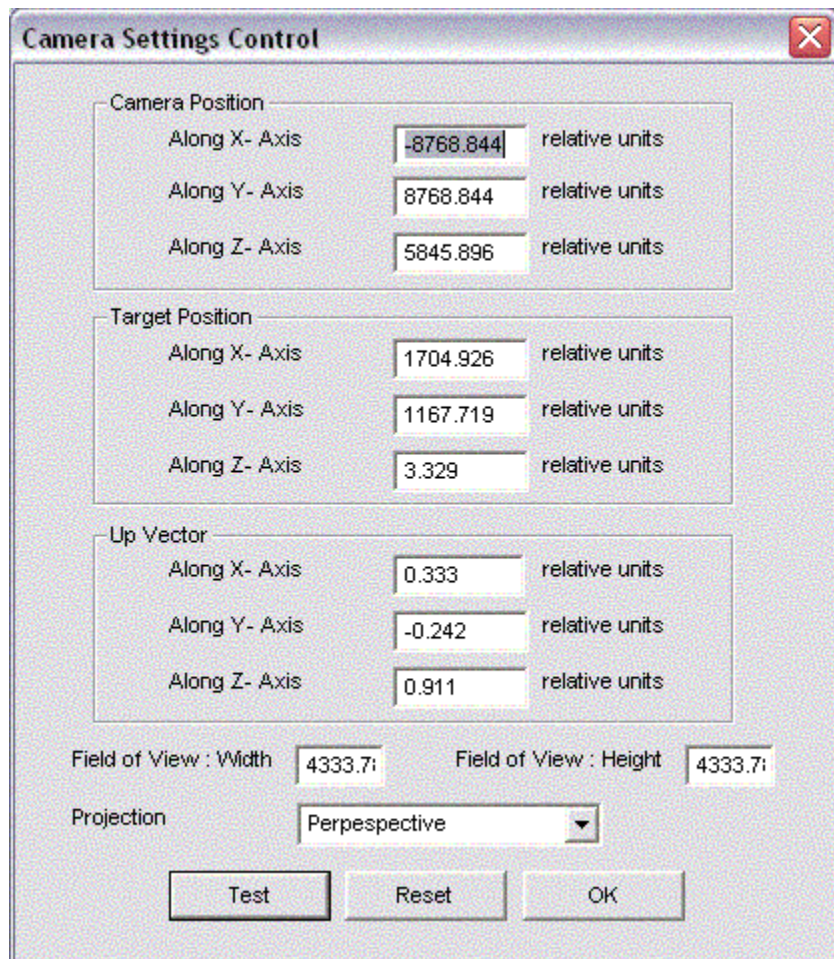




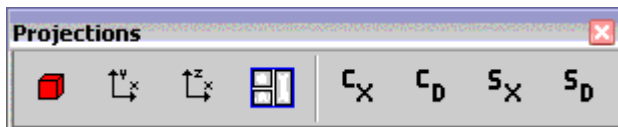
Figure 2.—Camera Setting Control


 **Camera Controls:**


Provides a window with text boxes used to modify the camera position, target position and the up vector along the three axes. Window also provides text boxes to adjust the field of view and the projection.


 **About:** Provides the user with Version, Company, and Copyright information.


7.3.2 Projections Toolbar





 **3D-View:** Provides the user with a 3-dimensional view of the plume.


 **Plan View:** Provides the user with an overhead view of the plume.


 **Side View:** Provides the user with a side view of the plume.

 **Split View:** Provides the user with a cross-sectioned screen showing 3D View, Plan View, and Side View.

 **Concentration Vs. Downstream Distance Graph:** User's current window changes into a graph of concentration vs. downstream distance.

 **Concentration Vs. Centerline Trajectory Graph:** User's current window changes into a graph of concentration vs. centerline trajectory.

 **Dilution Vs. Downstream Distance Graph:** User's current window changes into a graph of dilution vs. downstream distance.

 **Dilution Vs. Centerline Trajectory Graph:** User's current window changes into a graph of dilution vs. centerline trajectory.

7.3.3 Transformations and Visualization Controls Toolbar



Rotate: After clicking the button, the user can rotate the plume by pressing and holding the left mouse button and dragging the mouse to rotate the plume in the desired direction.

