



CITY OF RICHMOND

REPORT TO COMMITTEE

TO: Public Works and Transportation Committee

To PWT - September 7, 2000
DATE: August 24, 2000

FROM: Jeff Day, P. Eng.
Director, Engineering

FILE: 6340-01

RE: Implementation of a Global Positioning System Reference Network and Survey Monument System

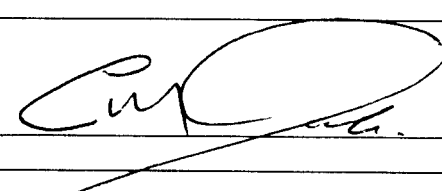
STAFF RECOMMENDATIONS

1. That the City of Richmond support implementation of the Greater Vancouver Regional District's proposal to replace the current physical survey monument system with a Global Positioning System (GPS) reference network and a "reduced density" survey monument system.
2. That the regional GPS implementation cost to the City be included in the Capital Program as a three year program such that expenditures are \$76,900 in 2001, \$49,300 in 2002 and \$53,000 in 2003 for a total of \$180,300 as described in the appended business case.
3. That staff continue to work with the GVRD – GPS Study Group to resolve out standing issues including the GVRD project management structure, the cost to the City for GPS equipment purchase and details regarding conversion of historical survey data to the new NAD83 datum and UTM mapping standards, and report back to Committee in June of 2001 with respect to progress in this regard.

JD

Jeff Day, P. Eng.
Director, Engineering

Att. 1

FOR ORIGINATING DIVISION USE ONLY
CONCURRENCE OF GENERAL MANAGER 

ORIGIN

The Greater Vancouver Regional District (GVRD) is considering implementing a region wide satellite Global Positioning System (GPS) based survey monument system to replace the ageing Integrated Survey Area monument system, and would like the endorsement of its member municipalities for this initiative.

ANALYSIS

Over the last 30 years, a network of conventional survey monuments has provided a three-dimensional reference system that consists of geographic and UTM horizontal co-ordinates, and elevations based on mean sea-level. This network supports all mapping, engineering, public works, property surveys, and geographic information system projects. The conventional system requires a dense network of maintained survey monuments (geodetic controls) in urban areas, and a less dense network in rural areas.

Advances in satellite global positioning systems has allowed this technology to be integrated with the conventional survey monument network. In 1997, the Province ceased to support the Integrated Survey Area Program using the conventional system of survey control monuments. Through its Crown agency Geographic Data BC (GDBC), the Province is supporting the replacement of the current conventional physical monument system with a Global Positioning System (GPS) based network. Using a network of strategically located GPS based satellite receivers plus a radio broadcast system, accurate positioning can be achieved. The GPS network will reduce the dependence on rural control points and will allow the dense urban control networks to become "reduced density" networks. The extension of the regional GPS system into urban areas can dramatically decrease the requirements for dense geodetic control networks as well as allow many new applications such as Geographic Information Systems (GIS) and Automatic Vehicle Location Systems (AVLS).

The system is currently being used in the City of Calgary, and also is being implemented by the Capital Regional District on behalf of its member municipalities.

Provincial and Municipal Roles

The Regional Engineers Advisory Committee (REAC) has prepared the attached Business Case for implementing a GPS-based survey reference network in Greater Vancouver. It also has developed the Draft Memorandum of Agreement with GDBC to reflect the intention to establish the system through a partnership in which GDBC takes the lead in implementation and makes a substantial contribution in kind to the cost of the project.

REAC believes it would be timely and beneficial to move forward with implementation of the new system as soon as possible.

Alternatives

1. The municipalities can implement their own separate GPS reference networks along with the associated radio broadcast systems. This would result in greater individual costs plus duplication of effort as compared to a collaborative approach.

2. The municipalities can decline the opportunity to implement a GPS-based system and continue to use the existing conventional monument system. However, the effectiveness of the existing system is decaying gradually as a result of its requirement for intensive maintenance and replacement. Consequently, it is becoming less reliable and will not be able to offer the level of efficiency and accuracy available from the proposed GPS-based system.
3. REAC also considered alternative implementation mechanisms such as a non-profit society or a non-share corporation such as E-Comm. These alternatives do not offer sufficient financial stability, project management capability, and risk management capability. After considering these alternatives, the Regional Administrative Advisory Committee (RAAC) and REAC have approved, in principle, the following recommendations:
 - A. That the GVRD, on behalf of member municipalities, implement a region-wide high precision GPS Reference Network along with a "reduced density" survey monument system at an estimated cost of \$2.379 million over a period of five years, based on a contribution of \$500,000 from GDBC, and \$1,879,000 from municipalities;
 - B. That the cost to municipalities is to be allocated on the basis of assessed values and is to be considered outside the GVRD budget envelope as a direct service to members;
 - C. That the GVRD implement the GPS Network and Survey Monument System in partnership with GDBC through a Memorandum of Agreement.

Staff support the GVRD's regional GPS initiative, although City operational details remain to be assessed and resolved. Staff would work with the GVRD's GPS Study Group to resolve implementation details including the City's need to purchase a GPS receiver, the City's need to convert historical survey data to the new NAD 83 datum and UTM mapping standards, and the GVRD's project management plan for the GPS implementation. Staff would report back to Committee as the GPS project progresses.

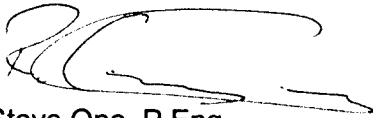
FINANCIAL IMPACT

The financial impact to the City of Richmond for establishing the regional GPS network would be a contribution to the GVRD of \$180,200 in total, distributed over the three year period from 2001 to 2003. This could be implemented as a three year capital program with \$76,900 expended in 2001, \$49,300 in 2000 and \$53,000 in 2003. The breakdown for each year as well as the financial impact to each of the GVRD member municipalities is outlined in the appended *Business Case for the Implementation of a Regional GPS Network*, GPS Study Group, May 17, 2000.

Over and above the City's contribution to the GVRD, the City will need to purchase one high accuracy GPS receiver in the year 2003 in order to make use of the GPS system. Such a receiver costs in the order of \$40,000. It is anticipated that the GPS monument system will result in operational efficiencies and cost savings to the City over the long term because there will be fewer survey monuments to maintain.

CONCLUSION

The opportunity to replace the physical survey system with a GPS-based system has a positive business case. Implementation through the regional district is an appropriate approach to meeting the needs of member municipalities for this system.



for Steve Ono, P.Eng.
Manager, Engineering Design & Construction

SO:rg

GPS Study Group

***A Business Case
for the Implementation of
a Regional GPS Network***

Prepared for:

REAC

**Submitted by:
The GPS Study Group**

May 17, 2000

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page No.</u>
1.0	Executive Summary	1
2.0	Prologue	2
3.0	Statement of the Problem/Opportunity	3
4.0	Identification of Alternatives	4
5.0	Evaluation	5
6.0	Risks and Uncertainties	6
7.0	Conclusions	7
8.0	Acknowledgment & References	8
Appendix A	Financial Calculations	
Appendix B	Proposed GVRD Allocation Table	
Appendix C	GVRD ACS Project Details	
Appendix D	Project Cost Payback Analysis	

1.0 Executive Summary

There are two recent changes in the survey, engineering and GIS fields which are significantly impacting municipalities in BC. Firstly, in the 1990's the Global Positioning System (GPS), a U.S. satellite based survey and navigation system, became fully operational. Secondly, as of September 1, 1997, the Province of British Columbia has withdrawn support for the ISA (Integrated Survey Area) and municipalities are now responsible for the maintenance of over 13,000 survey control monuments in the Greater Vancouver area.

