What is claimed is:

1. A cassette based fluid pumping system comprising:

a pumping cassette having a first side including a plurality of valve wells and second side having a fluid bus, the first and second side each covered by a flexible membrane;

a control surface having a plurality of valve well control stations actuatable with respect to the flexible membrane covering the first side of the cassette to open and close the plurality of valve wells when the cassette is mated against the control surface;

a pressure distribution assembly having a positive and negative pressure source and a plurality of pneumatic valves;

a controller configured to selectively actuate the plurality of pneumatic valves to apply pressure against the valve well control stations in a valve pumping sequence causing the plurality of valve wells to be opened and closed in sequence so as to pump fluid through the fluid bus of the pumping cassette from a source to a destination until a volume displaced through the fluid bus of the pumping cassette from the source to the destination is within a range of a target volume.

2. The system of claim 1, wherein the destination is selected from a list consisting of a mixing reservoir in fluid communication with the cassette, a heater bag in fluid communication with the cassette, and a pump chamber disposed within the pumping cassette.

3. The system of claim 1, wherein the source is selected from a list consisting of a pump chamber disposed within the pumping cassette, and a source component in fluid communication with the cassette.

4. The system of claim 1, wherein the source is a source component containing one of component from a list consisting of a buffer solution, an acid solution, a purified water source, and a dialysate concentrate.

5. The system of claim 1, wherein each valve pumping sequence transfers under 150 microliters.

6. The system of claim 1, wherein each valve pumping sequence transfers a nominal volume of 70 microliters.

7. The system of claim 1, wherein at least one of the plurality of valve wells is a dedicated holding volume valve well.

8. The system of claim 1, wherein the pumping cassette includes a pump chamber on the first side of the pumping cassette, the control surface includes a pump chamber control region adjacent the pump chamber when the cassette is mated against the control surface, and the controller is further configured to apply negative pressure to the pump chamber control region via actuation of the pneumatic valves while selectively actuating the plurality of pneumatic valves to apply pressure against the valve well control stations in a valve pumping sequence.

9. The system of claim 8, wherein the controller configured to monitor the volume of the pump chamber while selectively actuating the plurality of pneumatic valves to apply pressure against the valve well control stations in a valve pumping sequence via a pressure sensor disposed in a volume bounded at least partially by the pump chamber control region.

10. The system according to claim 1, wherein the pumping cassette only includes valve wells between the source reservoir and the destination.

11. The system according to claim 1, wherein all of the valve wells include volcano valves.

12. The system according to claim 1, wherein the valve wells includes a first valve well, a second valve well, and a third valve well.

13. The system according to claim 1, wherein the control surface is configured to fluidly isolate the valve wells from each other when the control surface is mated against the flexible membrane covering the first side of the cassette.

14. A fluid pumping system comprising:

a pumping cassette having a first side and a second side, the first side covered by a first flexible membrane and the second side covered by a second flexible membrane, the pumping cassette further including a midbody disposed between the first flexible membrane and the second

flexible membrane, the midbody forming a plurality of valve wells on a first side of the midbody adjacent the first flexible membrane, the midbody forming a common fluid bus on a second side of the midbody adjacent to the second flexible membrane;

a control surface configured to mate against the first flexible membrane of the pumping cassette, the control surface including valve-well control stations, wherein each valve-well control station of the valve-well control stations configured to engage with a respective valve well of the plurality of valve wells of the pumping cassette;

a positive pressure source configured to selectively apply a positive pressure to the first flexible membrane adjacent to one or more of the plurality of valve wells;

a negative pressure source configured to selectively apply a negative pressure to the first flexible membrane adjacent to one or more of the plurality of valve wells; and

a controller configured to selectively control application of the positive pressure source and the negative pressure source to the valve-well control stations in order to displace the first flexible membrane to open and close the plurality of valve wells in a valve-pumping sequence causing the plurality of valve wells to be opened and closed in sequence so as to pump fluid through the fluid bus of the pumping cassette from a source reservoir to a destination, the controller configured to repeat the valve-pumping sequence until a volume transferred via the pumping cassette from the source reservoir to the destination is within a first range of a target volume.

15. The system of claim 14, wherein the destination is a mixing reservoir.

16. The system of claim 14, wherein the destination is a heater bag.

17. The system of claim 14, wherein the destination is a pump chamber disposed within the pumping cassette.

18. The system of claim 14, wherein the source reservoir is a pump chamber disposed within the pumping cassette.

19. The system of claim 14, wherein the source reservoir is a source component connected to the pumping cassette via a fluid line.

20. The system of claim 19, wherein the source component is selected from one of a buffer solution, an acid solution, a purified water source, or a dialysate concentrate.

21. The system of claim 14, wherein each valve pumping sequence transfers under 150 microliters.

22. The system of claim 14, wherein each valve pumping sequence transfers a nominal volume of 70 microliters.

23. The system of claim 14, wherein at least one of the plurality of valve wells is a dedicated holding volume valve well.

24. The system of claim 14, wherein the pumping cassette includes a pump chamber on the first side of the pumping cassette and the control surface includes a pump chamber control region which is in selective communication with the positive pressure and the negative pressure via pneumatic pump control valves, and wherein the controller is further configured to fill the pump chamber by applying the negative pressure to the flexible membrane adjacent to the pump chamber via actuation of one of the pneumatic pump control valves, the controller configured to monitor the volume of the pump chamber and close the one of the pneumatic pump control valves when the volume of the pump chamber is within a second range of the target volume.

25. The system of claim 24, wherein a difference between bounds of the second range is greater than a difference between bounds of the first range.

26. The system according to claim 14, wherein the positive pressure source and the negative pressure source are in fluid communication with the plurality of valve wells through a pneumatic valve network.

27. The system according to claim 14, wherein the pumping cassette only includes valved-pumping chambers between the source reservoir and the destination.

28. The system according to claim 14, wherein all of the valve wells include volcano valves.

29. The system according to claim 14, wherein the valve wells include a first valve well, a second valve well, and a third valve well.

30. The system according to claim 29, wherein the control surface is configured to fluidly isolate the first valve well, the second valve well, and the third valve well from each other when the control surface is mated against the first flexible membrane.