

CH&FR Glover's Bend System Plan

Version 1.0

Last Updated 8/20/2010

Introduction

This document describes the system plan for the CH&FR Glover's Bend model railroad. This is an N-scale, DCC powered layout in 80x38 inches. Operational/electrical features include:

- Multiple trains
- DCC operation
- Remote switch control
- Train location sensing
- Operational signals
- Computer interface

Not all of these features will be implemented, but all must be considered so that the layout is easily upgradeable as time and funds permit.

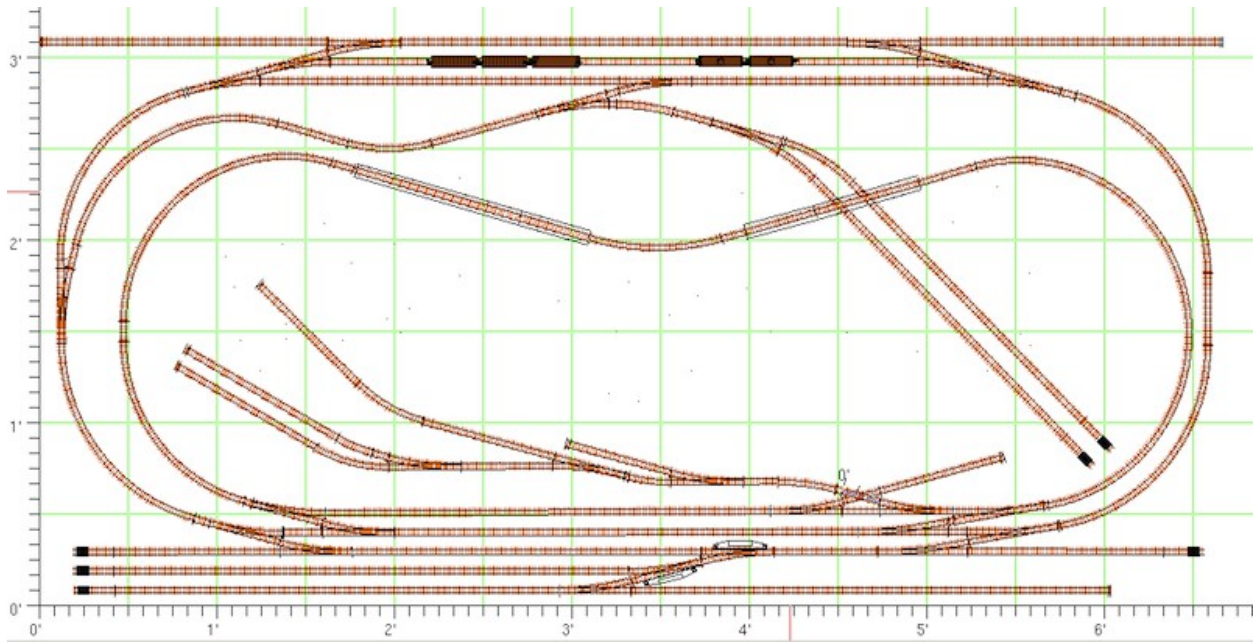
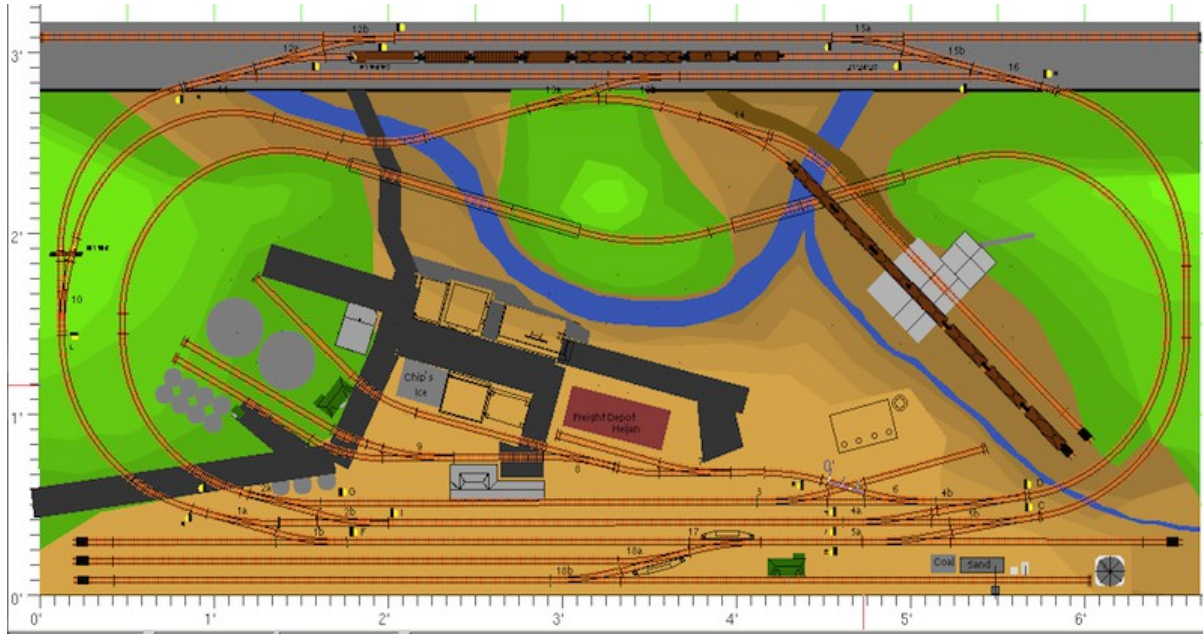
One of the challenges of an electrical system for MRR use is the physically distributed nature of the layout itself. There are, for example, 26 turnouts distributed around all areas of the board, along with numerous track signals, accessory lights and so on. Providing power and signal to all of these locations without creating a “rats nest” can pose a real challenge. Therefore, a careful plan for neatly distributed wiring is a requirement. Providing independent control for each of these items (e.g. being able to turn on/off an individual building's lights) adds to the complexity.