REAC formed the GPS Study Group to consider using GPS (Global Position System) for precision surveying and to make recommendations on a replacement for the Integrated Survey Area program. After an extensive review, it was determined that: 1) a "reduced density" survey monument system of approximately 500 strategically placed and georeferenced monuments could replace the old ISA monument system, 2) it would cost in excess of \$200,000 to maintain the 13,000 geodetic survey monuments, 3) GPS is now used throughout the world and can obtain accuracy's of under one cm, and 4) a common survey datum is needed in the Lower Mainland in order to develop common geodetic standards for survey and mapping in the Region.

The following two-part Regional GPS Reference Network project is proposed for the GVRD:

- 1) A Reduced Density Monument Network: Five hundred survey monuments (250 existing and 250 new) would be installed and adjusted as first order survey monuments.
- 2) Differential GPS System: High-end differential GPS survey equipment can now obtain accuracy of under 1cm provided that there is an appropriate network of GPS Reference Stations. It is anticipated that 4 Regional GPS Reference Stations, each with a radius of 20km, would be needed with a radio transmission system to achieve this accuracy for survey measurements. This proposed Regional GPS system can also be used for engineering construction and AVL (automatic vehicle location).

Geographic Data BC (GDBC) is willing to form a partnership with GVRD municipalities for this project. GDBC, through a proposed memorandum of agreement with the GVRD, would design, install and maintain Regional GPS Reference Network including a "reduced Density" survey monument system over a five year period. The cost of this project is \$2,379,000. The proposed cost sharing for this program is \$500,000 from GDBC and \$1,879,000 from municipalities.

There are other groups and organizations like engineers, surveyors, utility companies, E-Comm, TransLink, transportation companies, and marine companies, who would like to use the differential GPS service and would lease GPS radios from the GVRD. It is anticipated the annual revenue of \$150,000 from GPS radios leases would at least cover the annual maintenance costs (\$100,000) plus some return on capital investment. The payback period to municipalities is estimated to be 5 years based on an average annual ISA survey monument replacement costs of \$300,000 plus \$150,000 for network adjustments. Additional savings to municipalities are expected from the low cost and time savings of DGPS survey.

The Regional GPS Network will deliver the following benefits to the GVRD:

- An accurate and efficient survey system
- Lower monument maintenance costs
- Common survey standard and GIS geodetic datum standards throughout the GVRD
- Better information provided to GVRD members
- Automated Vehicle Tracking
- Added revenue from GPS broadcast corrections sales to third parties

System implementation is a relatively low-risk project because the hardware and software available are proven, and have been commercially available for some time.

Three alternatives were considered:

- > **Alternative 1:** do nothing
- > **Alternative 2:** maintain existing monuments
- > **Alternative 3:** implement a regional GPS network

Based on the business case analysis, alternative 3 is recommended. The 5-year Project would start in year 2001 with capital installation by 2003 plus a 2 year maintenance period to 2005.

Recommendations:

1. That the GVRD, on behalf of member municipalities, implement a region-wide high precision GPS Reference Network along with a "reduced density" survey monument system at an estimated cost of \$2.379M over a period of five years.
2. That GVRD implement the GPS Network and Survey Monument program in partnership with Geographic Data BC (GDBC) as outlined in the attached draft Memorandum of Agreement.
3. That the GVRD use the standard GVRD assessments formula to allocate the \$1.279M to member municipalities and electoral areas over a three year period.

4. That the GVRD assume overall responsibility for the service but create a legal entity (non-profit society or other legal entity) under the new provisions of the Municipal Act to deliver it.

2.0 Prologue

Geodetic survey control monuments are essential for legal and engineering surveys in GVRD municipalities. Legal survey plans, GIS maps and navigation systems are all ultimately referenced to these monuments.

As of September 1, 1997, the Province of British Columbia has withdrawn support for the ISA (Integrated Survey Area) monuments and municipalities are now responsible for these survey control monuments. As municipalities have limited resources and funds available for this new responsibility, the ISA monument system is not being maintained and is slowly deteriorating.

GPS, a new satellite based positioning system is now commonly used throughout the world for surveying, mapping and navigation.

REAC formed the GPS Study Group to consider using GPS (Global Position System) for precision surveying, GIS, and AVL, and to investigate options for operating and maintaining a survey control monument system. The GPS study group reviewed survey and GPS developments occurring in North America and other countries to see how to address the long-term needs of municipalities in the GVRD. The GPS study group investigated public/private partnership as well as inter-agency partnerships for service delivery alternatives.

This business case will focus on the alternatives to address the survey issues and provide the justification for a regional GPS network to be implemented through a partnership with GVRD & GDBC.

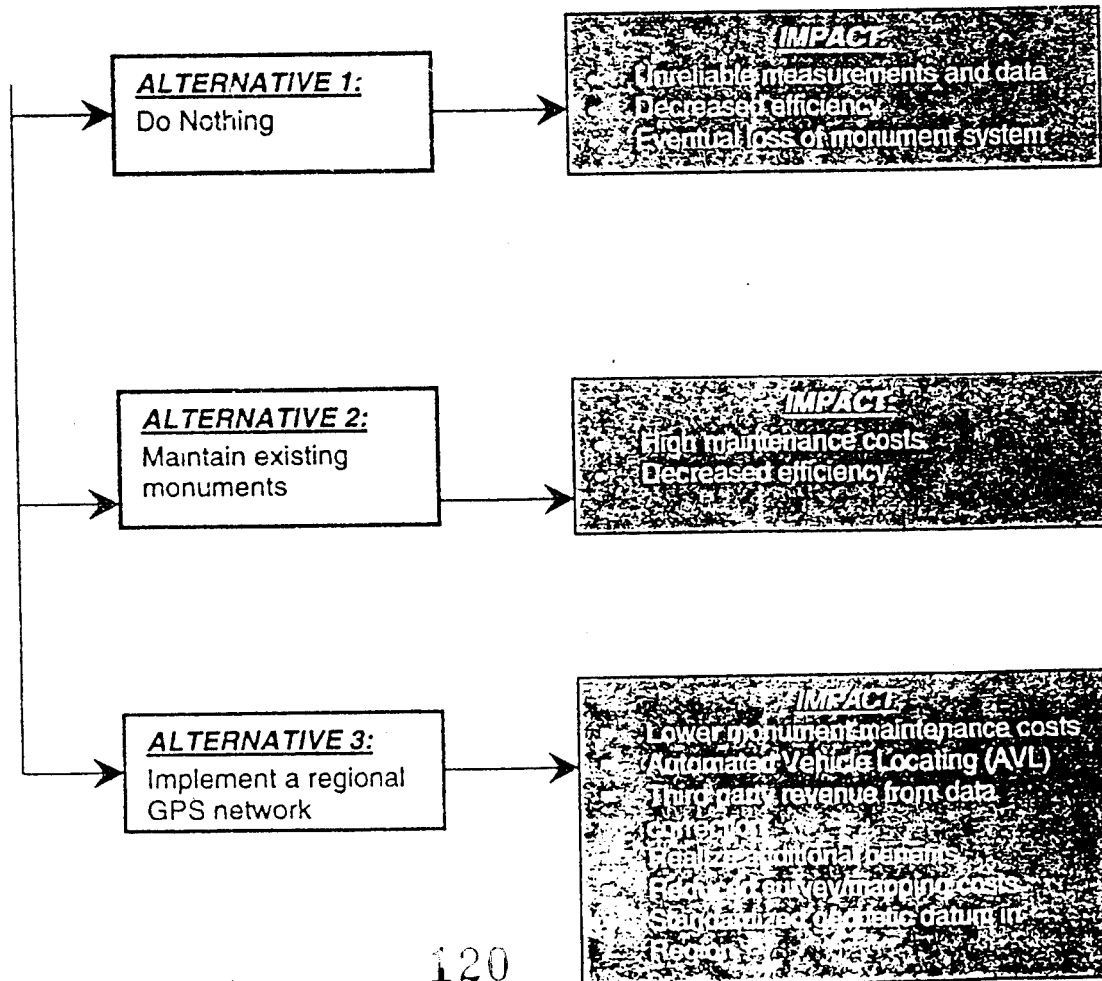
3.0 Statement of the Problem/Opportunity