Translate: After clicking the button, the user can move or translate the plume by pressing and holding the left mouse button and dragging the mouse to move the plume.

Zoom: After clicking the button, the user can zoom in or out by pressing and holding the left mouse button, and dragging the mouse up to zoom in and down to zoom out.

Zoom to Extends: Zooms out on the entire plume so that the entire image is visible.

Scale Factor: Provides window with controls to modify the scale of Y:X and Z:X.

Region of Visualization: Provides a window with a text box used to modify the region of the plume being seen.

Near Field: Shows **only** the near field of the plume.

Full Field Shows both the near field and far field of the plume.

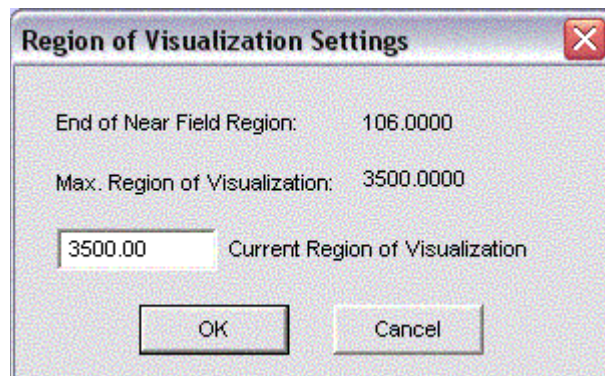
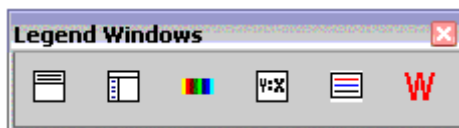



Figure 3.—Region of Visualization Setting Control


7.3.4 Legend Window Toolbar




Simulation Case Window Toggle: Toggles the simulation case window on the upper side of the users screen.

Simulation Information Window Toggle: Toggles a window on the left side of the user's screen which provides the specifics for the simulation.

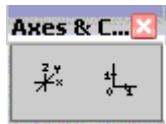
 **Concentration Window Toggle:** Provides the user with a window on the bottom left of the screen which has a concentration key for the plume.


 **Distortion Scale Window Toggle:** Provides a window on the bottom of the screen which displays the distortion scale of Y:X and Z:X.

 **RMZ/TDZ Legend Window Toggle:** Toggles the legend window on the bottom of the user's screen.

 **Simulation Warnings Window Toggle:** Provides a window on the lower right of the screen which displays any simulation warnings.

7.3.5 Axes and Coordinate Control Toolbar



 **Axes Control:** Provides a window which enables the user to change the length of all three axes by sliding the dial left and right. Also contains check boxes to turn on/off axes.