This document will also cover physical / mechanical and operational aspects of the layout. This includes benchwork construction, landscape, roadbed and track construction, scenic elements, locomotives and rolling stock, and so on.

Revision History

Revision	Date	Description
1	08/20/10	Initial Revision.
1.1	01/10/11	Updates Switches & Signals for new Wye and modified Town Branch

Overall Layout Design



The layout is an 80x38 inch “Hollow Core Door” (“HCD”) style design. It comprises two mainline ovals with a town and yard on one long side, and a mountain scenic area and staging on the other long side. In the pictures above, “North” is to the bottom and “South” is to the top.

Track Standards

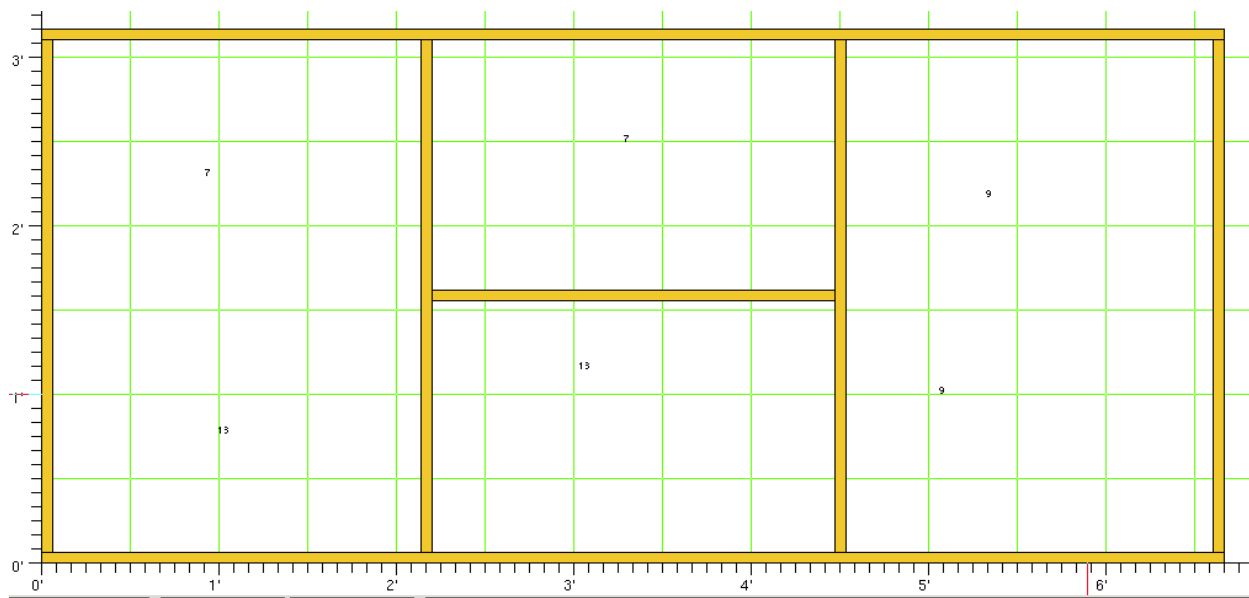
Following are design standards for the track.