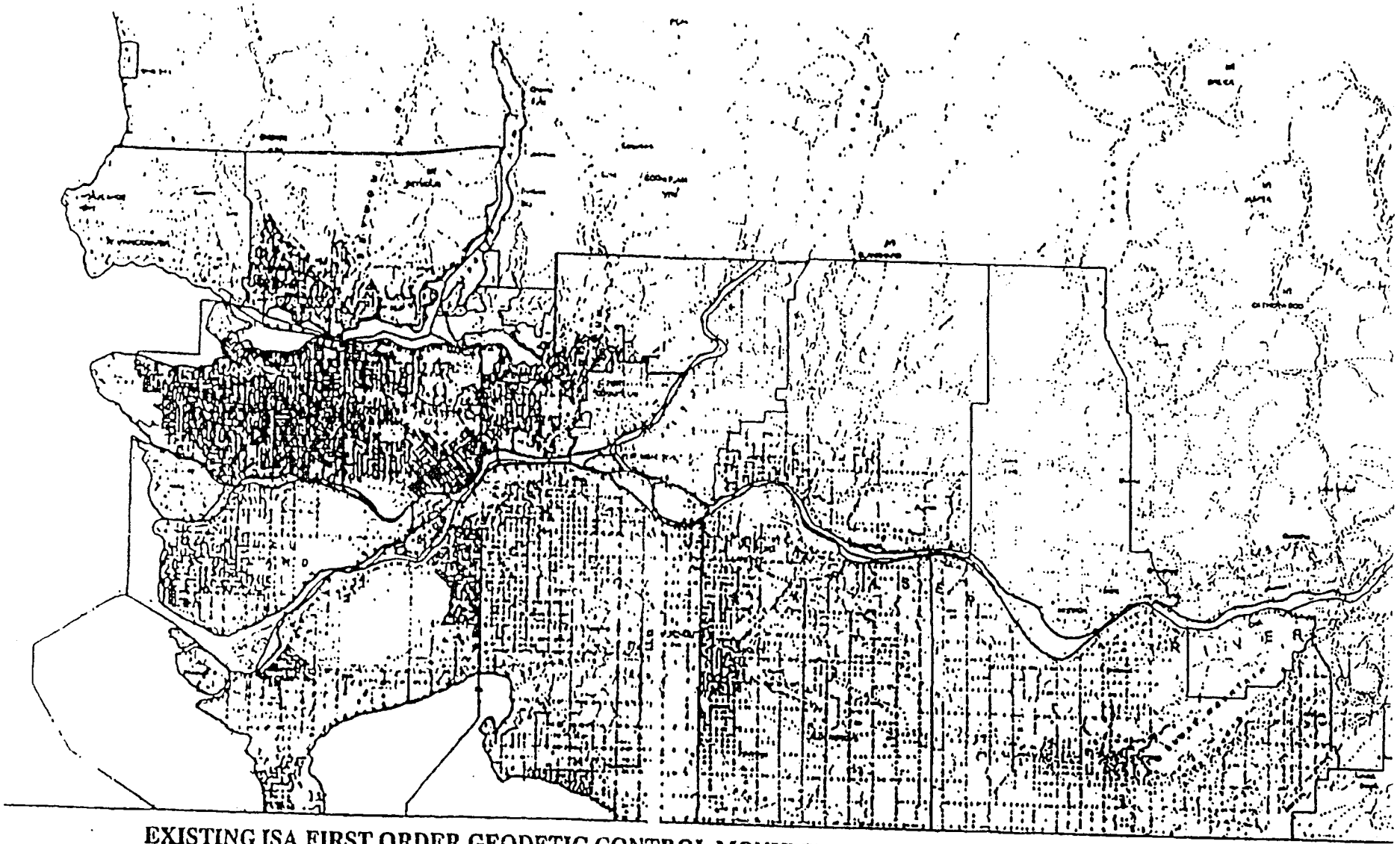
As was already mentioned, the Province of British Columbia has withdrawn support for the ISA and municipalities are now responsible for maintaining survey control monuments. See Plan 1 – Existing ISA First Order Geodetic Control Monuments. Annual maintenance on the existing ISA survey monuments are expected to exceed \$300,000 in the next 5 years. There are 3 options:

- **Alternative 1:** do nothing
- **Alternative 2:** maintain existing monuments
- **Alternative 3:** implement a regional GPS network

Figure 1 below shows the high level impacts of the three alternatives.