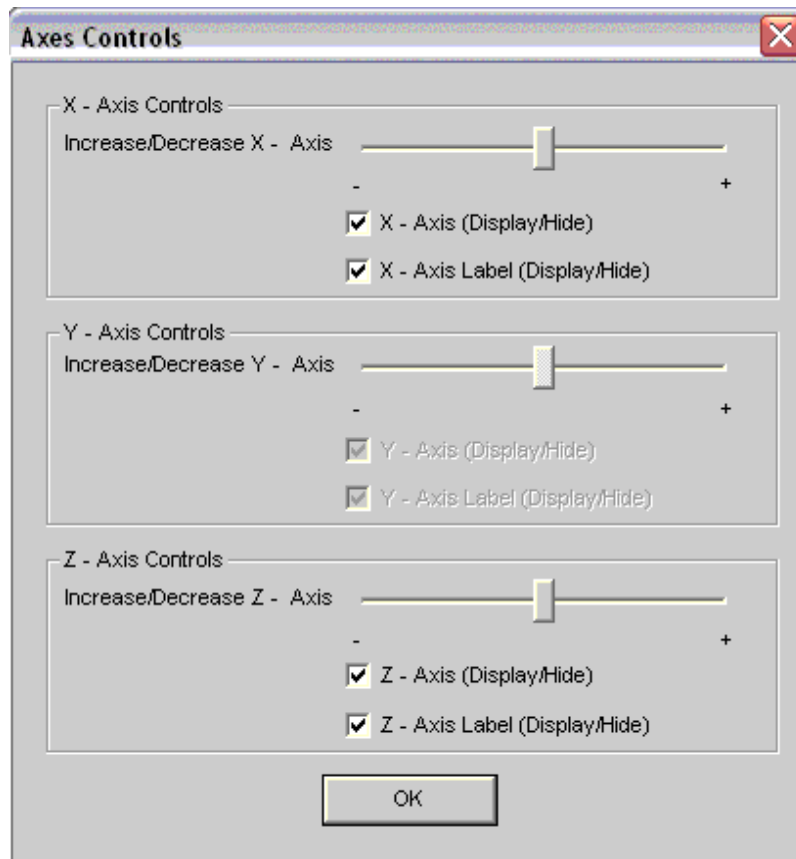


Figure 4.—Axes Setting Control

Axis Label Control:
Provides the user with a window to change the offset X and Z axes labels by sliding the dial left and right. A checkbox to turn axes labels on and off and a text box to control the number of ticks, is only available in the plan and side views.

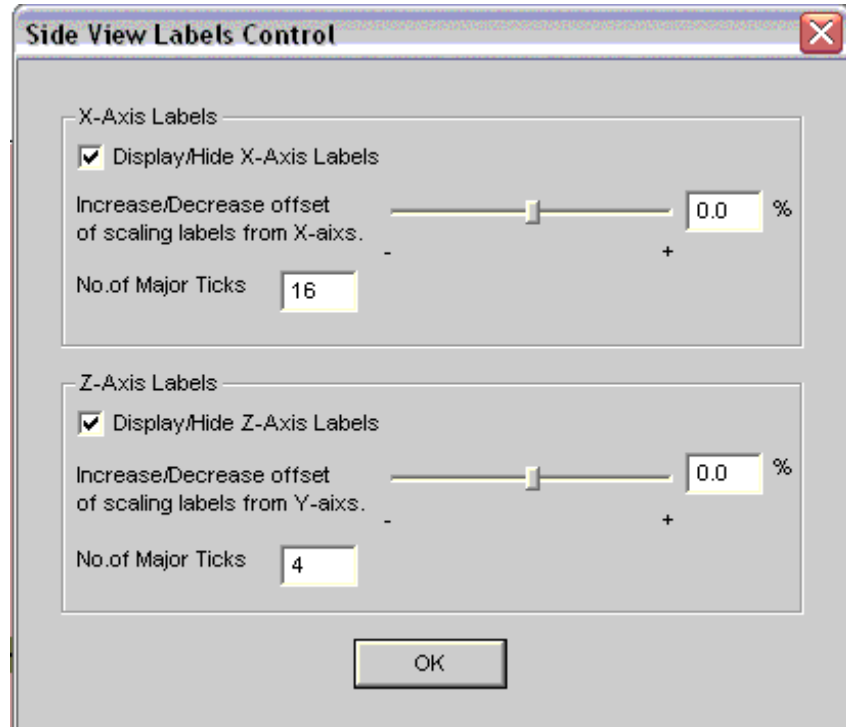
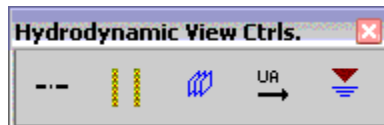


Figure 5.—Side View Label Control

7.3.6 Hydrodynamic View Controls Toolbar



Centerline Toggle: Turns on/off the display of the plume centerline.

Boundary Interaction Toggle: Toggles on/off the display of the boundary interaction indicators.

Modules Control: Provides a window with controls to the CORMIX prediction module indication on the image.

Ambient Velocity Indicator Toggle: Provides text boxes to reposition the UA indicator along the axes, a textbox to determine the UA sizing factor, and a checkbox to hide the UA indicator.

Water Surface Indicator Toggle: provides a window to modify the visibility and size and labels of the water surface.

