

To: Board of Management

From: Robin D. Hale
Chief Operating Officer

Subject: **MAGNOVATE TRANSPORTATION INC. – REVISED PROPOSAL**

Date: 2018-11-14

SUMMARY:

This report updates the Board on the results of the “Swiss Challenge” of the unsolicited proposal received from Magnovate Transportation Inc. (Magnovate) in 2016 and the subsequent revised proposal received from Magnovate to construct a demonstration and fully functional Magnetic Levitation (Maglev) train ride on the site of the original Domain Ride route at the Toronto Zoo, with recommendations of next steps for approval by the Board.

RECOMMENDATIONS:

It is recommended that the Board approve the installation of a fully functional Magnetic Levitation train ride at the Toronto Zoo, as outlined in the revised proposal received from Magnovate Transportation Inc., subject to the following:

- a) Magnovate satisfying the City of Toronto and the Toronto and Region Conservation Authority (TRCA) approval requirements to facilitate the construction/implementation process;**
- b) Negotiation of the terms of an agreement with Magnovate acceptable to the Board.**

FINANCIAL IMPACT:

There is no financial impact as all required capital costs are to be funded by the Magnovate. Once successfully implemented and operational, there is significant revenue potential for the Zoo under the proposed revenue share and operational costs will be covered through the revenue share agreement.

DECISION HISTORY:

As directed by the Board, the Swiss Challenge process was completed under the purview of a fairness monitor and yielded no competitive submissions. Magnovate was advised of the Swiss Challenge and has submitted an updated proposal which forms the basis for this report to the Board. The earlier Magnovate proposal is well outlined in the documents accessible through the following link.

(2016-04-07) Report and Appendix I from the Chief Operating Officer, Toronto Zoo, on Magnovate Transportation Inc. – Unsolicited Proposal.

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2016.ZB8.2>

COMMENTS/DISCUSSION:

The Maglev ride proposal is based on innovative modern technology, and would be an opportunity to visit the Rouge Valley in the comfort of an enclosed climate controlled vehicle on a year-round basis.

There is much external interest in Magnovate from various investors and funding agencies, most notably Sustainable Technology Development Canada (STDC), the consortium partners, and capital financing entities in order to create a lower-speed Maglev system that emulates the high-speed examples in Shanghai, China and Linimo, Japan. The total amount of the project to Magnovate and their investors would be approximately \$25.0 million, with no funding requirement from the Toronto Zoo or the City of Toronto.

In order to proceed with various government infrastructure (STDC) funding applications and to secure all necessary financing, the Magnovate team is looking to secure confirmation that the Board is interested in further pursuing this project (often a “which comes first” scenario with the various levels of infrastructure applications). Confirmation from the Board would effectively transition the Magnovate initiative from concept to project from the perspective of various funding entities, facilitating and enabling the application process. The next window for several Federal applications is in Spring 2019, so it may be closed by the time the new Zoo Board is in place.

The Magnovate collaboration with the Board would ultimately result in a Maglev Ride on the Zoo site that will not only serve as a prime site for Magnovate to exhibit the technologies, but would also create a new attraction for Zoo visitors to ride the first commercial maglev transit system in North America. This will serve to improve mobility options at the Zoo and would be an opportunity for demonstrating sustainable technologies. It is notable that the Magnovate proposal includes a detailed overview on the safety and redundancy features of the maglev system, which is of significance, due to the emphasis and importance of safety at the Toronto Zoo.

Once operational, the revised Magnovate proposal includes the operation of the system for a period of fifteen (15) years (previously 5) with the Magnovate and the Board sharing the **net** revenues on a 50/50 basis after operating and financing costs. At the end of the 15 year period, Magnovate would turn all of the equipment over to the Toronto Zoo and would continue to maintain the system and equipment on a service agreement basis.

In analyzing the financial projections from Magnovate, staff were quite conservative in their approach in assessing the ongoing annual operating and maintenance costs. For example, the contingency used by Magnovate was increased by 25% and an amount was added for Zoo specific expenditures, for purposes of determining a more realistic breakeven point. Also, the analysis completed by staff utilized the maximum leveraged debt scenario (Magnovate Scenario 1).

A total of four (4) different price points were utilized by staff as presented in Appendix II, with the breakeven ridership / attendance point included for each scenario. The charts in this appendix also highlight the capture rate point that would provide the Zoo with a minimum of \$750,000 in annual **net** revenue share. As outlined in Appendix II, at a price point of \$12.00 per rider and annual attendance objective of 1,250,000, the capture rate at which the Zoo realizes a net revenue share of \$750,000 would be 20%. The respective capture rate to realize the same net revenue would be 13.3% at a price point of \$18.00 per rider.

As part of the process, the revised Magnovate proposal, financial analysis, and project details will be provided to the Financial Planning Division of the City for purposes of supplementary review, analysis, and opinion.

Based on the revised proposal from Magnovate and the results of our analysis of the information provided, it is recommended that the Board approve the recommendation to proceed with the Maglev project at the Toronto Zoo. This will enable Magnovate to proceed with the STDC application requirements and aligning other financing partners at no risk to the Board.

R. D. Hale
Chief Operating Officer

List of Attachments:

Appendix I – Magnovate Proposal – November 2018
Appendix II – Financial Scenarios

BRDGRP/2018/NOV/Magnovate.Board.Report.2018.11.14

Appendix I – Magnovate Proposal – November 2018



Efficient, Quiet & Sustainable Ground Transportation

A Collaborative Proposal for:

The Toronto Zoo

November 2018

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1. Vendor Profile

1.1 Magnovate

Magnovate was founded to commercialize Magline, a proprietary magnetic levitation (maglev) powertrain platform that enables a whole new generation of advanced transit systems. Our portfolio is to expand the practical applications of maglev technology to power efficient, economical and sustainable high efficiency and performance transit networks. Magline technology comprises pivotal developments that overcome the technical and economic limitations that have prevented the widespread adoption of maglev drive systems. These advances include innovations in suspension, power train, track and switching. Magline is nearly silent and frictionless and runs on any source of electric power, including solar, wind and hydro.

Magnovate is the lynchpin of a consortium that includes several multi-billion dollar international industrial leaders who are all committed to creating a complete maglev transportation industry in Canada. The Magnovate consortium will provide end-to-end services, from planning and analysis, infrastructure and vehicle manufacturing and operations, to ticket, routing, and condition based maintenance.