Figure 1: Synopsis of Alternatives

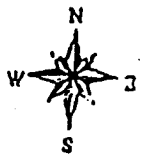




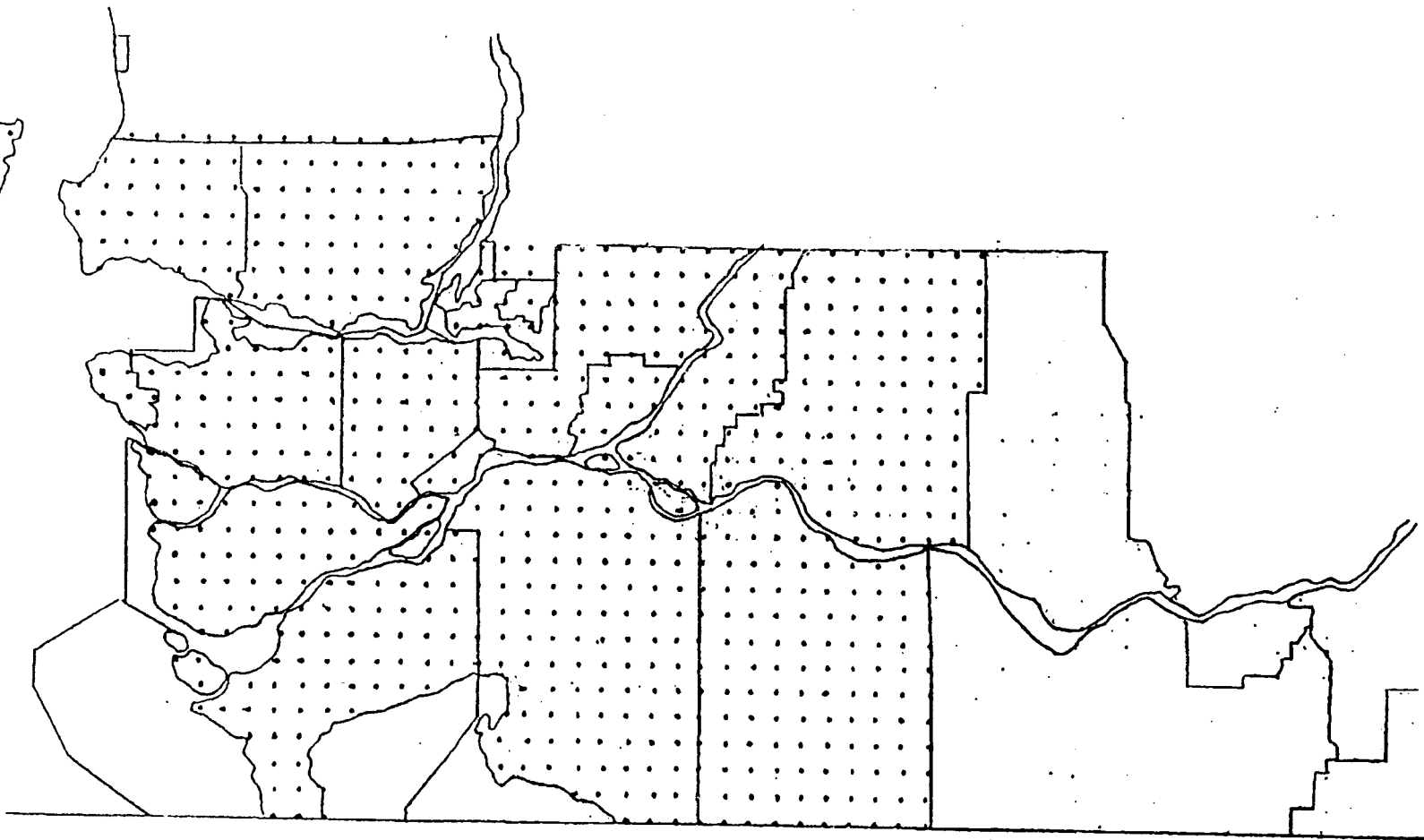
EXISTING ISA FIRST ORDER GEODETIC CONTROL MONUMENTS

LOWER MAINLAND AREA

PLAN 1

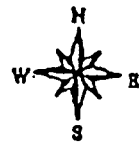


122



PROPOSED FIRST ORDER GEODETIC CONTROL MONUMENTS

LOWER MAINLAND AREA



PLAN 2

4.0 Identification of Alternatives

There are 3 basic alternatives associated with this business case. They are:

Alternative #1: Do Nothing

This alternative would see the survey monument system not maintained. Monument loss over time (mostly due to construction) is estimated to be about 1% annually. Also, existing monuments move over time and require adjustments. With inaccurate survey measurements for municipal governments, this alternative could potentially prove costly. A lack of maintenance the survey monument system would not be acceptable considering the critically important physical and legal roles that survey boundaries provide in a municipality's administration. Not maintaining the survey monuments and records, within the GVRD, could come at a high future cost to member municipalities.

Alternative #2: Maintain existing monuments

This alternative would see municipalities within the GVRD maintain the existing network of survey monuments. Based on a cost of approximately \$2,000 to replace one geodetic survey control monument, it would cost municipalities within the GVRD approximately \$300,000 per year to replace survey monuments. There would be an additional cost of \$150,000 for network maintenance and data management services that have been provided by the Province in the past.

Alternative #3: Implement a regional GPS network

Under this alternative, the following two-part Regional GPS Reference Network project would be implemented in the GVRD:

- 1) A Reduced Density Monument Network: Five hundred survey monuments (250 existing and 250 new) would be installed and adjusted as first order survey monuments. A reduced density grid of 2 km would be used (see Plan 2).
- 2) Differential GPS System: High-end differential GPS survey equipment can now obtain accuracy of under 1cm provided that there is an appropriate network of GPS Reference Stations. It is anticipated that 4 Regional GPS Reference Stations, each with a radius of 20km, would be needed with radio transmission (6 to 8 UHF transmitters) to achieve high accuracy needed for survey measurements. The Regional GPS Network would also allow for other uses such as engineering construction and AVL for specially equipped

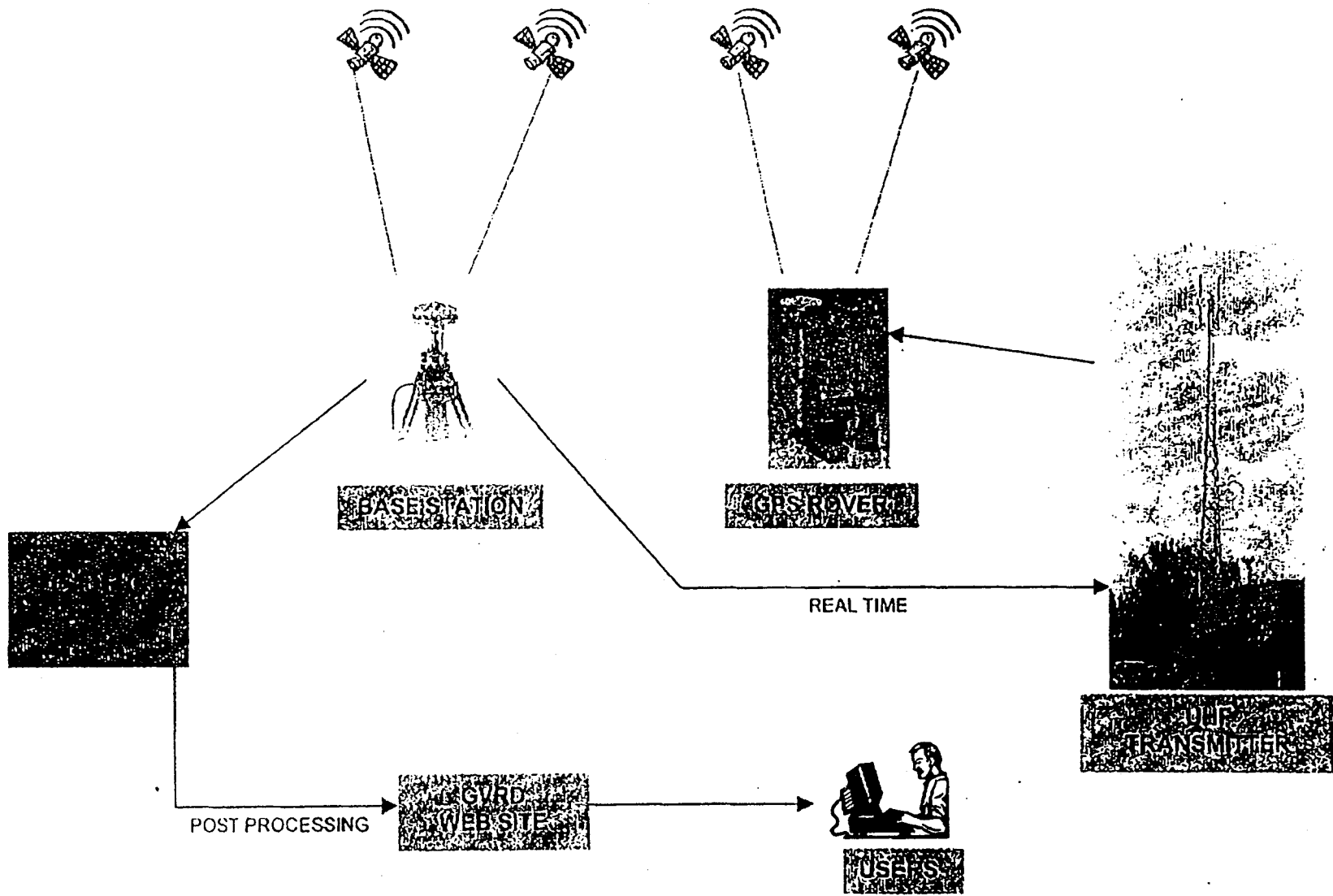
vehicles. In addition, a web site will be developed to provide post processing GPS data and information to users. The implementation of the Regional GPS Network would also allow the GVRD to create a revenue source from the differential GPS corrections broadcast being sold to third parties using GPS.