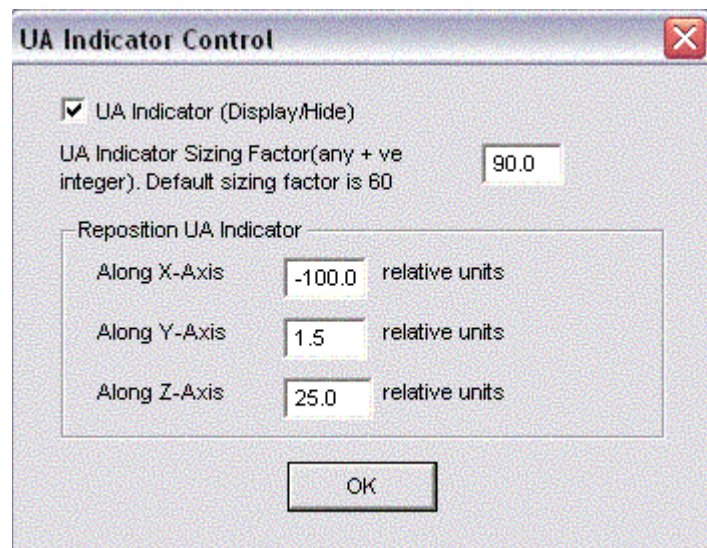
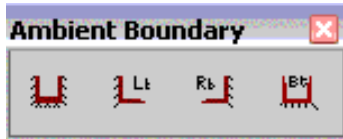


Figure 6.—UA Indicator Setting Control

7.3.7 Ambient Boundary Toolbar



Ambient Boundary

Toggle: Toggles on/off the display of ambient boundaries.

Left Bank Control:

Provides a window to change the thickness of the left bank by moving the dial left and right and to turn off the bank by clicking the check box. Can only be activated in plan view, when simulation is attached to the left bank.

Right Bank Control:

Provides a window to change the thickness of the right bank by moving the dial left and right and to turn off the bank by clicking the check box. Can only be activated in plan view, when simulation is attached to the right bank.

Channel Bottom

Controls: Provides a window with controls to change the thickness of the channel bottom by moving the dial left and right and to turn off the bank by clicking the check box. Can only be activated in side view.