1.2 The Consortium

Magnovate's engineering and science partners have worked on maglev satellite launch systems, and invented maglev heart valves... and now the first maglev automated transit system with passive switching capabilities. Our industrial consortium includes:

Lockheed Martin: This aerospace leader will be the systems integrator for the Maglev Ride at the Toronto Zoo.

Stantec Engineering: Stantec's leadership and experience in transit infrastructure extends to some of the most innovative systems in North America, including management of complete light rail projects, track work, design of individual components, stations, bridges, and mechanical and electrical systems. Stantec will support the Condition Based Maintenance program of all Magline systems.

Magna International: Magna, the most diversified automotive supplier in the world, will build Magline vehicles. Magna has 305 manufacturing operations and 88 product development, engineering and sales centers in 27 countries on five continents.

AllTrade Industrial Contractors: AllTrade is a leading specialty contractor with extensive experience building transit infrastructure projects. Alltrade engages the most current technology to deliver competitive pricing and predictable execution of projects.

2. Proposal Overview

2.1 Zoo Transit System

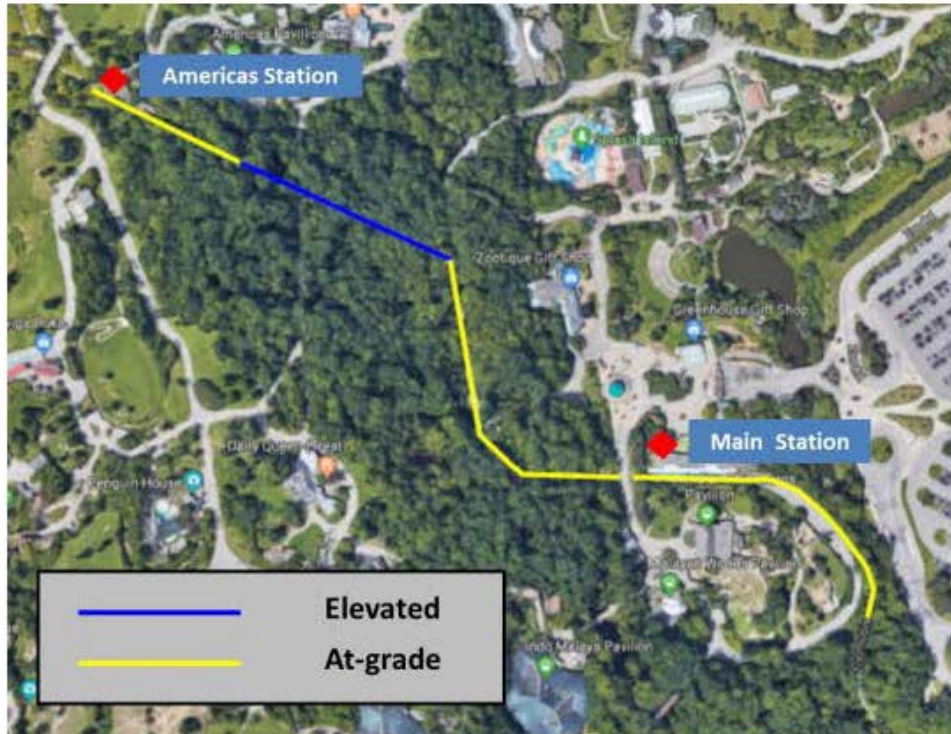
Magnovate proposes to build a Maglev Ride on the guideway and other existing ride infrastructure at the Toronto Zoo. A map of the ride is depicted below.

Maglev Ride Map



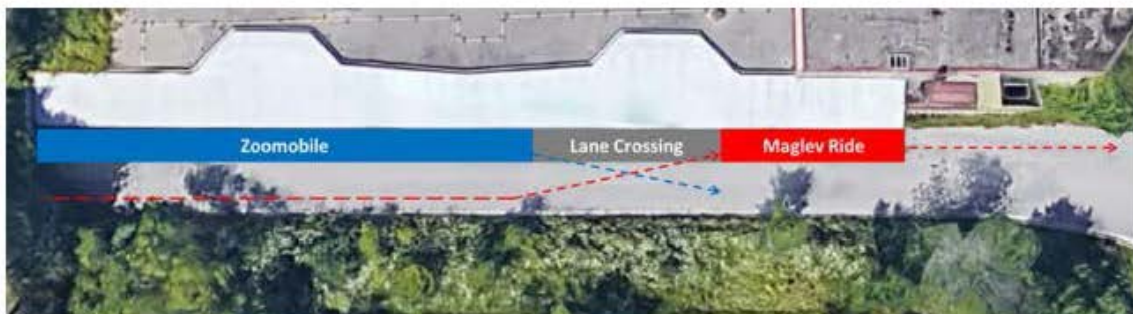
2.2 New Guideway

As shown below, Magnovate will replace the guideway that was previously dismantled between the Main Station and Americas Station. The guideway will be built to match the specifications of the original Domain Ride guideway with an elevated section over the service road. The guideway will be built with pre-cast concrete and will be installed during the offseason.



2.3 Main Station Configuration

The configuration of the Main Station to accommodate the Zoomobiles and Maglev vehicles is shown below.



2.4 Synergies

The proposed project will accomplish several goals important to the mission of the Toronto Zoo and to Magnovate.

Toronto Zoo: As one of the top Zoo's in the world the Toronto Zoo has taken a leadership role in green initiatives and in reducing its ecological footprint. To fulfill its mission and progress towards realizing its vision the Toronto Zoo has set out a strategy that includes investing in the Zoo's infrastructure and support systems with a commitment to state-of-the-art facilities, equipment and environmental best practices.

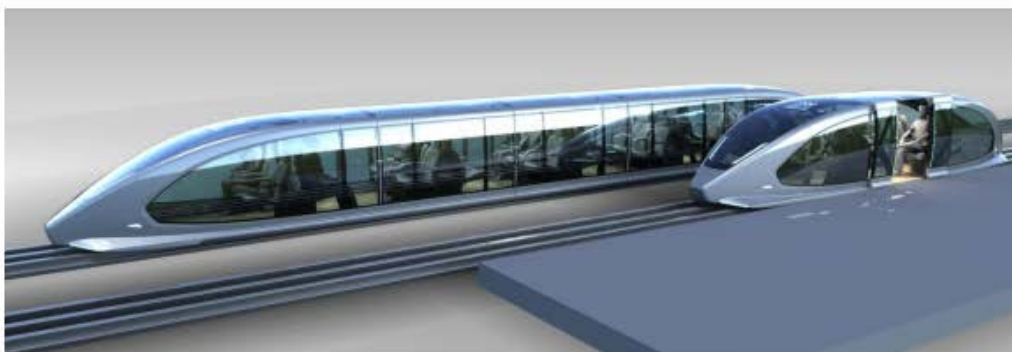
Magnovate: Magnovate has developed and tested prototypes of Magline, a breakthrough green and sustainable transit system. The existing infrastructure at the Zoo would be an ideal place to begin building the world's first commercial Magline system. It is well matched to Magline technology from a structural perspective, and obviates the substantial cost of building infrastructure from scratch for our development program.