- Track type: Atlas Code 80, N scale.
- Roadbed type: N scale cork

- Minimum radius, mainline: 11”
- Minimum radius, branches and spurs: 9-3/4”
- Minimum turnout number: #4
- Ruling grade: 3.0%
- Minimum bridge clearance: TBD

Benchwork Design

The benchwork is a frame of 1x3 Poplar, covered with 3/16” MDF hardboard and 2” of extruded foam insulation. Additional layers of extruded foam are added to produce elevation change. Slots are cut in the internal braces to provide routing channels for the wires, and felt pads applied to the bottoms of the inner braces provide protection for the desk which provides a temporary support.



Above is a basic drawing of the benchwork frame.

Primary Electrical Subsystems

There are several mostly-independent subsystems within the layout itself.

- Track power and blocking (including DCC main bus)
- Signal controls
- Accessories (Lighting, effects, etc.)
- Track Sensing
- Computer interface

Each of these will be addressed independently in subsections below.

Power Routing

There are two primary power routing requirements. First, the DCC track power, and second, power for accessories throughout the layout. These will be kept strictly separate (even to the point of having a

second DCC bus for DCC-controlled accessories).

There will be several remotely-mounted circuit boards dispersed throughout the layout, performing such accessory functions as lighting, signals, track detection, and so on. Some of these are DCC, and some are not. To accommodate non-DCC accessory power, a common 12V DC supply bus will be routed in an appropriate pattern to provide a nearby power feed for any accessory requirements.

TO DO Items:

- Map out accessory locations and plan Accessory Power bus.
- Investigate connecting up a PC switching power supply for track and accessory power needs.