As there is some potential revenue from sales of differential GPS signals to survey, engineering, utility companies, and transportation firms, the GPS study group was pursuing a public/private partnerships for service. However, the federal government has just announced a Canada wide DGPS service with 1-10m accuracy. This initiative will substantially reduce the revenue potential to a private partner.

Various options were can be considered for financing, installing and operating the Regional Integrated Survey Monument and GPS systems including the private sector, public-private partnerships, intermunicipal agreements a non-profit corporation, as well as provincial agencies. After evaluating these options, it is recommended that the GVRD, on behalf of the member municipalities, arrange for financing, enter into a partnership agreement with GDBC and provided overall project supervision. Municipalities would contribute \$1,879,000 and GDBC would contribute \$500,000 in resources and expertise towards the total project cost of \$2,379,000.

GDBC, who has recently partnered with CRD in a CRD regional GPS network, has offered to partner with the GVRD in implementing a regional GPS network proposed in Alternative 3. GDBC would design, procure and supervise the installation of the GPS system and monuments over a three year period then maintain the system for two additional years before turning the whole system over to the GVRD. In this partnership, the GVRD, on behalf of member municipalities, would finance and provide overall supervision for the project. Also, the GVRD would lease the GPS radio receivers to third parties. After the installation is complete, the GVRD, would, through GDBC, be responsible for the GPS system maintenance and the individual municipalities would be responsible for survey monument maintenance.

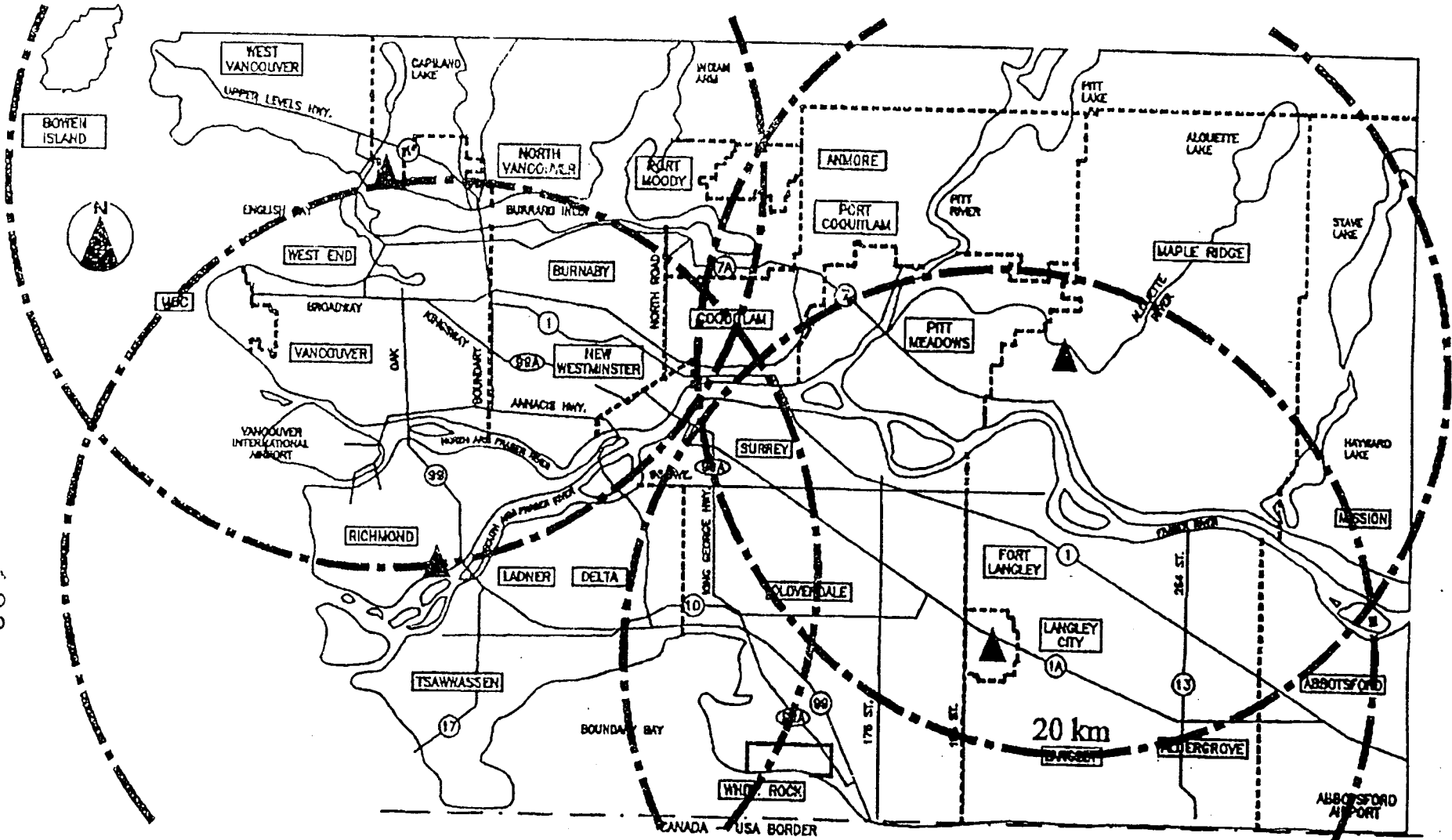
GVRD - REGIONAL GPS NETWORK



125

Plan 3

126



▲ Location of GPS Receivers

Plan 4

PROPOSED REGIONAL GPS REFERENCE NETWORK

January, 2000



5.0 Evaluation

The evaluation methodology used in this business case is straight forward, and is described as follows:

- It is assumed that REAC is not willing to let the regional survey monument system fail and not replace it. This is because the consequence of a lack of maintenance to the survey monument system could lead to very high future costs for all member municipalities and the GVRD. Therefore something must be done.
- As shown in Appendix A, the capital cost of the GVRD regional GPS system & reduced density monument system is \$2,379M. In addition, \$100k per year is required for maintenance.
- There would be some revenue through leasing of differential GPS signals to third parties such as legal surveyors consulting engineers, contractors, utility companies and other government agencies. A market survey of potential users of differential GPS radio signals completed in the CRD in 1998 by KPMG showed that there are 41 organizations interested in this service. It is estimated that there would be at least 75 third party users in the Lower Mainland. Assuming an annual leasing cost of \$2,000 per GPS radio receiver in the first few years, the revenue from radio leases would be at \$150,000 per year. These revenues are expected to at least cover the annual maintenance costs of \$100,000 plus a return on investment.
- Payback based for the regional integrated monument and GPS systems is estimated to be 5 years.
- As GPS provides a fast and accurate system for positioning, there are additional cost savings in survey work to municipalities when using GPS.
- A new Regional GPS Network will deliver other benefits to the GVRD, including:
 - Lower annual survey monument maintenance costs;
 - Better information provided to the GVRD and member municipalities for decision making;
 - Common survey standard and GIS geodetic datum standards throughout the GVRD.
 - Automated Vehicle Location (AVL);

Various governance options could be considered for service delivery including:

- 1) an independent non-profit society
- 2) a GVRD departmental service
- 3) a non-profit entity reporting to the GVRD

Under new provisions of the Municipal Act, a Regional District can create a non-profit entity reporting to the Regional District Board for service delivery. If the GVRD assumed overall responsibility for the service and created a non-profit entity to help manage the new Regional GPS Network, the GVRD would be able to utilize the GVRD administration/borrowing capabilities while, at the same time, utilize the entrepreneurial approach of a non-governmental entity for revenue generating and marketing.

Based on the business case analysis, alternative 3 is recommended. This 5-year Project would start in year 2001 with capital installation by 2002 plus a 2 year maintenance period to 2005.

6.0 Risks and Uncertainties

The implementation of a Regional GPS Network is a relatively low risk project. That is because the hardware and software that are available have been commercially available for some time by many vendors. As the Capital Regional District is currently implementing a similar regional GPS network in partnership with GDBC, the GVRD can benefit from the experience in the Victoria area.

7.0 Conclusions

The existing survey monument system is inefficient and requires more maintenance and upkeep than the "Reduced Density" monument system.

It is recommended that the GVRD implement the Regional GPS Network system in partnership with GDBC at a total cost of \$2,379M based on contributions of \$500,000 in resources and expertise from GVRD and \$1,879,000 from municipalities.

The payback is 5 years for the purchase cost of \$1.83M annualized over 3 years @ 8% real discount rate, plus \$100k/year for maintenance.

The GVRD, by creating a non-profit entity to help manage the new Regional GPS Network, would be able to utilize the GVRD administration/borrowing capabilities while, at the same time, utilize the entrepreneurial approach of a non-governmental entity for revenue generating and marketing.

The new Regional GPS network will deliver the following benefits to the member municipalities:

- Lower annual survey monument maintenance costs;
- Better information provided to the GVRD and member municipalities for decision making;
- Third party revenue source
- Common survey standard and GIS geodetic datum standards throughout the GVRD
- Automated Vehicle Location (AVL);

System implementation is a relatively low-risk project because the available hardware and software are proven, and have been commercially available for some time.

8.0 Acknowledgement & References

The Regional Engineers Advisory Committee appointed the GPS Study Group to investigate and report on alternatives for the Integrated Survey Monument program and the application of GPS for survey, GIS and GPS. Several individuals have participated in the GPS Study Group as listed below. Their contribution role in the GVRD GPS project and in the preparation of this business case is appreciated and acknowledged.

I.R. Zahynacz, City of Port Coquitlam (Chair)
Amin Kassam, Ministry of Environment, Land and Parks
Chuck Salmon, Surveyor General
Jim Sutherland, Ministry of Environment and Parks
Ken Cameron, GVRD
Frank Huber, GVRD
Laurence Cohen, GVRD
Noel Peters, City of Vancouver
Mike Thomson, City of Vancouver
Terry Naylor, City of Surrey
Peeter Liivamagi, City of Burnaby
Bob Peterson, City of Burnaby
Paul Sung, City of Richmond
Steve Ono, City of Richmond
Henry Wong, City of Coquitlam
Don Moore, Corp. of Delta
Rick Walters, Corp of Delta
Bob Turner, Corp of Delta
Matt Pongracz, City of Langley
Bob Hummel, City of Langley
Mike Ross, District of Maple Ridge
Terry Garrow, B.C. Ambulance
Eric Hoogenraad City of Abbotsford
Hansel Wang, Coast Mountain
Arnie Vsetcka, Coast Mountain

APPENDIX A:

APPENDIX A:

Financial Calculations

CAPITAL COSTS:

1. Differential GPS Capital Project Costs

a) 4 DGPS Reference Stations	\$ 375,000
b) RTK & UHF Radio Communication Infrastructure	365,000
c) Testing Demonstration h/w & s/w	80,000
d) Marketing and Client Servicing	80,000
e) Web Site for Post-Mission & Data Access	<u>304,000</u>
Total DGPS Cost	\$1,204,000

2. Georeference System Capital Costs

a) Adoption of NAD 83/UTM standards & Monument Reductions	\$ 30,000
b) Additional Monuments (250)	700,000
c) High Accuracy Geoid Modeling & Vert. Adjustments	370,000
d) Develop MGRF – ACS Standards	45,000
e) ISA revisions and BCACS Augmentation	<u>30,000</u>
Total Georeference System Cost	<u>\$ 1,125,000</u>

Total Project Capital Costs **\$ 2,379,000**

OPERATING AND MAINTENANCE COSTS:

After the construction of the GVRD Regional GPS Reference Network is completed, there would be an annual operating and maintenance cost of \$100,000.

ANTICIPATED REVENUE:

Based on an initial sign-up of 75 third party users of the differential GPS radio broadcast service in the Lower Mainland and a lease charge of \$2,000 per year the annual lease revenue would be \$150,000.