2.5 Proposal

Magnovate proposes collaboration with the Toronto Zoo to build a Maglev Ride on the zoo campus that will not only serve the practical transportation needs of visitors, but also create a new attraction to bring visitors desirous of riding on the first commercial maglev transit system on our continent.

2.6 Technology

Magnovate's technology is a breakthrough development of maglev (magnetic levitation) propulsion. It is a silent, frictionless and highly energy efficient powertrain that can run without recourse to carbon-based fuels. Solar panels mounted on stations and on other elements of the infrastructure can supply much of the system's day-to-day power requirements.¹



¹ A more complete discussion of Magline Technology is included in Appendix A.

3. Objectives

3.1 Toronto Zoo Objectives

- **Maglev Ride:** Provide visitor transit so that it is easier for small children, mobility impaired and seniors to enjoy the Canadian Domain and other distant exhibits.
- **Environmental Leadership:** Express in a tangible, powerful way the zoo's commitment to energy efficiency, green and sustainable business practices. Tangibly exhibit Toronto Zoo's leadership in fighting global climate change.
- **Public Relations/Marketing:** Installation of the Maglev Ride at the Zoo is a genuinely newsworthy event. Local and national press will cover the story and that will create a substantial wave of interest and positive coverage. It will enhance the stature of the Zoo and bring visitors.
- **Added Attraction:** Building a modern and truly unique transit system creates a new attraction to the Zoo. Some people who may not have otherwise visited may come to see and experience the Maglev Ride. Word of mouth about the attraction will result in repeat visitors to the Zoo.
- **Revenue:** Ticket sales for the new ride will grow Zoo revenue by attracting new guests and more revenue per visitor.
- **Low Capital Outlay:** The new Maglev Ride will be designed to make maximum use of the existing infrastructure including rights of way, stations, and towers which will minimize capital expenditures. Further, the Magnovate Consortium and Sustainable Technology Development Canada will contribute considerable resources.
- **All-Weather Operations:** Offering tours of the Zoo in climate controlled vehicles will increase attendance by enabling all-season enjoyment of the Zoo. A 'Christmas Lights Train Tour' could run in November and December; similar to the Christmas train tour at Bright Nights in Stanley Park, Vancouver which attracts 200,000 visitors every year.

3.2 Magnovate Objectives

- **Commercial Installation:** The Toronto Zoo represents a unique opportunity because so much of the Domain Ride infrastructure remains in place.
- **Showcase:** This project represents an opportunity to introduce this cutting edge technology to the market place, to the press, to the general public, to government agencies, to investors and to both public and private prospects from all over the world.
- **Sustainable Development Technology Canada:** This project is a keystone to completion of our quest to qualify for coordinating funding and business development support from SDTC and other government grant agencies.

4. Work Plan & Deliverables

4.1 Three-Phase Project

The project is designed with three major phases. For Phase 1, we will design, construct and test a full scale Maglev vehicle specific to the Maglev Ride. In Phase 2, we will construct the full scale track and integrate the control system. In Phase 3 we will test the system on site at the Zoo. Note that some of the development activities of the three phases will overlap with each other. A Gantt chart is shown below.

- **Phase 1: Full-scale Maglev Test System**

Timeline: 15 months

A full-scale test vehicle will be designed, constructed, tested and refined until it meets Phase 2 operational requirements. The vehicle will include a fully functional maglev suspension, low-power linear motor, digital control system, and off-board power supply. A test track will be designed and constructed, including one second-generation maglev switch. Operational requirements will include stable levitation during acceleration, deceleration, and transition through the switch before advancing to Phase 2.

- **Phase 2: Production Maglev System**

Timeline: 16 months

Production-quality vehicles will be designed, constructed, and tested on the Phase 2 track. The vehicles will include the same operational features as the Phase 1 vehicle but will use production quality materials and components. The passenger cabins will include full amenities, including HVAC. Production quality track elements and segments will be designed, fabricated and tested on the Phase 2 track. Production drawings for the vehicles and track elements will be produced. A traffic control system will be deployed and tested on the Phase 2 track.

- **Phase 3: Commissioning/Safety Certification**

Timeline: 5 months

Conduct trial runs and safety testing and then begin commercial operations.

Project Phases	Months																																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
1. Test Track																◆																					
2. Production System																																◆					
3. Safety Testing & Commissioning																																				◆	
4. Grand Opening																																				◆	

4.2 Budget

Maglev Ride Budget			
1) Site-Specific Detailed Engineering			
	Cost	% of Milestone	% of Total
Project Management/Customer interface	175,000	17.5%	
Systems Engineering Management	90,000	9%	
Vehicles	75,000	7.5%	
Suspension	125,000	12.5%	
Magnetic Tracks	50,000	5%	
Maintenance Yard / Equipment	10,000	1%	
Energy Supply Systems	75,000	7.5%	
Command and Control System	260,000	26%	
Guideway Structure	70,000	7%	
Project Integration	70,000	7%	
Total	\$1,000,000	100%	5%
2) Construction			
	Cost	% of Milestone	% of Total
Project Management/Customer interface	850,000	5%	
Systems Engineering Management	700,000	4%	
Manufacture 12 Vehicles	4,200,000	19%	
Suspension	400,000	2%	
Magnetic Tracks	7,500,000	40%	
Energy Supply Systems / Maintenance Yard	600,000	3%	
Command and Control System	500,000	2%	
Guideway Structure	4,000,000	21%	
Station renovations	350,000	2%	
Project Integration	370,000	2%	
Total	\$19,470,000	100%	92%
3) Commissioning			
	Cost	% of Milestone	% of Total
Project Management/Customer interface	100,000	25%	
Safety Testing/Training	300,000	75%	
Total	\$ 400,000	100%	3%
Total Project Value	\$20,870,000	100%	100%
Total with Contingency (20%)	25,044,000		

5. Controls & Constraints

5.1 Project Management Controls

The Magnovate Consortium will deploy the best practices of engineering project management to assure that the new Maglev Ride achieves the highest levels of quality and safety in its construction and operation. The sections that follow are an outline of the methodology that the Consortium will use. We will develop specific detail as part of the System Requirements Review and Preliminary Design Review, described below.