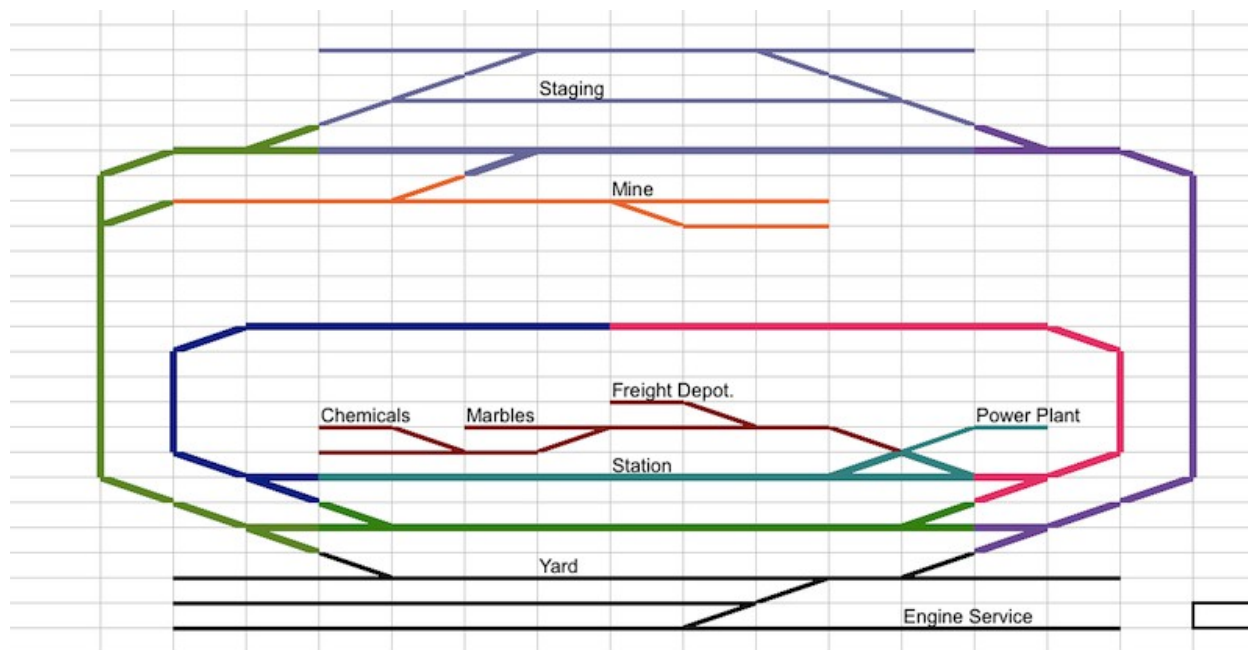
Track Power and Blocking

Track power will be provided by a Main DCC Bus, with short, small gauge track feeders placed according to the following rules:

- At least 1 feeder per block
- At least 1 feeder per 3 feet of track
- At least 1 feeder per sectional track element

The layout will be divided into logical blocks according to the operational plan. Blocks will not be wired separately, but will be on a common DCC Power District. The exception is the Engine Service block, which doubles as an isolated Programming Track.

Feeder wires will be 24 gauge solid wire. Block Bus wires will be 16 or 18 gauge solid or stranded (TBD). The small layout size and correspondingly short cable runs do not indicate a need for larger gauge wiring.



Blocks:

Num	Name	Schematic Color
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ber		
1	Main 1 West	Olive Green
2	Station (Main 2 Interlocking)	Turquoise
3	Main 1 Interlocking	Bright Green
4	Main 1 East	Purple
5	Main 2 West	Dark Blue
6	Main 2 East	Pink
7	Town Branch	Brown
8	Mine Branch	Orange
9	Yard	Black
10	Staging	Lavender
11	Engine Service / Programming	Black

Benchwork Considerations

The benchwork is 1x3 (0.75 x 2.5 finished) Poplar (on edge) in a box shape with cross braces placed 24" in from each end. To facilitate cable routing, through slots 1" x 2" will be drilled 12" in from each side and centered on the inner cross braces.

Track Wiring Plan

The benchwork divides the layout into six regions (we'll call them "quadrants", even though there's more than 4 of them). Each region will have a 2x16-terminal bus strip (8 terminal pairs each for Track+ and Track-) for connecting the feeders in that region. The maximum number of identified feed points in any quadrant is 13.

Plan is to mount one 16x2 barrier strip in each quadrant. Each strip will accommodate up to 14 feeder wires without doubling up on the screws. A seventh strip (or pair of strips) will tie all six into a star network with a master feed from the booster. Typical is 1x16x2 (Tyco/AMP 1-1546306-6) at \$5.54 each. Estimated cost: \$38.78 for 7 strips.

A useful candidate cable for the main bus is 7x18ga. Thermostat wire (\$12.92/50ft at Lowe's). It has sufficient wire gauge to carry considerable power, and plenty of conductors for the track wiring. Additional signals beyond 7 must be carefully considered. One notable drawback of thermostat wire is that the conductors are not twisted, which may have some effect on signal integrity. For the short runs envisioned on this layout (should use less than 30 feet of cable, total), this should not be an issue.

The main bus cable, if done right, can distribute a number of signals around the layout. Candidate signals for the pinout are:

Pin #	Description	Notes
1	GROUND	Accessory Ground
2	DCC Aux +	CAN bus?

3	DCC Aux -	CAN bus?
4	+12V DC	Accessory Power
5	+5V DC	Accessory Power
6	DCC Track -	
7	DCC Track +	
8	GROUND	Accessory Ground

Initial implementation will be DCC +/- only, with the other 5 held in reserve.

LocoNet will be carried on a separate cable set, apart from this cable.

Power Panel

A small panel will be constructed on the fascia in a convenient place. Haven't decided exactly where. This fascia panel will have a 4-pin connector (KYCON [KPJX-PM-4S](#)) for track and programming power, and a panel-mount USB connector (Amphenol MUSB-A-311-30) for interfacing the Digitrax PR3 (or similar). This way the PR3 can be mounted out of sight under the layout, and the computer can be connected directly to the layout fascia. Space will be provided for future connectors, including the possible switch panel connector described elsewhere.