APPENDIX B:

APPENDIX B:

Proposed GVRD Cost Allocation

GVRD GPS Reference Network – 5 Year Program

Project Cost = \$2,379,000
 Less Contribution from GDBC = - 500,000
 Contribution from Municipalities \$1,879,000

	1999 Assessments	Share %	2001 \$	2002 \$	2003 \$	Total \$
Cities:						
Burnaby	\$2,495,208,349	9.98	80,000	51,300	56,300	187,600
Coquitlam	1,125,780,393	4.50	36,100	23,100	25,400	84,600
Langley City	255,258,283	1.02	8,200	5,200	5,800	19,200
New Westminster	523,281,777	2.10	16,800	10,800	11,800	39,400
N. Vancouver City	599,886,389	2.40	19,300	12,300	13,500	45,100
Port Coquitlam	456,663,662	1.83	14,600	9,400	10,300	34,300
Port Moody	245,039,930	0.98	7,900	5,000	5,500	18,400
Richmond	2,396,971,017	9.59	76,900	49,300	54,000	180,200
Surrey	3,118,489,087	12.48	100,000	61,100	70,300	234,400
Vancouver	8,557,129,726	34.24	274,500	176,000	192,900	643,400
White Rock	203,625,645	0.81	6,500	4,200	4,600	15,300
Districts:						
Bowen Island	52,658,615	0.21	1,700	1,100	1,200	4,000
Delta	1,205,230,158	4.82	38,700	24,800	27,200	90,600
Langley	892,236,179	3.57	28,600	18,400	20,100	67,100
Maple Ridge	524,568,889	2.10	16,800	10,800	11,800	39,400
North Vancouver	1,076,288,319	4.31	34,500	22,100	24,300	80,900
Pitt Meadows	123,434,694	0.49	4,000	2,500	2,800	9,300
West Vancouver	986,584,605	3.95	31,700	20,300	22,200	74,200
Villages:						
Anmore	16,495,850	0.07	500	300	400	1,200
Belcarra	13,298,238	0.05	400	300	300	1,000
Lions Bay	22,535,379	0.09	700	500	500	1,700
Electoral Areas						
	102,630,923	0.41	3,300	2,200	2,300	7,700
	\$24,993,296,107	100.00	801,500	518,500	559,000	1,879,000

Note: Under the contract with GDBC for this program, GDBC would continue to operate and maintain the Regional GPS Network during 2004 and 2005.

APPENDIX C

GVRD ACS Project Requirements Update, including required GDBC support resources

The Provincial proposal to the GVRD (June 1997 and as revised May, 1998) related to the development and implementation of a new Geo-Spatial Reference within the GVRD provides a break-down of tasks required to complete the project. However, the Provincial contributions to the project were not clearly highlighted in that document. All together, this update to the original proposal reflects the following revisions: (1) May, 1998, incorporation of need for GDBC to recover staff costs in the context of an overall picture of the GDBC contributions and the amounts targeted for cost recovery; and (2) updated capital program costs based on any new information derived over the last year (re CRD project experience), including a hike in the projected costs for the radio infrastructure as well as the requirement to install and survey more monuments (re GPS Study recommendations), (3) exclusion and separation of FVRD requirements (i.e. this document only defines GVRD requirements), and (4) cost reductions as suggested by GPS Study group (e.g. provision of one high end GPS receiver only).

All of this should provide clarity to the GVRD on GDBC's proposed contributions and the overall project requirements.

Following the headings outlined in the original Provincial proposal (June, 1997), identified below are the Provincial contributions and resource requirements in support of this project. Finally, a summary of the costs and recommendations for the project are outlined for GVRD consideration.

- 4.1 *On-line Municipal Geo-Spatial Reference (MGSR) Data Access.* The Province has spent well over \$ 200,000 in the construction of an Internet World Wide Web access system for geodetic control monuments. This access system will be used to provide the geodetic control monuments information under the new GVRD geo-spatial reference program. The costs (already identified) of updating and maintaining the system to accommodate the GVRD information is estimated at \$ 4,000 per year (i.e. \$12,000 over 3 years). The GVRD will therefore be leveraging considerably the Provincial investment to its advantage. The Province will however, expect to, additionally charge the GVRD its direct costs, including personnel time, related to the work. This is estimated at \$ 10,000 based on a nominal rate of \$ 60,000 per year for personnel time and other expenses at cost.
- 4.2 *Establish Active Control Points (ACPs) in CRD.* The Provincial investment in the BC Active Control System (BC ACS) network of 9 ACPs runs to about \$ 1 million. Considerable expertise has been developed over the past five years (as the network was researched, designed and unfolded) in the requirements, installation, operation and utility of the network. The GVRD will leverage this expertise, including that gained under the CRD project, and limit its costs to direct capital expenditures only (estimated at \$ 200,000). The Province will however, expect to, additionally charge the GVRD its direct costs, including personnel time, related to the work. This is estimated at \$ 25,000 based on the nominal rate of \$ 60,000 per year for personnel time and other expenses at cost.
- 4.3 *MGSR ACS Post-mission Service Delivery.* Considerable hardware, software (including custom software) have been put in place to serve the post-mission users. The assembly will be increased in capacity to handle five more ACPs in the BC ACS network, thereby reducing considerably the effort and costs to the GVRD. The capital costs charged to the GVRD are estimated at \$ 12,000, whereas the GDBC time charges to the GVRD are estimated at \$ 20,000.
- 4.4 *Ongoing Client, User and Stakeholder Communications.* On-going dialogue with the core and new users must be done in order for the project to be successful. A periodic newsletter over the 3 year project would be produced. The capital costs charged to the GVRD are estimated at \$ 20,000 per year, whereas the GDBC time charges to the GVRD are estimated at \$ 20,000 over 3 years.

- 4.5 *Adoption of NAD83 Datum and UTM Mapping Standards.* The GVRD will adopt these standards as part of the project. However, the actual conversion of historical data to these standards is left to the GVRD and its member municipalities. This work is outside of the scope of this project.
- 4.6 *Monument reductions.* Though there is no planned program for the physical destruction of some of the existing monuments, GDBC will have to work out with the GVRD and the member municipalities a strategy for identifying key monuments in the region which will have to be protected and earmarked as vital to the transition from the present system to the future system. GDBC costs (largely personnel time) in this program are estimated at \$ 30,000.
- 4.7 *Implementation of a Robust, Highly Accurate NAD83 Datum.* This work will result in a high accuracy, long term network of monuments in the region. (that will support all needs and effectively allow for the non-maintenance of large parts of the present dense network of monuments). The management, supervision, analysis and data processing at GDBC for the external contracted work is estimated at \$ 20,000. The external contract work is now valued at about \$ 600,000 given the desire of REAC (GPS Study Group) to increase the number of key monuments to a 2-km grid density. As well, this item includes precise levelling of all 2-km grid points in support of the High Accuracy Geoid Model (item 4.8). The largest effort required of GDBC is the readjustment (integration) of the data gathered into the Provincial coordinate system. This will require just under a one and a half person year effort (i.e. \$ 80,000) resulting in new and robust NAD83 (CSRS) coordinates for the region.
- 4.8 *High Accuracy Geoid Model.* This will result in a high precision geoid model in the region, thereby facilitating (along with the new vertical readjustment, below) GPS users in the region the ability to derive high accuracy elevations. The external contracted work is estimated to be worth about \$ 20,000. GDBC costs (largely personnel time) associated with this work is estimated at \$ 20,000.
- 4.9 *Vertical Readjustment and New Vertical Datum Adoption.* In order to maximize the utility of the new system, including the capability for GPS users to derive high accuracy elevations in the region, a vertical readjustment of the new monument network will have to be completed. The external contracted work is estimated to be worth about \$ 40,000. GDBC costs (largely personnel time) are estimated at \$ 240,000. GDBC has already spent considerable effort (several person years) preparing the GVRD and provincial data for such a readjustment. It is for this reason that the GDBC effort, though still significant, is less than what would otherwise be required. Note also that the conversion of historical vertical elevation data to the new datum by the GVRD and member municipalities is outside the scope of this project. Although the GVRD and the municipalities will adopt the new datum, as delivered under the new system, conversion efforts will have to be scheduled by the municipalities accordingly (as with NAD83 and UTM conversions, above).
- 4.10 *Implementation of MGSR ACS Real-Time Kinematic (RTK) Service.* Some \$ 285,000 are required for hardware, software and external consulting related to this aspect of the project. Additional charges to cover GDBC expenses (largely personnel time) are estimated at \$ 30,000.
- 4.11 *Development of MGSR ACS Geo-Positioning Standards.* Contract work related to this component of the project is estimated at \$ 25,000. However, considerable time and expertise will have to be invested by GDBC to support this activity. GDBC charges in support of this activity are estimated at \$ 20,000.
- 4.12 *Testing, Demonstration and Application Pilots.* Hardware, software and consulting contract services earmarked for this activity were estimated at \$60,000. However, considerable time and expertise will have to be invested by GDBC to support this activity. GDBC charges in support of this activity are estimated at \$ 20,000.