System Requirements Review (SRR)

This review examines the functional and performance requirements defined for the system by Toronto Zoo and the Magnovate Consortium and drafts the preliminary project plan. This is to ensure that the requirements and the selected concept will satisfy the overall mission of both parties.

Preliminary Design Review (PDR)

The preliminary design review documents that the initial design meets all system requirements with acceptable risk and within the cost and schedule constraints while establishing the basis for proceeding with a detailed design. It will show that the correct vehicle, infrastructure and control design options have been selected, and that all interfaces have been identified, and verification methods described.

Objectives:

- Ensure that all system requirements have been allocated, the requirements are complete, and the flow down is adequate to verify system performance
- Show that the proposed design is expected to meet the functional and performance requirements
- Show sufficient maturity in the proposed design approach to proceed to final design
- Show that the design is verifiable and that the risks have been identified, characterized, and mitigated where appropriate

Critical Design Review (CDR)

The CDR demonstrates that the maturity of the design is appropriate to support proceeding with full-scale fabrication, assembly, integration, and testing. CDR determines that the technical effort is on track to complete the Magline system development and ride mission operations while meeting performance requirements within the identified cost and schedule constraints.

Objectives:

- Ensure that the "build-to" baseline contains detailed hardware and software specifications that can meet functional and performance requirements
- Ensure that the design has been satisfactorily audited by production, verification, operations, and other specialty engineering organizations
- Ensure that the production processes and controls are sufficient to proceed to the fabrication stage
- Establish that planned Quality Assurance (QA) activities will establish perceptible

- verification and screening processes for producing a quality product
- Verify that the final design fulfills the specifications established at PDR

Test Readiness Review (TRR)

Our TRR will ensure that the infrastructure and vehicles, as well as the test facility, support personnel, and test procedures are ready for testing and data acquisition, reduction, and control.

5.2 Constraints

Magnovate recognizes that the challenge of every project is to make it work within the classic Triple Constraint; the interaction of quality (scope), cost (resources) and schedule (time). These three elements of a project must necessarily work in tandem with one another. Where one of these elements is restricted or extended, the Project Manager must adjust the other two elements to re-balance. The Project Manager shoulders the ongoing responsibility to monitor, analyze, and re-balance the three elements by careful planning, ongoing coordination, thoughtful resourcing and expeditious execution. Magnovate will assure project success for the Toronto Zoo project by coordinating activities and deliverables.



- **Rigorous Review Process:** The Magnovate Consortium will implement a thorough planning, testing and review methodology as outlined in section 5.1. A Gantt chart and resource diagram will be created to monitor the timeline, budget, percentage of completion for each milestone, and dependency relationships.
- **TSSA Approval:** Magnovate will engage with the TSSA in year one of the project to develop a plan for achieving TSSA approval so that the Magline ride will be certified to transport passengers by the end of the project.
- **Environmental Approvals:** Our consortium partner, Stantec Consulting, will work with environmental authorities to obtain all necessary environmental approvals.

6. Reporting & Project Management

6.1 Milestone Reports

As the project proceeds through a series of milestones, the project team will report on the results of the prior milestone and produce specific plans for the upcoming milestone using the format below.

Milestone #:	1	Activity Period	[DATE]	to	[DATE]
Objective:	Complete a revised preliminary project plan and determine the functional and performance requirements for the system				
Item	Milestone Deliverable	Metrics/Success Criteria		Completion Date	
1	System Requirements	System Requirements Review/The requirements and selected concept satisfy all project goals		[DATE]	
2	Preliminary Project Plan	System Requirements Review/The plan incorporates any changes due to results of development work prior to project start and includes all tasks required to accomplish project goals within the cost and time allotted		[DATE]	

6.2 Report Format

The project team will produce reports in a form and level of detail as agreed between the team and the Toronto Zoo management.

7. Magnovate & Toronto Zoo Responsibilities

7.1 Magnovate Consortium & Responsibilities

The Magnovate Consortium will assume responsibility for design, construction and testing of the Toronto Zoo project, with the following understandings:

- **Collaboration on Design:** The Consortium and the Toronto Zoo will collaborate and cooperate in good faith to achieve the agreed project mission.
- **Costs:** Magnovate will assume full responsibility for financing the project and for coordinating, and raising, all necessary funding to complete the project.
- **Operations:** Magnovate will be responsible for the maintenance of the equipment and infrastructure after implementation.
- **Difference Resolution:** The Consortium and the Toronto Zoo will conduct ad hoc meetings as necessary and regular scheduled meetings to discuss all aspects of the project. The parties agree to negotiate in good faith to resolve any and all differences that may arise. Where negotiations prove ineffective, the parties agree to an informal mediation process.

7.2 Pricing/Ridership & Revenue

The Toronto Zoo offers several rides/climb, the prices of these are as listed below.

- TundraAir Ride, Cost per ride is \$12.00 or four tickets for \$40.00
- Gorilla Climb Ropes Course, Cost per climb is \$8.00
- Zoomobile Ride Ride-all-day pass costs \$8.00, and four ride-all-day passes cost \$28.00

The estimated optimal price for the Maglev Ride at the Toronto Zoo is \$12.00 - \$15.00, which is reasonable compared to above benchmarks. However, due to the high-quality service and excellent view of the zoo provided by the Maglev Ride, it is possible that the revenue could be further enhanced if more information is available such as a preference survey conducted on existing and potential zoo visitors.

Historical Domain Ride Ridership

The Toronto Zoo Domain Ride was in service from 1976 to 1994. The historical Toronto Zoo Domain Ride ridership is shown below. It can be seen from that the percent of Toronto Zoo visitors that chose to ride the Domain Ride was 27 to 30 percent of the total zoo attendance with the average capture rate of 28%. The ridership ranged from 298,039 to 353,995 from 1990 to 1993.