Connectors:

- LocoNet: Digitrax UP5 or UR92
- USB: Amphenol MUSB-A-311-30
- Track Power: KYCON KPJX-PM-4S (mating conn: KPPX-4P)
- Switch Control: Amphenol G17S-250X-110-EU (DB-25)
- Programming Track Toggle Switch

Provision for a master power switch will be added to the power panel. This switch will be connected to the master power supply when it is designed.

Switch Control

There are 26 switches on the layout. 16 are in 8 crossover pairs, and the other 10 are individual switches. Initial switch control will be manual, using Caboose Industries #105 ground throws. Automated control will be provided by Tam Valley Depot servo controllers and R/C Servos.

Switches:

Name	Location	Through Route	Diverging Route
1a/1b	Main 1/AD, West end	Main 1, A/D	Main 1 to A/D
2a/2b	Main 2/Main 1, West end	Main 1, Main 2	Main 2 to Main 1
3	Main 2, power plant stub	Main 2	Main 2 to Plant Stub
4a/4b	Main2/Main 1, East end	Main 1, Main 2	Main 2 to Main 1
5a/5b	Main 1/AD, East end	Main 1, Yard Lead	Main 1 to A/D
6	Main 2, town branch	Main 2	Main 2 to Town Branch

7	Town Branch, Freight House	Town Branch	Freight House Stub
8	Town Branch	Town Branch	Industry Spur
9	Town Branch, Chem Plant	CP Track 1	CP Track 2
10	Tow Branch, Factory	TEC Track 1	TEC Track 2
11	Main 1, Mine Branch Entrance	Main 1	Mine Branch
12	Main 1, Staging West End	Staging 1	Staging 2 or 3
13a/13b	Staging, West End	Staging 3	Staging 2
14a/14b	Mine Branch Cutoff	Mine Branch	Staging 1 to Mine Branch
15	Mine Branch	Mine Track 1	Mine Track 2
16a/16b	Staging, East End	Staging 3	Staging 2
17	Main 1, Staging East End	Staging 1	Staging 2 or 3
18	Yard Ladder	A/D	Yard Track 2 or 3
19	Yard Ladder / Engine Service	Yard Track 2	Yard Track 3
20	Engine Service	Yard Lead	Engine Service
21	Main 1, Wye Cutoff	Main 1	Wye Track
22	Wye Tail	Wye Track	Yard Lead
23	Town Branch Wye	Town Branch	Town Branch

TVD has two controllers that are applicable: the Singlet and Quad controller. The TVD controllers can be connected to the DCC bus for DCC control, or can have panel-mount switch control. Initial installation will be DCC with throttle control. Later, a DCC (or LocoNet) enabled switch panel will be provided for direct control of the turnouts.

Each TVD Quad controller can control four devices and a total of six servos. This allows each controller to manage two crossover pairs and two individual turnouts. The parts required for remote power control of all switches include:

- TVD Quad-Pic Servo Driver (5 x \$28.76 = \$143.80)
- TVD DCC Accessory Booster (\$55.00)
- Miniature Servo (26 x \$4.50 = \$117.00)
- Miniature Servo Mount Kit (26 x \$2.50 = \$65.00)

Total cost for power operation = \$380.80

Incremental cost per Quad (1 @ \$35.95 + 6 servos & kits) = \$77.95

TO DO Items:

- Determine grouping, arrangement and placement of TVD Quad controllers
- Determine wiring plan for turnout control switches.
- Determine wiring plan for DCC control of TVD Quads.
- Investigate alternate control plan using Digitrax LocoNet switch control options.
- Investigate switch position feedback (for computer automation)

Train Position Sensing

Train position sensing will be added at some point, for signal and train control automation.

TO DO Items:

- Investigate sensing options

Signaling

Operational signals will be provided at key locations – particularly around the town interlocking plant. Signals will be tri-color LED “searchlight” style. The signal aspects will be a simplified system intended for easy understanding by non-MRR users of the layout, but will be based loosely upon the speed-signaling plans of C&O and CSX railroads.