4.13 *Integrated Survey Area (ISA) Regulations Revision.* The education and training contract work for this activity is now eliminated. GDBC charges related to this activity are expected to be about \$ 5,000.

4.14 *BC ACS Maintenance and Augmentation.* Upon system implementation, these costs are estimated at \$ 100,000 per year. This includes GDBC charges related to this activity (\$50,000 per year). These costs should be wholly offset from fee for service revenues from non-municipal clients. During the first 3 years (i.e. during the project development and implementation), capital costs for system (hardware/software) maintenance are budgeted at \$20,250 plus \$5000 for GDBC support costs. It is assumed that there will be no site rental costs for the first 3 years for the ACS / radio system.

Summary

There is an out of pocket cost to the Province, which must be recovered from the project funders, of about \$ 545,000 (largely in personnel time) in executing the project. At a nominal rate of \$ 60,000 per person per year, this translates to the dedication of three people for three years by the Province. It has been shown previously (and summarized above) that the GVRD stands to directly leverage more than a million dollars worth of hardware, software and expertise from the Province, quite apart from the cost recovery portion. The GVRD and the Province can also capitalize on the CRD project start up, thereby building synergy between the projects (hence reduce costs, etc).

It is recommended that the GVRD help sponsor the project by committing \$ 1.879 million dollars over a three year development and implementation period, starting in early 2000. Through a phased approach, a post-mission system may be delivered by January, 2001, whereas the fully functioning real-time system can be implemented by December, 2002. The Memorandum of Agreement negotiated with the Capital Region District can be used as a model for the GVRD

A.Kassam, P.Eng.
Last update: May 7, 2000

GVRD Project Capital Costs Summary (over 3 years)

Task / Item	Provincial investments Leveraged by GVRD ¹		GVRD equipment, contract services and software costs	GDBC staff costs
	Total	Direct		
On-line MGSR Data Access	\$200,000 +	\$150,000	\$ 12,000	\$ 10,000
Establish Active Control Points (ACPs) in GVRD.	\$ 1 million.	\$150,000	\$ 200,000	\$ 25,000
MGSR ACS Post-Mission Service Delivery	\$ 200,000 +	\$100,000	\$ 12,000	\$20,000
Adoption of NAD83 Datum & UTM Mapping Standards	n/a		n/a	n/a
Client/User/Stakeholder Communications / marketing	significant		\$ 60,000	\$ 20,000
Monument reductions	n/a		\$ 0	\$30,000
Implementation of a Robust, Highly Accurate NAD83 Datum	n/a		\$ 600,000	\$100,000
High Accuracy Geoid Model.	n/a		\$ 20,000	\$ 20,000
Vertical Readjustment & new Vertical Datum Adopt	\$ 100,000 +	\$50,000	\$ 40,000	\$ 240,000
Implementation of MGSR ACS Real-Time Kinematic (RTK) Service.	\$ 100,000 +	\$ 50,000	\$ 285,000	\$ 30,000
Development of MGSR ACS Geo-Positioning Standards	n/a		\$ 25,000	\$ 20,000
Testing, Demonstration and Application Pilots	n/a		\$ 60,000	\$ 20,000
Integrated Survey Area (ISA) Regulations Revision	n/a		\$ 0	\$ 5,000
System maintenance and Augmentation	significant		\$ 20,250	\$ 4,750
Sub-Totals:	\$ 1.6 million+	\$500,000+	\$ 1,334,250	\$ 544,750
TOTAL GVRD Project Capital Costs:			\$ 1,334,250 + \$ 544,750 = \$ 1,879,000	

¹ Total leveraging includes both direct and indirect benefits to GVRD. Direct leveraging relates to the direct project costs that would be incurred, at a minimum, without Provincial participation.

APPENDIX D

8.0% Discount rate

Time zero	year 1	2	3	4	5	6	7	8	9	10
1.000	0.926	0.857	0.794	0.735	0.681	0.630	0.583	0.540	0.500	0.463

INTERNAL TANGIBLE COSTS

	Time zero	year 1	2	3	4	5	6	7	8	9	10
Capital Costs (Installation)	1,879,000										
Operating Costs-administration											
Maintenance		0	12,825	12,825	100,000	100,000	100,000	125,000	125,000	150,000	150,000
TOTAL INTERNAL TANGIBLE COSTS	1,879,000	0	12,825	12,825	100,000	100,000	100,000	125,000	125,000	150,000	150,000

INTERNAL TANGIBLE BENEFITS

	year 1	2	3	4	5	6	7	8	9	10
Maintain Monuments	250,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Network Maintenance and Data management	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Total	400,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000

"TOTAL IMPACT" BENEFITS AND COSTS

	year 1	2	3	4	5	6	7	8	9	10
Customer Service Benefits										
Quality										
Reliability										
Safety/Value of Life										
Total	0	0	0	0	0	0	0	0	0	0
Environmental Benefits										
Air Quality Treatment										
Water Quality Treatment										
Total	0	0	0	0	0	0	0	0	0	0
Social Benefits										
Public Image										
Economic Development										
Total	0	0	0	0	0	0	0	0	0	0
TOTAL BENEFITS	\$100,000	\$450,000	\$450,000	\$450,000	\$450,000	\$450,000	\$450,000	\$450,000	\$450,000	\$450,000

"Total Impact" B/C Ratio 1.24
 "Total Impact" Net Present Value \$583,830

Internal tangible B/C ratio 1.24
 Internal tangible Net Present Value \$583,830

Financial Payback in years 4.73
 Internal Rate of Return 15.01%