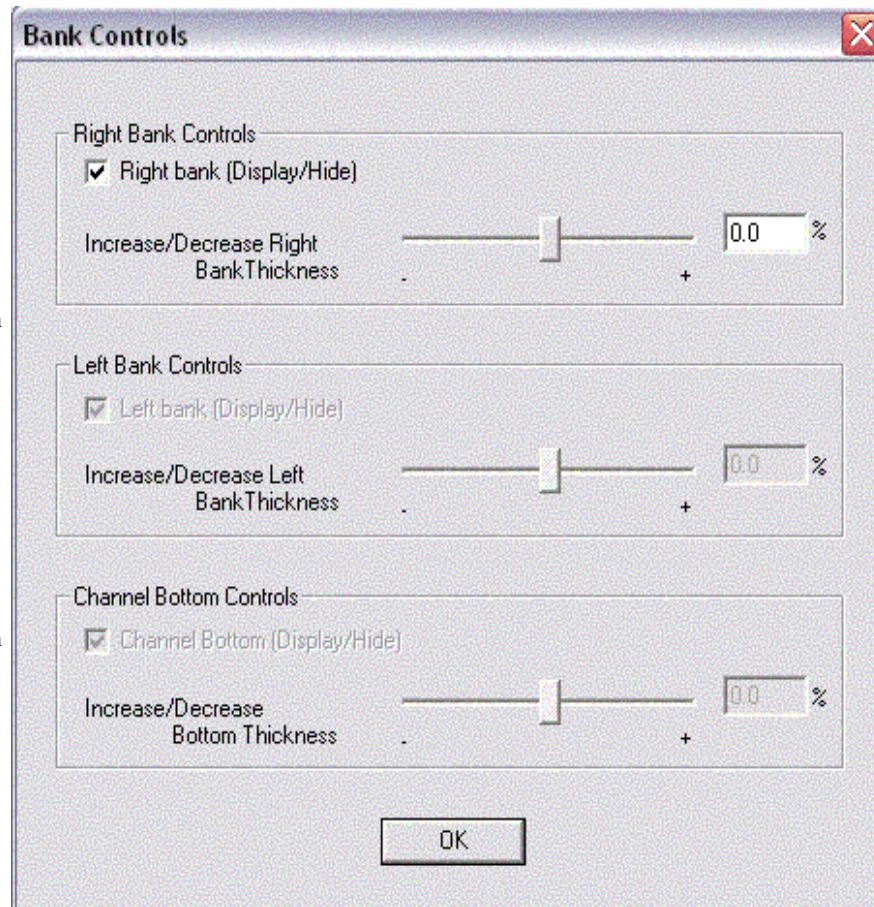


Figure 7.—Bank Setting Control

7.3.8 Regulatory Mixing Zone Toolbar



RMZ **RMZ Control:** Provides controls which modify the CORMIX Regulatory Mixing Zone (RMZ) indicator by sliding a dial left and right, also contains a check box to turn off the RMZ Symbol and a box used to select the size of the RMZ label.

TDZ **TDZ Control:** Provides a window to modify the Toxic Dilution Zone (TDZ) indicator.

Outfall Toolbar



Discharge Port Toggle: Toggles the discharge port image in the 3D and side views.

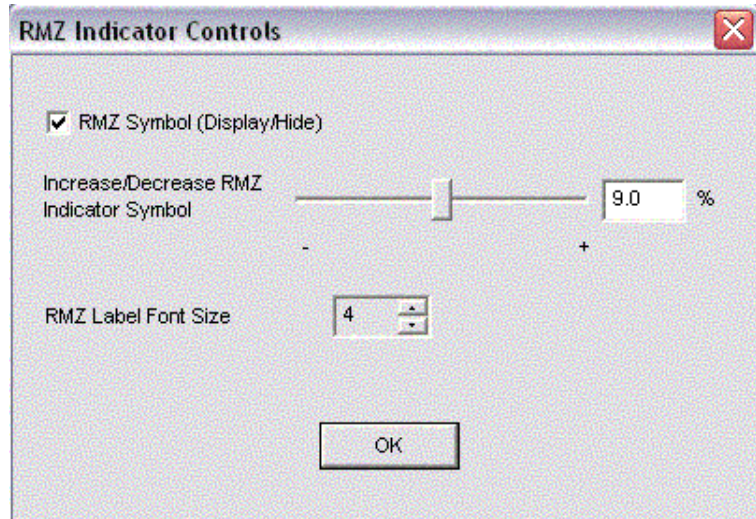


Figure 8.—RMZ Indicator Setting Control

8 Appendix B: CorSpy User Help

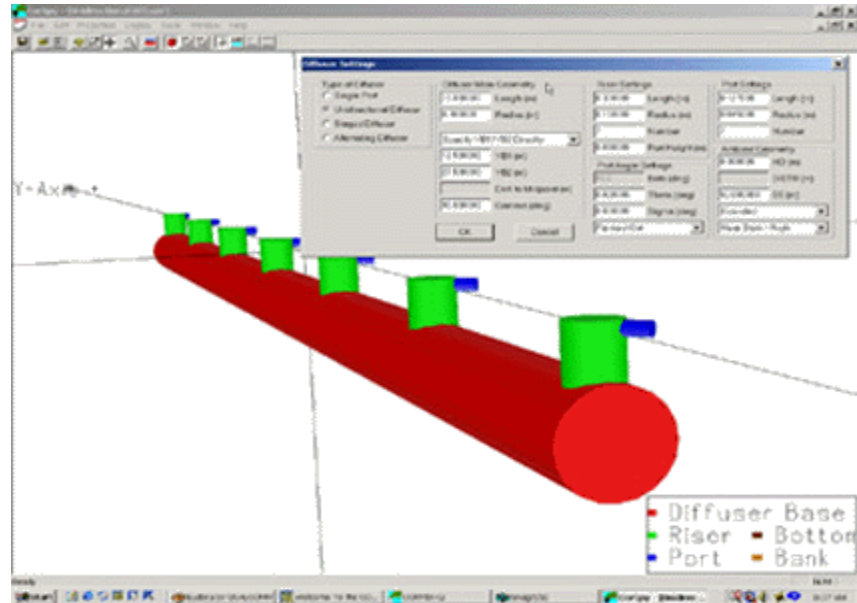
8.1 Introduction

CorSpy v 2.0: Interactive 3-D Mixing Zone Graphics

Do you have trouble knowing the differences between unidirectional, staged, or alternating diffusers? Would you like to visualize your diffuser in relation to ambient boundaries? What type of diffuser is best for lakes versus rivers? Does specification of discharge Beta, Gamma, Sigma, and Theta angles have you confused? Help is available!