Signals:

Name	Location	Direction	Type	Heads	Colors
A	Main 1, West end	Eastbound	Tall Searchlight	2	GYR/GYR
B	Main 2, West end	Eastbound	Tall Searchlight	2	GYR/GYR
C	Main 1, East end	Westbound	Tall Searchlight	2	GYR/GYR
D	Main 2, East end	Westbound	Tall Searchlight	2	GYR/GYR
E	A/D, East end	Eastbound	Dwarf	1	GR
F	A/D, West end	Westbound	Dwarf	1	GR
G	Main 2, West end	Westbound	Dwarf	1	GYR
H	Main 2, East end	Eastbound	Dwarf	1	GYR
I	Main 1, West end	Westbound	Dwarf	1	GYR
J	Main 1, East end	Eastbound	Dwarf	1	GYR
K	Town Branch, East end	Eastbound	Dwarf	1	R or GR
L	Mine Branch, West end	Westbound	Tall searchlight	1	GYR
M1	Mine Branch, West end, Main	Eastbound	Cantilever	TBD	TBD
M2	Mine Branch, West end, Branch	Eastbound	Cantilever	1	GYR
N	Staging, West end	Westbound	Dwarf	1	GYR
O	(Omitted)	N/A	N/A	N/A	N/A
P1-3	Staging, West end	Eastbound	Dwarf	1	R or GR
Q1-3	Staging, East end	Westbound	Dwarf	1	R or GR
R	Staging, East end	Eastbound	Dwarf	1	GYR

Note 1: “Westbound” is generally clockwise, “Eastbound” is counterclockwise.

Note 2: P1-3, Q1-3 are numbered for the staging track they control. Staging tracks are numbered South to North.

TO DO Items:

- Determine placement and aspects of all signals

- Determine signal control method.
- Investigate commercial products for signal control
- Figure out computer interface

Grade Crossings and other Auxiliary Features

Automated, operating grade crossings will be provided at at least one road/rail crossing location. Lighting and other electrical effects in the town and surrounding areas will also be provided, with independent power and control from the train control.

There are two grade crossings in the Southwest corner of the layout, both on the same road. The tracks may be separated by too much distance and grade to use a single gate pair for protection. Besides, it's tricky handling two track bidirectional control with COTS equipment. I may need to use two separate, independent gate controls, with separate pairs of gates.

Grade Crossing Signal Options

- NJ International pedestal type gates w/arms \$29.99 per pair.

Grade Crossing Control Logic Options

- Logic Rail Technologies Grade Crossing Pro IR (\$54.95 per track)
- NJ International Servo Master (\$119.99 + \$59.99/extra track)

TO DO Items:

- Determine wiring plan for lighting and auxiliary effects.
- Investigate and select grade crossing automation system.

DCC

The layout will be controlled by Digitrax DCC. Requirements include 3 throttles (at least one handheld), computer interface, and ease of use. Additional needs include being able to DCC-control turnouts, signals, and other accessories.

Digitrax Version (wired): Total cost \$381.84 MSRP \$306.46 street

- Digitrax Zephyr (\$199.99 MSRP \$159.99 street)
- UP5 Interconnect Panel (\$16.95 MSRP \$15.49 street)
- PR3 Computer Interface (\$84.95 MSRP \$66.99 street)
- UT4 Utility throttle (\$79.95 MSRP \$63.99 street)

Digitrax Version (wireless): Total cost \$579.94

- Digitrax Zephyr (\$199.99 MSRP)
- UR92 Wireless Receiver Panel (\$160.00 MSRP)
- PR3 Computer Interface (\$84.95 MSRP)
- UT4D Duplex Utility throttle (\$135.00 MSRP)

TO DO Items:

- Spec, Research and select commercial DCC option
- Investigate “homebrew” DCC control.

Computer Interface

Once the layout is upgraded to DCC, the layout will be interfaced to a computer. This will be handled via the DCC provider's given computer interface. The computer control software will be JMRI.

Ultimately, a direct Ethernet-to-DCC command bus bridge will be designed, to bypass the commercial DCC electronics.

TO DO Items:

- Investigate RocRail and other alternate software
- Investigate Ethernet/DCC bridge.