Toronto Zoo Domain Ride Ridership

Year	Zoo Attendance	Domain Ride Ridership	Percent of Zoo Visitors for Domain Ride
1990	1,194,143	353,995	30%
1991	1,282,595	353,203	28%
1992	1,122,700	298,039	27%
1993	1,186,001	327,029	28%

Source: Attendance and ridership data provided by Toronto Zoo

Historical Toronto Zoo Attendance

The Zoo attendance from 2009 to 2016 is shown below:

Year	Zoo Attendance
2009	1,459,574
2010	1,308,788
2011	1,241,695
2012	1,286,673
2013	1,462,910
2014	1,186,019
2015	1,141,162
2016	1,309,542
Average	1,299,545

Source: Attendance data provided by Toronto Zoo

Ridership and Revenue Projection

The chart below depicts the potential revenue based on a range of ticket pricing scenarios. The number of tickets sold is based on capturing 15-35% of a conservative annual attendance of 1.2 million.

Ticket Price	Capture Rate (Tickets Sold)			
	20%	25%	30%	35%
	(240,000)	(300,000)	(360,000)	(420,000)
\$13.00	\$3,120,000	\$3,900,000	\$4,680,000	\$5,460,000
\$15.00	\$3,600,000	\$4,500,000	\$5,400,000	\$6,300,000
\$17.00	\$4,080,000	\$5,100,000	\$6,120,000	\$7,140,000

Revenue Range		
Conservative	Moderate	Optimistic
\$3,600,000	\$4,500,000	\$5,400,000

Indirect Revenue Potential

As the first commercial maglev system in North America the Maglev Ride has the potential to become a must-see attraction in Toronto and, consequently, has the potential to increase the annual number of visitors. Using 1.2 million visitors per year as a conservative baseline relative to the average attendance of 1,295,545 from 2009-2016, the graph below shows the potential additional revenue that could result from an increase in attendance due to the Maglev Ride.

Revenue Summary		
Source	Revenue	Per Visitor
Entrance	19,359,045	14.72
Retail	3,606,323	2.74
Food	7,821,797	5.95
Parking	4,093,895	3.11
Rides	3,389,270	2.58
Total	38,270,330	\$29.10

Additional Visitors					
	+ 3%	+ 6%	+ 9%	+ 12%	+ 15%
Baseline	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
Additional Visitors	36,000	72,000	108,000	144,000	180,000
Revenue Per Visitor	29.10	29.10	29.10	29.10	29.10
Additional Revenue	\$1,047,600	\$2,095,200	\$3,142,800	\$4,190,400	\$5,238,000

7.3 Benefits/Risk Sharing

- Magnovate has paid for a guideway inspection that was performed by Stantec which concludes that the existing structure is in very good condition.
- The Liability is solely Magnovate's for 15 years. Magnovate will assume full responsibility for expenses caused by or arising out of the acts, omissions, errors or negligence of Magnovate during the 15 year period. The Zoo will assume liability when the Maglev Ride is accepted by the Zoo after 15 years.
- Magnovate will be responsible for operations and maintenance for 15 years. After 15 years Magnovate agrees to continue maintaining the Maglev Ride on a service agreement basis and provide access to replacement parts and to qualified technicians to perform regular maintenance and repairs.
- Magnovate and the Toronto Zoo will share the profit on a 50/50 basis after operating, maintenance and financing expenses are paid for with revenues generated from ticket sales.
- In recognizing that visitor attendance drops in the off-season Magnovate will establish an operating reserve fund as a contingency to ensure that operations can be paid for in the case that revenue from ticket sales is not sufficient in certain months.
- The term of the revenue share agreement shall be 15 years.

7.4 Contract Terms

- Magnovate will assume full responsibility for raising and coordinating funding to complete the Project.
- Magnovate, in consultation with the Zoo, will prepare applications for grant funding and other relevant sources of financing.
- Specifications and milestones for the project plan will be agreed on in advance.
- Magnovate will operate and maintain the ride for a fee that is agreeable to Magnovate and the Toronto Zoo. Operations and financing will be paid out of the total revenue and then Magnovate and the Toronto Zoo will share the revenue on a 50/50 basis.

Appendix A: Magline Technology

Maglev Technology

Magnetic levitation (maglev) using magnetic forces to float a vehicle on a guideway eliminates traction and friction and so enables quick acceleration and deceleration and very high speeds. Maglev is also unaffected by weather and uses less energy than conventional high speed rail. Cars riding on magnetic cushions are quiet, smooth and comfortable. Reduced friction has made maglev trains that were built as demonstration projects to showcase the technology to hold the speed record for rail transportation for decades. Eliminating friction also reduces energy use quite substantially, especially in low speed installations. Presently, there are two commercial maglev trains in operation, with two others under construction. The Transrapid in Shanghai, began commercial operations in 2004, and the Linimo began relatively low-speed HSST operations in Japan in March 2005.

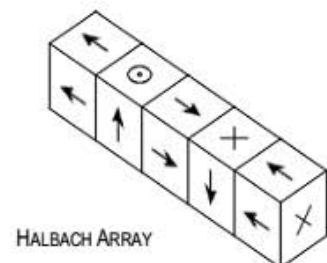
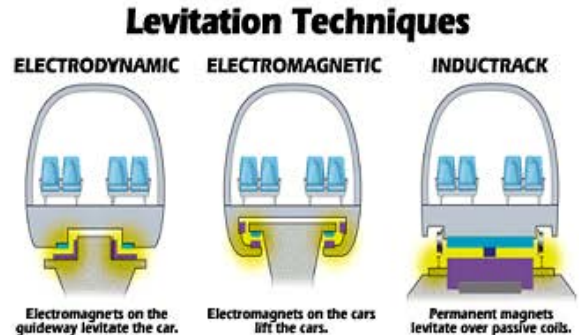
Generally, a horizontal set of magnets levitates the vehicle vertically above the track and a vertical set at the sides stabilizes the vehicle from side to side and keeps it on the track. With conventional maglev, narrow levitation gaps must remain in precise and stable alignment. In virtually all current designs, either the suspension components must wrap around the track edges or the tracks must wrap around the suspension, making switching cumbersome, slow and expensive. Due to these and other technical limitations, only two maglev systems are currently under construction; one in China and another in South Korea.