CorSpy is an interactive 3-D outfall design and specification tool for single port ([CORMIX1](#)) and multiport ([CORMIX2](#)) and surface ([CORMIX3](#)) discharges. This diffuser visualization program for Windows makes specification of complex multiport diffuser geometry a snap. In addition, **CorSpy** can be used as part of the CORMIX-GI system for outfall design.

For More Information go to <http://www.cormix.info>



The CorSpy tool is an interactive 3-D outfall design and specification tool for single port (CORMIX1) and multiport (CORMIX2) and surface (CORMIX3) discharges. CorSpy provides a 3-D view location of outfall in relation to ambient boundaries, and provides interactive specification of discharge diffuser orientation parameters. It visualizes unidirectional, alternating, and staged diffuser types, and illustrate optimized designs with fanned multiport diffusers.

8.2 Hints for use

Try the following lists of GUI toolbar functions, generally in order, to help optimize your visualization.

- Zoom in or out
- Change axis labels, ticks, and offsets
- Right click on screen to change font size
- Use bottom, water surface, bank toggles
- Change the position of the water surface and current direction
- Use the rotate image tool
- Zoom in/ Zoom out
- Translate image tool
- Change Camera Position

8.3 Description of Functions and Controls:

8.3.1 *Diffuser Settings*

The diffuser settings window shown in Figure 1 allows for specification of single port CORMIX1, multiport CORMIX2, or surface CORMIX3 discharge sources. It includes default example files.