Power Supply Requirements

The system needs a consolidated power supply solution. I don't want a bunch of wall warts all over the place.

Subsystem Power Requirements:

- DCC
 - Digitrax Zephyr: 12-16VAC / 12-18VDC, 3A (DB50) or 5A / 80VA (DB150)
- Accessories
 - TVD Quad Servo Driver: 7.5-18V DC (??? mA?) or 9-24V AC 1.5A (budget, not spec)
 - Logic Rail Tech GCP-IR: 7-9V AC or 9-12V DC, 390mA
 - NJ International Servo Master: 9-16V AC or DC, 500mA
 - Custom signal heads: 3-12V DC, 25mA/light. ~100mA / head, ~ 2.2A total.
 - Typical LED lighting: 3-12V DC, 25mA/light.

An approximation of the power requirements would be 12V DC, 15A for accessories, plus the DCC power as required. That is 180W for accessories + 45W for track power.

Operations Plan

The operations plan is dependent upon the industries and other locations. These are identified as:

Name	Location	Track Block	Product Type	Car Type(s)
Staging	Orchestra Pit	Staging	All	All
Yard	Yard	Yard	All	All
Glover's Bend Station	Mainline Station	Station	Passengers	Passenger
The Electric Co.	Plant Stub	Station	Electrical parts	Box, flat
NSN Chemicals	West of Town	Town Branch	Chemicals, raw materials, fuel	Tanks, Covered Hoppers, Open Hoppers, Boxcars

Loscher Marbles	North of Chem Plant	Town Branch	Unknown	Unknown
Freight House	Town	Town Branch	Mixed	Box, Gon, Flat
Scrap Yard	Town	Town Branch	Scrap	Box, Gon, Flat
Mine	Mine	Mine Branch	Coal	Coal Hoppers

From the available industries and customers, we can derive an operational plan that will drive the signaling, power, and other issues for the layout.

Industry Descriptions

The industries in and around Glover's Bend are as follows:

NSN Industries, Chemical Division

This plant has two tracks at the end of Town Branch on the west side of town. Raw materials in are in tanks and covered hoppers. Finished product out are tanks and hoppers. Occasional deliveries of supplies and equipment by Box, Gon or Flat.

NSN Chemical Shipping Manifest				
Product Type		Car Type	Quantity	Frequency
Incoming Supplies				
	Liquid Raw Materials	Tank	2	Daily
	Solid Raw Materials	Covered Hopper	1	Daily
	Small Quantity Raw Materials	Boxcar	1	Weekly
	Packaging/Shipping supplies	Boxcar	2	Weekly
	Tools and repair parts	Box, Flat or Gon	1	Random
Outgoing Product				
	Liquid Finished Product	Tank	2	Daily
	Solid Finished Product	Covered Hopper	3	Weekly
	Specialty Finished Product	Boxcar	1	Random
	Waste Materials	Hopper, Tank or Gon	1	Weekly

Loscher Marble Co.

The Loscher Marble Company (LLC) is a family run business that manufactures marbles. The factory has a “commercial” line at with a relatively high volume automated process, but also an “artisan” line of beautifully handcrafted marbles in a variety of (some very, very large) sizes.

Loscher Marbles Shipping Manifest				
Product Type		Car Type	Quantity	Frequency
Incoming Supplies				
	Silica for glass	Covered Hopper	1	Daily

	Various chemical impurities	Boxcar	1	Daily
	Packaging/Shipping supplies	Boxcar	2	Weekly
	Tools and repair parts	Box, Flat or Gon	1	Random
Outgoing Product				
	Packaged Marbles	Boxcar	3	Weekly
	Specialty Loads	Boxcar or Flat	1	Random

Scrap Yard

The scrap yard is a small area in the back of the town (between the town and the town branch). It processes scrap metal and ships it out by rail.

Scrap Yard Shipping Manifest				
Product Type		Car Type	Quantity	Frequency
Incoming Supplies				
	Tools and repair parts	Box, Flat or Gon	1	Random
Outgoing Product				
	Scrap Metal	Gon, Flat, or Box	2	Daily

Freight House

This is the general freight depot for the town.