Prefabricated, robust sections of precision concrete rail with magnetic materials embedded are expensive to fabricate, to transport to building sites, and to assemble and maintain in precise alignment. They also present enormous switching challenges. Tiny levitation gaps mean that heavy, cumbersome sections must be moved mechanically and realigned perfectly in order to direct a vehicle from one track to another. Slow switch speeds limit the performance and efficiency of high speed rail and so most installations comprise a single line connecting stations. Magline makes complex, intricate networks feasible as it cuts infrastructure costs.

Magline Solutions

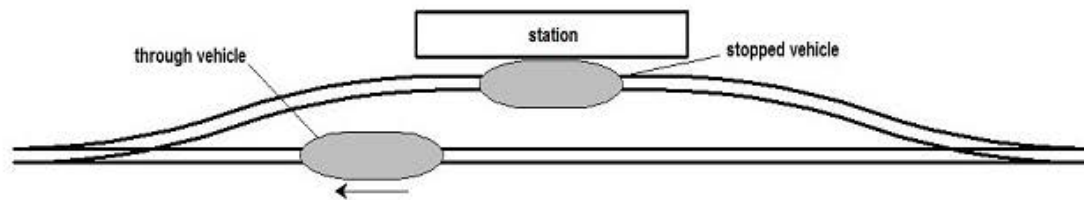
Magline technology fundamentally alters the state of the art and vastly broadens the range of applications possible for maglev transit. The vertical levitation gap of Magline design is an order of magnitude larger than those of existing designs, obviating the need for close-tolerance track alignment, and permitting the use of lighter guideways, bridges and other infrastructure to substantially reduce costs.

Based on a "Halbach Array" of magnets, Magline technology can switch tracks without mechanically moving the guideway. It thus can achieve high-speed passive switching while maintaining lateral stability and directional control without mechanically moving parts. Magline automation enables vehicles to run safely with short headways.



Lightweight Infrastructure

Lightweight infrastructure brings several advantages, especially when systems operate using off-line stations and individual vehicles instead of trains. Eliminating massive, heavy trains of cars further reduces the need for mammoth bridges and other extra heavy infrastructural components. Computer controlled individual vehicles running at short headway distances and high speeds can create many new operating efficiencies because they are able to bypass one another at stations and employ network routing. Off-line stations enable vehicles with no disembarking passengers to bypass stations where vehicles ahead may have stopped. That creates smooth traffic flows and stop-start efficiencies. Vehicles arrive more frequently and stop only where passengers aboard hold tickets, reducing wait and travel times.



Substantially less expensive infrastructure means developers can add more links and loops to create a larger network and to serve more populations even those remote from major cities. Bypassing "loops" off the main line bring operating advantages similar to off-line stations. The greater the number of hubs in the network, the greater the number of possible paths between destinations. Computers can reroute vehicles at every hub to avoid slow-downs.

Friction

Although most vehicles consume most energy to overcome air drag at speeds over 100 kph, thermal and frictional losses are also quite significant even at low speed. Maglev converts relatively small amounts of its power to heat losses and virtually none to mechanical friction. A maglev vehicle carrying four passengers and cruising at 120 kph would require about 7.5 kilowatts of power, or about 0.06 kWh per kilometer, costing about half a cent per km. An automobile that gets 50 km/gal costs more than 8 cents/km. Fuel savings and limited heat losses combine with low maintenance costs to achieve unprecedented low operating costs. Magline is the perfect choice for the Toronto Zoo, and it will herald many other new possibilities because it is sustainable, safe and automated transit with low power consumption while being very quiet and having smooth operation.

Appendix B: Maglev Ride Safety Features

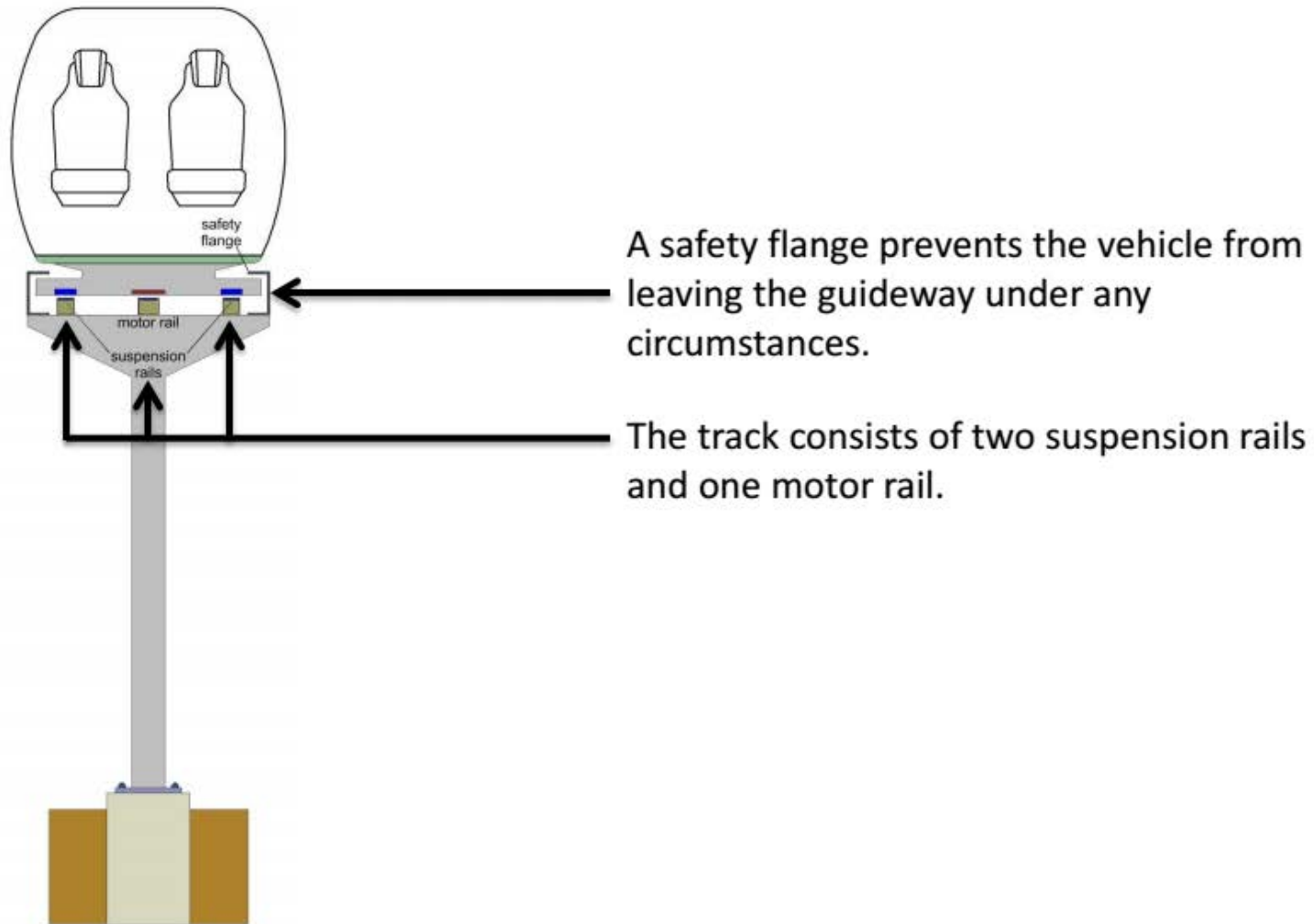
Magnovate recognizes that safety is of primary importance to the Toronto Zoo. The following section provides an overview the Maglev Ride safety features and demonstrates how the safety and redundancy of the technology are clearly aligned with the safety priorities of the Toronto Zoo.