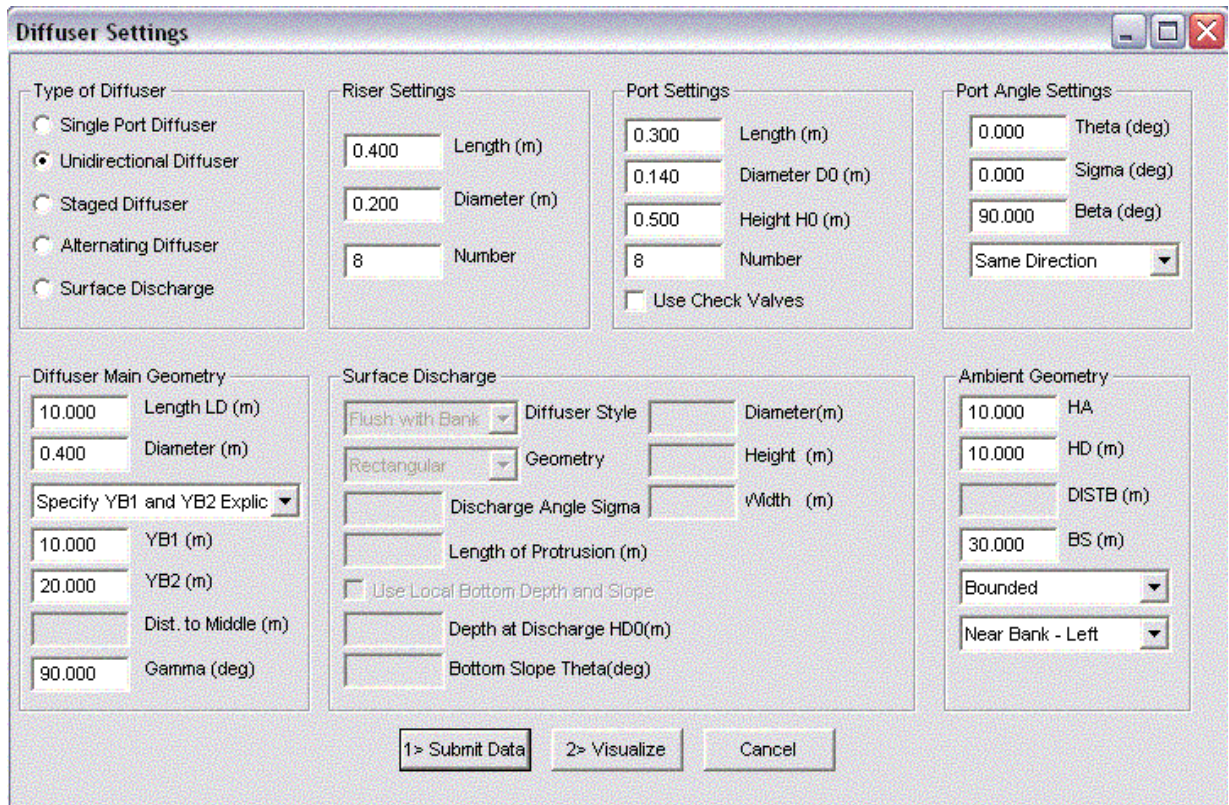




Figure 1.—Diffuser Setting Control





Figure 2.—Toolbar


8.3.2 Toolbar Controls


 **New:** Opens a window with many parameters. The user can set the parameters and type of diffuser as desired or leave them as CORMIX has set. Then the user must submit the data, and then visualized it. The new image will open in a new window, leaving the previous image.


 **Modify:** Opens the same window as **New**. When the data is submitted and visualized it is **not** opened in a new window, but instead the image on screen is modified.


 **Save(*.spy):** Saves the diffuser settings and outfall design specifications as a CorSpy Data file (*.spy format) that can then be reopened later.


 **Open:** Opens and renders a CorSpy data file (*.spy)


 **Save(*.ps):** Saves the active document as a postscript file (*.ps), which can later be viewed and edited using an application like Adobe Photoshop®. Note that the CorSpy v 3.0 application must be terminated or exited before the image in a postscript can be viewed.


 **Camera Controls:** Provides a window with text boxes which controls to modify the camera position, target position and the up vector along the three axes. Window also provides text boxes to adjust the field of view and the projection.


 **Rotate:** After clicking the button, the users can rotate the plume by pressing and holding the left mouse button and dragging the mouse to rotate the plume in the desired direction.


 **Zoom:** After clicking the button, the user can zoom in or out by pressing a holding the left mouse button, and dragging the mouse up to zoom in and down to zoom out.

 **Zoom to Extends:** Zooms out, making the entire image visible

 **Translate:** After clicking the button, the users can move or translate the plum by pressing and holding the left mouse button and dragging the mouse to move the plume.