Freight House Shipping Manifest				
Product Type		Car Type	Quantity	Frequency
Incoming Supplies				
	Tools and repair parts	Box, Flat or Gon	1	Random
	Various LCL or Carload	Box, Flat or Gon	???	Daily
Outgoing Product				
	Various LCL or Carload	Box, Flat or Gon	???	Daily

The Electric Company, Inc. (TEC, Inc.)

This used to be the power plant for the town. Now the building houses a maker of custom electrical supply items (conduit, boxes, high voltage parts, electronics assemblies, custom wire harnesses, etc.) for various customers. They specialize in small runs of specialty items and prototypes, rather than mass production. Customers in aerospace, military and automotive.

TEC Inc. Shipping Manifest				
Product Type		Car Type	Quantity	Frequency

Incoming Supplies				
	Sheet steel, conduit, block	Box, Flat or Gon	1	Random
	Electrical / Electronic parts	Box	1	Daily
Outgoing Product				
	Electrical / Electronic finished parts	Box	1	Daily

Passenger Station

This is the passenger station for the town.

Passenger Station Shipping Manifest				
Product Type		Car Type	Quantity	Frequency
Incoming Supplies				
	Passengers	Passenger Car	4	Daily
	Tools and repair parts	Box, Flat or Gon	1	Random
Outgoing Product				
	Passengers	Passenger Car	14	Daily

Mine

This is the mine.

Mine Shipping Manifest				
Product Type		Car Type	Quantity	Frequency
Incoming Supplies				
	Tools and repair parts	Box, Flat or Gon	1	Random
Outgoing Product				
	Coal	Hoppers	14	Daily

Car Inventory

To service these industries, the railroad will need to have the following equipment on the roster (minimum):

Car Type	Qty	Frequency
Coal Hopper	14	Daily
Passenger Car	4	Daily
Box Car	7	2 Daily, 5 weekly
Covered Hopper (Silica)	1	Daily
Covered Hopper (Chemical)	4	1 Daily in, 3 Weekly out

Tank Car	4	2 in, 2 out Daily
Gondola	2	Daily

Train Listing

Train #	Description	Type	Schedule	Source	Dest
1	Daily Coal Drag	Coal	Daily	Mine	Elsewhere
2	Morning/Evening Commute	Passengers	2x Daily	Station	Elsewhere
3	Town Branch Supply	Manifest	Daily	Yard	Town Branch
4	Town Branch Delivery	Manifest	Daily	Town Branch	Yard
5	Outside Manifest	Manifest	Daily	Yard	Elsewhere

In addition to the scheduled trains, “Extra” trains will be run as needed, particularly for the “random” deliveries of supplies, repair parts, and special deliveries.

Train Schedule

Odd numbered trains are Eastbound, Even are Westbound, nominally. “L” trains are locals, “V” trains are interchange or through.

- 100-series trains are freight manifests headed to interchange or through freights
- 200-series trains are local freights
- 300-series trains are passenger trains

Train #	Description	Type	Schedule	Source	Dest
V103/104	Daily Coal Drag	Coal	Daily	Mine	Russel, KY
L301/302	Morning/Evening Commute	Passengers	2x Daily	Station	Elsewhere
V201/202	Town Branch Supply	Manifest	Daily	Yard	Town Branch
L203/204	Town Branch Delivery	Manifest	Daily	Town Branch	Yard
V101/102	Interchange to/from CSX Russel KY	Manifest	Daily	Yard	Russel, KY

Locomotive Roster

In order to run all of these trains, a number of locomotives will need to be available. Listed by Train #, these are:

Train #	Consist	Notes
1	2x SD40-2	Could be SD50, 60, or 70...

2	WM 761	Steamer!
3, 4	GP-9 or GP40	Use Santa Fe Bachmann, then “downgrade”
5	GP-40	Santa Fe Bachmann (for now)
Yard Duty	NW2	Chessie Livery

It should be noted that at least 3 trains, with 4 units can be active at any given time: the yard switcher, the passenger train, and at least one of the coal drag, town branch turn, or manifest freights.

Notes:

- Atlas has a Chessie GP30/35 that would do nicely instead of the GP9.
- Kato doesn't seem to have an SD40 or SD40-2 in a friendly livery. There is an undecorated SD40-2 that could be done up in CH&FR colors...