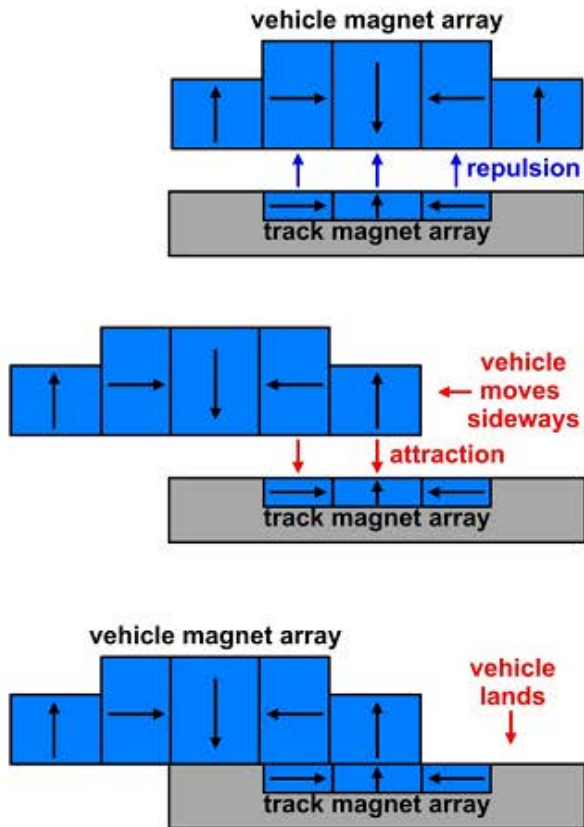
Magnovate Transportation Inc
Toronto Zoo Maglev Ride – Safety Features

www.magnovate.com

Guideway Configuration



Emergency Brake Operation



Each suspension rail interacts with a magnet array on the vehicle. In normal operation electromagnets keep the vehicle arrays centered above the rails, where repulsive magnetic force levitates the vehicle.

Power cannot be interrupted unless there are multiple failures in the control system. Such an event would result in the magnetic levitation becoming magnetic attraction and cause the vehicle to move sideways and slowly come to a stop.

Brake pads control friction between the vehicle and rails while the safety flange limits sideways motion. After the cause of the problem is corrected, the vehicle can be re-levitated and returned to service.

Safety Features

Fail safe emergency braking requires no action by an operator or the vehicle control system – it happens automatically if the control system or vehicle power fails.

Regenerative electrodynamic brakes are highly reliable due to few moving parts and will be included on the vehicles for use during normal operation.

Redundant systems ensures there's always a backup.

Levitation eliminates friction resulting in higher reliability due to less wear and tear.

Automated control eliminates driver errors.

Appendix C: Project Financing Scenarios

The charts below present the estimated operations and maintenance cost and potential scenarios for financing the Maglev Ride. The scenarios are based on preliminary discussions with various government grant authorities and infrastructure financiers. The equity value shown in each scenario represents cash contributed to the project by the Magnovate Consortium that does not require debt servicing. The Magnovate Consortium will proceed with writing and submitting grant applications and negotiating project financing terms once board approval has been obtained.

Estimated Annual O&M Costs	
Expense	Cost
Vehicle Maintenance	\$24,000
Snow Removal	\$18,000
Facility Maintenance	\$20,000
Electricity	\$21,000
Vehicle attendants	\$100,000
Control Room Operator	\$68,000
Insurance	\$20,000
Admin & Other	\$15,000
TOTAL O & M Costs	\$286,000
Contingency 10%	\$28,600
TOTAL w/ Contingency	\$314,600

Scenario 1 - Project Details	
Capital Cost	25,050,000
Grants	4,500,000
Equity	5,550,000
Debt	15,000,000
Amortization	30 years
Interest	5.00%
Yearly Payments	\$966,240

Scenario 1 - Profit Projection			
	Conservative	Moderate	Optimistic
Revenue	3,600,000	4,500,000	5,400,000
Operating Costs	314,600	314,600	314,600
Debt Payment	\$966,240	\$966,240	\$966,240
Total Expenses	1,280,840	1,280,840	1,280,840
Profit	\$2,319,160	\$3,219,160	\$4,119,160

Scenario 1 - Break-Even Analysis			
Ticket Price	\$13.00	\$15.00	\$17.00
Tickets Sold	98,526	85,389	75,343
*Required Capture Rate	8%	7%	6%
Break-Even Revenue	1,280,840	1,280,840	1,280,840
Total Expenses	1,280,840	1,280,840	1,280,840
* Based on annual attendance of 1.2 million			

Scenario 2 - Project Details	
Capital Cost	25,050,000
Grants	7,500,000
Equity	7,550,000
Debt	10,000,000
Amortization	30 years
Interest	5.00%
Yearly Payments	\$644,160

Scenario 2 - Profit Projection			
	Conservative	Moderate	Optimistic
Revenue	3,600,000	4,500,000	5,400,000
Operating Costs	314,600	314,600	314,600
Debt Payment	644,160	644,160	644,160
Total Expenses	958,760	958,760	958,760
Profit	\$2,641,240	\$3,541,240	\$4,441,240