 **3D-View:** Provides the user with a 3-dimentional view.

 **Side View:** Provides the user with a side view

 **Plan View:** Provides the user with an overhead.

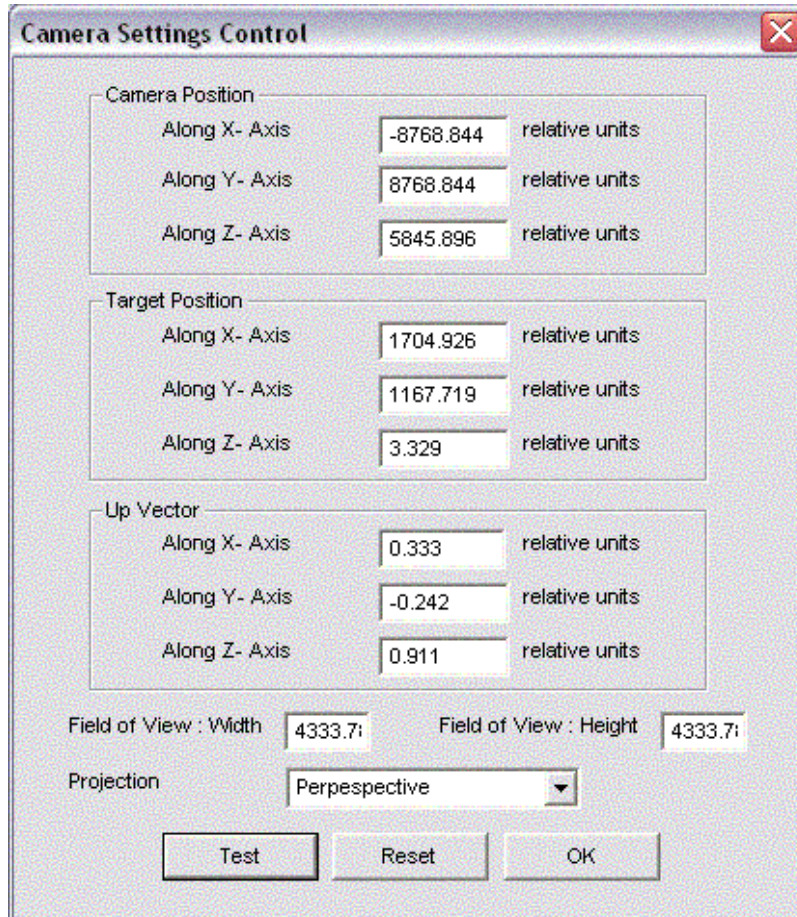







Figure 3.—Camera Setting Control


 **Axes Control:** Provides a window which enables the user to change the length of all three axes by moving the dial left and right, and turn of the axis and its label with a check box.


 **Water Surface Indicator Toggle:** Toggles on and off the water surface in the 3-D, Plan and Side views.


 **Channel Bottom:** Toggles on and off the channel bottom in the 3-D, Plan and Side views.

 **Left Bank:** Toggles on and off the left bank in the 3-D, Plan and Side views.

 **Right Bank:** Toggles on and off the right bank in the 3-D, Plan and Side views.

 **Diffuser Information Window** Toggles on and off the diffuser information window on the left side of the screen.

 **Legend Window:** Toggles on and off the legend window on the bottom left of the screen

 **About:** Provides the user with Version, Company, and Copyright information.

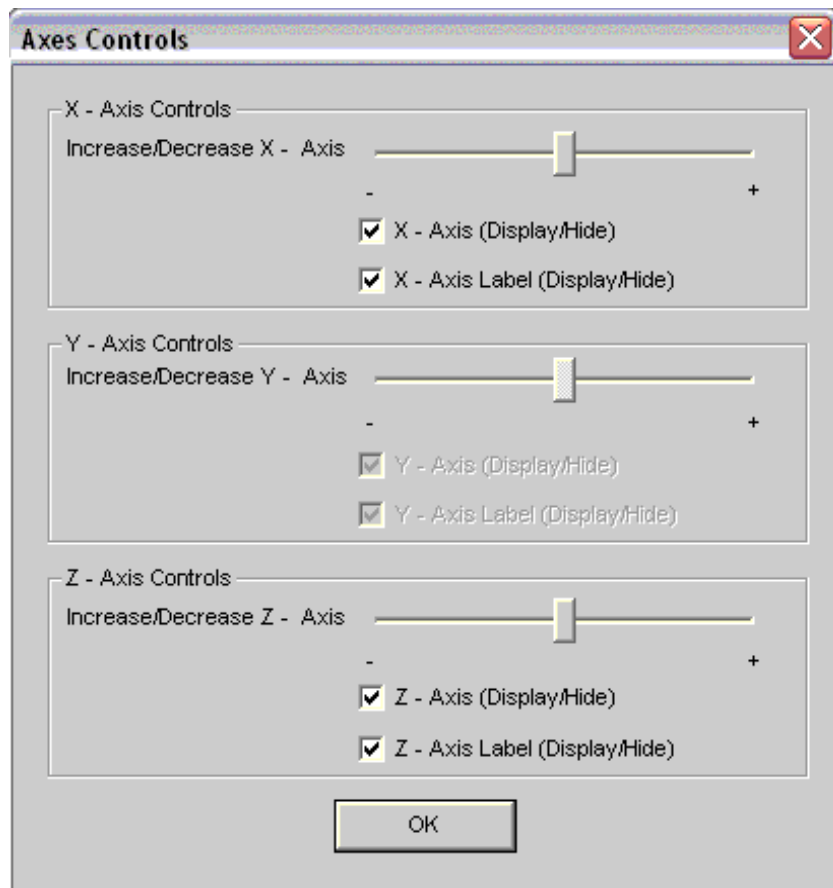


Figure 4.—Axes Setting Control

Sleeve for separate CD