Scenario 2 - Break-Even Analysis			
Ticket Price	\$13.00	\$15.00	\$17.00
Tickets Sold	73,705	63,917	53,398
*Required Capture Rate	6%	5%	4.7%
Break-Even Revenue	958,760	958,760	958,760
Total Expenses	958,760	958,760	958,760
* Based on annual attendance of 1.2 million			

Scenario 3	
Capital Cost	25,050,000
Grants	12,500,000
Equity	12,550,000
Debt	0
Amortization	0
Interest	0%
Yearly Payments	\$0

Scenario 3 - Profit Projection			
	Conservative	Moderate	Optimistic
Revenue	3,600,000	4,500,000	5,400,000
Operating Costs	314,600	314,600	314,600
Debt Payment	0	0	0
Total Expenses	314,600	314,600	314,600
Profit	\$3,285,400	\$4,185,400	\$5,085,400

Scenario 3 - Break-Even Analysis			
Ticket Price	\$13.00	\$15.00	\$17.00
Tickets Sold	24,200	20,973	18,506
*Required Capture Rate	2%	1.7%	1.5%
Break-Even Revenue	314,600	314,600	314,600
Total Expenses	314,600	314,600	314,600
* Based on annual attendance of 1.2 million			

APPENDIX II

Toronto Zoo Magnovate Ride Proposal - Scenario 1: \$12 2018-11-15									
Expenses:									
Magnovate Operating	\$	389,600.00			Price		\$12		
Financing 1	\$	966,240.00			Breakeven Attendance		125,487		
Total Magnovate Operating	\$	1,355,840.00							
Zoo Annual Costs	\$	150,000.00			Capture rate to = \$750,000		20.0%		
Total Annual Costs	\$	1,505,840.00							
Annual Attendance	10%		15%		20%		25%		
	Riders	Gross Revenue	Riders	Gross Revenue	Riders	Gross Revenue	Riders	Gross Revenue	
1,200,000	120,000	\$1,440,000	180,000	\$2,160,000	240,000	\$2,880,000	300,000	\$3,600,000	
1,225,000	122,500	\$1,470,000	183,750	\$2,205,000	245,000	\$2,940,000	306,250	\$3,675,000	
1,250,000	125,000	\$1,500,000	187,500	\$2,250,000	250,000	\$3,000,000	312,500	\$3,750,000	
1,275,000	127,500	\$1,530,000	191,250	\$2,295,000	255,000	\$3,060,000	318,750	\$3,825,000	
1,300,000	130,000	\$1,560,000	195,000	\$2,340,000	260,000	\$3,120,000	325,000	\$3,900,000	

Toronto Zoo Magnovate Ride Proposal - Scenario 2: \$14 2018-11-15									
Expenses:									
Magnovate Operating	\$	389,600.00			Price		\$14		
Financing 1	\$	966,240.00			Breakeven Attendance		107,560		
Total Magnovate Operating	\$	1,355,840.00							
Zoo Annual Costs	\$	150,000.00			Capture rate to = \$750,000		17.1%		
Total Annual Costs	\$	1,505,840.00							
Annual Attendance	10%		15%		20%		25%		
	Riders	Gross Revenue	Riders	Gross Revenue	Riders	Gross Revenue	Riders	Gross Revenue	
1,200,000	120,000	\$1,680,000	180,000	\$2,520,000	240,000	\$3,360,000	300,000	\$4,200,000	
1,225,000	122,500	\$1,715,000	183,750	\$2,572,500	245,000	\$3,430,000	306,250	\$4,287,500	
1,250,000	125,000	\$1,750,000	187,500	\$2,625,000	250,000	\$3,500,000	312,500	\$4,375,000	
1,275,000	127,500	\$1,785,000	191,250	\$2,677,500	255,000	\$3,570,000	318,750	\$4,462,500	
1,300,000	130,000	\$1,820,000	195,000	\$2,730,000	260,000	\$3,640,000	325,000	\$4,550,000	

Toronto Zoo
Magnovate Ride Proposal - Scenario 3: \$16
2018-11-15

Expenses:

Magnovate Operating	\$ 389,600.00	Price	\$16
Financing 1	\$ 966,240.00	Breakeven Attendance	94,115
Total Magnovate Operating	\$ 1,355,840.00		
Zoo Annual Costs	\$ 150,000.00	Capture rate to = \$750,000	15.0%
Total Annual Costs	\$ 1,505,840.00		

Annual Attendance	10%		15%		20%		25%	
	Riders	Gross Revenue	Riders	Gross Revenue	Riders	Gross Revenue	Riders	Gross Revenue
1,200,000	120,000	\$1,920,000	180,000	\$2,880,000	240,000	\$3,840,000	300,000	\$4,800,000
1,225,000	122,500	\$1,960,000	183,750	\$2,940,000	245,000	\$3,920,000	306,250	\$4,900,000
1,250,000	125,000	\$2,000,000	187,500	\$3,000,000	250,000	\$4,000,000	312,500	\$5,000,000
1,275,000	127,500	\$2,040,000	191,250	\$3,060,000	255,000	\$4,080,000	318,750	\$5,100,000
1,300,000	130,000	\$2,080,000	195,000	\$3,120,000	260,000	\$4,160,000	325,000	\$5,200,000

Toronto Zoo
Magnovate Ride Proposal - Scenario 4: \$18
2018-11-15

Expenses:

Magnovate Operating	\$ 389,600.00	Price	\$18
Financing 1	\$ 966,240.00	Breakeven Attendance	83,658
Total Magnovate Operating	\$ 1,355,840.00		
Zoo Annual Costs	\$ 150,000.00	Capture rate to = \$750,000	13.3%
Total Annual Costs	\$ 1,505,840.00		

Annual Attendance	10%		15%		20%		25%	
	Riders	Gross Revenue	Riders	Gross Revenue	Riders	Gross Revenue	Riders	Gross Revenue
1,200,000	120,000	\$2,160,000	180,000	\$3,240,000	240,000	\$4,320,000	300,000	\$5,400,000
1,225,000	122,500	\$2,205,000	183,750	\$3,307,500	245,000	\$4,410,000	306,250	\$5,512,500
1,250,000	125,000	\$2,250,000	187,500	\$3,375,000	250,000	\$4,500,000	312,500	\$5,625,000
1,275,000	127,500	\$2,295,000	191,250	\$3,442,500	255,000	\$4,590,000	318,750	\$5,737,500
1,300,000	130,000	\$2,340,000	195,000	\$3,510,000	260,000	\$4,680,000	325,000	\$5,850,000